

jBPM Documentation

The JBoss jBPM team [<http://www.jbpm.org/community/team.html>]

jBPM Documentation

by

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.....	xi
I. Getting Started	1
1. Overview	2
1.1. What is jBPM?	2
1.2. Overview	4
1.3. Core Engine	5
1.4. Process Designer	6
1.5. Data Modeler	6
1.6. Form Modeler	7
1.7. Process Instance and Task Management	8
1.8. Business Activity Monitoring	8
1.9. Workbench	10
1.10. Eclipse Developer Tools	10
2. Getting Started	12
2.1. Downloads	12
2.2. Getting Started	12
2.3. Community	12
2.4. Sources	13
2.4.1. License	13
2.4.2. Source code	13
2.4.3. Building from source	14
2.5. Getting Involved	14
2.5.1. Sign up to jboss.org	14
2.5.2. Sign the Contributor Agreement	15
2.5.3. Submitting issues via JIRA	15
2.5.4. Fork GitHub	16
2.5.5. Writing Tests	16
2.5.6. Commit with Correct Conventions	18
2.5.7. Submit Pull Requests	19
2.6. What to do if I encounter problems or have questions?	21
3. jBPM Installer	22
3.1. Prerequisites	22
3.2. Downloading the Installer	22
3.3. Demo Setup	22
3.4. 10-Minute Tutorial using the Workbench	25
3.5. 10-Minute Tutorial using Eclipse	27
3.6. Configuration	28
3.6.1. Playgrounds	28
3.6.2. Workbench Authentication	29
3.6.3. Using your own database with the jBPM installer	30
3.6.4. jBPM database schema scripts (DDL scripts)	37
3.6.5. jBPM installer script	37
3.7. Frequently Asked Questions	38
4. Examples	40

4.1. Introduction	40
4.2. Human Resources Example	40
4.2.1. The KIE Project: human-resources	42
4.2.2. Building the Human Resources Example	43
4.2.3. Create a new Process Instance	45
4.3. Examples zip	46
II. jBPM Core	47
5. Core Engine API	48
5.1. Overview	48
5.2. KieBase	49
5.3. KieSession	50
5.3.1. ProcessRuntime	50
5.3.2. Event Listeners	52
5.3.3. Correlation Keys	54
5.3.4. Threads	55
5.4. RuntimeManager	56
5.4.1. Overview	56
5.4.2. Strategies	58
5.4.3. Usage	60
5.4.4. Configuration	62
5.5. Services	69
5.5.1. Deployment Service	70
5.5.2. Definition Service	71
5.5.3. Process Service	72
5.5.4. Runtime Data Service	74
5.5.5. User Task Service	77
5.5.6. Working with deployments	78
5.6. Configuration	80
6. Processes	84
6.1. What is BPMN 2.0	84
6.2. Process	89
6.2.1. Creating a process	89
6.3. Activities	94
6.3.1. Script task	94
6.3.2. Service task	96
6.3.3. User task	97
6.3.4. Reusable sub-process	99
6.3.5. Business rule task	100
6.3.6. Embedded sub-process	101
6.3.7. Multi-instance sub-process	102
6.4. Events	103
6.4.1. Start event	103
6.4.2. End events	104
6.4.3. Intermediate events	106

6.5. Gateways	109
6.5.1. Diverging gateway	109
6.5.2. Converging gateway	111
6.6. Others	112
6.6.1. Variables	112
6.6.2. Scripts	114
6.6.3. Constraints	115
6.6.4. Timers	116
6.7. Process Fluent API	118
6.7.1. Example	118
6.8. Testing	119
6.8.1. Unit testing	119
7. Human Tasks	126
7.1. Introduction	126
7.2. Using User Tasks in our Processes	126
7.2.1. Swimlanes	128
7.3. Data Mappings	129
7.4. Task Lifecycle	131
7.5. Task Permissions	132
7.5.1. Task Permissions Matrix	132
7.6. Task Service and The Process Engine	134
7.7. Task Service API	135
7.8. Interacting with the Task Service	136
8. Persistence and Transactions	138
8.1. Process Instance State	138
8.1.1. Runtime State	138
8.2. Audit Log	143
8.2.1. The jBPM Audit data model	143
8.2.2. Storing Process Events in a Database	146
8.2.3. Storing Process Events in a JMS queue for further processing	148
8.2.4. Variables auditing	148
8.3. Transactions	152
8.3.1. Container managed transactions	153
8.4. Configuration	155
8.4.1. Adding dependencies	155
8.4.2. Manually configuring the engine to use persistence	156
8.4.3. Configuring the engine to use persistence using <code>JBPMHelper</code> - for tests only	158
III. Workbench	161
9. Workbench	162
9.1. Installation	162
9.1.1. War installation	162
9.1.2. Workbench data	162
9.1.3. System properties	163

9.1.4. Trouble shooting	164
9.2. Quick Start	165
9.2.1. Add repository	165
9.2.2. Add project	167
9.2.3. Define Data Model	171
9.2.4. Define Rule	174
9.2.5. Build and Deploy	177
9.3. Administration	178
9.3.1. Administration overview	178
9.3.2. Organizational unit	178
9.3.3. Repositories	179
9.4. Configuration	181
9.4.1. User management	181
9.4.2. Roles	181
9.4.3. Restricting access to repositories	183
9.4.4. Command line config tool	183
9.5. Introduction	184
9.5.1. Log in and log out	184
9.5.2. Home screen	185
9.5.3. Workbench concepts	185
9.5.4. Initial layout	185
9.6. Changing the layout	186
9.6.1. Resizing	187
9.6.2. Repositioning	187
9.7. Authoring	189
9.7.1. Artifact Repository	189
9.7.2. Asset Editor	191
9.7.3. Tags Editor	195
9.7.4. Project Explorer	197
9.7.5. Project Editor	210
9.7.6. Validation	217
9.7.7. Data Modeller	219
9.7.8. Data Sets	259
9.8. Embedding Workbench In Your Application	273
9.9. Asset Management	274
9.9.1. Asset Management Overview	274
9.9.2. Managed vs Unmanaged Repositories	274
9.9.3. Asset Management Processes	274
9.9.4. Usage Flow	276
9.9.5. Repository Structure	278
9.9.6. Managed Repositories Operations	279
9.9.7. Remote APIs	285
10. Workbench Integration	286
10.1. REST	286

10.1.1. Job calls	286
10.1.2. Repository calls	287
10.1.3. Organizational unit calls	290
10.1.4. Maven calls	291
10.1.5. REST summary	292
11. Workbench High Availability	294
11.1.	294
11.1.1. VFS clustering	294
11.1.2. jBPM clustering	297
12. Designer	298
12.1. Designer UI Explained	299
12.2. Getting started with Modelling	300
12.3. Designer Toolbar	304
13. Forms	326
13.1. Configure process and human tasks	328
13.2. Generate forms from task definitions	330
13.3. Edit forms	333
13.3.1. Form generated description	333
13.3.2. Customizing form	333
13.3.3. Field types	361
13.4. Document attachments	370
13.4.1. Process and forms configuration	370
13.4.2. Marshalling strategy and deployment configuration	372
13.5. Using forms on client applications	375
13.5.1. What does the API provides?	375
13.5.2. Sample usage	377
14. Runtime Management	382
14.1. Deployments	382
14.1.1. Deployment descriptors	382
14.2. Process Deployments	391
14.3. Jobs	393
15. Process and Task Management	396
15.1. Process Management	396
15.1.1. Process Definitions	396
15.1.2. Process Instances	399
15.2. Tasks	407
15.2.1. Task List	408
15.2.2. New Task (Ad-Hoc Task)	414
16. Business Activity Monitoring	417
16.1. Overview	417
16.2. Business Dashboards	418
16.3. Process Dashboard	420
16.3.1. Task Dashboard	424
17. Remote API	426

17.1. Remote Java API	426
17.1.1. Remote REST Java API Client Configuration	428
17.1.2. Remote JMS Java API Client Configuration	430
17.1.3. Remote CommandWebService Java API Client Configuration	437
17.1.4. Supported methods	441
17.2. REST	452
17.2.1. REST permissions	453
17.2.2. Runtime calls	460
17.2.3. Task calls	468
17.2.4. Deployment Calls	472
17.2.5. Deployment call details	474
17.2.6. Execute calls	476
17.2.7. REST summary	482
17.3. REST Query API	488
17.3.1. Query URL layout	488
17.3.2. Query Parameters	490
17.3.3. Parameter Table	493
17.3.4. Parameter examples	496
17.3.5. Query Output Format	497
17.4. JMS	498
17.4.1. JMS Queue setup	499
17.4.2. Using the remote Java API	499
17.4.3. Example JMS usage	500
17.5. Additional Information	505
17.5.1. REST Serialization: JAXB or JSON	505
17.5.2. Sending and receiving user class instances	505
17.5.3. Including the deployment id	507
17.5.4. REST Pagination	508
17.5.5. REST Map query parameters	514
17.5.6. REST Number query parameters	515
17.5.7. Runtime strategies	515
IV. Eclipse	518
18. jBPM Eclipse Plugin	519
18.1. jBPM Eclipse Plugin	519
18.1.1. Installation	519
18.1.2. jBPM Project Wizard	521
18.1.3. New BPMN2 Process Wizard	524
18.1.4. jBPM Runtime	524
18.1.5. jBPM Maven Project Wizard	528
18.1.6. Drools Eclipse plugin	531
18.2. Debugging	531
18.2.1. The Process Instances View	532
18.2.2. The Audit View	533
18.3. Synchronizing with Workbench Repositories	534

18.3.1. Importing a workbench repository	534
18.3.2. Committing changes to the workbench	537
18.3.3. Updating from to the workbench	539
18.3.4. Working on individual projects	541
19. Eclipse BPMN 2.0 Modeler	545
19.1. Overview	545
19.2. Installation	545
19.3. Documentation	546
V. Integration	549
20. Integration	550
20.1. Maven	550
20.1.1. Maven artifacts as deployment units	550
20.1.2. Use Maven for dependency management	552
20.2. CDI	554
20.2.1. Overview	554
20.2.2. Configuring CDI integration	558
20.2.3. RuntimeManager as CDI bean	561
20.3. Spring	563
20.3.1. Direct use of Runtime Manager API	564
20.3.2. jBPM services with Spring	568
20.4. Ejb	571
20.4.1. Ejb services implementation	572
20.4.2. Local interface	574
20.4.3. Remote interface	575
20.5. OSGi	578
VI. Advanced Topics	579
21. Domain-specific Processes	580
21.1. Introduction	580
21.2. Overview	581
21.2.1. Work Item Definitions	581
21.2.2. Work Item Handlers	581
21.3. Example: Notifications	583
21.3.1. The Notification Work Item Definition	584
21.3.2. The <code>NotificationWorkItemHandler</code>	589
21.4. Service Repository	591
21.4.1. Public jBPM service repository	593
21.4.2. Setting up your own service repository	593
22. Exception Management	596
22.1. Overview	596
22.2. Introduction	596
22.3.	596
22.3.1. Technical Exceptions	596
22.3.2. Technical Exception Examples	599
22.4.	607

22.4.1. Business Exceptions	608
23. Flexible Processes	611
24. Concurrency and asynchronous execution	614
24.1. Concurrency	614
24.1.1. Engine execution	614
24.1.2. Multiple knowledge sessions and persistence	615
24.2. Asynchronous execution	616
24.2.1. Asynchronous handlers	616
24.2.2. jbpm executor	616
25. Release Notes	623
25.1. jBPM 6.4	623
25.1.1. New and Noteworthy in jBPM 6.4.0	623
25.1.2. New and Noteworthy in KIE Workbench 6.4.0	626
25.2. jBPM 6.3	631
25.2.1. New and Noteworthy in jBPM 6.3.0	631
25.2.2. New and Noteworthy in KIE Workbench 6.3.0	639
25.3. jBPM 6.2	646
25.3.1. New and Noteworthy in jBPM 6.2.0	646
25.3.2. New and Noteworthy in KIE Workbench 6.2.0	649
25.4. jBPM 6.1	669
25.4.1. New and Noteworthy in jBPM 6.1.0	669
25.4.2. New and Noteworthy in KIE Workbench 6.1.0	671
25.5. jBPM 6.0	673
25.5.1. New and Noteworthy in KIE API 6.0.0	673
25.5.2. New and Noteworthy in jBPM 6.0.0	677
25.5.3. New and Noteworthy in KIE Workbench 6.0.0	680
25.5.4. New and Noteworthy in Integration 6.0.0	683



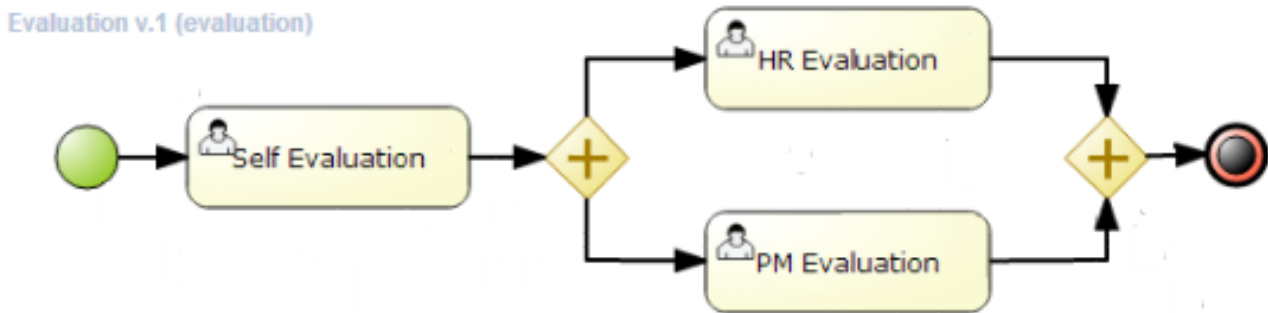
Part I. Getting Started

Introduction and getting started with jBPM

Chapter 1. Overview

1.1. What is jBPM?

jBPM is a flexible Business Process Management (BPM) Suite. It is light-weight, fully open-source (distributed under Apache license) and written in Java. It allows you to model, execute, and monitor business processes throughout their life cycle.



A business process allows you to model your business goals by describing the steps that need to be executed to achieve those goals, and the order of those goals are depicted using a flow chart. This process greatly improves the visibility and agility of your business logic. jBPM focuses on executable business processes, which are business processes that contain enough detail so they can actually be executed on a BPM engine. Executable business processes bridge the gap between business users and developers as they are higher-level and use domain-specific concepts that are understood by business users but can also be executed directly.

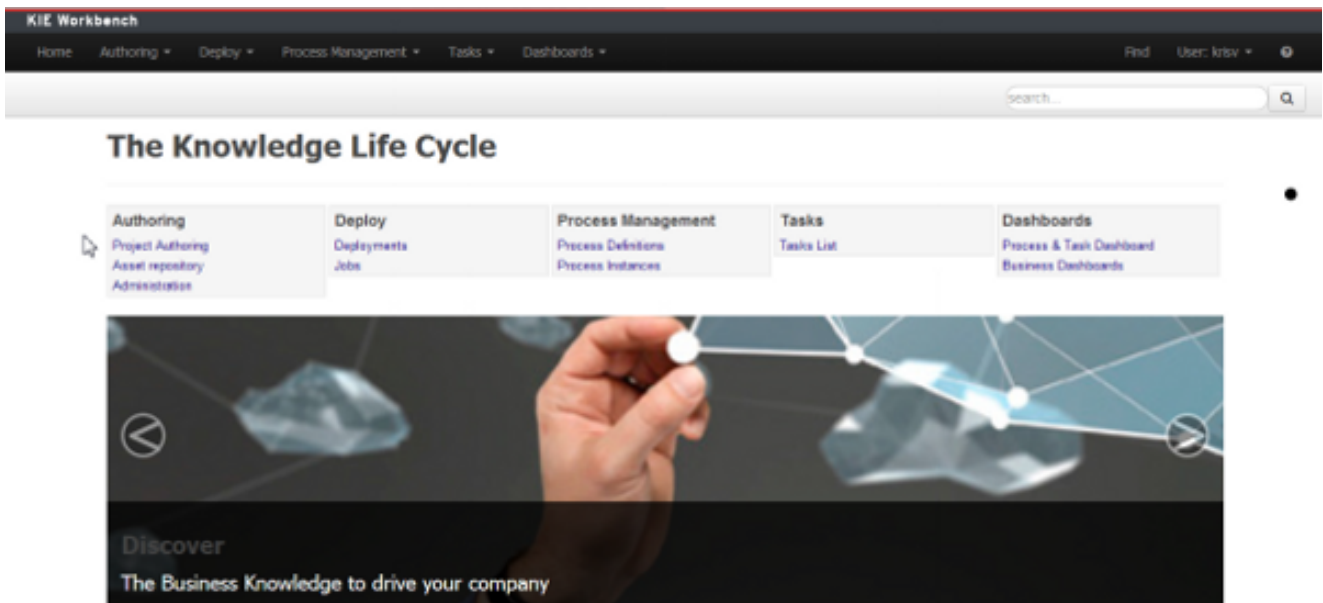
Business processes need to be supported throughout their entire life cycle: authoring, deployment, process management and task lists, and dashboards and reporting.

The core of jBPM is a light-weight, extensible workflow engine written in pure Java that allows you to execute business processes using the latest BPMN 2.0 specification. It can run in any Java environment, embedded in your application or as a service.

On top of the core engine, a lot of features and tools are offered to support business processes throughout their entire life cycle:

- Pluggable human task service based on WS-HumanTask for including tasks that need to be performed by human actors.
- Pluggable persistence and transactions (based on JPA / JTA).
- Web-based process designer to support the graphical creation and simulation of your business processes (drag and drop).
- Web-based data modeler and form modeler to support the creation of data models and process and task forms

- Web-based, customizable dashboards and reporting
- All combined in one web-based workbench, supporting the complete BPM life cycle:
 - Modeling and deployment - author your processes, rules, data models, forms and other assets
 - Execution - execute processes, tasks, rules and events on the core runtime engine
 - Runtime Management - work on assigned task, manage process instances, etc
 - Reporting - keep track of the execution using Business Activity Monitoring capabilities



- Eclipse-based developer tools to support the modeling, testing and debugging of processes
- Remote API to process engine as a service (REST, JMS, Remote Java API)
- Integration with Maven, Spring, OSGi, etc.

BPM creates the bridge between business analysts, developers and end users by offering process management features and tools in a way that both business users and developers like. Domain-specific nodes can be plugged into the palette, making the processes more easily understood by business users.

jBPM supports adaptive and dynamic processes that require flexibility to model complex, real-life situations that cannot easily be described using a rigid process. We bring control back to the end users by allowing them to control which parts of the process should be executed; this allows dynamic deviation from the process.

jBPM is not just an isolated process engine. Complex business logic can be modeled as a combination of business processes with business rules and complex event processing. jBPM can be combined with the Drools project to support one unified environment that integrates these paradigms where you model your business logic as a combination of processes, rules and events.

1.2. Overview

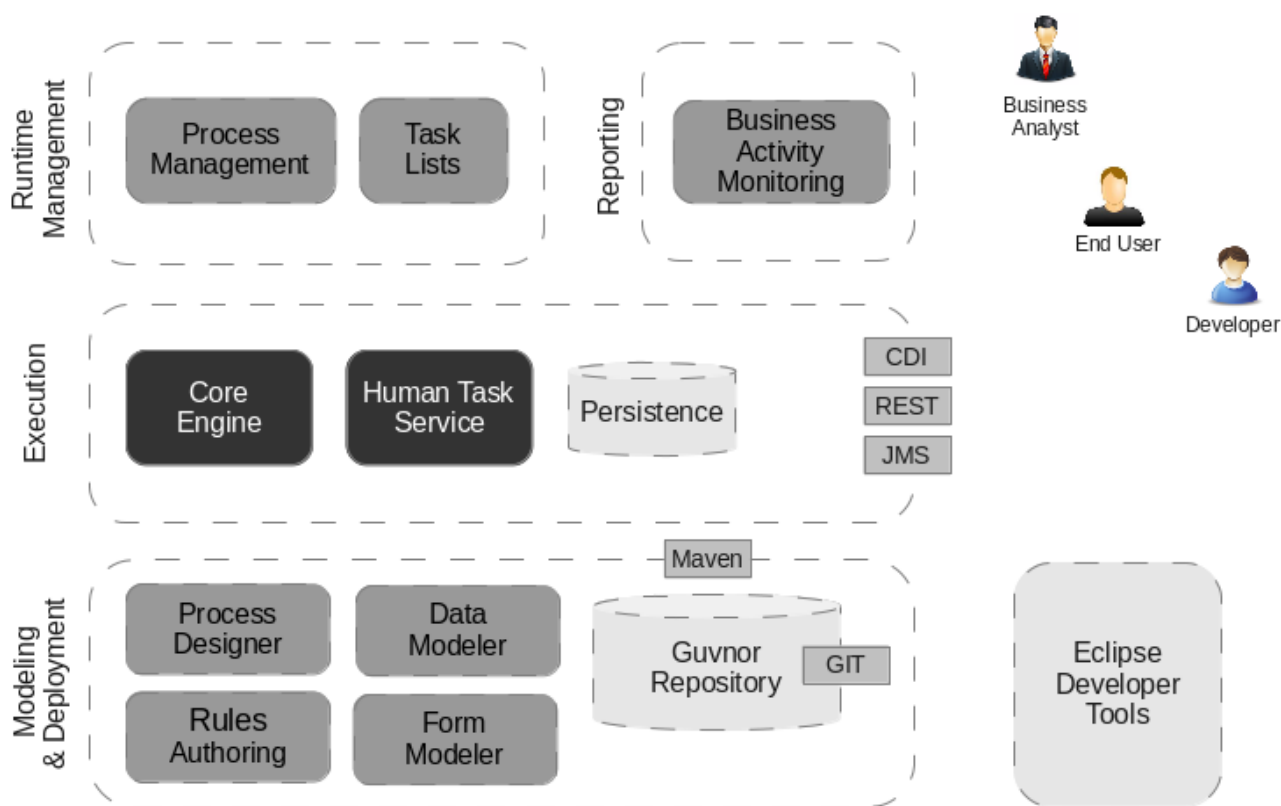


Figure 1.1.

This figure gives an overview of the different components of the jBPM project.

- The core engine is the heart of the project and allows you to execute business processes in a flexible manner. It is a pure Java component that you can choose to embed as part of your application or deploy it as a service and connect to it through the web-based UI or remote APIs.
 - An optional core service is the human task service that will take care of the human task life cycle if human actors participate in the process.
 - Another optional core service is runtime persistence; this will persist the state of all your process instances and log audit information about everything that is happening at runtime.
 - Applications can connect to the core engine by through its Java API or as a set of CDI services, but also remotely through a REST and JMS API.
- Web-based tools allows you to model, simulate and deploy your processes and other related artifacts (like data models, forms, rules, etc.):
 - The process designer allows business users to design and simulate business processes in a web-based environment.

- The data modeler allows non-technical users to view, modify and create data models for use in your processes.
- A web-based form modeler also allows you to create, generate or edit forms related to your processes (to start the process or to complete one of the user tasks).
- Rule authoring allows you to specify different types of business rules (decision tables, guided rules, etc.) for combination with your processes.
- All assets are stored and managed on the Guvnor repository (exposed through Git) and can be managed (versioning), built and deployed.
- The web-based management console allows business users to manage their runtime (manage business processes like start new processes, inspect running instances, etc.), to manage their task list and to perform Business Activity Monitoring (BAM) and see reports.
- The Eclipse-based developer tools are an extension to the Eclipse IDE, targeted towards developers, and allows you to create business processes using drag and drop, test and debug your processes, etc.

Each of the components are described in more detail below.

1.3. Core Engine

The core jBPM engine is the heart of the project. It's a light-weight workflow engine that executes your business processes. It can be embedded as part of your application or deployed as a service (possibly on the cloud). Its most important features are the following:

- Solid, stable core engine for executing your process instances.
- Native support for the latest BPMN 2.0 specification for modeling and executing business processes.
- Strong focus on performance and scalability.
- Light-weight (can be deployed on almost any device that supports a simple Java Runtime Environment; does not require any web container at all).
- (Optional) pluggable persistence with a default JPA implementation.
- Pluggable transaction support with a default JTA implementation.
- Implemented as a generic process engine, so it can be extended to support new node types or other process languages.
- Listeners to be notified of various events.
- Ability to migrate running process instances to a new version of their process definition

The core engine can also be integrated with a few other (independent) core services:

- The human task service can be used to manage human tasks when human actors need to participate in the process. It is fully pluggable and the default implementation is based on the WS-HumanTask specification and manages the life cycle of the tasks, task lists, task forms, and some more advanced features like escalation, delegation, rule-based assignments, etc.
- The history log can store all information about the execution of all the processes in the engine. This is necessary if you need access to historic information as runtime persistence only stores the current state of all active process instances. The history log can be used to store all current and historic states of active and completed process instances. It can be used to query for any information related to the execution of process instances, for monitoring, analysis, etc.

1.4. Process Designer

The web-based designer allows you to model your business processes in a web-based environment. It is targeted towards business users and offers a graphical editor for viewing and editing your business processes (using drag and drop), similar to the Eclipse plugin. It supports round-tripping between the Eclipse editor and the web-based designer. It also supports simulation of processes.

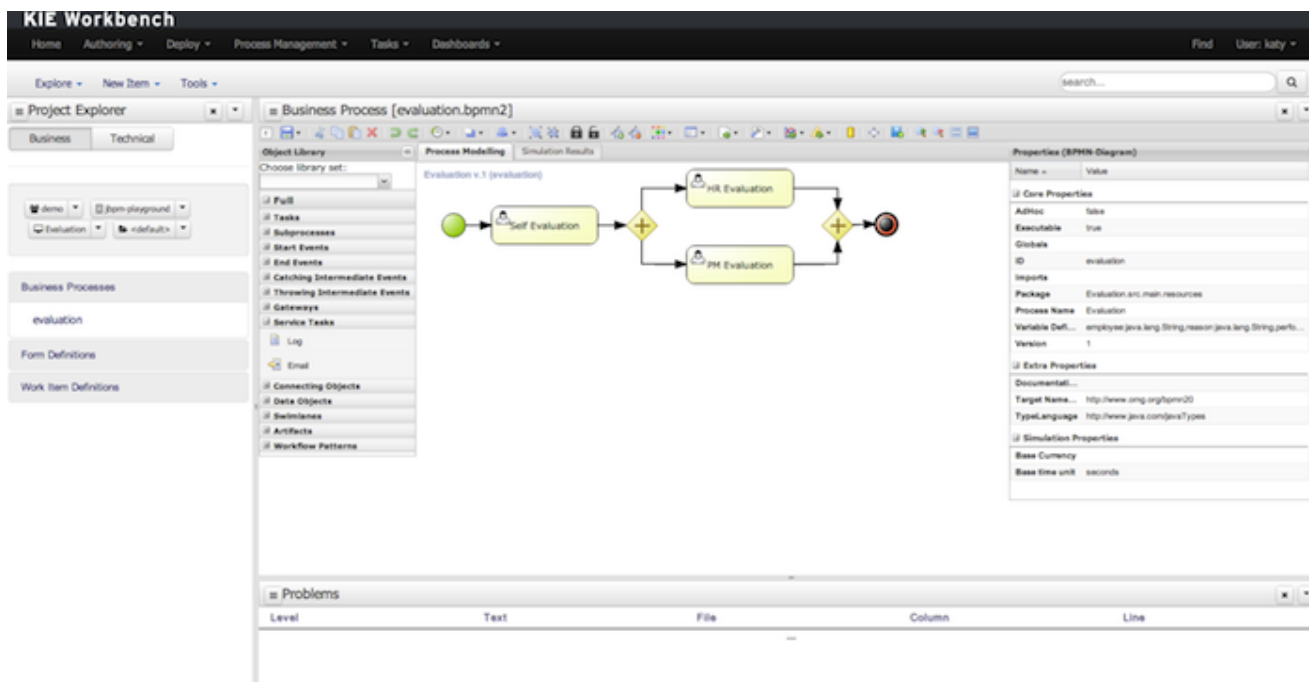


Figure 1.2. Web-based designer for creating BPMN2 processes

1.5. Data Modeler

Processes almost always have some kind of data to work with. The data modeler allows non-technical users to view, edit or create these data models.

Typically, a business process analyst or data analyst will capture the requirements for a process or application and turn these into a formal set of interrelated data structures. The new Data Modeler tool provides an easy, straightforward and visual aid for building both logical and physical data models, without the need for advanced development skills or explicit coding. The data modelers is transparently integrate into the workbench. Its main goals are to make data models into first class citizens in the process improvement cycle and allow for full process automation through the integrated use of data structures (and the forms that will be used to interact with them).

1.6. Form Modeler

The jBPM Form Modeler is a form engine and editor that enables users to create forms to capture and display information during process or task execution, without needing any coding or template markup skills.

It provides a WYSIWYG environment to model forms that it's easy to use for less technical users.

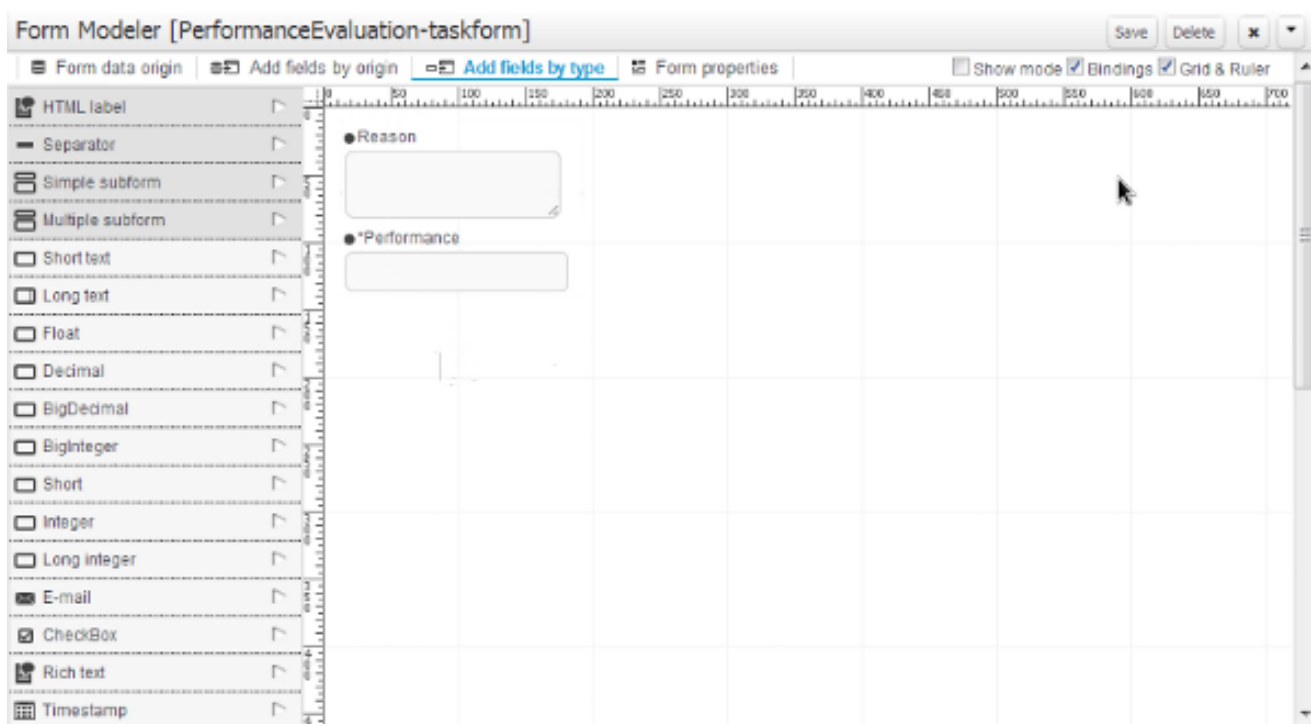


Figure 1.3. Form Modeler

Key features:

- Form Modeling WYSIWYG UI for forms
- Form autogeneration from data model / Java objects
- Data binding for Java objects

- Formula and expressions
- Customized forms layouts
- Forms embedding

The form modeler's user interfaces is aimed both at process analyst and developers for building and testing forms.

Developers or advanced users will also have some advanced features to customize form behavior and look&feel.

1.7. Process Instance and Task Management

Business processes can be managed through a web-based management console. It is targeted towards business users and its main features are the following:

- Process instance management: the ability to start new process instances, get a list of running process instances, visually inspect the state of a specific process instances.
- Human task management: being able to get a list of all your current tasks (either assigned to you or that you might be able to claim), and completing tasks on your task list (using customizable task forms).

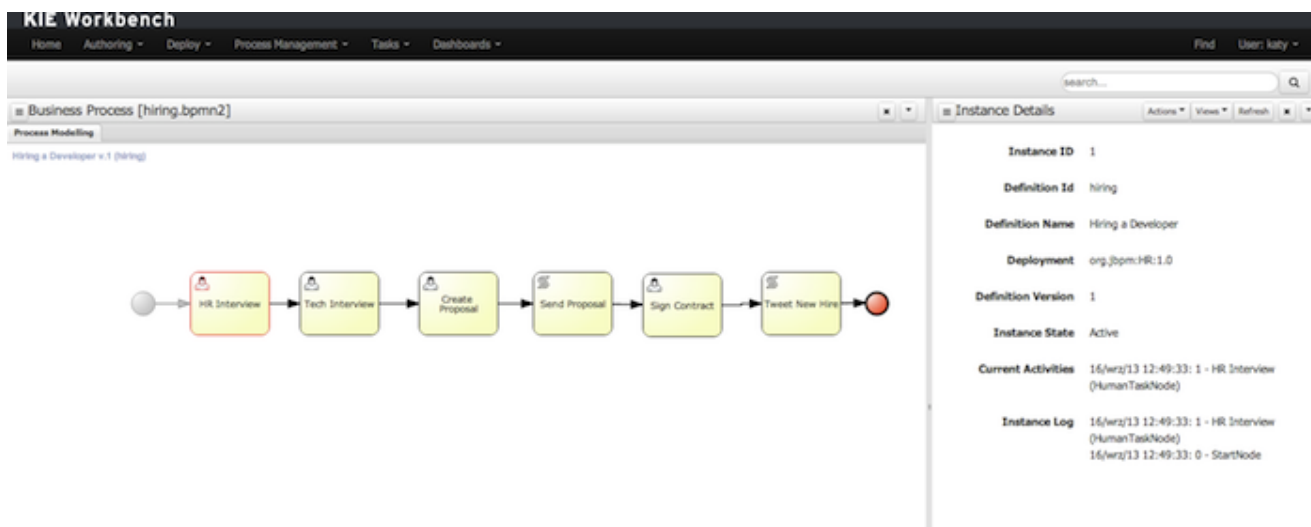


Figure 1.4. Managing your process instances

1.8. Business Activity Monitoring

As of version 6.0, jBPM comes with a full-featured BAM tooling which allows non-technical users to visually compose business dashboards. With this brand new module, to develop business activity monitoring and reporting solutions on top of jBPM has never been so easy!

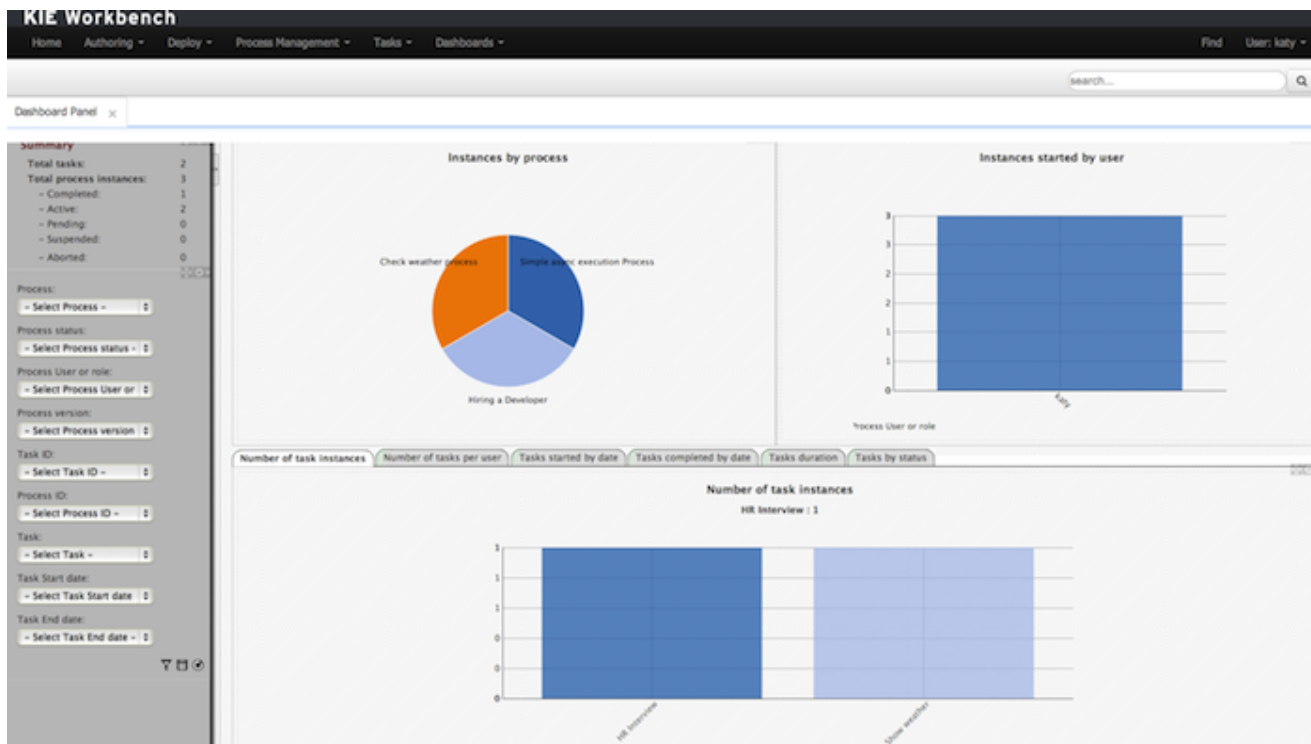


Figure 1.5. Business Activity Monitoring

Key features:

- Visual configuration of dashboards (Drag'n'drop).
- Graphical representation of KPIs (Key Performance Indicators).
- Configuration of interactive report tables.
- Data export to Excel and CSV format.
- Filtering and search, both in-memory or SQL based.
- Data extraction from external systems, through different protocols.
- Granular access control for different user profiles.
- Look'n'feel customization tools.
- Pluggable chart library architecture.
- Chart libraries provided: NVD3 & OFC2.

Target users:

- Managers / Business owners. Consumer of dashboards and reports.
- IT / System architects. Connectivity and data extraction.
- Analysts. Dashboard composition & configuration.

To get further information about the new and noteworthy BAM capabilities of jBPM please read the chapter Business Activity Monitoring.

1.9. Workbench

The workbench is the web-based application that combines all of the above web-based tools into one configurable solution.

It supports the following:

- A repository service to store your business processes and related artefacts, using a Git repository, which supports versioning, remote accessing (as a file system), and using REST services.
- A web-based user interface to manage your business processes, targeted towards business users; it also supports the visualization (and editing) of your artifacts (the web-based editors like designer, data and form modeler are integrated here), but also categorisation, build and deployment, etc..
- Collaboration features to have multiple actors (for example business users and developers) work together on the same project.

Workbench application covers complete life cycle of BPM projects starting at authoring phase, going through implementation, execution and monitoring.

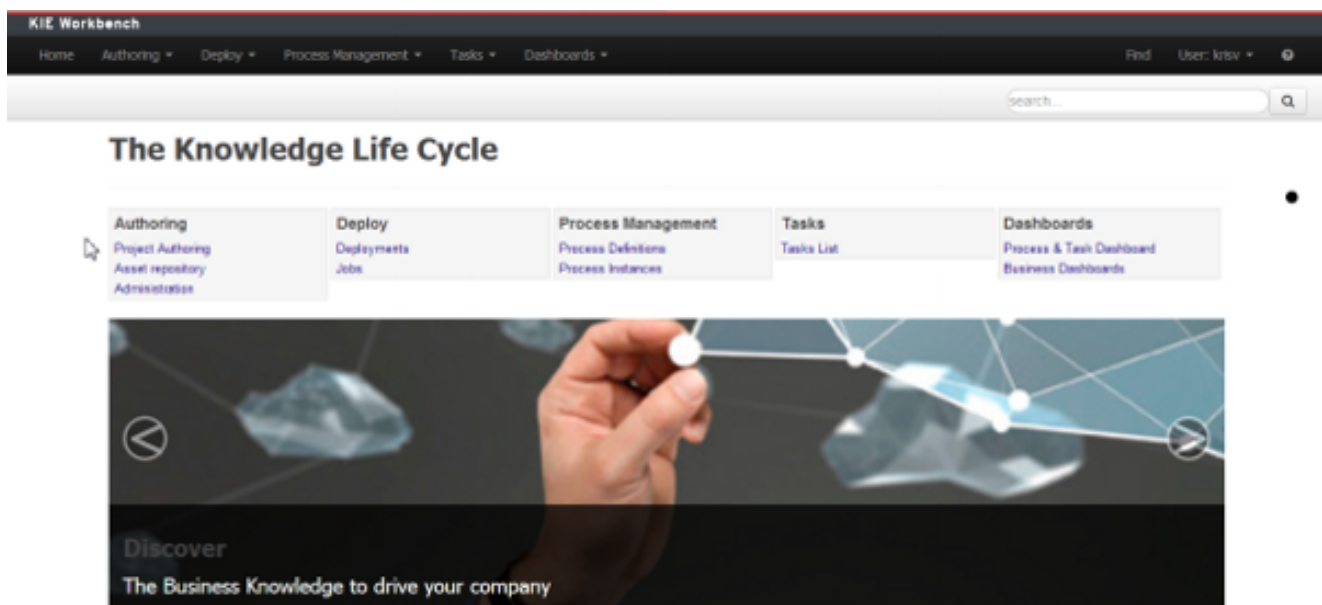


Figure 1.6. KIE workbench application

1.10. Eclipse Developer Tools

The Eclipse-based tools are a set of plugins to the Eclipse IDE and allow you to integrate your business processes in your development environment. It is targeted towards developers and has some wizards to get started, a graphical editor for creating your business processes (using drag and drop) and a lot of advanced testing and debugging capabilities.

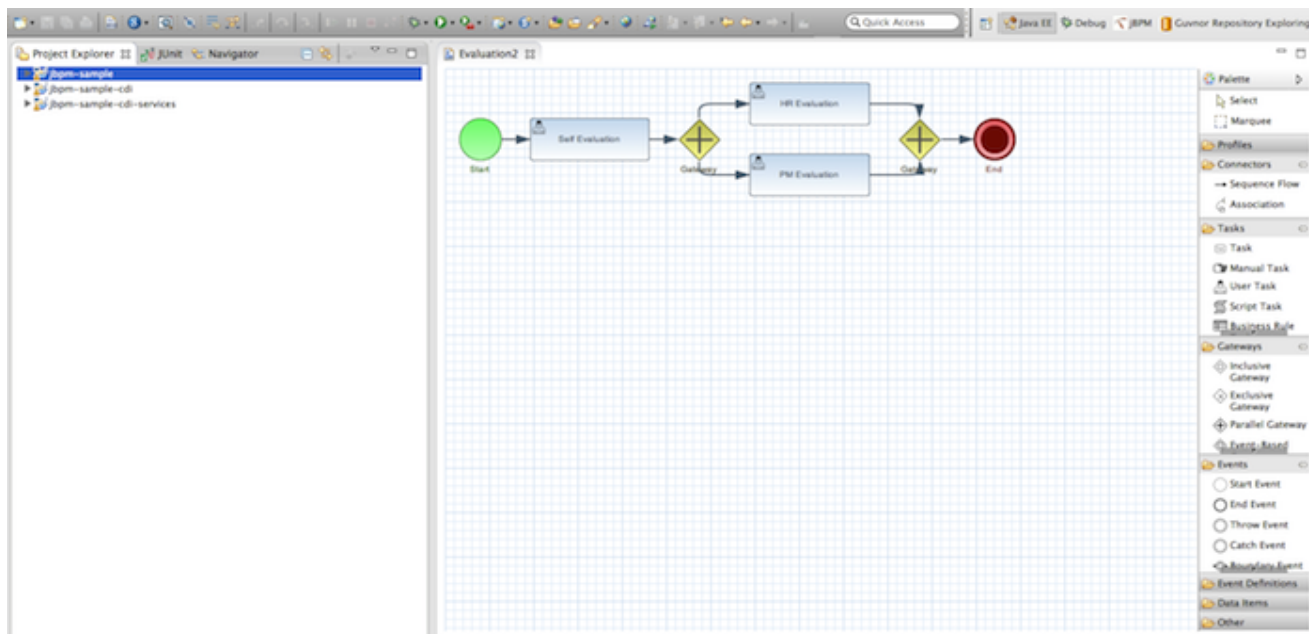


Figure 1.7. Eclipse editor for creating BPMN2 processes

It includes the following features:

- Wizard for creating a new jBPM project
- A graphical editor for BPMN 2.0 processes
- The ability to plug in your own domain-specific nodes
- Validation
- Runtime support (so you can select which version of jBPM you would like to use)
- Graphical debugging to see all running process instances of a selected session, to visualize the current state of one specific process instance, etc.

Chapter 2. Getting Started

2.1. Downloads

All releases can be downloaded from SourceForge [<https://sourceforge.net/projects/jbpm/files/>]. Select the version you want to download and then select which artifact you want:

- bin: all the jBPM binaries (JARs) and their dependencies
- src: the sources of the core components
- docs: the documentation
- examples: some jBPM examples, can be imported into Eclipse
- installer: the jbpm-installer, downloads and installs a demo setup of jBPM
- installer-full: the jbpm-installer, downloads and installs a demo setup of jBPM, already contains a number of dependencies prepackages (so they don't need to be downloaded separately)

2.2. Getting Started

If you like to take a quick tutorial that will guide you through most of the components using a simple example, take a look at the Installer chapter. This will teach you how to download and use the installer to create a demo setup, including most of the components. It uses a simple example to guide you through the most important features. Screenshots are available to help you out as well.

If you like to read more information first, the following chapters first focus on the core engine (API, BPMN 2.0, etc.). Further chapters will then describe the other components and other more complex topics like domain-specific processes, flexible processes, etc. After reading the core chapters, you should be able to jump to other chapters that you might find interesting.

You can also start playing around with some examples that are offered in a separate download. Check out the examples chapter to see how to start playing with these.

After reading through these chapters, you should be ready to start creating your own processes and integrate the engine with your application. These processes can be started from the installer or be started from scratch.

2.3. Community

Here are a lot of useful links part of the jBPM community:

- A feed of blog entries [<http://planet.jboss.org/view/feed.seam?name=jbossjbpm>] related to jBPM

- The #jbossjbpm Twitter account [<http://twitter.com/jbossjbpm>].
- A user forum [<http://www.jboss.com/index.html?module=bb&op=viewforum&f=217>] for asking questions and giving answers
- A JIRA bug tracking system [<https://jira.jboss.org/jira/browse/JBPM>] for bugs, feature requests and roadmap
- A continuous build server [<https://hudson.jboss.org/hudson/job/jBPM/>] for getting the latest snapshots [<https://hudson.jboss.org/hudson/job/jBPM/lastSuccessfulBuild/artifact/jbpm-distribution/target/>]

Please feel free to join us in our IRC channel at [#jbp](http://chat.freenode.net)m. This is where most of the real-time discussion about the project takes place and where you can find most of the developers most of their time as well. Don't have an IRC client installed? Simply go to <http://webchat.freenode.net/>, input your desired nickname, and specify #jbpm. Then click login to join the fun.

2.4. Sources

2.4.1. License

The jBPM code itself is using the Apache License v2.0.

Some other components we integrate with have their own license:

- The new Eclipse BPMN2 plugin is Eclipse Public License (EPL) v1.0.
- The web-based designer is based on Oryx/Wapama and is MIT License
- The Drools project is Apache License v2.0.

2.4.2. Source code

jBPM now uses git for its source code version control system. The sources of the jBPM project can be found here (including all releases starting from jBPM 5.0-CR1):

<https://github.com/droolsjbpm/jbpm>

The source of some of the other components we integrate with can be found here:

- Other components related to the jBPM and Drools project can be found here [<https://github.com/droolsjbpm>].
- The new Eclipse BPMN2 plugin can be found here [<https://git.eclipse.org/c/bpmn2-modeler/org.eclipse.bpmn2-modeler.git>].

- The web-based designer can be found here [<https://github.com/droolsjbpm/jbpm-designer>]
- The kie workbench can be found here [<https://github.com/droolsjbpm/kie-wb-distribution-wars>] note this is an aggregate of other projects (drools-wb, jbpm-console-ng)

2.4.3. Building from source

If you're interested in building the source code, contributing, releasing, etc. make sure to read this README [<https://github.com/droolsjbpm/droolsjbpm-build-bootstrap/blob/master/README.md>].

2.5. Getting Involved

We are often asked "How do I get involved". Luckily the answer is simple, just write some code and submit it :) There are no hoops you have to jump through or secret handshakes. We have a very minimal "overhead" that we do request to allow for scalable project development. Below we provide a general overview of the tools and "workflow" we request, along with some general advice.

If you contribute some good work, don't forget to blog about it :)

2.5.1. Sign up to jboss.org

Signing to jboss.org will give you access to the JBoss wiki, forums and JIRA. Go to <http://www.jboss.org/> and click "Register".



2.5.2. Sign the Contributor Agreement

The only form you need to sign is the contributor agreement, which is fully automated via the web. As the image below says "This establishes the terms and conditions for your contributions and ensures that source code can be licensed appropriately"

<https://cla.jboss.org/>

Sign CLA

If you've submitted a patch that's been accepted, or been offered an invitation to commit directly into a project's source code repository, then please login using your [jboss.org](#) user account and sign an [Individual](#) or [Corporate](#) Contributor License Agreement (CLA).

This establishes the terms and conditions for your contributions and ensures that the source code can be licensed appropriately.

Username:

Password:



Do not sign a CLA unless you've met the conditions above.

This helps to keep our systems tidy and prevents project leads from reviewing unnecessary agreements.

2.5.3. Submitting issues via JIRA

To be able to interact with the core development team you will need to use JIRA, the issue tracker. This ensures that all requests are logged and allocated to a release schedule and all discussions captured in one place. Bug reports, bug fixes, feature requests and feature submissions should all go here. General questions should be undertaken at the mailing lists.


Minor code submissions, like format or documentation fixes do not need an associated JIRA issue created.

<https://issues.jboss.org/browse/JBRULES> [<https://issues.jboss.org/browse/JBRULES>](Drools)

<https://issues.jboss.org/browse/JBPM>

<https://issues.jboss.org/browse/GUVNOR>



Dashboards ▾ Projects ▾ Issues ▾ Agile ▾

 Drools / JBRULES-3370

Array fields are not supported in declared facts

[Log In](#)

▼ **Details**

Type:	 Enhancement	Status:	 Open (View Workflow)
Priority:	 Minor	Resolution:	Unresolved
Affects Version/s:	None	Fix Version/s:	None
Component/s:	drools-compiler, drools-core	Security Level:	Public (Everyone can see)
Labels:	None		

Similar Issues: [Show 10 results](#) ▶

▼ **Description**

it should be possible to do

```
declare Bean
arrayField : SomeObject[]
end


optionally,

declare Bean
arrayField : SomeObject[] = new SomeObject[3]
end
```

2.5.4. Fork GitHub

With the contributor agreement signed and your requests submitted to JIRA you should now be ready to code :) Create a GitHub account and fork any of the Drools, jBPM or Guvnor repositories. The fork will create a copy in your own GitHub space which you can work on at your own pace. If you make a mistake, don't worry blow it away and fork again. Note each GitHub repository provides you the clone (checkout) URL, GitHub will provide you URLs specific to your fork.

<https://github.com/droolsjbpm>

 droolsjbpm / drools [Admin](#) [Watch](#) [Fork](#) [Pull Request](#) [125](#) [81](#)

Code Network Pull Requests **10** Stats & Graphs

Drools Expert is the rule engine and Drools Fusion does complex event processing (CEP). — [Read more](#)
<http://www.jboss.org/drools>

[ZIP](#) [SSH](#) [HTTP](#) [Git Read-Only](#) [Read+Write access](#)

▲ branch: master ▼ **Files** Commits Branches **4** Tags **10** Downloads

2.5.5. Writing Tests

When writing tests, try and keep them minimal and self contained. We prefer to keep the DRL fragments within the test, as it makes for quicker reviewing. If their are a large number of rules

then using a String is not practical so then by all means place them in separate DRL files instead to be loaded from the classpath. If your tests need to use a model, please try to use those that already exist for other unit tests; such as Person, Cheese or Order. If no classes exist that have the fields you need, try and update fields of existing classes before adding a new class.

There are a vast number of tests to look over to get an idea, MiscTest is a good place to start.

<https://github.com/droolsjbpm/drools/blob/master/drools-compiler/src/test/java/org/drools/integrationtests/MiscTest.java> [<https://github.com/droolsjbpm>]

```
557     @Test
558     public void testEvalWithBigDecimal() throws Exception {
559         String str = "";
560         str += "package org.drools \n";
561         str += "import java.math.BigDecimal; \n";
562         str += "global java.util.List list \n";
563         str += "rule rule1 \n";
564         str += "    dialect \"java\" \n";
565         str += "when \n";
566         str += "    $bd : BigDecimal() \n";
567         str += "    eval( $bd.compareTo( BigDecimal.ZERO ) > 0 ) \n";
568         str += "then \n";
569         str += "    list.add( $bd ); \n";
570         str += "end \n";
571
572         KnowledgeBuilder kbuilder = KnowledgeBuilderFactory.newKnowledgeBuilder();
573
574         kbuilder.add( ResourceFactory.newByteArrayResource( str.getBytes() ),
575                     ResourceType.DRL );
576
577         if ( kbuilder.hasErrors() ) {
578             logger.warn( kbuilder.getErrors().toString() );
579         }
580         assertFalse( kbuilder.hasErrors() );
581
582         KnowledgeBase kbase = KnowledgeBaseFactory.newKnowledgeBase();
583         kbase.addKnowledgePackages( kbuilder.getKnowledgePackages() );
584
585         StatefulKnowledgeSession ksession = createKnowledgeSession(kbase);
586         List list = new ArrayList();
587         ksession.setGlobal( "list",
588                             list );
589         ksession.insert( new BigDecimal( 1.5 ) );
590
591         ksession.fireAllRules();
592
593         assertEquals( 1,
594                      list.size() );
595         assertEquals( new BigDecimal( 1.5 ),
596                      list.get( 0 ) );
597     }
598 }
```

2.5.6. Commit with Correct Conventions

When you commit, make sure you use the correct conventions. The commit must start with the JIRA issue id, such as JBRULES-220. This ensures the commits are cross referenced via JIRA, so we can see all commits for a given issue in the same place. After the id the title of the issue should come next. Then use a newline, indented with a dash, to provide additional information

related to this commit. Use an additional new line and dash for each separate point you wish to make. You may add additional JIRA cross references to the same commit, if it's appropriate. In general try to avoid combining unrelated issues in the same commit.

Don't forget to rebase your local fork from the original master and then push your commits back to your fork.

The screenshot shows a GitHub pull request interface. At the top, there's a header with the repository name 'Drools / JBRULES-328 FactTemplates / JBRULES-329' and the title 'implement core handling of Templates for ObjectType'. Below the header is a 'Log In' button. The main content area shows a list of commits. The first commit is by 'mark.proctor@jboss.com' with the message 'submitted changeset 5421 to trunk in JBossRules (29 files) - 02/Aug/06 8:14 PM'. It lists three JIRA issues: 'JBRULES-220 Refactor ObjectType to work with Templates', 'JBRULES-329 implement core handling of Templates for ObjectType', and 'JBRULES-246 Allow & and | connectives for field constraints'. The second commit is by 'Mark Proctor <mdproctor@gmail.com>' with the message 'submitted changeset b98d43508c91f1cb01d53b22395693ca87d69d5e to 5.2.x in 8:14 PM'. It lists the same three JIRA issues. The commit details for the first commit are expanded, showing a list of files with their change counts and icons for file actions.

Drools / JBRULES-328 FactTemplates / JBRULES-329
implement core handling of Templates for ObjectType

Log In

▼ mark.proctor@jboss.com submitted changeset 5421 to trunk in JBossRules (29 files) - 02/Aug/06 8:14 PM

[JBRULES-220](#) Refactor ObjectType to work with Templates
-This also involved refactor Evaluator to use Enums for ValueType and Operator

[JBRULES-329](#) implement core handling of Templates for ObjectType
-Initial commit for FactTemplate work, still not integrated into parsers and builds, it also needs unit tests.

[JBRULES-246](#) Allow & and | connectives for field constraints
-XmlReader is now fixed
-Xml and Dri Dumpers have been fixed

- trunk/drools-compiler/src/main/java/org/drools/lang/DriDumper.java (+53 -27) ▲ □ 🔍 ⬇
- trunk/drools-compiler/src/main/java/org/drools/lang/descr/FieldConstraintDescr.java (+5 -1) ▲ □ 🔍 ⬇
- trunk/drools-compiler/src/main/java/org/drools/lang/descr/LiteralRestrictionDescr.java (+7 -7) ▲ □ 🔍 ⬇
- trunk/drools-compiler/src/main/java/org/drools/lang/descr/ReturnValueRestrictionDescr.java (+7 -9) ▲ □ 🔍 ⬇
- trunk/drools-compiler/src/main/java/org/drools/semantics/java/RuleBuilder.java (+74 -62) ▲ □ 🔍 ⬇
- trunk/drools-compiler/src/main/java/org/drools/xml/BoundVariableHandler.java (+0 -110) ▲ □ 🔍 ⬇
- trunk/drools-compiler/src/main/java/org/drools/xml/FieldBindingHandler.java (+2 -6) ▲ □ 🔍 ⬇
- trunk/drools-compiler/src/main/java/org/drools/xml/FieldConstraintHandler.java (+95) ▲ □ 🔍 ⬇
- trunk/drools-compiler/src/main/java/org/drools/xml/LiteralHandler.java (+0 -110) ▲ □ 🔍 ⬇
- trunk/drools-compiler/src/main/java/org/drools/xml/LiteralRestrictionHandler.java (+103) ▲ □ 🔍 ⬇

...19 more files in changeset

▼ Mark Proctor <mdproctor@gmail.com> submitted changeset b98d43508c91f1cb01d53b22395693ca87d69d5e to 5.2.x in 8:14 PM

[JBRULES-220](#) Refactor ObjectType to work with Templates -This also involved refactor Evaluator to use Enums for Value

[JBRULES-329](#) implement core handling of Templates for ObjectType
-Initial commit for FactTemplate work, still not integrated into parsers and builds, it also needs unit tests.

[JBRULES-246](#) Allow & and | connectives for field constraints
-XmlReader is now fixed
-Xml and Dri Dumpers have been fixed

2.5.7. Submit Pull Requests

With your code rebased from original master and pushed to your personal GitHub area, you can now submit your work as a pull request. If you look at the top of the page in GitHub for your work area there will be a "Pull Request" button. Selecting this will then provide a gui to automate the submission of your pull request.

The pull request then goes into a queue for everyone to see and comment on. Below you can see a typical pull request. The pull requests allow for discussions and it shows all associated commits and the diffs for each commit. The discussions typically involve code reviews which provide helpful suggestions for improvements, and allows for us to leave inline comments on specific parts of the code. Don't be disheartened if we don't merge straight away, it can often take several revisions before we accept a pull request. Luckily GitHub makes it very trivial to go back to your code, do some more commits and then update your pull request to your latest and greatest.

It can take time for us to get round to responding to pull requests, so please be patient. Submitted tests that come with a fix will generally be applied quite quickly, where as just tests will often wait until we get time to also submit that with a fix. Don't forget to rebase and resubmit your request from time to time, otherwise over time it will have merge conflicts and core developers will generally ignore those.

The screenshot shows a GitHub pull request interface. At the top, it says "Open" in a green box, followed by "sotty wants someone to merge 5 commits into droolsjbpm:master from sotty:master" and "#90" on the right. Below this is a navigation bar with "Discussion" selected, "Commits <> 5", and "Diff >= 8".

The main content area shows the pull request details: "sotty opened this pull request 22 days ago" with a profile picture, the title "JBRULES-3370 Array fields are not supported in declared facts", "No one is assigned" with a gear icon, and "No milestone" with a gear icon. The description reads: "Well, not exactly a ground-breaking feature, but still useful :) Also improves bean initialization with MVEL expression". On the right, there is a green "Open" button, "+ 388 additions", "- 60 deletions", and a link to "All Pull Requests".

Below the details, it says "sotty and etirelli are participating in this pull request." with their profile pictures. A comment from "etirelli" is shown, dated "22 days ago", saying: "@sotty thanks for providing this. I was reviewing the code, and with a few changes it can also support multi-dimensional arrays (e.g. Object[][], int[][][], etc). Do you think you can change it for that?".

At the bottom, it says "etirelli started a discussion in the diff 22 days ago". Below this is a diff view for the file "drools-compiler/src/main/java/org/drools/lang/DRLParser.java". The diff shows a change in a method signature: "@@ -924,6 +924,31 @@ private void field(AbstractClassTypeDeclarationBuilder declare) {". The code snippet shows a closing brace for the method. A comment from "etirelli" is attached to this diff, dated "22 days ago", saying: "There is already a rule called type(). Please use that instead of creating a fieldType() rule. It supports multi-dimensional arrays and generics, although I know MVEL does not support generics yet." Below the comment is an "Add a line note" button.

2.6. What to do if I encounter problems or have questions?

You can always contact the jBPM community for assistance.

IRC: #jbpm at chat.freenode.net

jBPM User Forum [<http://community.jboss.org/en/jbpm?view=discussions>]

Chapter 3. jBPM Installer

3.1. Prerequisites

This script assumes you have Java JDK 1.6+ (set as JAVA_HOME), and Ant 1.7+ installed. If you don't, use the following links to download and install them:

Java: <http://java.sun.com/javase/downloads/index.jsp>

Ant: <http://ant.apache.org/bindownload.cgi>



Tip

To check whether Java and Ant are installed correctly, type the following commands inside a command prompt:

```
java -version
```

```
ant -version
```

This should return information about which version of Java and Ant you are currently using.

3.2. Downloading the Installer

First of all, you need to download [<https://sourceforge.net/projects/jbpm/files/jBPM%206/>] the installer and unzip it to your local file system. There are two versions

- full installer - which already contains a lot of the dependencies that are necessary during the installation
 - minimal installer - which only contains the installer and will download all dependencies
- In general, it is probably best to download the full installer: `jbpm-{version}-installer-full.zip`

You can also find the latest snapshot release here (only minimal installer) here:

<https://hudson.jboss.org/jenkins/job/jBPM/lastSuccessfulBuild/artifact/jbpm-distribution/target/>
[<https://hudson.jboss.org/jenkins/job/jBPM/lastSuccessfulBuild/artifact/jbpm-distribution/target/>]

3.3. Demo Setup

The easiest way to get started is to simply run the installation script to install the demo setup. The demo install will setup all the web tooling (on top of WildFly) and Eclipse tooling in a pre-configured setup. Go into the `jbpm-installer` folder where you unzipped the installer and (from a command prompt) run:

```
ant install.demo
```

This will:

- Download WildFly application server
- Configure and deploy the web tooling
- Download Eclipse
- Install the Drools and jBPM Eclipse plugin
- Install the Eclipse BPMN 2.0 Modeler

Running this command could take a while (REALLY, not kidding, we are for example downloading an Eclipse installation, even if you downloaded the full installer, specifically for your operating system).



Tip

The script always shows which file it is downloading (you could for example check whether it is still downloading by checking the whether the size of the file in question in the `jbpm-installer/lib` folder is still increasing). If you want to avoid downloading specific components (because you will not be using them or you already have them installed somewhere else), check below for running only specific parts of the demo or directing the installer to an already installed component.

Once the demo setup has finished, you can start playing with the various components by starting the demo setup:

```
ant start.demo
```

This will:

- Start H2 database server
- Start WildFly application server
- Start Eclipse

Now wait until the process management console comes up:

<http://localhost:8080/jbpm-console>

**Note**

It could take a minute to start up the application server and web application. If the web page doesn't show up after a while, make sure you don't have a firewall blocking that port, or another application already using the port 8080. You can always take a look at the server log `jbpm-installer/wildfly-8.1.0.Final/standalone/log/server.log`

Finally, if you also want to use the DashBuilder for reporting (which is implemented as a separate war), you can now also install this:

```
ant install.dashboard.into.jboss
```

Once everything is started, you can start playing with the Eclipse and web tooling, as explained in the following sections.

If you only want to try out the web tooling and do not wish to download and install the Eclipse tooling, you can use these alternative commands:

```
ant install.demo.noclipse
ant start.demo.noclipse
```

Similarly, if you only want to try out the Eclipse tooling and do not wish to download and install the web tooling, you can use these alternative commands:

```
ant install.demo.eclipse
ant start.demo.eclipse
```

Now continue with the 10-minute tutorials. Once you're done playing and you want to shut down the demo setup, you can use:

```
ant stop.demo
```

If at any point in time you would like to start over with a clean demo setup - meaning all changes you did inside the web tooling and/or saved in the database will be lost, you can run the following command (after which you can run the installer again from scratch, note that this cannot be undone):

```
ant clean.demo
```

3.4. 10-Minute Tutorial using the Workbench

Open up the process management console:

<http://localhost:8080/jbpm-console>



Note

It could take a minute to start up the AS and web application. If the web page doesn't show up after a while, make sure you don't have a firewall blocking that port, or another application already using the port 8080. You can always take a look at the server log `jbpm-installer/jboss-as-7.1.1.Final/standalone/log/server.log`

Log in, using `krisv / krisv` as username / password.

Using a prebuilt Evaluation example, the following screencast [<http://people.redhat.com/kverlaen/jbpm6F-installer-console.swf>] gives an overview of how to manage your process instances. It shows you:

- How to build and deploy a process
- How to start a new process instance
- How to look up the current status of a running process instance
- How to look up your tasks
- How to complete a task
- How to generate reports to monitor your process execution

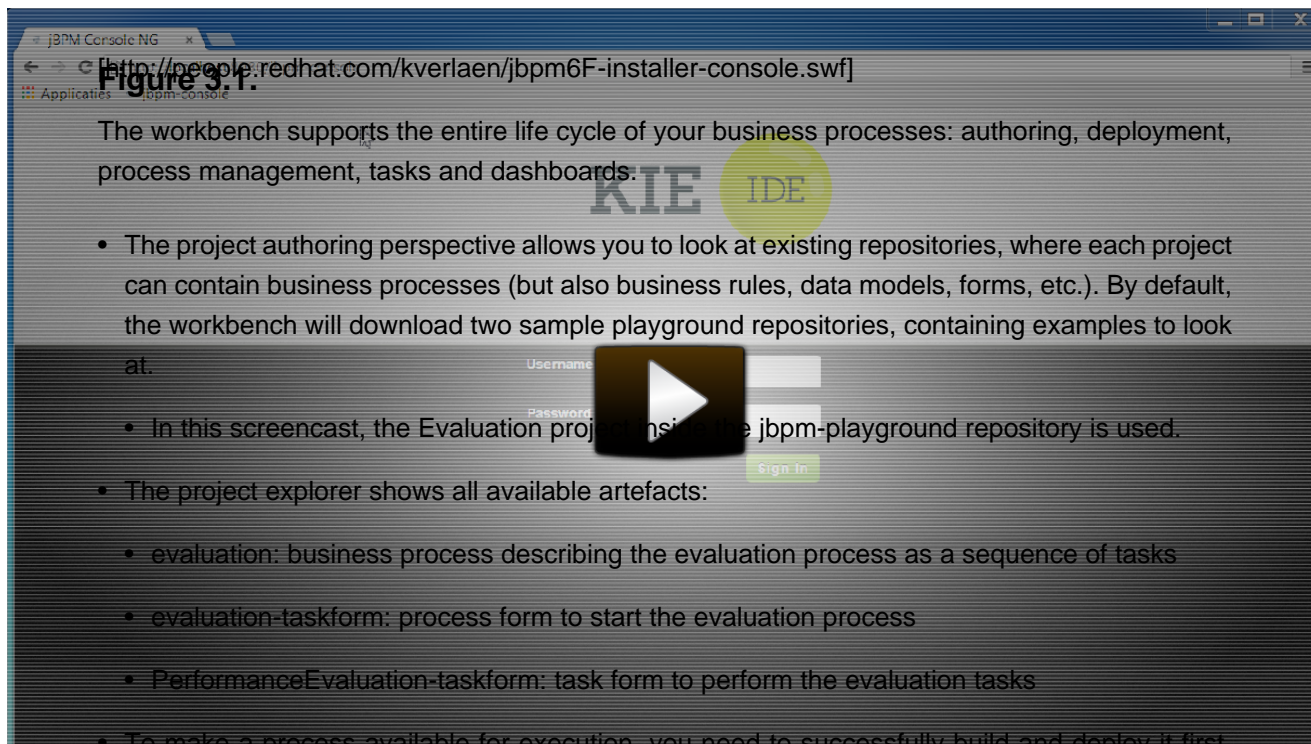


Figure 3.1.

The workbench supports the entire life cycle of your business processes: authoring, deployment, process management, tasks and dashboards.

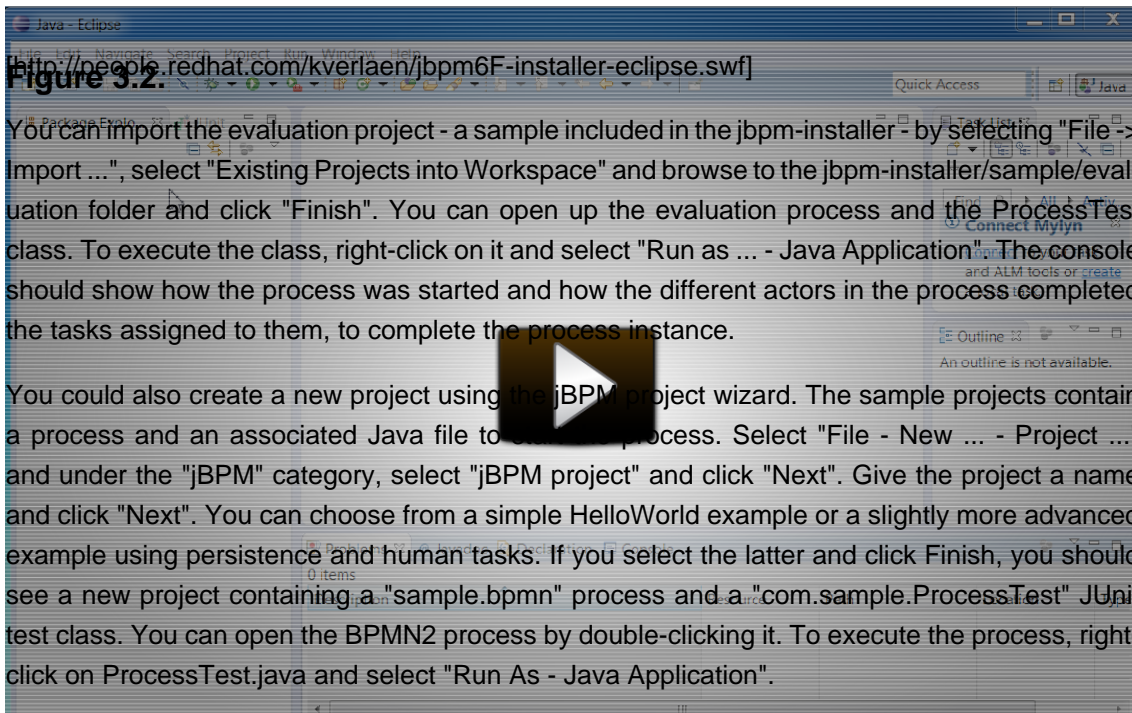
- The project authoring perspective allows you to look at existing repositories, where each project can contain business processes (but also business rules, data models, forms, etc.). By default, the workbench will download two sample playground repositories, containing examples to look at.
- In this screencast, the Evaluation project inside the jbpm-playground repository is used.
- The project explorer shows all available artefacts:
 - evaluation: business process describing the evaluation process as a sequence of tasks
 - evaluation-taskform: process form to start the evaluation process
 - PerformanceEvaluation-taskform: task form to perform the evaluation tasks
- To make a process available for execution, you need to successfully build and deploy it first. To do so, open up the Project Editor (from the Tools menu) and click Build & Deploy.
- To manage your process definitions and instances, click on the "Process Management" menu option at the top menu bar and select one of available options depending on your interest:
 - Process Definitions - lists all available process definitions

- Process Instances - lists all active process instances (allows to show completed, aborted as well by changing filter criteria)
- Process definitions panel allow you to start a new process instance by clicking on the "Play" button. The process form (as defined in the project) will be shown, where you need to fill in the necessary information to start the process. In this case, you need to fill the user you want to start an evaluation for (in this case use "krisv") and a reason for the request, after which you can complete the form. Some details about the process instance that was just started will be shown in the process instance details panel. From there you can access additional details:
 - Process model - to visualize current state of the process
 - Process variables - to see current values of process variablesThe process instance that you just started is first requiring a self-evaluation of the user and is waiting until the user has completed this task.
- To see the tasks that have been assigned to you, choose the "Tasks" menu option on the top bar and select "Task List" (you may need to click refresh to update your task view). The personal tasks table should show a "Performance Evaluation" task reserved for you. After starting the task, you can complete the task, which will open up the task form related to this task. You can fill in the necessary data and then complete the form and close the window. After completing the task, you could check the "Process Instances" once more to check the progress of your process instance. You should be able to see that the process is now waiting for your HR manager and project manager to also perform an evaluation. You could log in as "john" / "john" and "mary" / "mary" to complete these tasks.
- After starting and/or completing a few process instances and human tasks, you can generate a report of what has happened so far. Under "Dashboards", select "Process & Task Dashboard". This is a set of see predefined charts that allow users to spot what is going on in the system. Charts can be fully customized as well, as explained in the Business Activity Monitoring chapter.

3.5. 10-Minute Tutorial using Eclipse

The following screencast [<http://people.redhat.com/kverlaen/jbpm6F-installer-eclipse.swf>] gives an overview of how to use the Eclipse tooling. It shows you:

- How to import and execute the evaluation sample project
 - Import the evaluation project (included in the jbpn-installer)
 - Open the Evaluation.bpmn process
 - Open the com.sample.ProcessTest Java class
 - Execute the ProcessTest class to run the process
- How to create a new jBPM project (including sample process and JUnit test)



3.6. Configuration

3.6.1. Playgrounds

The workbench by default brings two sample playground repositories (by cloning the jbpm-playground repository hosted on GitHub). In cases where this is not wanted (access to Internet might not be available or there might be a need to start with a completely clean installation of the work-

bench) this default behavior can be turned off. To do so, change the following system property in the start.jboss target to false in the build.xml:

```
-Dorg.kie.demo=false
```

Note that this will create a completely empty version of the workbench. To be able to start modeling processes, the following elements need to be created first:

- Organizational unit
- Repository (new or clone existing one)
- Project

3.6.2. Workbench Authentication

The workbench web application is using the "default" security domain for authenticating and authorizing users (as specified in the WEB-INF/jboss-web.xml inside the WARs).

The application server is configured by default to use properties files for specifying users. Note that this is for demo purposes only (as passwords and roles are stored in simple property files). The security domain is configured in the standalone.xml configuration file as follows:

```
<security-domain name="other" cache-type="default">
  <authentication>
    <login-module code="UsersRoles" flag="required">
      <module-option name="usersProperties" value="\${jboss.server.config.dir}/users.properties"/>
      <module-option name="rolesProperties" value="\${jboss.server.config.dir}/roles.properties"/>
    </login-module>
  </authentication>
</security-domain>

name="other" cache-type="default">
  <authentication>
    <login-module code="UsersRoles" flag="required">
      <module-option name="usersProperties" value="\${jboss.server.config.dir}/users.properties"/>
      <module-option name="rolesProperties" value="\${jboss.server.config.dir}/roles.properties"/>
    </login-module>
  </authentication>
</security-domain>
```

By default, these configuration files contain the following users:

Table 3.1. Default users

Name	Password	Workbench roles	Task roles
admin	admin	admin,analyst	
krisv	krisv	admin,analyst	
john	john	analyst	Accounting,PM
mary	mary	analyst	HR
sales-rep	sales-rep	analyst	sales

Name	Password	Workbench roles	Task roles
jack	jack	analyst	IT
katy	katy	analyst	HR
salaboy	salaboy	admin,analyst	IT,HR,Accounting

Authentication can be customized by editing the authentication and configuration files in the `jbpm-installer/auth` folder and/or by changing the `standalone-*.xml` files in the `jbpm-installer` folder. Note that you need to rerun the installer to make sure the modified files are copied and picked correctly.

3.6.3. Using your own database with the jBPM installer

3.6.3.1. Introduction

jBPM uses the Java Persistence API specification (v2) to allow users to configure whatever data-source they want to use to persist runtime data. As a result, the instructions below describe how you should configure a datasource when using JPA on JBoss application server (e.g. AS7, EAP6 or Wildfly8) using a `persistence.xml` file and configuring your datasource and driver in your application server's `standalone.xml`, similar to how you would configure any other application using JPA on JBoss application server. The installer automates some of this (like copying the right files to the right location after installation).

By default, the `jbpm-installer` uses an H2 database for persisting runtime data. In this section we will:

1. modify the persistence settings for runtime persistence of process instance state
2. test the startup with our new settings!

You will need a local instance of a database, in this case we will use MySQL.

3.6.3.2. Database setup

In the MySQL database used in this quickstart, create a single user:

- user/schema "jbpm" with password "jbpm" (which will be used to persist all entities)

If you end up using different names for your user/schemas, please make a note of where we insert "jbpm" in the configuration files.

If you want to try this quickstart with *another* database, a section at the end of this quickstart describes what you may need to modify.

3.6.3.3. Configuration

The following files define the persistence settings for the `jbpm-installer` demo:

- `jbpm-installer/db/jbpm-persistence-JPA2.xml`

- Application server configuration
 - standalone-*.xml



Tip

There are multiple standalone.xml files available (depending on whether you are using JBoss AS7, JBoss EAP6 or Wildfly8 and whether you are running the normal or full profile). The full profile is required to use the JMS component for remote integration, so will be used by default by the installer. Best practice is to update all standalone.xml files to have consistent setup but most important is to have standalone-full-wildfly-8.1.0.Final.xml properly configured as this is used by default by the installer.

Do the following:

- Disable H2 default database and enable MySQL database in build.properties

```
#      default      is      H2#      H2.version=1.3.168#      db.name=h2#      db.driver.jar.name=
${db.name}.jar#      db.driver.download.url=http://repo1.maven.org/maven2/com/h2database/h2/
${H2.version}/h2-${H2.version}.jar#mysqldb.driver.module.prefix=com/
mysqlldb.driver.jar.name=mysql-connector-java-5.1.18.jar#db.driver.download.url=https://
repository.jboss.org/nexus/service/local/repositories/central/content/mysql/mysql-connector-
java/5.1.18/mysql-connector-java-5.1.18.jar
H2#
H2.version=1.3.168#
db.name=h2# db.driver.jar.name=
${db.name}.jar# db.driver.download.url=http://repo1.maven.org/maven2/com/h2database/h2/${H2.version}/
h2-
${H2.version}.jar
#mysql
db.name=mysqlldb.driver.module.prefix=com/
mysqlldb.driver.jar.name=mysql-connector-
java-5.1.18.jar#db.driver.download.url=https://repository.jboss.org/nexus/service/local/
repositories/central/content/mysql/mysql-connector-java/5.1.18/mysql-connector-
java-5.1.18.jar
```

You might want to update the db driver jar name and download url to whatever version of the jar matches your installation.

- db/jbpm-persistence-JPA2.xml:

This is the JPA persistence file that defines the persistence settings used by jBPM for both the process engine information, the logging/BAM information and task service.

In this file, you will have to change the name of the hibernate dialect used for your database.

The original line is:

```
<property name="hibernate.dialect" value="org.hibernate.dialect.H2Dialect" />
```

In the case of a MySQL database, you need to change it to:

```
<property name="hibernate.dialect" value="org.hibernate.dialect.MySQLDialect" />
```

For those of you who decided to use another database, a list of the available hibernate dialect classes can be found [here](http://docs.jboss.org/hibernate/core/3.3/reference/en-US/html/session-configuration.html#configuration-optional-dialects) [http://docs.jboss.org/hibernate/core/3.3/reference/en-US/html/session-configuration.html#configuration-optional-dialects].

- standalone-full-wildfly-8.1.0.Final.xml:

Standalone.xml and standalone-full.xml are the configuration for the standalone JBoss application server. When the installer installs the demo, it copies these files to the standalone/configuration directory in the JBoss server directory. Since the installer uses Wildfly8 by default as application server, you probably need to change standalone-full-wildfly-8.1.0.Final.xml.

We need to change the datasource configuration in standalone-full.xml so that the jBPM process engine can use our MySQL database. The original file contains (something very similar to) the following lines:

```
<datasource jta="true" jndi-name="java:jboss/datasources/jbpmDS" pool-name="H2DS"
  enabled="true" use-java-context="true" use-ccm="true"> <connection-url>jdbc:h2:tcp://
localhost/~ /jbpm-db;MVCC=TRUE</connection-url> <driver>h2</driver> <security>
  <user-name>sa</user-name> </security></datasource><drivers> <driver name="h2"
  module="com.h2database.h2"> <xa-datasource-class>org.h2.jdbcx.JdbcDataSource</xa-
datasource-class> </driver></drivers>
va-context="true" use-ccm="true"> <connection-url>jdbc:h2:tcp://localhost/
~/jbpm-db;MVCC=TRUE</connection-url>
  <driver>h2</driver>
  <security>
  <user-name>sa</user-name>

</security></datasource><drivers>
<driver name="h2" module="com.h2database.h2"> <xa-
datasource-class>org.h2.jdbcx.JdbcDataSource</xa-datasource-class>
```

Change the lines to the following:

```
<datasource jta="true" jndi-name="java:jboss/datasources/jbpmDS" pool-name="MySQLDS"
  enabled="true" use-java-context="true" use-ccm="true"> <connection-url>
ccm="true"> <connection-jdbc:mysql://localhost:3306/jbpm</connection-url>
  <driver>mysql</driver>
```

```
<security>
  <user-name>jbpm</user-name>
  <password>jbpm</password>
</security>
</datasource>
```

and add an additional driver configuration:

```
<driver name="mysql" module="com.mysql">
  <xa-datasource-class>com.mysql.jdbc.jdbc2.optional.MysqlXADataSource</xa-datasource-
class>
</driver>
```

- To install driver jars in JBoss application server (Wildfly8, EAP6, etc.), it is recommended to install the driver jar as a module. The installer already takes care of this mostly: it will copy the driver jar (you specified in the `build.properties`) to the right folder inside the modules directory of your server and put a matching `module.xml` next to it. For MySQL, this file is called `db/mysql_module.xml`. Open this file and make sure that the file name of the driver jar listed there is identical the driver jar name you specified in the `build.properties` (including the version). Note that, even if you simply uncommented the default MySQL configuration, you will still need to add the right version here.
- Starting the demo

We've modified all the necessary files at this point. Now would be a good time to make sure your database is started up as well!

The installer script copies this file into the `jbpm-console` WAR before the WAR is installed on the server. If you have already run the installer, it is recommended to stop the installer and clean it first using

```
ant stop.demo
```

and

```
ant clean.demo
```

before continuing.

Run

```
ant install.demo
```

to (re)install the wars and copy the necessary configuration files. Once you've done that, (re)start the demo using

```
ant start.demo
```

- Problems?

If this isn't working for you, please try the following:

- Please double check the files you've modified: I *wrote* this, but still made mistakes when changing files!
- Please make sure that you don't secretly have another (unmodified) instance of JBoss AS running.
- If neither of those work (and you're using MySQL), please do then let us know.

3.6.3.4. Using a different database

If you decide to use a different database with this demo, you need to remember the following when going through the steps above:

- Configuring the jBPM datasource in `standalone.xml`:
 - After locating the `java:jboss/datasources/jbpmDS` datasource, you need to provide the following properties specific to your database:
 - Change url of your database
 - Change the user-name and password
 - Change the name of the driver (which you'll create next)

For example:

```
<datasource jta="true" jndi-name="java:jboss/datasources/jbpmDS" pool-name="PostgreSQLDS"
  enabled="true" use-java-context="true" use-ccm="true">
  <connection-url>jdbc:postgresql://localhost:5432/jbpm</connection-url>
  <driver>postgresql</driver>
  <security>
    <user-name>jbpm</user-name>
    <password>jbpm</password>
  </security></datasource>
  <connection-url>jdbc:postgresql://localhost:5432/jbpm</connection-url>
  <driver>postgresql</driver>
  <security>
    <user-name>jbpm</user-name>
    <password>jbpm</password>
```

- Add an additional driver configuration:

- Change the name of the driver to match the name you specified when configuring the datasource in the previous step
- Change the module of the driver: the database driver jar should be installed as a module (see below) and here you should reference the unique name of the module. Since the installer can take care of automatically generating this module for you (see below), this should match the `db.driver.module.prefix` property in `build.properties` (where forward slashes are replaced by a point). In the example below, I used `org/postgresql` as `db.driver.module.prefix` which means that I should then use `org.postgresql` as module name for the driver.
- Fill in the correct name of the XA datasource class to use

For example:

```
<driver name="postgresql" module="org.postgresql">
  <xa-datasource-class>org.postgresql.xa.PGXADatasource</xa-datasource-class>
</driver>
```

- You need to change the dialect in `persistence.xml` to the dialect for your database, for example:

```
<property name="hibernate.dialect" value="org.hibernate.dialect.PostgreSQLDialect"/>
```

- In order to make sure your driver will be correctly installed in the JBoss application server, there are typically multiple options, like install as a module or as a deployment. It is recommended to install the driver as a module for AS7, EAP6 and Wildfly8. For example, for AS7 both ways are explained here [<https://community.jboss.org/wiki/DataSourceConfigurationinAS7>].

- Install [https://community.jboss.org/wiki/DataSourceConfigurationinAS7#Installing_a_JDBC_driver_as_a_module] the driver JAR as a *module*, which is what the install script does.
- Otherwise, you can modify and install [https://community.jboss.org/wiki/DataSourceConfigurationinAS7#Installing_a_JDBC_driver_as_a_deployment] the downloaded JAR as a *deployment*. In this case you will have to copy the JAR yourself to the `standalone/deployments` directory.

If you choose to install driver as JBoss module (recommended), please do the following:

- In `build.properties`, disable the default H2 driver properties

```
# default is H2# H2.version=1.3.168# db.name=h2# db.driver.jar.name=h2-
${H2.version}.jar# db.driver.download.url=http://repo1.maven.org/maven2/com/h2database/h2/
${H2.version}/h2-${H2.version}.jar
H2#
H2.version=1.3.168#
```

```
db.name=h2# db.driver.jar.name=h2-
${H2.version}.jar# db.driver.download.url=http://repol.maven.org/maven2/com/h2database/h2/${H2.version}/
h2-
```

- Uncomment one of the other example configs (mysql or postgresql) or create your own:

```
#postgresqldb.name=postgresqldb.driver.module.prefix=org/
postgresqldb.driver.jar.name=postgresql-9.1-902.jdbc4.jar#db.driver.download.url=https://
repository.jboss.org/nexus/content/repositories/thirdparty-uploads/postgresql/
postgresql/9.1-902.jdbc4/postgresql-9.1-902.jdbc4.jar
gresql
db.name=postgresqldb.driver.module.prefix=org/
postgresql
db.driver.jar.name=postgresql-9.1-902.jdbc4.jar#db.driver.download.url=https://repository.jboss.org/nexus/cont
thirdparty-uploads/postgresql/postgresql/9.1-902.jdbc4/
```

- Change the `db.name` property in `build.properties` to a name for your database.
- Change the `db.driver.module.prefix` property to a name for the module of your driver. Note that this should match the module property when configuring the driver in `standalone.xml` (where forward slashes in the prefix here are replaced by a point). In the example above, I used “`org/postgresql`” as `db.driver.module.prefix` which means that I should then use `org.postgresql` as module name for the driver.
- Change the `db.driver.jar.name` property to the name of the jar that contains your database driver.
- Change the `db.driver.download.url` property to where the driver jar can be downloaded. Alternatively, you could manually download the jar yourself, and place it in the `db/drivers` folder, using the same name as you specified in the `db.driver.jar.name` property.
- Lastly, you'll have to create the `db/${db.name}_module.xml` file. As an example you can use `db/mysql_module.xml`, so just make a copy of it and:

- Change the name of the *module* to match the driver module name above
- Change the name of the module resource path to the name of the `db.driver.jar.name` property.

For example, the top of the file would look like:

```
<module xmlns="urn:jboss:module:1.0" name="org.postgresql">
  <resources>
    <resource-root path="postgresql-9.1-902.jdbc4.jar"/>
  </resources>
```

3.6.4. jBPM database schema scripts (DDL scripts)

By default the demo setup makes use of Hibernate auto DDL generation capabilities to build up the complete database schema, including all tables, sequences, etc. This might not always be welcomed (by your database administrator), and thus the installer provides DDL scripts for most popular databases.

Table 3.2. DDL scripts

Database name	Location
db2	jbpm-installer/db/ddl-scripts/db2
derby	jbpm-installer/db/ddl-scripts/derby
h2	jbpm-installer/db/ddl-scripts/h2
hsqldb	jbpm-installer/db/ddl-scripts/hsqldb
mysql5	jbpm-installer/db/ddl-scripts/mysql5
mysqlinnodb	jbpm-installer/db/ddl-scripts/mysqlinnodb
oracle	jbpm-installer/db/ddl-scripts/oracle
postgresql	jbpm-installer/db/ddl-scripts/postgresql
sqlserver	jbpm-installer/db/ddl-scripts/sqlserver
sqlserver2008	jbpm-installer/db/ddl-scripts/sqlserver2008

DDL scripts are provided for both jBPM and Quartz schemas although Quartz schema DDL script is only required when the timer service should be configured with Quartz database job store. See the section on timers for additional details.

This can be used to initially create the database schema, but it can also serve as the basis for any optimization that needs to be applied - such as indexes, etc.

3.6.5. jBPM installer script

jBPM installer ant script performs most of the work automatically and usually does not require additional attention but in case it does, here is a list of available targets that might be needed to perform some of the steps manually.

Table 3.3. jBPM installer available targets

Target	Description
clean.db	cleans up database used by jBPM demo (applies only to H2 database)
clean.demo	cleans up entire installation so new installation can be performed
clean.demo.noclipse	same as clean.demo but does not remove Eclipse

Target	Description
clean.eclipse	removes Eclipse and its workspace
clean.generated.ddl	removes DDL scripts generated if any
clean.jboss	removes application server with all its deployments
clean.jboss.repository	removes repository content for demo setup (guvnor Maven repo, niogit, etc)
download.dashboard	downloads jBPM dashboard component (BAM)
download.db.driver	downloads DB driver configured in build.properties
download.ddl.dependencies	downloads all dependencies required to run DDL script generation tool
download.droolsjbpm.eclipse	downloads Drools and jBPM Eclipse plugin
download.eclipse	downloads Eclipse distribution
download.jboss	downloads JBoss Application Server
download.jBPM.bin	downloads jBPM binary distribution (jBPM libs and its dependencies)
download.jBPM.console	downloads jBPM console for JBoss AS
install.dashboard.into.jboss	installs jBPM dashboard into JBoss AS
install.db.files	installs DB driver as JBoss module
install.demo	installs complete demo environment
install.demo.eclipse	installs Eclipse with all jBPM plugins, no server installation
install.demo.noclipse	similar to install.demo but skips Eclipse installation
install.dependencies	installs custom libraries (such as work item handlers, etc) into the jBPM console
install.droolsjbpm-eclipse.into.eclipse	installs droolsjbpm Eclipse plugin into Eclipse
install.eclipse	install Eclipse IDE
install.jboss	installs JBoss AS
install.jBPM-console.into.jboss	installs jBPM console application into JBoss AS

3.7. Frequently Asked Questions

Some common issues are explained below.

Q: What if the installer complains it cannot download component X?

A: Are you connected to the Internet? Do you have a firewall turned on? Do you require a proxy? It might be possible that one of the locations we're downloading the components from is temporarily offline. Try downloading the components manually (possibly from alternate locations) and put them in the jbpm-installer/lib folder.

Q: What if the installer complains it cannot extract / unzip a certain JAR/WAR/zip?

A: If your download failed while downloading a component, it is possible that the installer is trying to use an incomplete file. Try deleting the component in question from the jbpm-installer/lib folder and reinstall, so it will be downloaded again.

Q: What if I have been changing my installation (and it no longer works) and I want to start over again with a clean installation?

A: You can use ant clean.demo to remove all the installed components, so you end up with a fresh installation again.

Q: I sometimes see exceptions when trying to stop or restart certain services, what should I do?

A: If you see errors during shutdown, are you sure the services were still running? If you see exceptions during restart, are you sure the service you started earlier was successfully shutdown? Maybe try killing the services manually if necessary.

Q: Something seems to be going wrong when running Eclipse but I have no idea what. What can I do?

A: Always check the consoles for output like error messages or stack traces. You can also check the Eclipse Error Log for exceptions. Try adding an audit logger to your session to figure out what's happening at runtime, or try debugging your application.

Q: Something seems to be going wrong when running the a web-based application like the jbpm-console. What can I do?

A: You can check the server log for possible exceptions: jbpm-installer/jboss-as-{version}/stand-alone/log/server.log (for JBoss AS7).

For all other questions, try contacting the jBPM community as described in the Getting Started chapter.

Chapter 4. Examples

4.1. Introduction

This chapter provides a walkthrough of a pre-made Red Hat JBoss BPM Suite example project. In this chapter, you will:

- Import a number of pre-made example projects into your JBoss BPM Suite
- Learn about the Human Resources Example and its usecase
- Build and deploy the example project
- Instantiate and explore the project

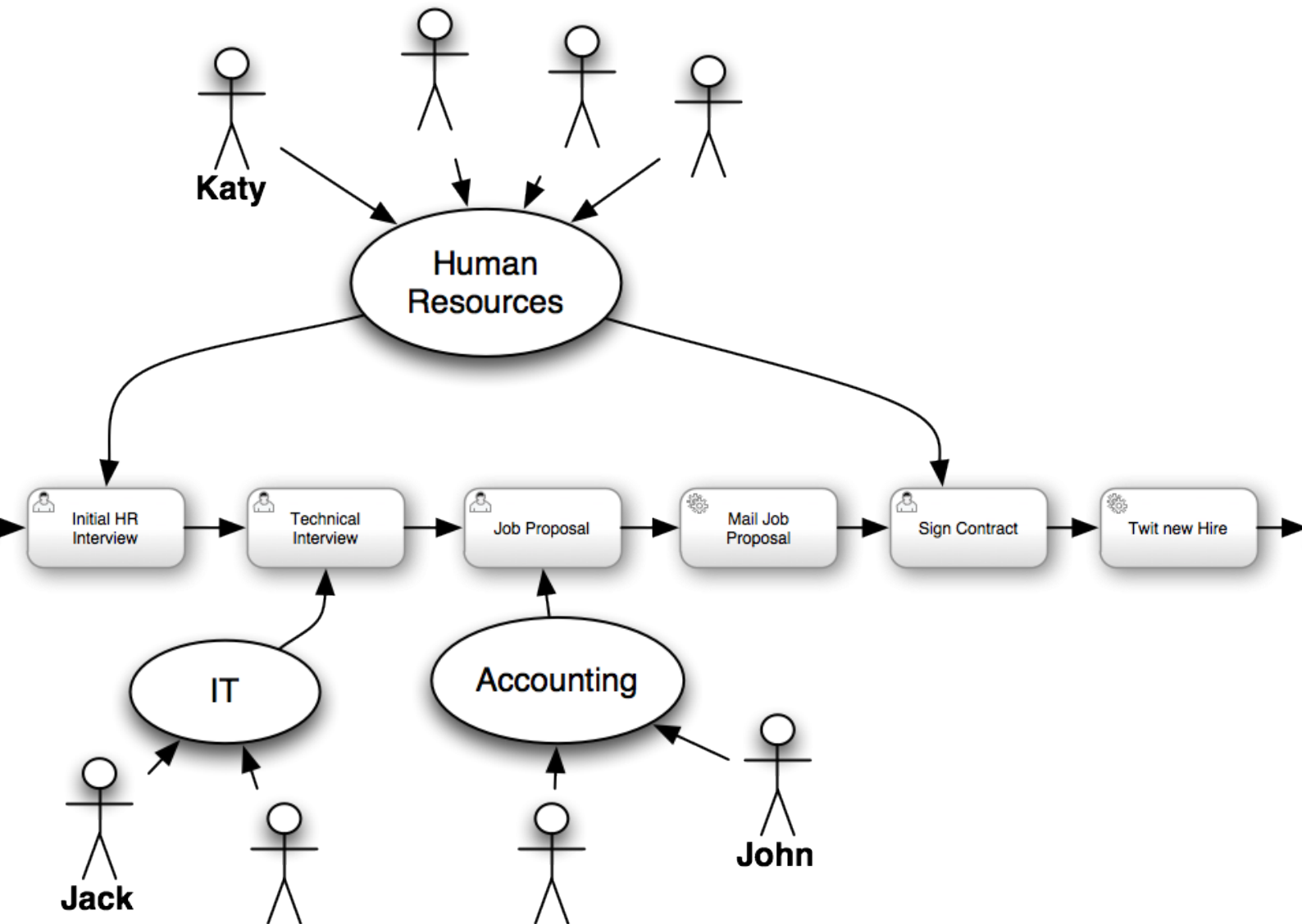
The project, together with many other example projects, can be imported through github [<https://github.com/droolsjbpm/jbpm-playground>]. To learn how to import projects through github, see the JBoss BPM Suite Getting Started Guide.

The web-based workbench by default will install two sample repositories that contain various sample projects that help you getting started. This section shows different examples that can be found in the jbpm-playground repository (also available here: <https://github.com/droolsjbpm/jbpm-playground>). All these examples are high level and business oriented.

If you want to contribute with these examples please get in touch with any member of the jBPM/Drools Team.

4.2. Human Resources Example

The Human Resource Example's use case can be described as follows: A company wants to hire new developers. In this process, three departments (that is the Human resources, IT, and Accounting) are involved. These departments are represented by three users: Katy, Jack, and John respectively.



Business process designed for the Human Resource Example's use case

Figure 4.1. Business Process

Note that only four out of the six defined activities within the business process are User Tasks. User Tasks require human interaction. The other two tasks are Service Tasks, which are automated and connected to other systems.

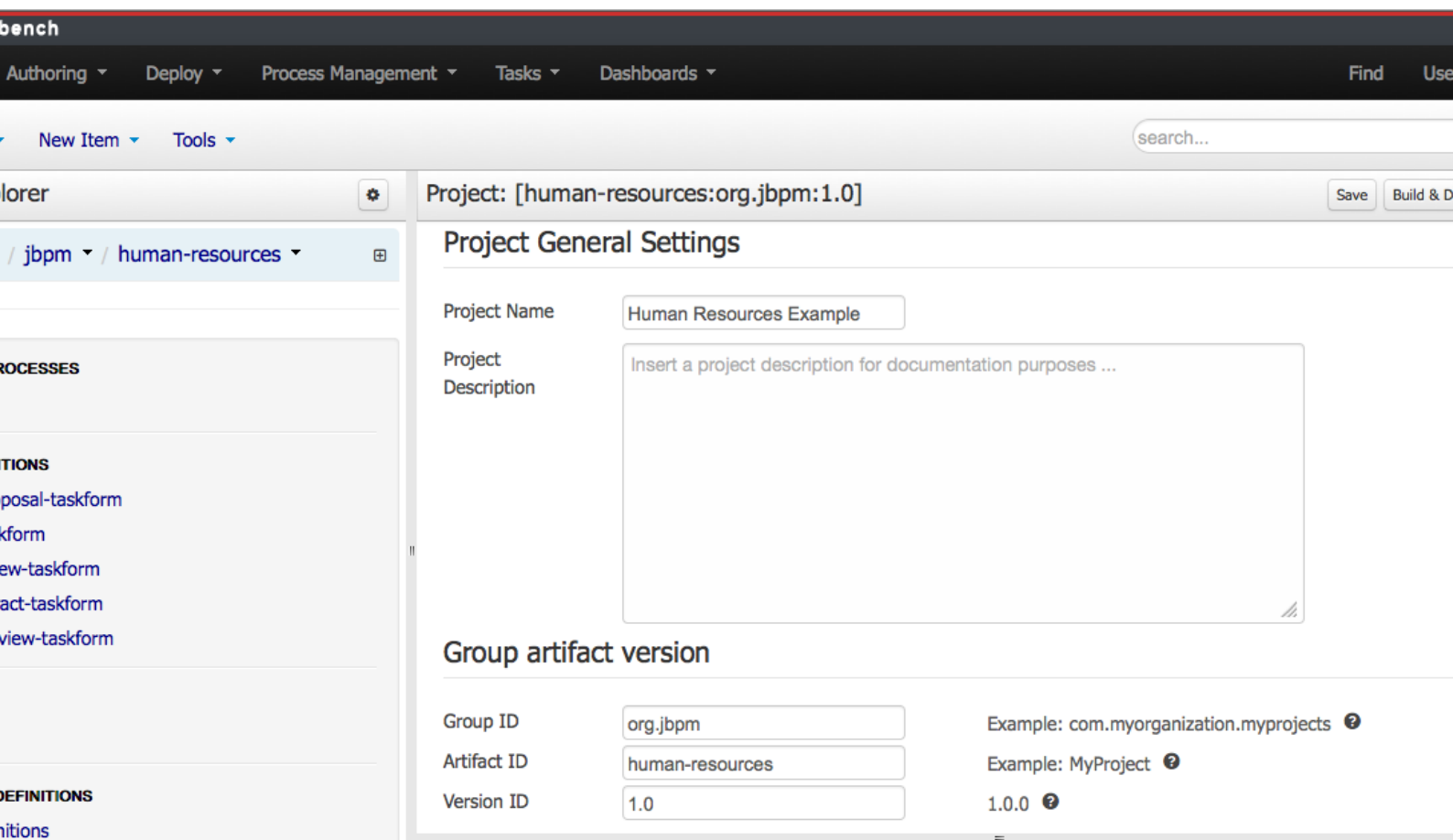
Each instance of the process will follow certain actions:

- The human resources team performs the initial interview with the candidate
- The IT department team performs the technical interview

- Based on the output from the previous two steps, the accounting team creates a job proposal
- When the proposal has been drafted, it is automatically sent to the candidate via email
- If the candidate accepts the proposal, a new meeting to sign the contract is scheduled
- Finally, if the candidate accepts the proposal, the system posts a message about the new hire using Twitter service connector

Note, that Jack, John, and Katy may represent any employee within the company with appropriate role assigned.

4.2.1. The KIE Project: human-resources



Project content in the Authoring Perspective

Figure 4.2. Authoring Perspective

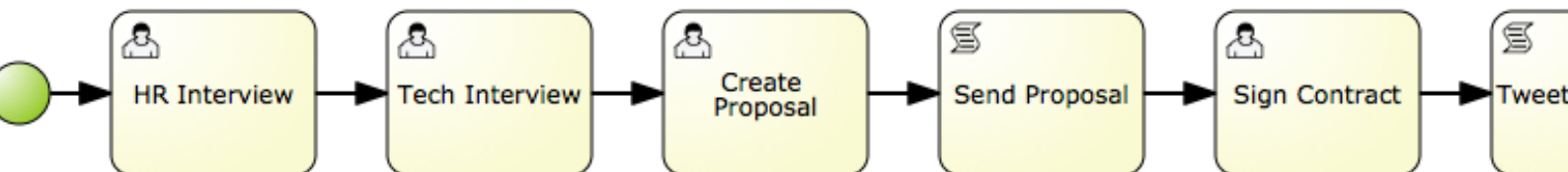
The Authoring Perspective contains the **hiring.bpmn2** process and a set of forms for each human task. You may explore these knowledge assets by clicking on them. Notice that different editors open for different types of assets. If you click on the Business Process file, the Process Designer opens:

s Process [hiring]



Process Modelling Simulation Results

g a Developer v.1 (hiring)



You may also explore the forms. Notice that the Form Modeller will be opened, which allows you to edit the forms to fit your requirements.

Form Modeller [HRInterview-taskform]

Form data origin Add fields by origin Add fields by type Form properties Show mode Bindings

- HTML label
- Separator
- Simple subform
- Multiple subform
- Short text
- Long text
- Float
- Decimal
- BigDecimal
- BigInteger
- Short

● Candidate Name

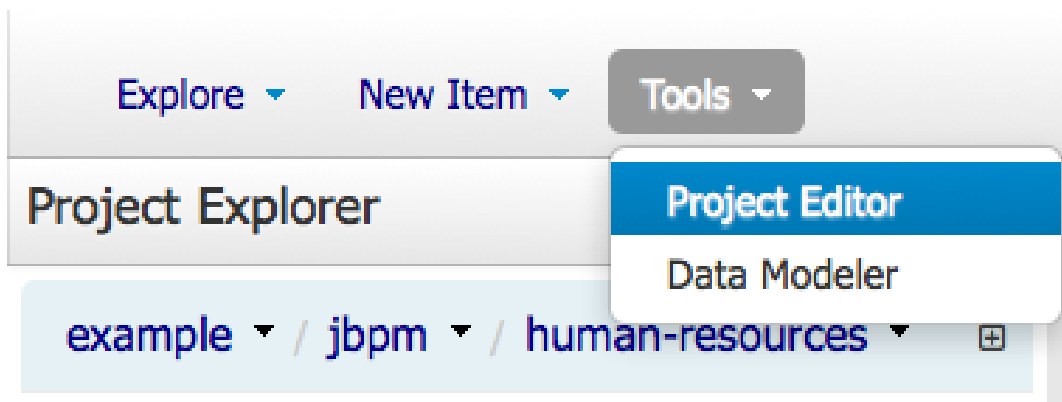
● Age

● Email

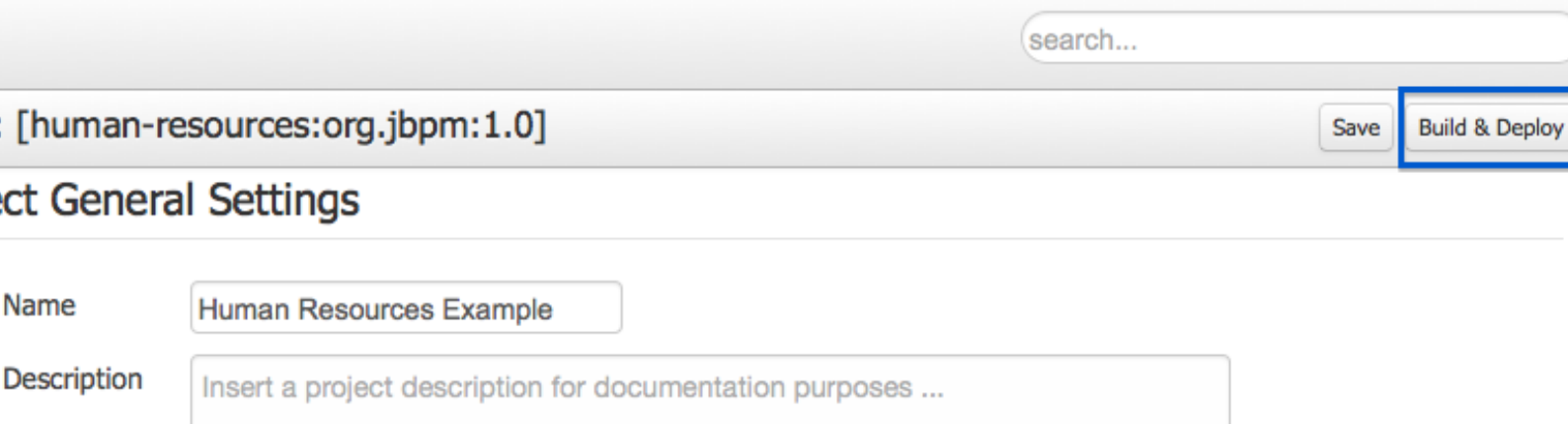
● Score

4.2.2. Building the Human Resources Example

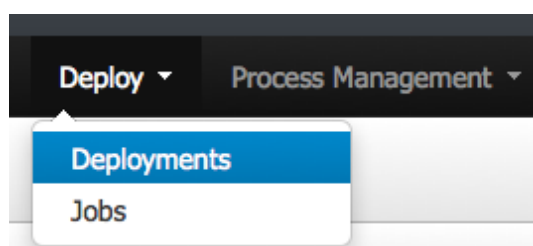
In order to build the Project, you need to go to the Authoring Perspective and open the Project Editor panel:



Once you open the Project Editor, you will see in the top right corner of the panel Build & Deploy. This button allows you to create a new JAR artifact that will be deployed to the runtime environment as a new deployment unit.



Once you get the visual notification that the project was built and deployed successfully, you may verify its presence in the Deployments tab. To do so, click Deploy → .



You may find all the deployed units in the Deployments tab. When you *Build & Deploy* a project from the Project Editor, it is automatically deployed using the default configurations. Therefore, Singleton Strategy, the default KIE Base and the default KIE Session will be used.

In case you wish a more advanced deployment, you may undeploy and re-deploy your artifacts using their GAV and selecting non-default settings. By doing so, you will be able to set a different strategy, or use non-default KIE Base or KIE Session.

	Group ID	Artifact	Version	Kie Base Name	Kie Session Name	Runtime strategy
ation:1.0	org.jbpm	evaluation	1.0	DEFAULT	DEFAULT	SINGLETON
n-resources:1.0	org.jbpm	human-resources	1.0	DEFAULT	DEFAULT	SINGLETON

Once your artifact that contains the process definition is deployed, the Process Definition will become available in Process Management → Process Definitions.

4.2.3. Create a new Process Instance

In order to create new Process Instances click Process Management → Process Definitions.

The Process Definitions tab contains all the available process definitions in the runtime environment. In order to add new process definitions, build and deploy a new project.

	Version	Actions
	1	
per	1	

Definition Id hiring

Definition Name Hiring a Developer

Deployment org.jbpm:human-resources:1.0

Human Tasks Sign Contract
Create Proposal
Tech Interview
HR Interview

Human Task Count 4

User and Groups HR - Sign Contract
Accounting - Create Proposal
IT - Tech Interview
HR - HR Interview

You may start process instances using any of the two highlighted options

Figure 4.3. Starting Process Instances

Most processes require additional information to create a new process instance. This is done through forms. For this project, fill in the name of the candidate that is to be interviewed.

Hiring a Developer

*Candidate Name
salaboy

▶

By clicking the start button, a new process instance will be created. This creates the first task, that is available for the Human Resources team. In order to see the task, you need to logout and log in as a user with the appropriate role assigned, that is someone from the Human Resources.

Once you have started the process, you may interact with the human tasks. To do so, click Task → Tasks. Note that in order to see the tasks in the task list, you need to belong to specific user groups, for which the task is designed. For example, the HR Interview task is visible only for the members of the HR group, and the Tech Interview Task is visible only to the members of the IT group.

4.3. Examples zip

A zip file of examples can also be downloaded from the downloads page, containing various examples that can be opened in the Eclipse-based Developers Tools. Simply download and unzip the examples artefact and import into your Eclipse workspace.

Part II. jBPM Core

Using the jBPM Core Engine

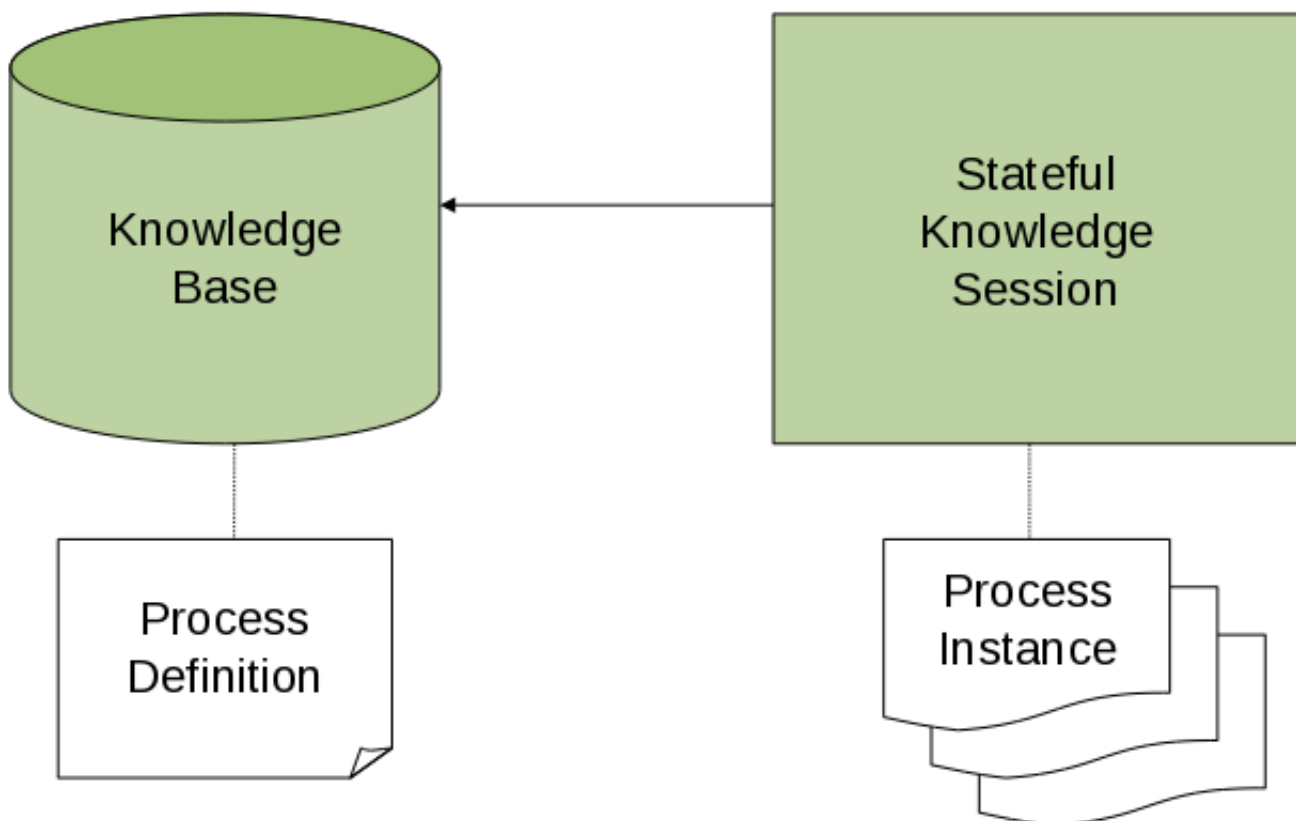
Chapter 5. Core Engine API

5.1. Overview

This chapter introduces the API you need to load processes and execute them. For more detail on how to define the processes themselves, check out the chapter on BPMN 2.0.

To interact with the process engine (for example, to start a process), you need to set up a session. This session will be used to communicate with the process engine. A session needs to have a reference to a knowledge base, which contains a reference to all the relevant process definitions. This knowledge base is used to look up the process definitions whenever necessary. To create a session, you first need to create a knowledge base, load all the necessary process definitions (this can be from various sources, like from classpath, file system or process repository) and then instantiate a session.

Once you have set up a session, you can use it to start executing processes. Whenever a process is started, a new process instance is created (for that process definition) that maintains the state of that specific instance of the process.



For example, imagine you are writing an application to process sales orders. You could then define one or more process definitions that define how the order should be processed. When starting up your application, you first need to create a knowledge base that contains those process definitions. You can then create a session based on this knowledge base so that, whenever a new sales order

comes in, a new process instance is started for that sales order. That process instance contains the state of the process for that specific sales request.

A knowledge base can be shared across sessions and usually is only created once, at the start of the application (as creating a knowledge base can be rather heavy-weight as it involves parsing and compiling the process definitions). Knowledge bases can be dynamically changed (so you can add or remove processes at runtime).

Sessions can be created based on a knowledge base and are used to execute processes and interact with the engine. You can create as many independent session as you need and creating a session is considered relatively lightweight. How many sessions you create is up to you. In general, most simple cases start out with creating one session that is then called from various places in your application. You could decide to create multiple sessions if for example you want to have multiple independent processing units (for example, if you want all processes from one customer to be completely independent from processes for another customer, you could create an independent session for each customer) or if you need multiple sessions for scalability reasons. If you don't know what to do, simply start by having one knowledge base that contains all your process definitions and create one session that you then use to execute all your processes.

The jBPM project has a clear separation between the API the users should be interacting with and the actual implementation classes. The public API exposes most of the features we believe "normal" users can safely use and should remain rather stable across releases. Expert users can still access internal classes but should be aware that they should know what they are doing and that the internal API might still change in the future.

As explained above, the jBPM API should thus be used to (1) create a knowledge base that contains your process definitions, and to (2) create a session to start new process instances, signal existing ones, register listeners, etc.

5.2. KieBase

The jBPM API allows you to first create a knowledge base. This knowledge base should include all your process definitions that might need to be executed by that session. To create a knowledge base, use a KieHelper to load processes from various resources (for example from the classpath or from the file system), and then create a new knowledge base from that helper. The following code snippet shows how to create a knowledge base consisting of only one process definition (using in this case a resource from the classpath).

```
KieHelper kieHelper = new KieHelper();
KieBase kieBase = kieHelper
    .addResource(ResourceFactory.newClassPathResource("MyProcess.bpmn"))
    .build();
```

The ResourceFactory has similar methods to load files from file system, from URL, InputStream, Reader, etc.

This is considered manual creation of knowledge base and while it is simple it is not recommended for real application development but more for try outs. Following you'll find recommended and much more powerful way of building knowledge base, knowledge session and more - Runtime-Manager.

5.3. KieSession

Once you've loaded your knowledge base, you should create a session to interact with the engine. This session can then be used to start new processes, signal events, etc. The following code snippet shows how easy it is to create a session based on the previously created knowledge base, and to start a process (by id).

```
KieSession ksession = kbase.newKieSession();
ProcessInstance processInstance = ksession.startProcess("com.sample.MyProcess");
```

5.3.1. ProcessRuntime

The `ProcessRuntime` interface defines all the session methods for interacting with processes, as shown below.

```
/**
 * Start a new process instance. The process (definition) that should
 * be used is referenced by the given process id.
 *
 * @param processId The id of the process that should be started
 * @return the that represents the instance of the process that was started
 */
ProcessInstance startProcess(String processId);

/**
 * Start a new process instance. The process (definition) that should
 * be used is referenced by the given process id. Parameters can be passed
 * to the process instance (as name-value pairs), and these will be set
 * as variables of the process instance.
 *
 * @param processId the id of the process that should be started
 * @param parameters the process variables that should be set when starting the process instance
 * @return the that represents the instance of the process that was started
 */
ProcessInstance startProcess(String processId,
                             Map<String, Object> parameters);

/**
 * Signals the engine that an event has occurred. The type parameter defines
 * which type of event and the event parameter can contain additional information
 * related to the event. All process instances that are listening to this type
 * of (external) event will be notified. For performance reasons, this type of event
 * signaling should only be used if one process instance should be able to notify
 * other process instances. For internal event within one process instance, use the
```

```
* signalEvent method that also include the processInstanceId of the process instance
* in question.
*
* @param type the type of event
* @param event the data associated with this event
*/
void signalEvent(String type,
                 Object event);

/**
 * Signals the process instance that an event has occurred. The type parameter defines
 * which type of event and the event parameter can contain additional information
 * related to the event. All node instances inside the given process instance that
 * are listening to this type of (internal) event will be notified. Note that the event
 * will only be processed inside the given process instance. All other process instances
 * waiting for this type of event will not be notified.
 *
 * @param type the type of event
 * @param event the data associated with this event
 * @param processInstanceId the id of the process instance that should be signaled
 */
void signalEvent(String type,
                 Object event,
                 long processInstanceId);

/**
 * Returns a collection of currently active process instances. Note that only process
 * instances that are currently loaded and active inside the engine will be returned.
 * When using persistence, it is likely not all running process instances will be loaded
 * as their state will be stored persistently. It is recommended not to use this
 * method to collect information about the state of your process instances but to use
 * a history log for that purpose.
 *
 * @return a collection of process instances currently active in the session
 */
Collection<ProcessInstance> getProcessInstances();

/**
 * Returns the process instance with the given id. Note that only active process instances
 * will be returned. If a process instance has been completed already, this method will return
 * null.
 *
 * @param id the id of the process instance
 * @return the process instance with the given id or null if it cannot be found
 */
ProcessInstance getProcessInstance(long processInstanceId);

/**
 * Aborts the process instance with the given id. If the process instance has been completed
 * (or aborted), or the process instance cannot be found, this method will throw an
 * IllegalArgumentException.
 *
 * @param id the id of the process instance
 */
void abortProcessInstance(long processInstanceId);

/**
 * Returns the WorkItemManager related to this session. This can be used to
 * register new WorkItemHandlers or to complete (or abort) WorkItems.

```

```
*  
* @return the WorkItemManager related to this session  
*/  
WorkItemManager getWorkItemManager();
```

5.3.2. Event Listeners

The session provides methods for registering and removing listeners. A `ProcessEventListener` can be used to listen to process-related events, like starting or completing a process, entering and leaving a node, etc. Below, the different methods of the `ProcessEventListener` class are shown. An event object provides access to related information, like the process instance and node instance linked to the event. You can use this API to register your own event listeners.

```
public interface ProcessEventListener {  
  
    void beforeProcessStarted( ProcessStartedEvent event );  
    void afterProcessStarted( ProcessStartedEvent event );  
    void beforeProcessCompleted( ProcessCompletedEvent event );  
    void afterProcessCompleted( ProcessCompletedEvent event );  
    void beforeNodeTriggered( ProcessNodeTriggeredEvent event );  
    void afterNodeTriggered( ProcessNodeTriggeredEvent event );  
    void beforeNodeLeft( ProcessNodeLeftEvent event );  
    void afterNodeLeft( ProcessNodeLeftEvent event );  
    void beforeVariableChanged( ProcessVariableChangedEvent event );  
    void afterVariableChanged( ProcessVariableChangedEvent event );  
  
}
```

A note about before and after events: these events typically act like a stack, which means that any events that occur as a direct result of the previous event, will occur between the before and the after of that event. For example, if a subsequent node is triggered as result of leaving a node, the node triggered events will occur inbetween the `beforeNodeLeftEvent` and the `afterNodeLeftEvent` of the node that is left (as the triggering of the second node is a direct result of leaving the first node). Doing that allows us to derive cause relationships between events more easily. Similarly, all node triggered and node left events that are the direct result of starting a process will occur between the `beforeProcessStarted` and `afterProcessStarted` events. In general, if you just want to be notified when a particular event occurs, you should be looking at the before events only (as they occur immediately before the event actually occurs). When only looking at the after events, one might get the impression that the events are fired in the wrong order, but because the after events are triggered as a stack (after events will only fire when all events that were triggered as a result of this event have already fired). After events should only be used if you want to make sure that all processing related to this has ended (for example, when you want to be notified when starting of a particular process instance has ended).

Also note that not all nodes always generate node triggered and/or node left events. Depending on the type of node, some nodes might only generate node left events, others might only generate node triggered events. Catching intermediate events for example are not generating triggered

events (they are only generating left events, as they are not really triggered by another node, rather activated from outside). Similarly, throwing intermediate events are not generating left events (they are only generating triggered events, as they are not really left, as they have no outgoing connection).






jBPM out-of-the-box provides a listener that can be used to create an audit log (either to the console or the a file on the file system). This audit log contains all the different events that occurred at runtime so it's easy to figure out what happened. Note that these loggers should only be used for debugging purposes. The following logger implementations are supported by default:

1. Console logger: This logger writes out all the events to the console.
2. File logger: This logger writes out all the events to a file using an XML representation. This log file might then be used in the IDE to generate a tree-based visualization of the events that occurred during execution.
3. Threaded file logger: Because a file logger writes the events to disk only when closing the logger or when the number of events in the logger reaches a predefined level, it cannot be used when debugging processes at runtime. A threaded file logger writes the events to a file after a specified time interval, making it possible to use the logger to visualize the progress in realtime, while debugging processes.

The `KieServices` lets you add a `KieRuntimeLogger` to your session, as shown below. When creating a console logger, the knowledge session for which the logger needs to be created must be passed as an argument. The file logger also requires the name of the log file to be created, and the threaded file logger requires the interval (in milliseconds) after which the events should be saved. You should always close the logger at the end of your application.

```
import org.kie.api.KieServices;
import org.kie.api.logger.KieRuntimeLogger;
...
KieRuntimeLogger logger = KieServices.Factory.get().getLoggers().newFileLogger(ksession, "test");
// add invocations to the process engine here,
// e.g. ksession.startProcess(processId);
...
logger.close();
```

The log file that is created by the file-based loggers contains an XML-based overview of all the events that occurred at runtime. It can be opened in Eclipse, using the Audit View in the Drools Eclipse plugin, where the events are visualized as a tree. Events that occur between the before and after event are shown as children of that event. The following screenshot shows a simple example, where a process is started, resulting in the activation of the Start node, an Action node and an End node, after which the process was completed.

- ▼  RuleFlow started: ruleflow[com.sample.ruleflow]
- ▼  RuleFlow node triggered: Start in process ruleflow[com.sample.ruleflow]
 - ▼  RuleFlow node triggered: Hello in process ruleflow[com.sample.ruleflow]
 - ▼  RuleFlow node triggered: End in process ruleflow[com.sample.ruleflow]
 -  RuleFlow completed: ruleflow[com.sample.ruleflow]

5.3.3. Correlation Keys

A common requirement when working with processes is ability to assign a given process instance some sort of business identifier that can be later on referenced without knowing the actual (generated) id of the process instance. To provide such capabilities, jBPM allows to use Correlation-Key that is composed of CorrelationProperties. CorrelationKey can have either single property describing it (which is in most cases) but it can be represented as multi valued properties set.

Correlation capabilities are provided as part of interface

```
CorrelationAwareProcessRuntime
```

that exposes following methods:

```
/**
 * Start a new process instance. The process (definition) that should
 * be used is referenced by the given process id. Parameters can be passed
 * to the process instance (as name-value pairs), and these will be set
 * as variables of the process instance.
 *
 * @param processId the id of the process that should be started
 * @param correlationKey custom correlation key that can be used to identify process instance
 * @param parameters the process variables that should be set when starting the process instance
 * @return the that represents the instance of the process that was started
 */
ProcessInstance startProcess(String processId, CorrelationKey correlationKey, Map<String, Object> parameters);

/**
 * Creates a new process instance (but does not yet start it). The process
 * (definition) that should be used is referenced by the given process id.
 * Parameters can be passed to the process instance (as name-value pairs),
 * and these will be set as variables of the process instance. You should only
 * use this method if you need a reference to the process instance before actually
 * starting it. Otherwise, use startProcess.
 *
 * @param processId the id of the process that should be started
 * @param correlationKey custom correlation key that can be used to identify process instance
 * @param parameters the process variables that should be set when creating the process instance
 * @return the that represents the instance of the process that was created (but not yet started)
 */
ProcessInstance createProcessInstance(String processId, CorrelationKey correlationKey, Map<String, Object> parameters);
```

```
/**
 * Returns the process instance with the given correlationKey. Note that only active process instances
 * will be returned. If a process instance has been completed already, this method will return
 * .
 *
 * @param correlationKey the custom correlation key assigned when process instance was created
 * @return the process instance with the given id or if it cannot be found
 */
ProcessInstance getProcessInstance(CorrelationKey correlationKey);
```

Correlation is usually used with long running processes and thus require persistence to be enabled to be able to permanently store correlation information.

5.3.4. Threads

In the following text, we will refer to two types of "multi-threading": *logical* and *technical*. *Technical multi-threading* is what happens when multiple threads or processes are started on a computer, for example by a Java or C program. *Logical multi-threading* is what we see in a BPM process after the process reaches a parallel gateway, for example. From a functional standpoint, the original process will then split into two processes that are executed in a parallel fashion.

Of course, the jBPM engine supports logical multi-threading: for example, processes that include a parallel gateway. We've chosen to implement logical multi-threading using one thread: a jBPM process that includes logical multi-threading will only be executed in one technical thread. The main reason for doing this is that multiple (technical) threads need to be able to communicate state information with each other if they are working on the same process. This requirement brings with it a number of complications. While it might seem that multi-threading would bring performance benefits with it, the extra logic needed to make sure the different threads work together well means that this is not guaranteed. There is also the extra overhead incurred because we need to avoid race conditions and deadlocks.

In general, the jBPM engine executes actions in serial. For example, when the engine encounters a script task in a process, it will synchronously execute that script and wait for it to complete before continuing execution. Similarly, if a process encounters a parallel gateway, it will sequentially trigger each of the outgoing branches, one after the other. This is possible since execution is almost always instantaneous, meaning that it is extremely fast and produces almost no overhead. As a result, the user will usually not even notice this. Similarly, action scripts in a process are also synchronously executed, and the engine will wait for them to finish before continuing the process. For example, doing a `Thread.sleep(...)` as part of a script will not make the engine continue execution elsewhere but will block the engine thread during that period.

The same principle applies to service tasks. When a service task is reached in a process, the engine will also invoke the handler of this service synchronously. The engine will wait for the `completeWorkItem(...)` method to return before continuing execution. It is important that your service handler executes your service asynchronously if its execution is not instantaneous.

An example of this would be a service task that invokes an external service. Since the delay in invoking this service remotely and waiting for the results might be too long, it might be a good idea to invoke this service asynchronously. This means that the handler will only invoke the service and will notify the engine later when the results are available. In the mean time, the process engine then continues execution of the process.

Human tasks are a typical example of a service that needs to be invoked asynchronously, as we don't want the engine to wait until a human actor has responded to the request. The human task handler will only create a new task (on the task list of the assigned actor) when the human task node is triggered. The engine will then be able to continue execution on the rest of the process (if necessary) and the handler will notify the engine asynchronously when the user has completed the task.

5.4. RuntimeManager

5.4.1. Overview

RuntimeManager has been introduced to simplify and empower usage of knowledge API especially in context of processes. It provides configurable strategies that control actual runtime execution (how KieSessions are provided) and by default provides following:

- Singleton - runtime manager maintains single KieSession regardless of number of processes available
- Per Request - runtime manager delivers new KieSession for every request
- Per Process Instance - runtime manager maintains mapping between process instance and KieSession and always provides same KieSession whenever working with given process instance

Runtime Manager is primary responsible for managing and delivering instances of RuntimeEngine to the caller. In turn, RuntimeEngine encapsulates two the most important elements of jBPM engine:

- KieSession
- TaskService

Both of these components are already configured to work with each other smoothly without additional configuration from end user. No more need to register human task handler or keeping track if it's connected to the service or not.

```
public interface RuntimeManager {  
  
    /**  
     * Returns RuntimeEngine instance that is fully initialized:  
     * 

  
     * <li>KiseSession is created or loaded depending on the strategy</li>  
     * <li>TaskService is initialized and attached to ksession (via listener)</li>  
     * 
  
     */  
}
```

```

    * <li>WorkItemHandlers are initialized and registered on ksession</li>
    * <li>EventListeners (process, agenda, working memory) are initialized and added to ksession</li>
    * </ul>
    * @param context the concrete implementation of the context that is supported by given <code>RuntimeManager</code>
    * @return instance of the <code>RuntimeEngine</code>
    */
    RuntimeEngine getRuntimeEngine(Context<?> context);

    /**
     * Unique identifier of the <code>RuntimeManager</code>
     * @return
     */
    String getIdentifier();

    /**
     * Disposes <code>RuntimeEngine</code> and notifies all listeners about that fact.
     * This method should always be used to dispose <code>RuntimeEngine</code> that is not needed
     * anymore. <br/>
     * ksession.dispose() shall never be used with RuntimeManager as it will break the internal
     * mechanisms of the manager responsible for clear and efficient disposal.<br/>
     * Dispose is not needed if <code>RuntimeEngine</code>
     * was obtained within active JTA transaction,
     * this means that when getRuntimeEngine method was invoked during active JTA transaction then dispose of
     * the runtime engine will happen automatically on transaction completion.
     * @param runtime
     */
    void disposeRuntimeEngine(RuntimeEngine runtime);

    /**
     * Closes <code>RuntimeManager</code> and releases its resources. Shall always be called when
     * runtime manager is not needed any more. Otherwise it will still be active and operational.
     */
    void close();
}

```

RuntimeEngine interface provides the most important methods to get access to engine components:

```

public interface RuntimeEngine {

    /**
     * Returns <code>KieSession</code> configured for this <code>RuntimeEngine</code>
     * @return
     */
    KieSession getKieSession();

    /**
     * Returns <code>TaskService</code> configured for this <code>RuntimeEngine</code>
     * @return
     */
    TaskService getTaskService();
}

```

RuntimeManager will ensure that regardless of the strategy it will provide same capabilities when it comes to initialization and configuration of the RuntimeEngine. That means

- KieSession will be loaded with same factories (either in memory or JPA based)
- WorkItemHandlers will be registered on every KieSession (either loaded from db or newly created)
- Event listeners (Process, Agenda, WorkingMemory) will be registered on every KieSession (either loaded from db or newly created)
- TaskService will be configured with:
 - JTA transaction manager
 - same entity manager factory as for the KieSession
 - UserGroupCallback from environment

On the other hand, RuntimeManager maintains the engine disposal as well by providing dedicated methods to dispose RuntimeEngine when it's no more needed to release any resources it might have acquired.



Note

RuntimeManager's identifier is used as "deploymentId" during runtime execution. For example, the identifier is persisted as "deploymentId" of a Task when the Task is persisted. Task's deploymentId is used to associate the RuntimeManager when the Task is completed and its process instance is resumed. The deploymentId is also persisted as "externalId" in history log tables. If you don't specify an identifier on RuntimeManager creation, a default value is applied (e.g. "default-per-pinstance" for PerProcessInstanceRuntimeManager). That means your application uses the same deployment in its lifecycle. If you maintain multiple RuntimeManagers in your application, you need to specify their identifiers. For example, jbpms-services (DeploymentService) maintains multiple RuntimeManagers with identifiers of kjar's GAV. kie-workbench web application too because it depends on jbpms-services.

5.4.2. Strategies

Singleton strategy - instructs RuntimeManager to maintain single instance of RuntimeEngine (and in turn single instance of KieSession and TaskService). Access to the RuntimeEngine is synchronized and by that thread safe although it comes with a performance penalty due to synchronization. This strategy is similar to what was available by default in jBPM version 5.x and it's considered easiest strategy and recommended to start with.

It has following characteristics that are important to evaluate while considering it for given scenario:

- small memory footprint - single instance of runtime engine and task service
- simple and compact in design and usage
- good fit for low to medium load on process engine due to synchronized access
- due to single KieSession instance all state objects (such as facts) are directly visible to all process instances and vice versa
- not contextual - meaning when retrieving instances of RuntimeEngine from singleton RuntimeManager Context instance is not important and usually EmptyContext.get() is used although null argument is acceptable as well
- keeps track of id of KieSession used between RuntimeManager restarts to ensure it will use same session - this id is stored as serialized file on disc in temp location that depends on the environment can be one of following:
 - value given by jbpn.data.dir system property
 - value given by jboss.server.data.dir system property
 - value given by java.io.tmpdir system property

Per request strategy - instructs RuntimeManager to provide new instance of RuntimeEngine for every request. As request RuntimeManager will consider one or more invocations within single transaction. It must return same instance of RuntimeEngine within single transaction to ensure correctness of state as otherwise operation done in one call would not be visible in the other. This is sort of "stateless" strategy that provides only request scope state and once request is completed RuntimeEngine will be permanently destroyed - KieSession information will be removed from the database in case persistence was used.

It has following characteristics:

- completely isolated process engine and task service operations for every request
- completely stateless, storing facts makes sense only for the duration of the request
- good fit for high load, stateless processes (no facts or timers involved that shall be preserved between requests)
- KieSession is only available during life time of request and at the end is destroyed
- not contextual - meaning when retrieving instances of RuntimeEngine from per request RuntimeManager Context instance is not important and usually EmptyContext.get() is used although null argument is acceptable as well

Per process instance strategy - instructs RuntimeManager to maintain a strict relationship between KieSession and ProcessInstance. That means that KieSession will be available as long as the ProcessInstance that it belongs to is active. This strategy provides the most flexible approach to use advanced capabilities of the engine like rule evaluation in isolation (for given process in-

stance only), maximum performance and reduction of potential bottlenecks introduced by synchronization; and at the same time reduces number of KieSessions to the actual number of process instances rather than number of requests (in contrast to per request strategy).

It has following characteristics:

- most advanced strategy to provide isolation to given process instance only
- maintains strict relationship between KieSession and ProcessInstance to ensure it will always deliver same KieSession for given ProcessInstance
- merges life cycle of KieSession with ProcessInstance making both to be disposed on process instance completion (complete or abort)
- allows to maintain data (such as facts, timers) in scope of process instance - only process instance will have access to that data
- introduces bit of overhead due to need to look up and load KieSession for process instance
- validates usage of KieSession so it cannot be (ab)used for other process instances, in such a case exception is thrown
- is contextual - accepts following context instances:
 - EmptyContext or null - when starting process instance as there is no process instance id available yet
 - ProcessInstanceIdContext - used after process instance was created
 - CorrelationKeyContext - used as an alternative to ProcessInstanceIdContext to use custom (business) key instead of process instance id

5.4.3. Usage

Regular usage scenario for RuntimeManager is:

- At application startup
 - build RuntimeManager and keep it for entire life time of the application, it's thread safe and can be (or even should be) accessed concurrently
- At request
 - get RuntimeEngine from RuntimeManager using proper context instance dedicated to strategy of RuntimeManager
 - get KieSession and/or TaskService from RuntimeEngine
 - perform operations on KieSession and/or TaskService such as startProcess, completeTask, etc

- once done with processing dispose `RuntimeEngine` using `RuntimeManager.disposeRuntimeEngine` method
- At application shutdown
- close `RuntimeManager`



Note

When `RuntimeEngine` is obtained from `RuntimeManager` within an active JTA transaction, then there is no need to dispose `RuntimeEngine` at the end, as `RuntimeManager` will automatically dispose the `RuntimeEngine` on transaction completion (regardless of the completion status commit or rollback).

5.4.3.1. Example

Here is how you can build `RuntimeManager` and get `RuntimeEngine` (that encapsulates `KieSession` and `TaskService`) from it:

```
// first configure environment that will be used by RuntimeManager
RuntimeEnvironment environment = RuntimeEnvironmentBuilder.Factory.get()
    .newDefaultInMemoryBuilder()
        .addAsset(ResourceFactory.newClassPathResource("BPMN2-ScriptTask.bpmn2"), ResourceType.BPMN2)
    .get();

// next create RuntimeManager - in this case singleton strategy is chosen
RuntimeManager manager = RuntimeManagerFactory.Factory.get().newSingletonRuntimeManager(environment);

// then get RuntimeEngine out of manager - using empty context as singleton does not keep track
// of runtime engine as there is only one
RuntimeEngine runtime = manager.getRuntimeEngine(EmptyContext.get());

// get KieSession from runtime runtimeEngine - already initialized with all handlers,
// listeners, etc that were configured
// on the environment
KieSession ksession = runtimeEngine.getKieSession();

// add invocations to the process engine here,
// e.g. ksession.startProcess(processId);

// and last dispose the runtime engine
manager.disposeRuntimeEngine(runtimeEngine);
```

This example provides simplest (minimal) way of using `RuntimeManager` and `RuntimeEngine` although it provides few quite valuable information:

- KieSession will be in memory only - by using newDefaultInMemoryBuilder
- there will be single process available for execution - by adding it as an asset
- TaskService will be configured and attached to KieSession via LocalHTWorkItemHandler to support user task capabilities within processes

5.4.4. Configuration

The complexity of knowing when to create, dispose, register handlers, etc is taken away from the end user and moved to the runtime manager that knows when/how to perform such operations but still allows to have a fine grained control over this process by providing comprehensive configuration of the RuntimeEnvironment.

```
public interface RuntimeEnvironment {  
  
    /**  
     * Returns <code>KieBase</code> that shall be used by the manager  
     * @return  
     */  
    KieBase getKieBase();  
  
    /**  
     * KieSession environment that shall be used to create instances of <code>KieSession</code>  
     * @return  
     */  
    Environment getEnvironment();  
  
    /**  
     * KieSession configuration that shall be used to create instances of <code>KieSession</code>  
     * @return  
     */  
    KieSessionConfiguration getConfiguration();  
  
    /**  
     * Indicates if persistence shall be used for the KieSession instances  
     * @return  
     */  
    boolean usePersistence();  
  
    /**  
     * Delivers concrete implementation of <code>RegisterableItemsFactory</code>  
     * to obtain handlers and listeners  
     * that shall be registered on instances of <code>KieSession</code>  
     * @return  
     */  
    RegisterableItemsFactory getRegisterableItemsFactory();  
  
    /**  
     * Delivers concrete implementation of <code>UserGroupCallback</code>  
     * that shall be registered on instances  
     * of <code>TaskService</code> for managing users and groups.  
     * @return  
     */  
}
```

```
UserGroupCallback getUserGroupCallback();

/**
 * Delivers custom class loader that shall be used by the process engine and task service instances
 * @return
 */
ClassLoader getClassLoader();

/**
 * Closes the environment allowing to close all depending components such as ksession factories, etc
 */
void close();
```

5.4.4.1. Building RuntimeEnvironment

While RuntimeEnvironment interface provides mostly access to data kept as part of the environment and will be used by the RuntimeManager, users should take advantage of builder style class that provides fluent API to configure RuntimeEnvironment with predefined settings.

```
public interface RuntimeEnvironmentBuilder {

    public RuntimeEnvironmentBuilder persistence(boolean persistenceEnabled);

    public RuntimeEnvironmentBuilder entityManagerFactory(Object emf);

    public RuntimeEnvironmentBuilder addAsset(Resource asset, ResourceType type);

    public RuntimeEnvironmentBuilder addEnvironmentEntry(String name, Object value);

    public RuntimeEnvironmentBuilder addConfiguration(String name, String value);

    public RuntimeEnvironmentBuilder knowledgeBase(KieBase kbase);

    public RuntimeEnvironmentBuilder userGroupCallback(UserGroupCallback callback);

    public RuntimeEnvironmentBuilder registerableItemsFactory(RegisterableItemsFactory factory);

    public RuntimeEnvironment get();

    public RuntimeEnvironmentBuilder classLoader(ClassLoader cl);

    public RuntimeEnvironmentBuilder schedulerService(Object globalScheduler);
```

Instances of the RuntimeEnvironmentBuilder can be obtained via RuntimeEnvironmentBuilderFactory that provides preconfigured sets of builder to simplify and help users to build the environment for the RuntimeManager.

```
public interface RuntimeEnvironmentBuilderFactory {
```

```

/**
     * Provides completely empty <code>RuntimeEnvironmentBuilder</code>
code> instance that allows to manually
     * set all required components instead of relying on any defaults.
     * @return new instance of <code>RuntimeEnvironmentBuilder</code>
     */
    public RuntimeEnvironmentBuilder newEmptyBuilder();

/**
     * Provides default configuration of <code>RuntimeEnvironmentBuilder</code> that is based on:
     * <ul>
     * <li>DefaultRuntimeEnvironment</li>
     * </ul>
     * @return new instance of <code>RuntimeEnvironmentBuilder</code>
code> that is already preconfigured with defaults
     *
     * @see DefaultRuntimeEnvironment
     */
    public RuntimeEnvironmentBuilder newDefaultBuilder();

/**
     * Provides default configuration of <code>RuntimeEnvironmentBuilder</code> that is based on:
     * <ul>
     * <li>DefaultRuntimeEnvironment</li>
     * </ul>
     * but it does not have persistence for process engine configured so it will only store process instances in m
     * @return new instance of <code>RuntimeEnvironmentBuilder</code>
code> that is already preconfigured with defaults
     *
     * @see DefaultRuntimeEnvironment
     */
    public RuntimeEnvironmentBuilder newDefaultInMemoryBuilder();

/**
     * Provides default configuration of <code>RuntimeEnvironmentBuilder</code> that is based on:
     * <ul>
     * <li>DefaultRuntimeEnvironment</li>
     * </ul>
     * This one is tailored to works smoothly with kjar as the notion of kbase and ksessions
     * @param groupId group id of kjar
     * @param artifactId artifact id of kjar
     * @param version version number of kjar
     * @return new instance of <code>RuntimeEnvironmentBuilder</code>
code> that is already preconfigured with defaults
     *
     * @see DefaultRuntimeEnvironment
     */
    public RuntimeEnvironmentBuilder newDefaultBuilder(String groupId, String artifactId, String version);

/**
     * Provides default configuration of <code>RuntimeEnvironmentBuilder</code> that is based on:
     * <ul>
     * <li>DefaultRuntimeEnvironment</li>
     * </ul>
     * This one is tailored to works smoothly with kjar as the notion of kbase and ksessions
     * @param groupId group id of kjar
     * @param artifactId artifact id of kjar
     * @param version version number of kjar
     * @param kbaseName name of the kbase defined in kmodule.xml stored in kjar

```

```

    * @param ksessionId name of the ksession define in kmodule.xml stored in kjar
        * @return new instance of <code>RuntimeEnvironmentBuilder</code>
code> that is already preconfigured with defaults
    *
    * @see DefaultRuntimeEnvironment
    */
    public RuntimeEnvironmentBuilder newDefaultBuilder(String groupId, String artifactId, String version, String ksessionId) {
        /**
        * Provides default configuration of <code>RuntimeEnvironmentBuilder</code> that is based on:
        * <ul>
        * <li>DefaultRuntimeEnvironment</li>
        * </ul>
        * This one is tailored to works smoothly with kjar as the notion of kbase and ksessions
        * @param releaseId <code>ReleaseId</code> that described the kjar
        * @return new instance of <code>RuntimeEnvironmentBuilder</code>
code> that is already preconfigured with defaults
        *
        * @see DefaultRuntimeEnvironment
        */
        public RuntimeEnvironmentBuilder newDefaultBuilder(ReleaseId releaseId);

        /**
        * Provides default configuration of <code>RuntimeEnvironmentBuilder</code> that is based on:
        * <ul>
        * <li>DefaultRuntimeEnvironment</li>
        * </ul>
        * This one is tailored to works smoothly with kjar as the notion of kbase and ksessions
        * @param releaseId <code>ReleaseId</code> that described the kjar
        * @param kbaseName name of the kbase defined in kmodule.xml stored in kjar
        * @param ksessionId name of the ksession define in kmodule.xml stored in kjar
        * @return new instance of <code>RuntimeEnvironmentBuilder</code>
code> that is already preconfigured with defaults
        *
        * @see DefaultRuntimeEnvironment
        */
        public RuntimeEnvironmentBuilder newDefaultBuilder(ReleaseId releaseId, String kbaseName, String ksessionId);

        /**
        * Provides default configuration of <code>RuntimeEnvironmentBuilder</code> that is based on:
        * <ul>
        * <li>DefaultRuntimeEnvironment</li>
        * </ul>
        * It relies on KieClasspathContainer that requires to have kmodule.xml present in META-INF folder which
        * defines the kjar itself.
        * Expects to use default kbase and ksession from kmodule.
        * @return new instance of <code>RuntimeEnvironmentBuilder</code>
code> that is already preconfigured with defaults
        *
        * @see DefaultRuntimeEnvironment
        */
        public RuntimeEnvironmentBuilder newClasspathKmoduleDefaultBuilder();

        /**
        * Provides default configuration of <code>RuntimeEnvironmentBuilder</code> that is based on:
        * <ul>
        * <li>DefaultRuntimeEnvironment</li>
        * </ul>

```

```

    * It relies on KieClasspathContainer that requires to have kmodule.xml present in META-INF folder which
    * defines the kjar itself.
    * @param kbaseName name of the kbase defined in kmodule.xml
    * @param ksessionName name of the ksession define in kmodule.xml
    * @return new instance of RuntimeEnvironmentBuilder that is already preconfigured with defaults
    *
    * @see DefaultRuntimeEnvironment
    */
    public RuntimeEnvironmentBuilder newClasspathKmoduleDefaultBuilder(String kbaseName, String ksessionName);

```

Besides KieSession Runtime Manager provides access to TaskService too as integrated component of a RuntimeEngine that will always be configured and ready for communication between process engine and task service.

Since the default builder was used, it will already come with predefined set of elements that consists of:

- Persistence unit name will be set to org.jbpm.persistence.jpa (for both process engine and task service)
- Human Task handler will be automatically registered on KieSession
- JPA based history log event listener will be automatically registered on KieSession
- Event listener to trigger rule task evaluation (fireAllRules) will be automatically registered on KieSession

5.4.4.2. Registering handlers and listeners

To extend it with your own handlers or listeners a dedicated mechanism is provided that comes as implementation of RegisterableItemsFactory

```

/**
     * Returns new instances of WorkItemHandler that will be registered on RuntimeEngine
     * @param runtime provides RuntimeEngine in case handler need to make use of it internally
     * @return map of handlers to be registered - in case of no handlers empty map shall be returned.
     */
    Map<String, WorkItemHandler> getWorkItemHandlers(RuntimeEngine runtime);

/**
     * Returns new instances of ProcessEventListener that will be registered on RuntimeEngine
     * @param runtime provides RuntimeEngine in case listeners need to make use of it internally
     * @return list of listeners to be registered - in case of no listeners empty list shall be returned.
     */
    List<ProcessEventListener> getProcessEventListeners(RuntimeEngine runtime);

```

```
/**
     * Returns new instances of AgendaEventListener
     * that will be registered on RuntimeEngine
     * @param runtime provides RuntimeEngine
     * in case listeners need to make use of it internally
     * @return list of listeners to be registered - in case of no listeners empty list shall be returned.
     */
    List<AgendaEventListener> getAgendaEventListeners(RuntimeEngine runtime);

/**
     * Returns new instances of WorkingMemoryEventListener
     * that will be registered on RuntimeEngine
     * @param runtime provides RuntimeEngine
     * in case listeners need to make use of it internally
     * @return list of listeners to be registered - in case of no listeners empty list shall be returned.
     */
    List<WorkingMemoryEventListener> getWorkingMemoryEventListeners(RuntimeEngine runtime);
```

A best practice is to just extend those that come out of the box and just add your own. Extensions are not always needed as the default implementations of `RegisterableItemsFactory` provides possibility to define custom handlers and listeners. Following is a list of available implementations that might be useful (they are ordered in the hierarchy of inheritance):

- `org.jbpm.runtime.manager.impl.SimpleRegisterableItemsFactory` - simplest possible implementations that comes empty and is based on reflection to produce instances of handlers and listeners based on given class names
- `org.jbpm.runtime.manager.impl.DefaultRegisterableItemsFactory` - extension of the Simple implementation that introduces defaults described above and still provides same capabilities as Simple implementation
- `org.jbpm.runtime.manager.impl.KModuleRegisterableItemsFactory` - extension of default implementation that provides specific capabilities for `kmodule` and still provides same capabilities as Simple implementation
- `org.jbpm.runtime.manager.impl.cdi.InjectableRegisterableItemsFactory` - extension of default implementation that is tailored for CDI environments and provides CDI style approach to finding handlers and listeners via producers

Alternatively, simple (stateless or requiring only `KieSession`) work item handlers might be registered in the well known way - defined as part of `CustomWorkItem.conf` file that shall be placed on class path. To use this approach do following:

- create file "drools.session.conf" inside META-INF of the root of the class path, for web applications it will be WEB-INF/classes/META-INF
- add following line to drools.session.conf file "drools.workItemHandlers = CustomWorkItemHandlers.conf"
- create file "CustomWorkItemHandlers.conf" inside META-INF of the root of the class path, for web applications it will be WEB-INF/classes/META-INF

- define custom work item handlers in MVEL style inside CustomWorkItemHandlers.conf

```
[
  "Log": new org.jbpm.process.instance.impl.demo.SystemOutWorkItemHandler(),
  "WebService": new org.jbpm.process.workitem.webservice.WebServiceWorkItemHandler(ksession),
  "Rest": new org.jbpm.process.workitem.rest.RESTWorkItemHandler(),
  "Service Task" : new org.jbpm.process.workitem.bpmn2.ServiceTaskHandler(ksession)
]
```

And that's it, now all these work item handlers will be registered for any KieSession created by that application, regardless if it uses RuntimeManager or not.

5.4.4.2.1. Registering handlers and listeners in CDI environment

When using RuntimeManager in CDI environment there are dedicated interfaces that can be used to provide custom WorkItemHandlers and EventListeners to the RuntimeEngine.

```
public interface WorkItemHandlerProducer {

    /**
     * Returns map of (key = work item name, value work item handler instance) of work items
     * to be registered on KieSession
     * <br/>
     * Parameters that might be given are as follows:
     * <ul>
     * <li>ksession</li>
     * <li>taskService</li>
     * <li>runtimeManager</li>
     * </ul>
     *
     * @param identifier - identifier of the owner - usually RuntimeManager that allows the producer to filter out
     * and provide valid instances for given owner
     * @param params - owner might provide some parameters, usually KieSession, TaskService, RuntimeManager instance
     * @return map of work item handler instances (recommendation is to always return new instances when this method is called)
     */
    Map<String, WorkItemHandler> getWorkItemHandlers(String identifier, Map<String, Object> params);
}
```

Event listener producer shall be annotated with proper qualifier to indicate what type of listeners they provide, so pick one of following to indicate they type:

- @Process - for ProcessEventListener
- @Agenda - for AgendaEventListener
- @WorkingMemory - for WorkingMemoryEventListener

```
public interface EventListenerProducer<T> {

    /**
     * Returns list of instances for given (T) type of listeners
     */
}
```

```

* <br/>
* Parameters that might be given are as follows:
* <ul>
* <li>ksession</li>
* <li>taskService</li>
* <li>runtimeManager</li>
* </ul>
* @param identifier - identifier of the owner - usually RuntimeManager that allows the producer to filter out
* and provide valid instances for given owner
* @param params - owner might provide some parameters, usually KieSession, TaskService, RuntimeManager instance
* @return list of listener instances (recommendation is to always return new instances when this method is invoked)
*/
List<T> getEventListeners(String identifier, Map<String, Object> params);
}

```

Implementations of these interfaces shall be packaged as bean archive (includes beans.xml inside META-INF) and placed on application classpath (e.g. WEB-INF/lib for web application). That is enough for CDI based RuntimeManager to discover them and register on every KieSession that is created or loaded from data store.

Some parameters are provided to the producers to allow handlers/listeners to be more stateful and be able to do more advanced things with the engine - like signal of the engine or process instance in case of an error. Thus all components are provided:

- KieSession
- TaskService
- RuntimeManager



Note

Whenever there is a need to interact with the process engine/task service from within handler or listener, recommended approach is to use RuntimeManager and retrieve RuntimeEngine (and then KieSession and/or TaskService) from it as that will ensure proper state managed according to strategy

In addition, some filtering can be applied based on identifier (that is given as argument to the methods) to decide if given RuntimeManager shall receive handlers/listeners or not.

5.5. Services

On top of RuntimeManager API a set of high level services has been provided from jBPM version 6.2. These services are meant to be the easiest way to embed (j)BPM capabilities into custom application. A complete set of modules are delivered as part of these services. They are partitioned into several modules to ease their adoptions in various environments.

- jbpm-services-api

contains only api classes and interfaces

- jbpm-kie-services

rewritten code implementation of services api - pure java, no framework dependencies

- jbpm-services-cdi

CDI wrapper on top of core services implementation

- jbpm-services-ejb-api

extension to services api for ejb needs

- jbpm-services-ejb-impl

EJB wrappers on top of core services implementation

- jbpm-services-ejb-timer

scheduler service based on EJB TimerService to support time based operations e.g. timer events, deadlines, etc

- jbpm-services-ejb-client

EJB remote client implementation - currently only for JBoss

Service modules are grouped with its framework dependencies, so developers are free to choose which one is suitable for them and use only that.

5.5.1. Deployment Service

As the name suggest, its primary responsibility is to deploy (and undeploy) units. Deployment unit is kjar that brings in business assets (like processes, rules, forms, data model) for execution. Deployment services allow to query it to get hold of available deployment units and even their `RuntimeManager` instances.



Note

there are some restrictions on EJB remote client to do not expose `RuntimeManager` as it won't make any sense on client side (after it was serialized).

So typical use case for this service is to provide dynamic behavior into your system so multiple kjar can be active at the same time and be executed simultaneously.

```
// create deployment unit by giving GAV
DeploymentUnit deploymentUnit = new KModuleDeploymentUnit(GROUP_ID, ARTIFACT_ID, VERSION);
// deploy
```

```
deploymentService.deploy(deploymentUnit);
// retrieve deployed unit
DeployedUnit deployed = deploymentService.getDeployedUnit(deploymentUnit.getIdentifier());
// get runtime manager
RuntimeManager manager = deployed.getRuntimeManager();
```

Complete DeploymentService interface is as follows:

```
public interface DeploymentService {

    void deploy(DeploymentUnit unit);

    void undeploy(DeploymentUnit unit);

    RuntimeManager getRuntimeManager(String deploymentUnitId);

    DeployedUnit getDeployedUnit(String deploymentUnitId);

    Collection<DeployedUnit> getDeployedUnits();

    void activate(String deploymentId);

    void deactivate(String deploymentId);

    boolean isDeployed(String deploymentUnitId);
}
```

5.5.2. Definition Service

Upon deployment, every process definition is scanned using definition service that parses the process and extracts valuable information out of it. These information can provide valuable input to the system to inform users about what is expected. Definition service provides information about:

- process definition - id, name, description
- process variables - name and type
- reusable subprocesses used in the process (if any)
- service tasks (domain specific activities)
- user tasks including assignment information
- task data input and output information

So definition service can be seen as sort of supporting service that provides quite a few information about process definition that are extracted directly from BPMN2.

```
String processId = "org.jbpm.writedocument";
```

```
Collection<UserTaskDefinition> processTasks =
bpmn2Service.getTasksDefinitions(deploymentUnit.getIdentifier(), processId);

Map<String, String> processData =
bpmn2Service.getProcessVariables(deploymentUnit.getIdentifier(), processId);

Map<String, String> taskInputMappings =
bpmn2Service.getTaskInputMappings(deploymentUnit.getIdentifier(), processId, "Write a
Document" );
```

While it usually is used with combination of other services (like deployment service) it can be used standalone as well to get details about process definition that do not come from kjar. This can be achieved by using `buildProcessDefinition` method of definition service.

```
public interface DefinitionService {

    ProcessDefinition buildProcessDefinition(String deploymentId, String bpmn2Content,
ClassLoader classLoader, boolean cache) throws IllegalArgumentException;

    ProcessDefinition getProcessDefinition(String deploymentId, String processId);

    Collection<String> getReusableSubProcesses(String deploymentId, String processId);

    Map<String, String> getProcessVariables(String deploymentId, String processId);

    Map<String, String> getServiceTasks(String deploymentId, String processId);

    Map<String, Collection<String>> getAssociatedEntities(String deploymentId, String processId);

    Collection<UserTaskDefinition> getTasksDefinitions(String deploymentId, String processId);

    Map<String, String> getTaskInputMappings(String deploymentId, String processId, String
taskName);

    Map<String, String> getTaskOutputMappings(String deploymentId, String processId, String
taskName);

}
```

5.5.3. Process Service

Process service is the one that usually is of the most interest. Once the deployment and definition service was already used to feed the system with something that can be executed. Process service provides access to execution environment that allows:

- start new process instance
- work with existing one - signal, get details of it, get variables, etc
- work with work items

At the same time process service is a command executor so it allows to execute commands (essentially on ksession) to extend its capabilities.

Important to note is that process service is focused on runtime operations so use it whenever there is a need to alter (signal, change variables, etc) process instance and not for read operations like show available process instances by looping through given list and invoking `getProcessInstance` method. For that there is dedicated runtime data service that is described below.

An example on how to deploy and run process can be done as follows:

```
KModuleDeploymentUnit deploymentUnit = new KModuleDeploymentUnit(GROUP_ID, ARTIFACT_ID,
    VERSION);

deploymentService.deploy(deploymentUnit);

long processInstanceId = processService.startProcess(deploymentUnit.getIdentifier(),
    "customtask");

ProcessInstance pi = processService.getProcessInstance(processInstanceId);
```

As you can see `startProcess` expects `deploymentId` as first argument. This is extremely powerful to enable service to easily work with various deployments, even with same processes but coming from different versions - kjar versions.

```
public interface ProcessService {

    Long startProcess(String deploymentId, String processId);

    Long startProcess(String deploymentId, String processId, Map<String, Object> params);

    void abortProcessInstance(Long processInstanceId);

    void abortProcessInstances(List<Long> processInstanceIds);

    void signalProcessInstance(Long processInstanceId, String signalName, Object event);

    void signalProcessInstances(List<Long> processInstanceIds, String signalName, Object event);

    ProcessInstance getProcessInstance(Long processInstanceId);

    void setProcessVariable(Long processInstanceId, String variableId, Object value);

    void setProcessVariables(Long processInstanceId, Map<String, Object> variables);

    Object getProcessInstanceVariable(Long processInstanceId, String variableName);

    Map<String, Object> getProcessInstanceVariables(Long processInstanceId);

    Collection<String> getAvailableSignals(Long processInstanceId);

    void completeWorkItem(Long id, Map<String, Object> results);
```

```
void abortWorkItem(Long id);

WorkItem getWorkItem(Long id);

List<WorkItem> getWorkItemByProcessInstance(Long processInstanceId);

public <T> T execute(String deploymentId, Command<T> command);

public <T> T execute(String deploymentId, Context<?> context, Command<T> command);

}
```

5.5.4. Runtime Data Service

Runtime data service as name suggests, deals with all that refers to runtime information:

- started process instances
- executed node instances
- executed node instances
- and more

Use this service as main source of information whenever building list based UI - to show process definitions, process instances, tasks for given user, etc. This service was designed to be as efficient as possible and still provide all required information.

Some examples:

- get all process definitions

```
Collection definitions = runtimeDataService.getProcesses(new QueryContext());
```

- get active process instances

```
Collection<processinstancedesc> instances = runtimeDataService.getProcessInstances(new QueryContext());
```

- get active nodes for given process instance

```
Collection<nodeinstancedesc> instances = runtimeDataService.getProcessInstanceHistoryActive(processInstanceId, new QueryContext());
```

- get tasks assigned to john

```
List<tasksummary> taskSummaries = runtimeDataService.getTasksAssignedAsPotentialOwner("john",
    new QueryFilter(0, 10));
```

There are two important arguments that the runtime data service operations supports:

- QueryContext
- QueryFilter - extension of QueryContext

These provide capabilities for efficient management result set like pagination, sorting and ordering (QueryContext). Moreover additional filtering can be applied to task queries to provide more advanced capabilities when searching for user tasks.

```
public interface RuntimeDataService {

    // Process instance information

    Collection<ProcessInstanceDesc> getProcessInstances(QueryContext queryContext);

    Collection<ProcessInstanceDesc> getProcessInstances(List<Integer> states, String initiator,
        QueryContext queryContext);

    Collection<ProcessInstanceDesc> getProcessInstancesByProcessId(List<Integer> states, String
        processId, String initiator, QueryContext queryContext);

    Collection<ProcessInstanceDesc> getProcessInstancesByProcessName(List<Integer> states,
        String processName, String initiator, QueryContext queryContext);

    Collection<ProcessInstanceDesc> getProcessInstancesByDeploymentId(String deploymentId,
        List<Integer> states, QueryContext queryContext);

    ProcessInstanceDesc getProcessInstanceById(long processInstanceId);

    Collection<ProcessInstanceDesc> getProcessInstancesByProcessDefinition(String processDefId,
        QueryContext queryContext);

    Collection<ProcessInstanceDesc> getProcessInstancesByProcessDefinition(String processDefId,
        List<Integer> states, QueryContext queryContext);

    // Node and Variable instance information

    NodeInstanceDesc getNodeInstanceForWorkItem(Long workItemId);

    Collection<NodeInstanceDesc> getProcessInstanceHistoryActive(long processInstanceId,
        QueryContext queryContext);

    Collection<NodeInstanceDesc> getProcessInstanceHistoryCompleted(long processInstanceId,
        QueryContext queryContext);
```

```
Collection<NodeInstanceDesc> getProcessInstanceFullHistory(long processInstanceId,
QueryContext queryContext);

Collection<NodeInstanceDesc> getProcessInstanceFullHistoryByType(long processInstanceId,
EntryType type, QueryContext queryContext);

Collection<VariableDesc> getVariablesCurrentState(long processInstanceId);

Collection<VariableDesc> getVariableHistory(long processInstanceId, String variableId,
QueryContext queryContext);

// Process information

Collection<ProcessDefinition> getProcessesByDeploymentId(String deploymentId, QueryContext
queryContext);

Collection<ProcessDefinition> getProcessesByFilter(String filter, QueryContext queryContext);

Collection<ProcessDefinition> getProcesses(QueryContext queryContext);

Collection<String> getProcessIds(String deploymentId, QueryContext queryContext);

ProcessDefinition getProcessById(String processId);

ProcessDefinition getProcessesByDeploymentIdProcessId(String deploymentId, String processId);

// user task query operations

UserTaskInstanceDesc getTaskByWorkItemId(Long workItemId);

UserTaskInstanceDesc getTaskById(Long taskId);

List<TaskSummary> getTasksAssignedAsBusinessAdministrator(String userId, QueryFilter filter);

List<TaskSummary> getTasksAssignedAsBusinessAdministratorByStatus(String userId,
List<Status> statuses, QueryFilter filter);

List<TaskSummary> getTasksAssignedAsPotentialOwner(String userId, QueryFilter filter);

List<TaskSummary> getTasksAssignedAsPotentialOwner(String userId, List<String> groupIds,
QueryFilter filter);

List<TaskSummary> getTasksAssignedAsPotentialOwnerByStatus(String userId, List<Status>
status, QueryFilter filter);

List<TaskSummary> getTasksAssignedAsPotentialOwner(String userId, List<String> groupIds,
List<Status> status, QueryFilter filter);

List<TaskSummary> getTasksAssignedAsPotentialOwnerByExpirationDateOptional(String userId,
List<Status> status, Date from, QueryFilter filter);

List<TaskSummary> getTasksOwnedByExpirationDateOptional(String userId, List<Status>
strStatuses, Date from, QueryFilter filter);

List<TaskSummary> getTasksOwned(String userId, QueryFilter filter);

List<TaskSummary> getTasksOwnedByStatus(String userId, List<Status> status, QueryFilter
filter);
```

```

    List<Long> getTasksByProcessInstanceId(Long processInstanceId);

    List<TaskSummary> getTasksByStatusByProcessInstanceId(Long processInstanceId, List<Status>
status, QueryFilter filter);

    List<AuditTask> getAllAuditTask(String userId, QueryFilter filter);
}

```

5.5.5. User Task Service

User task service covers complete life cycle of individual task so it can be managed from start to end. It explicitly eliminates queries from it to provide scoped execution and moves all query operations into runtime data service. Besides lifecycle operations user task service allows:

- modification of selected properties
- access to task variables
- access to task attachments
- access to task comments

On top of that user task service is a command executor as well that allows to execute custom task commands.

Complete example with start process and complete user task done by services:

```

long processInstanceId =
processService.startProcess(deployUnit.getIdentifier(), "org.jbpm.writedocument");

List<Long> taskIds =
runtimeDataService.getTasksByProcessInstanceId(processInstanceId);

Long taskId = taskIds.get(0);

userTaskService.start(taskId, "john");
UserTaskInstanceDesc task = runtimeDataService.getTaskById(taskId);

Map<String, Object> results = new HashMap<String, Object>();
results.put("Result", "some document data");
userTaskService.complete(taskId, "john", results);

```



Note

The most important thing when working with services is that there is no more need to create your own implementations of Process service that simply wraps runtime

manager, runtime engine, ksession usage. Services make use of RuntimeManager API best practices and thus eliminate various risks when working with that API.

5.5.6. Working with deployments

Deployment Service provides convenient way to put business assets to an execution environment but there are cases that requires some additional management to make them available in right context.

Activation and Deactivation of deployments

Imagine situation where there are number of processes already running of given deployment and then new version of these processes comes into the runtime environment. With that administrator can decide that new instances of given process definition should be using new version only while already active instances should continue with the previous version.

To help with that deployment service has been equipped with following methods:

- activate

allows to activate given deployment so it can be available for interaction meaning will show its process definition and allow to start new process instances of that project's processes

- deactivate

allows to deactivate deployment which will disable option to see or start new process instances of that project's processes but will allow to continue working with already active process instances, e.g. signal, work with user task etc

This feature allows smooth transition between project versions without need of process instance migration.

Deployment synchronization

Prior to jBPM 6.2, jbpm services did not have deployment store by default. When embedded in jbpm-console/kie-wb they utilized `system.git` VFS repository to preserve deployed units across server restarts. While that works fine, it comes with some drawbacks:

- not available for custom systems that use services
- requires complex setup in cluster - zookeeper and helix

With version 6.2 jbpm services come with deployment synchronizer that stores available deployments into data base, including its deployment descriptor. At the same time it constantly monitors that table to keep it in sync with other installations that might be using same data source. This is

especially important when running in cluster or when jbpm console runs next to custom application and both should be able to operate on the same artifacts.

By default synchronization must be configured (when running as core services while it is automatically enabled for ejb and cdi extensions). To configure synchronization following needs to be configured:

```
TransactionalCommandService commandService = new TransactionalCommandService(emf);

DeploymentStore store = new DeploymentStore();
store.setCommandService(commandService);

DeploymentSynchronizer sync = new DeploymentSynchronizer();
sync.setDeploymentService(deploymentService);
sync.setDeploymentStore(store);

DeploymentSyncInvoker invoker = new DeploymentSyncInvoker(sync, 2L, 3L, TimeUnit.SECONDS);
invoker.start();
....
invoker.stop();
```

With this, deployments will be synchronized every 3 seconds with initial delay of two seconds.

Invoking latest version of project's processes

In case there is a need to always work with latest version of project's process, services allow to interact with various operations using deployment id with latest keyword. Let's go over an example to better understand the feature.

Initially deployed unit is org.jbpm:HR:1.0 which has the first version of an hiring process. After several weeks, new version is developed and deployed to the execution server - org.jbpm:HR.2.0 with version 2 of the hiring process.

To allow callers of the services to interact without being worried if they work with latest version, they can use following deployment id:

```
org.jbpm.HR:latest
```

this will always find out latest available version of project that is identified by:

- groupId: org.jbpm
- artifactId: HR

version comparison is based on Maven version numbers and relies on Maven based algorithm to find the latest one.

**Note**

This is only supported when process identifier remains the same in all project versions

Here is a complete example with deployment of multiple versions and interacting always with the latest:

```
KModuleDeploymentUnit deploymentUnitV1 = new KModuleDeploymentUnit("org.jbpm", "HR", "1.0");
deploymentService.deploy(deploymentUnitV1);

long processInstanceId = processService.startProcess("org.jbpm:HR:LATEST", "customtask");
ProcessInstanceDesc piDesc = runtimeDataService.getProcessInstanceById(processInstanceId);

// we have started process with project's version 1
assertEquals(deploymentUnitV1.getIdentifier(), piDesc.getDeploymentId());

// next we deploy version 1
KModuleDeploymentUnit deploymentUnitV2 = new KModuleDeploymentUnit("org.jbpm", "HR", "2.0");
deploymentService.deploy(deploymentUnitV2);

processInstanceId = processService.startProcess("org.jbpm:HR:LATEST", "customtask");
piDesc = runtimeDataService.getProcessInstanceById(processInstanceId);

// this time we have started process with project's version 2
assertEquals(deploymentUnitV2.getIdentifier(), piDesc.getDeploymentId());
```

As illustrated this provides very powerful feature when interacting with frequently changing environment that allows to always be up to date when it comes to use of process definitions.

**Note**

This feature is also available in REST interface so whenever sending request with deployment id, it's enough to replace concrete version with LATEST keyword to make use of this feature.

5.6. Configuration

There are several control parameters available to alter engine default behavior. This allows to fine tune the execution for the environment needs and actual requirements. All of these parameters are set as JVM system properties, usually with `-D` when starting program e.g. application server.

Table 5.1. Control parameters

Name	Possible values	Default value	Description
jbpm.ut.jndi.lookup	String		Alternative JNDI name to be used when there is no access to the default one (java:comp/UserTransaction)
jbpm.enable.multi.cou	true false	false	Enables multiple incoming/outgoing sequence flows support for activities
jbpm.business.calendar	String properties	/ jbpm.business.calendar	Allows to provide alternative class-path location of business calendar configuration file
jbpm.overdue.timerDelay	Delay	2000	Specifies delay for overdue timers to allow proper initialization, in milliseconds
jbpm.process.nameComparator	String comparator		Allows to provide alternative comparator class to empower start process by name feature, if not set NumberVersionComparator is used
jbpm.loop.level.disable	true false	true	Allows to enable or disable loop iteration tracking, to allow advanced loop support when using XOR gateways

Name	Possible values	Default value	Description
org.kie.mail.session	String	mail/ jbpmMailSession	Allows to provide alternative JNDI name for mail session used by Task Deadlines
jbpm.usergroup.callback	String	/ jbpm.usergroup.callback	Allows to provide alternative classpath location for user group callback implementation (LDAP, DB)
jbpm.user.group.roles	String	/\${jboss.server.config.dir}/roles.properties	Allows to provide alternative location of roles.properties for JBossUserGroupCallbackImpl
jbpm.user.info.properties	String	/ jbpm.user.info.properties	Allows to provide alternative classpath location of user info configuration (used by LDAPUserInfoImpl)
org.jbpm.ht.user.separator	String	,	Allows to provide alternative separator of actors and groups for user tasks, default is comma (,)
org.quartz.properties	String		Allows to provide location of the quartz config file to activate quartz based timer service
jbpm.data.dir	String	/\${jboss.server.data.dir} is available other-	Allows to provide location where data files pro-

Name	Possible values	Default value	Description
org.kie.executor.poolsize	Integer	1	Allows to provide thread pool size for jbpm executor
org.kie.executor.retry	Integer	3	Allows to provide number of retries attempted in case of error by jbpm executor
org.kie.executor.interval	Integer	3	Allows to provide frequency used to check for pending jobs by jbpm executor, in seconds
org.kie.executor.disabled	Boolean	true	Enables or disable jbpm executor
org.kie.store.service	String	org.drools.persistence.jpa.KnowledgeStoreServiceImpl	name of the class that implements KieStoreServices that will be responsible for bootstrapping KieSession instances

Chapter 6. Processes

6.1. What is BPMN 2.0



Note

"The primary goal of BPMN is to provide a notation that is readily understandable by all business users, from the business analysts that create the initial drafts of the processes, to the technical developers responsible for implementing the technology that will perform those processes, and finally, to the business people who will manage and monitor those processes."

The Business Process Model and Notation (BPMN) 2.0 specification is an OMG specification that not only defines a standard on how to graphically represent a business process (like BPMN 1.x), but now also includes execution semantics for the elements defined, and an XML format on how to store (and share) process definitions.

jBPM6 allows you to execute processes defined using the BPMN 2.0 XML format. That means that you can use all the different jBPM6 tooling to model, execute, manage and monitor your business processes using the BPMN 2.0 format for specifying your executable business processes. Actually, the full BPMN 2.0 specification also includes details on how to represent things like choreographies and collaboration. The jBPM project however focuses on that part of the specification that can be used to specify executable processes.

Executable processes in BPMN consist of a different types of nodes being connected to each other using sequence flows. The BPMN 2.0 specification defines three main types of nodes:

- **Events:** They are used to model the occurrence of a particular event. This could be a start event (that is used to indicate the start of the process), end events (that define the end of the process, or of that subflow) and intermediate events (that indicate events that might occur during the execution of the process).
- **Activities:** These define the different actions that need to be performed during the execution of the process. Different types of tasks exist, depending on the type of activity you are trying to model (e.g. human task, service task, etc.) and activities could also be nested (using different types of sub-processes).
- **Gateways:** Can be used to define multiple paths in the process. Depending on the type of gateway, these might indicate parallel execution, choice, etc.

jBPM6 does not implement all elements and attributes as defined in the BPMN 2.0 specification. We do however support a significant subset, including the most common node types that can be used inside executable processes. This includes (almost) all elements and attributes as defined in the "Common Executable" subclass of the BPMN 2.0 specification, extended with some additional

elements and attributes we believe are valuable in that context as well. The full set of elements and attributes that are supported can be found below, but it includes elements like:

- *Flow objects*
 - Events
 - Start Event (None, Conditional, Signal, Message, Timer)
 - End Event (None, Terminate, Error, Escalation, Signal, Message, Compensation)
 - Intermediate Catch Event (Signal, Timer, Conditional, Message)
 - Intermediate Throw Event (None, Signal, Escalation, Message, Compensation)
 - Non-interrupting Boundary Event (Escalation, Signal, Timer, Conditional, Message)
 - Interrupting Boundary Event (Escalation, Error, Signal, Timer, Conditional, Message, Compensation)
 - Activities
 - Script Task
 - Task
 - Service Task
 - User Task
 - Business Rule Task
 - Manual Task
 - Send Task
 - Receive Task
 - Reusable Sub-Process (Call Activity)
 - Embedded Sub-Process
 - Event Sub-Process
 - Ad-Hoc Sub-Process
 - Data-Object
 - Gateways
 - Diverging
 - Exclusive

- Inclusive
- Parallel
- Event-Based
- Converging
 - Exclusive
 - Inclusive
 - Parallel
- Lanes
- *Data*
 - Java type language
 - Process properties
 - Embedded Sub-Process properties
 - Activity properties
- *Connecting objects*
 - Sequence flow

For example, consider the following "Hello World" BPMN 2.0 process, which does nothing more than writing out a "Hello World" statement when the process is started.

An executable version of this process expressed using BPMN 2.0 XML would look something like this:

```
<?xml version="1.0" encoding="UTF-8"?>
<definitions id="Definition"
  targetNamespace="http://www.example.org/MinimalExample"
  typeLanguage="http://www.java.com/javaTypes"
  expressionLanguage="http://www.mvel.org/2.0"
  xmlns="http://www.omg.org/spec/BPMN/20100524/MODEL"
  xmlns:xs="http://www.w3.org/2001/XMLSchema-instance"
  xs:schemaLocation="http://www.omg.org/spec/BPMN/20100524/MODEL BPMN20.xsd"
  xmlns:bpmndi="http://www.omg.org/spec/BPMN/20100524/DI"
  xmlns:dc="http://www.omg.org/spec/DD/20100524/DC"
  xmlns:di="http://www.omg.org/spec/DD/20100524/DI"
  xmlns:tns="http://www.jboss.org/drools">

  <process processType="Private" isExecutable="true" id="com.sample.HelloWorld" name="Hello
World" >
```

```
<!-- nodes -->
<startEvent id="_1" name="StartProcess" />
<scriptTask id="_2" name="Hello" >
  <script>System.out.println("Hello World");</script>
</scriptTask>
<endEvent id="_3" name="EndProcess" >
  <terminateEventDefinition/>
</endEvent>

<!-- connections -->
<sequenceFlow id="_1-2" sourceRef="_1" targetRef="_2" />
<sequenceFlow id="_2-3" sourceRef="_2" targetRef="_3" />

</process>

<bpmndi:BPMNDiagram>
  <bpmndi:BPMNPlane bpmnElement="Minimal" >
    <bpmndi:BPMNShape bpmnElement="_1" >
      <dc:Bounds x="15" y="91" width="48" height="48" />
    </bpmndi:BPMNShape>
    <bpmndi:BPMNShape bpmnElement="_2" >
      <dc:Bounds x="95" y="88" width="83" height="48" />
    </bpmndi:BPMNShape>
    <bpmndi:BPMNShape bpmnElement="_3" >
      <dc:Bounds x="258" y="86" width="48" height="48" />
    </bpmndi:BPMNShape>
    <bpmndi:BPMNEdge bpmnElement="_1-2" >
      <di:waypoint x="39" y="115" />
      <di:waypoint x="75" y="46" />
      <di:waypoint x="136" y="112" />
    </bpmndi:BPMNEdge>
    <bpmndi:BPMNEdge bpmnElement="_2-3" >
      <di:waypoint x="136" y="112" />
      <di:waypoint x="240" y="240" />
      <di:waypoint x="282" y="110" />
    </bpmndi:BPMNEdge>
  </bpmndi:BPMNPlane>
</bpmndi:BPMNDiagram>

</definitions>
```

To create your own process using BPMN 2.0 format, you can

- The jBPM Designer is an open-source web-based editor that supports the BPMN 2.0 format. We have embedded it into jbpm console for BPMN 2.0 process visualization and editing. You could use the Designer (either standalone or integrated) to create / edit BPMN 2.0 processes and then export them to BPMN 2.0 format or save them into repository and import them so they can be executed.
- A new BPMN2 Eclipse plugin is being created to support the full BPMN2 specification.
- You can always manually create your BPMN 2.0 process files by writing the XML directly. You can validate the syntax of your processes against the BPMN 2.0 XSD, or use the validator in the Eclipse plugin to check both syntax and completeness of your model.

**Note**

Drools Eclipse Process editor has been deprecated in favor of BPMN2 Modeler for process modeling. It can still be used for limited number of supported elements but should be faced out as it is not being developed any more.

Create a new Process file using the Drools Eclipse plugin wizard and in the last page of the wizard, make sure you select Drools 5.1 code compatibility. This will create a new process using the BPMN 2.0 XML format. Note however that this is not exactly a BPMN 2.0 editor, as it still uses different attributes names etc. It does however save the process using valid BPMN 2.0 syntax. Also note that the editor does not support all node types and attributes that are already supported in the execution engine.

The following code fragment shows you how to load a BPMN2 process into your knowledge base ...

```
private static KnowledgeBase createKnowledgeBase() throws Exception {
    KieHelper kieHelper = new KieHelper();
    KieBase kieBase = kieHelper
        .addResource(ResourceFactory.newClassPathResource("sample.bpmn2"))
        .build();

    return kieBase;
}
```

... and how to execute this process ...

```
KieBase kbase = createKnowledgeBase();
KieSession ksession = kbase.newKieSession();
ksession.startProcess("com.sample.HelloWorld");
```

For more detail, check out the chapter on the API and the basics.

6.2. Process

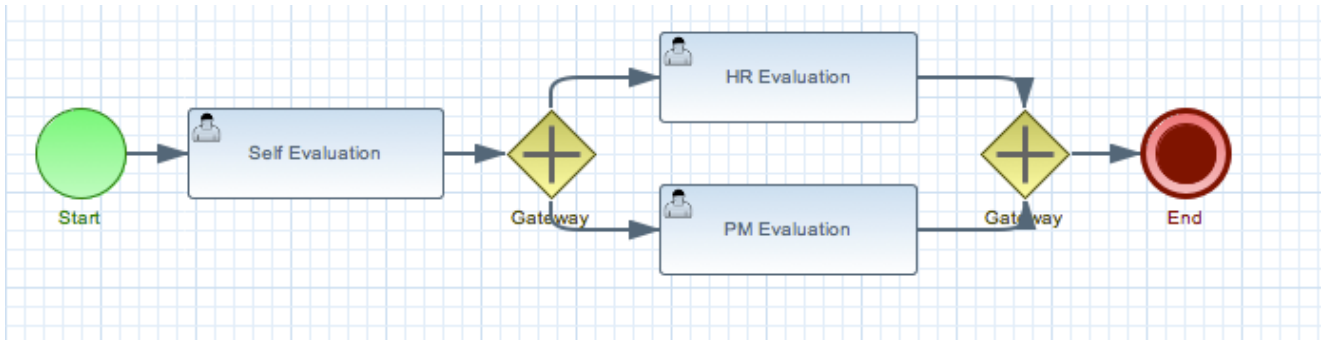


Figure 6.1.

A business process is a graph that describes the order in which a series of steps need to be executed, using a flow chart. A process consists of a collection of nodes that are linked to each other using connections. Each of the nodes represents one step in the overall process while the connections specify how to transition from one node to the other. A large selection of predefined node types have been defined. This chapter describes how to define such processes and use them in your application.

6.2.1. Creating a process

Processes can be created by using one of the following three methods:

1. Using the graphical process editor such as jBPM web designer or Eclipse BPMN2 modeler
2. As an XML file, according to the XML process format as defined in the XML Schema Definition in the BPMN 2.0 specification.
3. By directly creating a process using the Process API.

6.2.1.1. Using the graphical BPMN2 Editor

The graphical BPMN2 editor is an editor that allows you to create a process by dragging and dropping different nodes on a canvas and editing the properties of these nodes. The graphical BPMN2 modeler is an Eclipse plugin hosted on eclipse.org [<http://www.eclipse.org/bpmn2-modeler/>] that provides number of contributors where one of them is jBPM project. Once you have set up a jBPM project (see the installer for creating a working Eclipse environment where you can start), you can start adding processes. When in a project, launch the "New" wizard (use Ctrl+N) or right-click the directory you would like to put your process in and select "New", then "File". Give the file a name and the extension bpmn (e.g. MyProcess.bpmn). This will open up the process editor (you can safely ignore the warning that the file could not be read, this is just because the file is still empty).

First, ensure that you can see the Properties View down the bottom of the Eclipse window, as it will be necessary to fill in the different properties of the elements in your process. If you cannot see the properties view, open it using the menu "Window", then "Show View" and "Other...", and under the "General" folder select the Properties View.

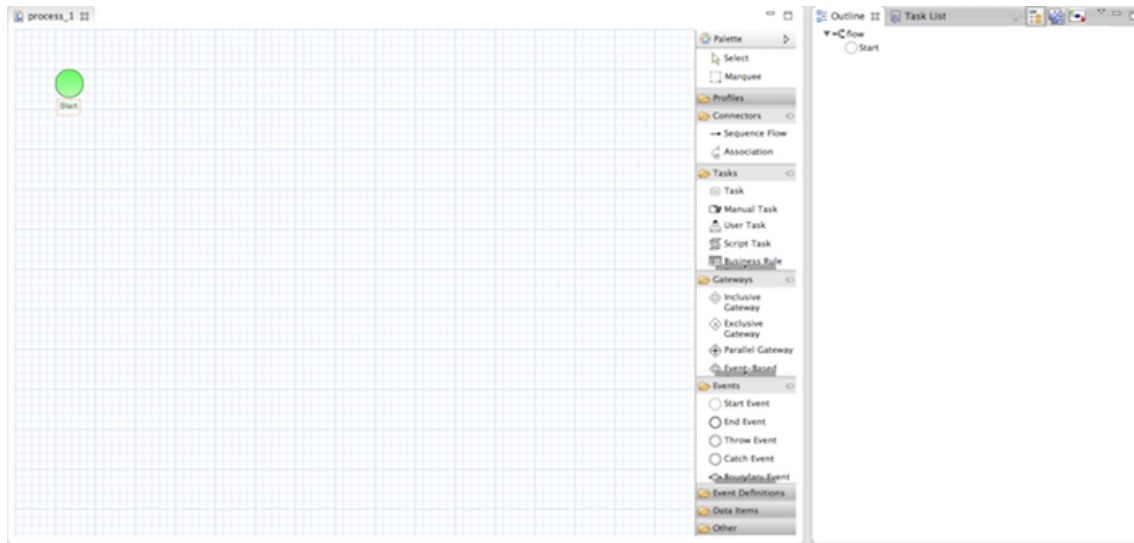


Figure 6.2. New process

The process editor consists of a palette, a canvas and an outline view. To add new elements to the canvas, select the element you would like to create in the palette and then add them to the canvas by clicking on the preferred location. For example, click on the "End Event" icon in the palette of the GUI. Clicking on an element in your process allows you to set the properties of that element. You can connect the nodes (as long as it is permitted by the different types of nodes) by using "Sequence Flow" from the palette.

You can keep adding nodes and connections to your process until it represents the business logic that you want to specify.

6.2.1.2. Defining processes using XML

It is also possible to specify processes using the underlying BPMN 2.0 XML directly. The syntax of these XML processes is defined using the BPMN 2.0 XML Schema Definition. For example, the following XML fragment shows a simple process that contains a sequence of a Start Event, a Script Task that prints "Hello World" to the console, and an End Event.

```
<?xml version="1.0" encoding="UTF-8"?>
<definitions id="Definition"
  targetNamespace="http://www.jboss.org/drools"
  typeLanguage="http://www.java.com/javaTypes"
  expressionLanguage="http://www.mvel.org/2.0"
  xmlns="http://www.omg.org/spec/BPMN/20100524/MODEL"Rule Task
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.omg.org/spec/BPMN/20100524/MODEL BPMN20.xsd"
  xmlns:g="http://www.jboss.org/drools/flow/gpd"
  xmlns:bpmndi="http://www.omg.org/spec/BPMN/20100524/DI"
  xmlns:dc="http://www.omg.org/spec/DD/20100524/DC"
  xmlns:di="http://www.omg.org/spec/DD/20100524/DI"
  xmlns:tns="http://www.jboss.org/drools">
  <process processType="Private" isExecutable="true" id="com.sample.hello" name="Hello Process" >
```

```

<!-- nodes -->
<startEvent id="_1" name="Start" />
<scriptTask id="_2" name="Hello" >
  <script>System.out.println("Hello World");</script>
</scriptTask>
<endEvent id="_3" name="End" >
  <terminateEventDefinition/>
</endEvent>

<!-- connections -->
<sequenceFlow id="_1-2" sourceRef="_1" targetRef="_2" />
<sequenceFlow id="_2-3" sourceRef="_2" targetRef="_3" />

</process>

<bpmndi:BPMNDiagram>
  <bpmndi:BPMNPlane bpmnElement="com.sample.hello" >
    <bpmndi:BPMNShape bpmnElement="_1" >
      <dc:Bounds x="16" y="16" width="48" height="48" />
    </bpmndi:BPMNShape>
    <bpmndi:BPMNShape bpmnElement="_2" >
      <dc:Bounds x="96" y="16" width="80" height="48" />
    </bpmndi:BPMNShape>
    <bpmndi:BPMNShape bpmnElement="_3" >
      <dc:Bounds x="208" y="16" width="48" height="48" />
    </bpmndi:BPMNShape>
    <bpmndi:BPMNEdge bpmnElement="_1-2" >
      <di:waypoint x="40" y="40" />
      <di:waypoint x="136" y="40" />
    </bpmndi:BPMNEdge>
    <bpmndi:BPMNEdge bpmnElement="_2-3" >
      <di:waypoint x="136" y="40" />
      <di:waypoint x="232" y="40" />
    </bpmndi:BPMNEdge>
  </bpmndi:BPMNPlane>
</bpmndi:BPMNDiagram>

</definitions>

```

The process XML file consists of two parts, the top part (the "process" element) contains the definition of the different nodes and their properties, the lower part (the "BPMNDiagram" element) contains all graphical information, like the location of the nodes. The process XML consist of exactly one <process> element. This element contains parameters related to the process (its type, name, id and package name), and consists of three subsections: a header section (where process-level information like variables, globals, imports and lanes can be defined), a nodes section that defines each of the nodes in the process, and a connections section that contains the connections between all the nodes in the process. In the nodes section, there is a specific element for each node, defining the various parameters and, possibly, sub-elements for that node type.

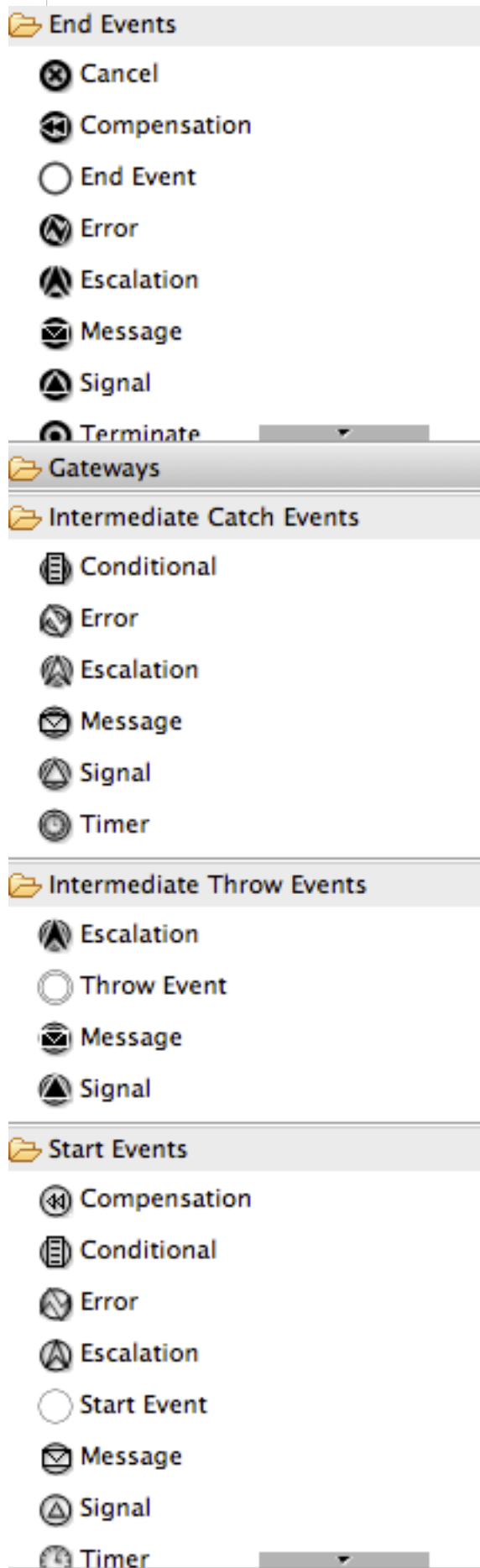


Figure 6.3. The different types of BPMN2 events

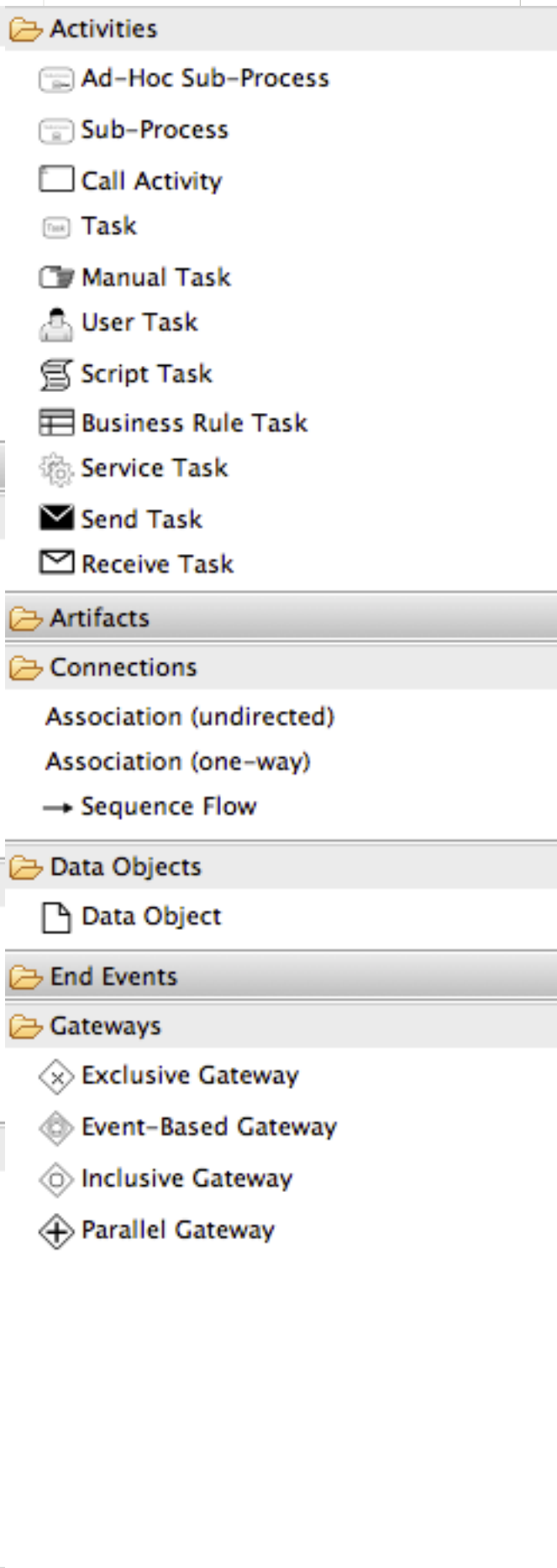


Figure 6.4. The different types of BPMN2 activities and gateways

6.2.1.3. Details: Process properties

A BPMN2 process is a flow chart where different types of nodes are linked using connections. The process itself exposes the following properties:

- *Id*: The unique id of the process.
- *Name*: The display name of the process.
- *Version*: The version number of the process.
- *Package*: The package (namespace) the process is defined in.

The screenshot shows a software interface for editing a BPMN2 process. The title bar reads 'humanTaskSample'. On the left is a vertical navigation pane with buttons for 'Description', 'Process', 'Interfaces', 'Definitions', and 'Data Items'. The 'Process' button is selected. The main area is titled 'Attributes' and contains the following fields:

Id	org.jbpm.writedocument
Name	humanTaskSample
Version	1
Package Name	defaultPackage
Ad Hoc	<input type="checkbox"/>
Is Executable	<input checked="" type="checkbox"/>

Figure 6.5. BPMN2 process properties

In addition to that following can be defined as well:

- *Variables*: Variables can be defined to store data during the execution of your process. See section “???” for details.
- *Swimlanes*: Specify the swimlanes used in this process for assigning human tasks. See chapter “???” for details.

The screenshot shows the configuration for process variables in a BPMN2 tool. On the left is a sidebar with a tree view containing 'Description', 'Process', 'Interfaces', 'Definitions', and 'Data Items'. The main area is titled 'humanTaskSample' and contains two expandable sections: 'Global List for Process "humanTaskSample"' and 'Variable List for Process "humanTaskSample"'. The 'Variable List' section is expanded to show a table of variables.

Name	Data Type
approval_document	String
approval_translatedDocument	String
approval_reviewComment	String

Figure 6.6. BPMN2 process variables

6.3. Activities

6.3.1. Script task

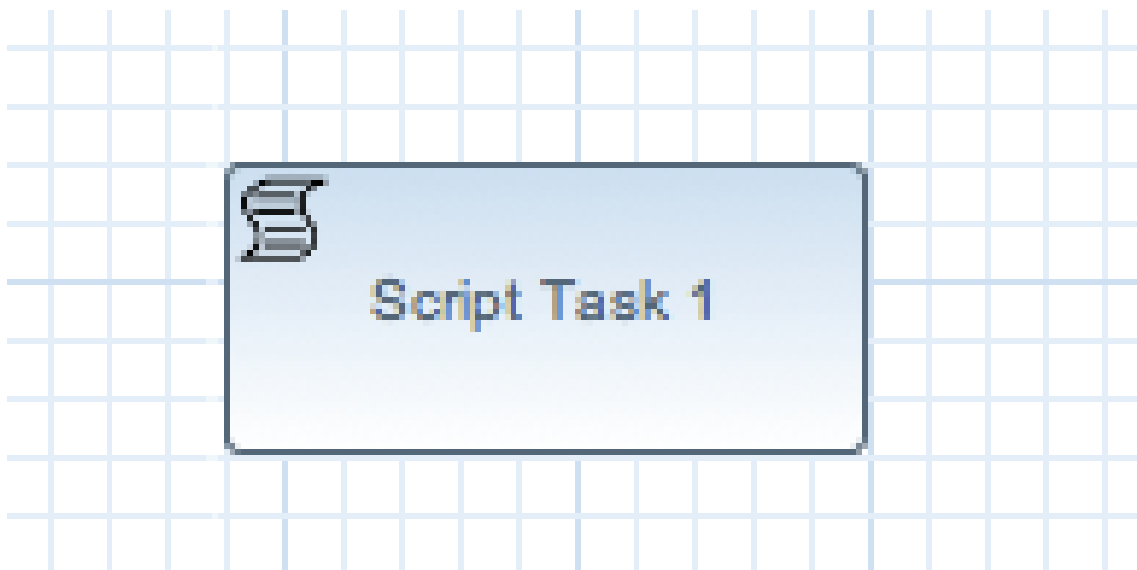


Figure 6.7. Script task

Represents a script that should be executed in this process. A Script Task should have one incoming connection and one outgoing connection. The associated action specifies what should be executed, the dialect used for coding the action (i.e., Java, JavaScript or MVEL), and the actual action code. This code can access any variables and globals. There is also a predefined variable `kcontext` that references the `ProcessContext` [<http://docs.jboss.org/jbpm/v6.0.1/javadocs/org/>]

kie/api/runtime/process/ProcessContext.html] object (which can, for example, be used to access the current `ProcessInstance` or `NodeInstance`, and to get and set variables, or get access to the `ksession` using `kcontext.getKieRuntime()`). When a Script Task is reached in the process, it will execute the action and then continue with the next node. It contains the following properties:

- *Id*: The id of the node (which is unique within one node container).
- *Name*: The display name of the node.
- *Action*: The action script associated with this action node.

Note that you can write any valid Java code inside a script node. This basically allows you to do anything inside such a script node. There are some caveats however:

- When trying to create a higher-level business process, that should also be understood by business users, it is probably wise to avoid low-level implementation details inside the process, including inside these script tasks. A Script Task could still be used to quickly manipulate variables etc. but other concepts like a Service Task could be used to model more complex behaviour in a higher-level manner.
- Scripts should be immediate. They are using the engine thread to execute the script. Scripts that could take some time to execute should probably be modeled as an asynchronous Service Task.
- You should try to avoid contacting external services through a script node. Not only does this usually violate the first two caveats, it is also interacting with external services without the knowledge of the engine, which can be problematic, especially when using persistence and transactions. In general, it is probably wiser to model communication with an external service using a service task.
- Scripts should not throw exceptions. Runtime exceptions should be caught and for example managed inside the script or transformed into signals or errors that can then be handled inside the process.

6.3.2. Service task

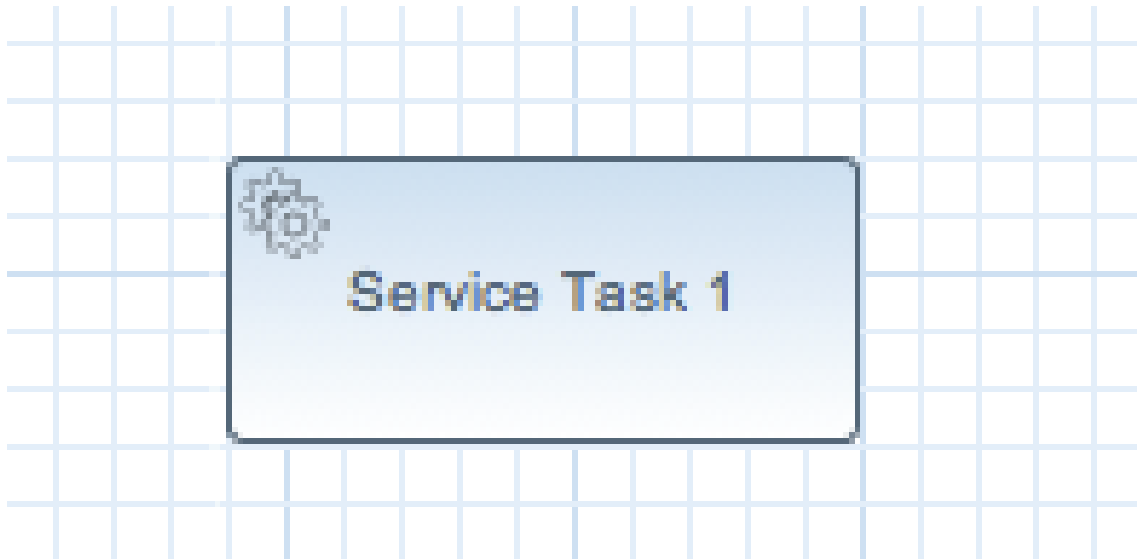


Figure 6.8. Service task

Represents an (abstract) unit of work that should be executed in this process. All work that is executed outside the process engine should be represented (in a declarative way) using a Service Task. Different types of services are predefined, e.g., sending an email, logging a message, etc. Users can define domain-specific services or work items, using a unique name and by defining the parameters (input) and results (output) that are associated with this type of work. Check the chapter on domain-specific processes for a detailed explanation and illustrative examples of how to define and use work items in your processes. When a Service Task is reached in the process, the associated work is executed. A Service Task should have one incoming connection and one outgoing connection.

- *Id*: The id of the node (which is unique within one node container).
- *Name*: The display name of the node.
- *Parameter mapping*: Allows copying the value of process variables to parameters of the work item. Upon creation of the work item, the values will be copied.
- *Result mapping*: Allows copying the value of result parameters of the work item to a process variable. Each type of work can define result parameters that will (potentially) be returned after the work item has been completed. A result mapping can be used to copy the value of the given result parameter to the given variable in this process. For example, the "FileFinder" work item returns a list of files that match the given search criteria within the result parameter `Files`. This list of files can then be bound to a process variable for use within the process. Upon completion of the work item, the values will be copied.
- *On-entry and on-exit actions*: Actions that are executed upon entry or exit of this node, respectively.

- *Additional parameters*: Each type of work item can define additional parameters that are relevant for that type of work. For example, the "Email" work item defines additional parameters such as `From`, `To`, `Subject` and `Body`. The user can either provide values for these parameters directly, or define a parameter mapping that will copy the value of the given variable in this process to the given parameter; if both are specified, the mapping will have precedence. Parameters of type `String` can use `#{expression}` to embed a value in the string. The value will be retrieved when creating the work item, and the substitution expression will be replaced by the result of calling `toString()` on the variable. The expression could simply be the name of a variable (in which case it resolves to the value of the variable), but more advanced MVEL expressions are possible as well, e.g., `#{person.name.firstname}`.

6.3.3. User task

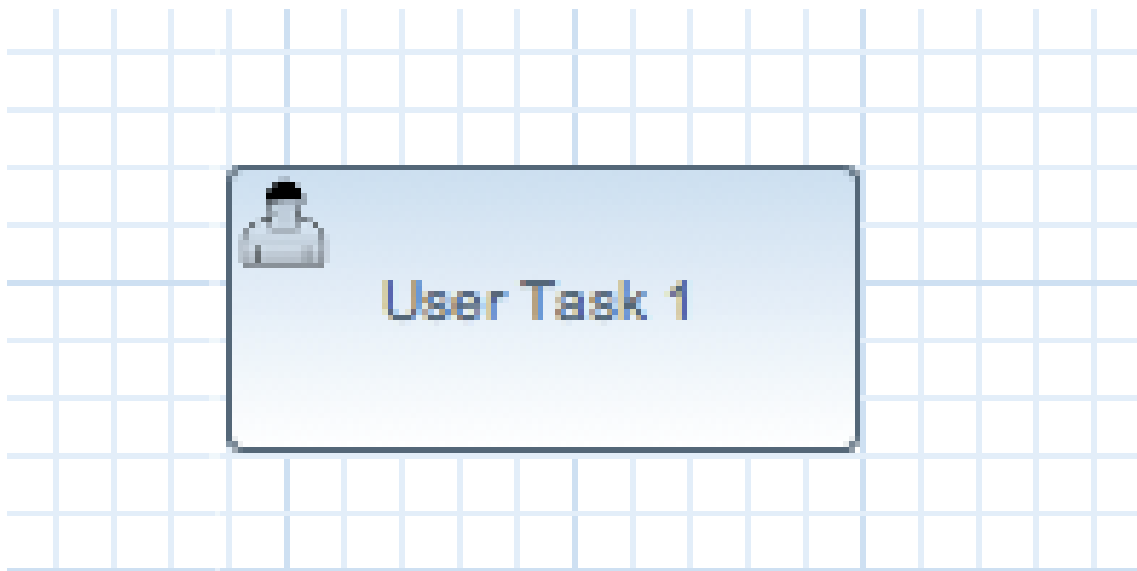


Figure 6.9. User task

Processes can also involve tasks that need to be executed by human actors. A User Task represents an atomic task to be executed by a human actor. It should have one incoming connection and one outgoing connection. User Tasks can be used in combination with Swimlanes to assign multiple human tasks to similar actors. Refer to the chapter on human tasks for more details. A User Task is actually nothing more than a specific type of service node (of type "Human Task"). A User Task contains the following properties:

- *Id*: The id of the node (which is unique within one node container).
- *Name*: The display name of the node.
- *TaskName*: The name of the human task.
- *Priority*: An integer indicating the priority of the human task.

- *Comment*: A comment associated with the human task.
- *ActorId*: The actor id that is responsible for executing the human task. A list of actor id's can be specified using a comma (',') as separator.
- *GroupId*: The group id that is responsible for executing the human task. A list of group id's can be specified using a comma (',') as separator.
- *Skippable*: Specifies whether the human task can be skipped, i.e., whether the actor may decide not to execute the task.
- *Content*: The data associated with this task.
- *Swimlane*: The swimlane this human task node is part of. Swimlanes make it easy to assign multiple human tasks to the same actor. See the human tasks chapter for more detail on how to use swimlanes.
- *On entry and on exit actions*: Action scripts that are executed upon entry and exit of this node, respectively.
- *Parameter mapping*: Allows copying the value of process variables to parameters of the human task. Upon creation of the human tasks, the values will be copied.
- *Result mapping*: Allows copying the value of result parameters of the human task to a process variable. Upon completion of the human task, the values will be copied. A human task has a result variable "Result" that contains the data returned by the human actor. The variable "ActorId" contains the id of the actor that actually executed the task.

A user task should define the type of task that needs to be executed (using properties like TaskName, Comment, etc.) and who needs to perform it (using either actorId or groupId). Note that if there is data related to this specific process instance that the end user needs when performing the task, this data should be passed as the content of the task. The task for example does not have access to process variables. Check out the chapter on human tasks to get more detail on how to pass data between human tasks and the process instance.

6.3.4. Reusable sub-process

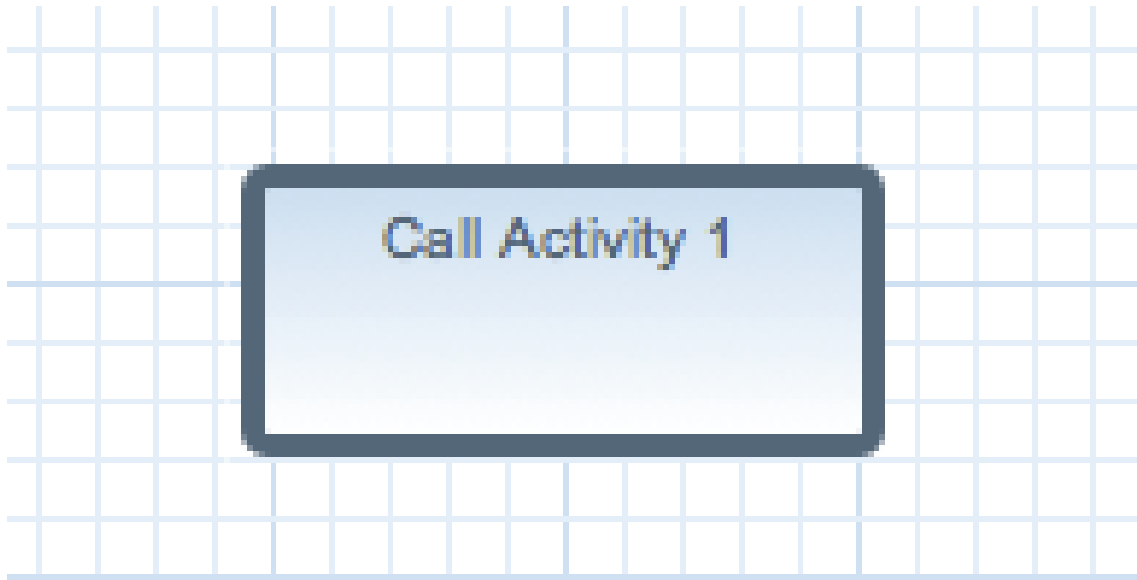


Figure 6.10. Reusable sub-process - Call activity

Represents the invocation of another process from within this process. A sub-process node should have one incoming connection and one outgoing connection. When a Reusable Sub-Process node is reached in the process, the engine will start the process with the given id. It contains the following properties:

- *Id*: The id of the node (which is unique within one node container).
- *Name*: The display name of the node.
- *ProcessId*: The id of the process that should be executed.
- *Wait for completion* (by default true): If this property is true, this sub-process node will only continue if the child process that was started has terminated its execution (completed or aborted); otherwise it will continue immediately after starting the subprocess (so it will not wait for its completion).
- *Independent* (by default true): If this property is true, the child process is started as an independent process, which means that the child process will not be terminated if this parent process is completed (or this sub-process node is canceled for some other reason); otherwise the active sub-process will be canceled on termination of the parent process (or cancellation of the sub-process node). Note that you can only set independent to "false" only when "Wait for completion" is set to true.
- *On-entry and on-exit actions*: Actions that are executed upon entry or exit of this node, respectively.

- *Parameter in/out mapping:* A sub-process node can also define in- and out-mappings for variables. The variables given in the "in" mapping will be used as parameters (with the associated parameter name) when starting the process. The variables of the child process that are defined for the "out" mappings will be copied to the variables of this process when the child process has been completed. Note that you can use "out" mappings only when "Wait for completion" is set to true.

6.3.5. Business rule task

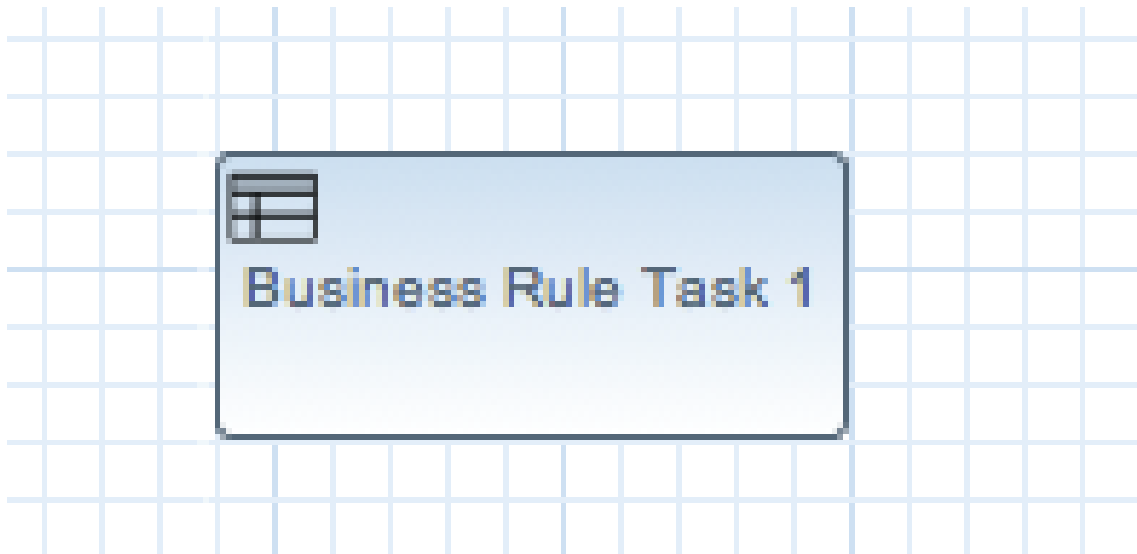


Figure 6.11. Business rule task

A Business Rule Task Represents a set of rules that need to be evaluated. The rules are evaluated when the node is reached. A Rule Task should have one incoming connection and one outgoing connection. Rules are defined in separate files using the Drools rule format. Rules can become part of a specific ruleflow group using the `ruleflow-group` attribute in the header of the rule.

When a Rule Task is reached in the process, the engine will start executing rules that are part of the corresponding ruleflow-group (if any). Execution will automatically continue to the next node if there are no more active rules in this ruleflow group. As a result, during the execution of a ruleflow group, new activations belonging to the currently active ruleflow group can be added to the Agenda due to changes made to the facts by the other rules. Note that the process will immediately continue with the next node if it encounters a ruleflow group where there are no active rules at that time.

If the ruleflow group was already active, the ruleflow group will remain active and execution will only continue if all active rules of the ruleflow group has been completed. It contains the following properties:

- *Id:* The id of the node (which is unique within one node container).

- *Name*: The display name of the node.
- *RuleFlowGroup*: The name of the ruleflow group that represents the set of rules of this Rule-FlowGroup node.

6.3.6. Embedded sub-process

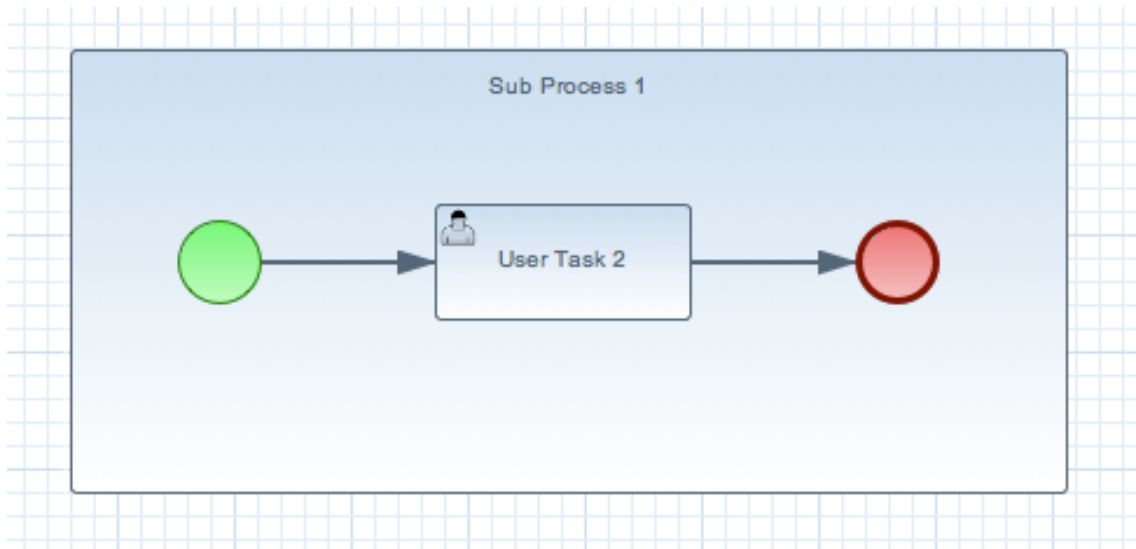


Figure 6.12. Embedded sub-process

A Sub-Process is a node that can contain other nodes so that it acts as a node container. This allows not only the embedding of a part of the process within such a sub-process node, but also the definition of additional variables that are accessible for all nodes inside this container. A sub-process should have one incoming connection and one outgoing connection. It should also contain one start node that defines where to start (inside the Sub-Process) when you reach the sub-process. It should also contain one or more end events. Note that, if you use a terminating event node inside a sub-process, you are terminating just that sub-process. A sub-process ends when there are no more active nodes inside the sub-process. It contains the following properties:

- *Id*: The id of the node (which is unique within one node container).
- *Name*: The display name of the node.
- *Variables*: Additional variables can be defined to store data during the execution of this node. See section “???” for details.

6.3.7. Multi-instance sub-process

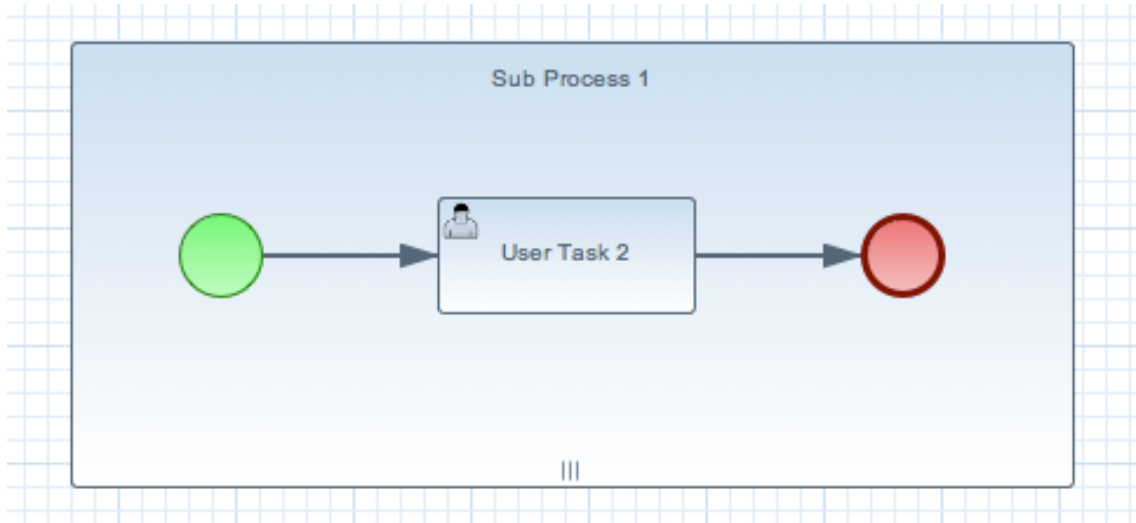


Figure 6.13. Multi-instance sub-process

A Multiple Instance sub-process is a special kind of sub-process that allows you to execute the contained process segment multiple times, once for each element in a collection. A multiple instance sub-process should have one incoming connection and one outgoing connection. It waits until the embedded process fragment is completed for each of the elements in the given collection before continuing. It contains the following properties:

- *Id*: The id of the node (which is unique within one node container).
- *Name*: The display name of the node.
- *CollectionExpression*: The name of a variable that represents the collection of elements that should be iterated over. The collection variable should be an array or of type `java.util.Collection`. If the collection expression evaluates to null or an empty collection, the multiple instances sub-process will be completed immediately and follow its outgoing connection.
- *VariableName*: The name of the variable to contain the current element from the collection. This gives nodes within the composite node access to the selected element.
- *CollectionOutput*: The name of a variable that represents collection of elements that will gather all output of the multi instance sub process
- *OutputVariableName*: The name of the variable to contain the currentl output from the multi instance activity
- *CompletionCondition*: MVEL expression that will be evaluated on each instance completion to check if given multi instance activity can already be completed. In case it evaluates to true all other remaining instances within multi instance activity will be canceled.

6.4. Events

6.4.1. Start event

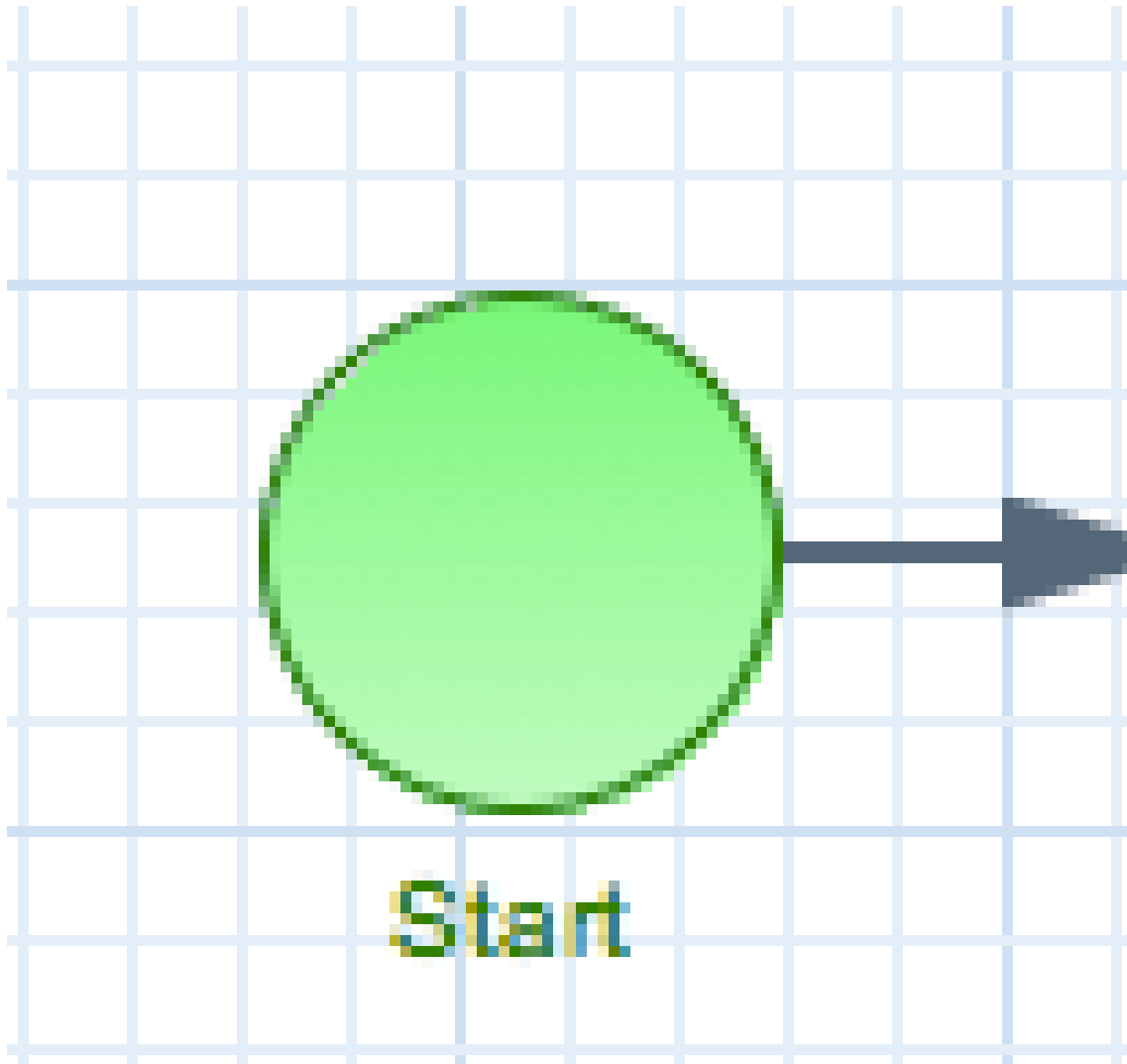


Figure 6.14. Start event

The start of the process. A process should have exactly one start node (none start node which does not have event definitions), which cannot have incoming connections and should have one outgoing connection. Whenever a process is started, execution will start at this node and automatically continue to the first node linked to this start event, and so on. It contains the following properties:

- *Id*: The id of the node (which is unique within one node container).
- *Name*: The display name of the node.

6.4.2. End events

6.4.2.1. End event

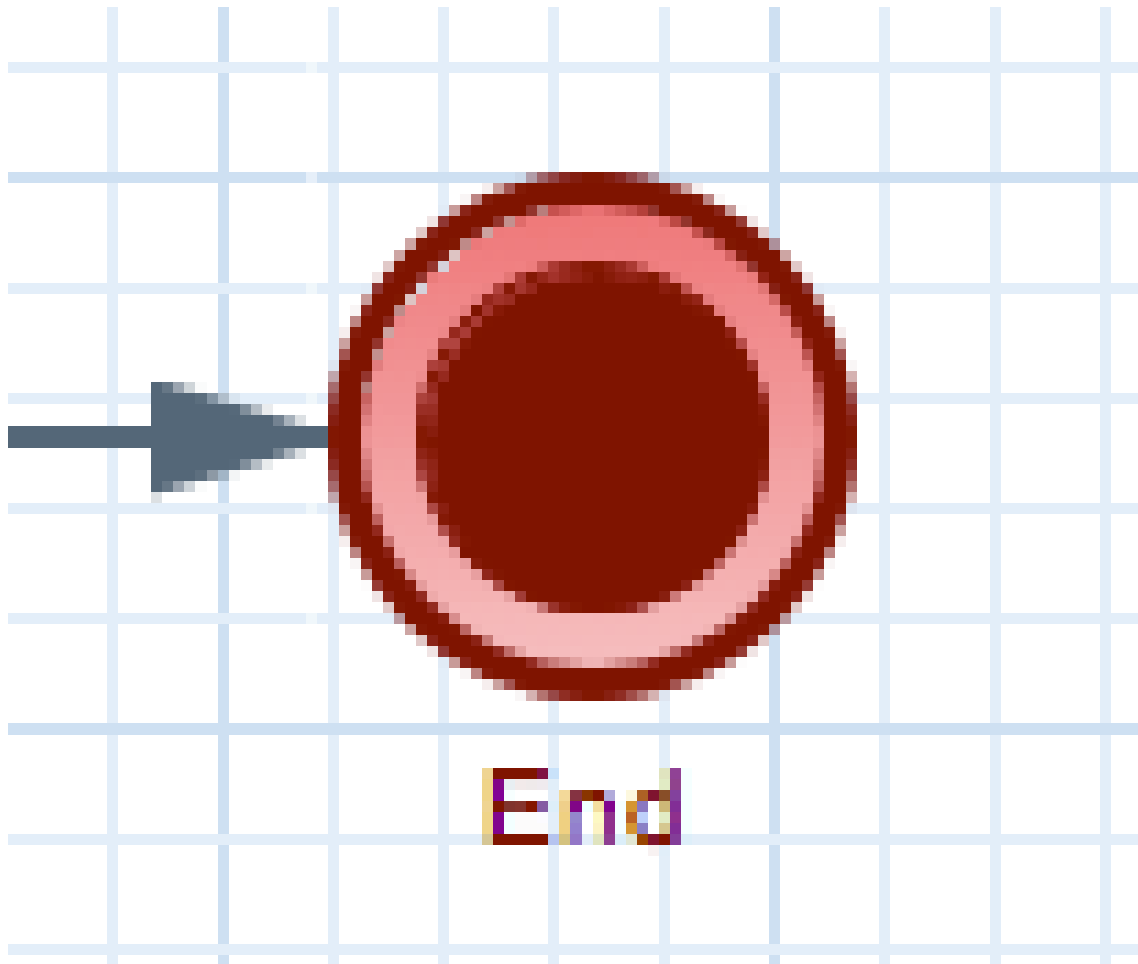


Figure 6.15. End event

The end of the process. A process should have one or more end events. The End Event should have one incoming connection and cannot have any outgoing connections. It contains the following properties:

- *Id*: The id of the node (which is unique within one node container).
- *Name*: The display name of the node.
- *Terminate*: An End Event can terminate the entire process or just the path. When a process instance is terminated, it means its state is set to completed and all other nodes that might still be active (on parallel paths) in this process instance are canceled. Non-terminating end events are simply end for this path (execution of this branch will end here), but other parallel paths can still continue. A process instance will automatically complete if there are no more active paths inside that process instance (for example, if a process instance reaches a non-terminating end node but there are no more active branches inside the process instance, the process instance

will be completed anyway). Terminating end events are visualized using a full circle inside the event node, non-terminating event nodes are empty. Note that, if you use a terminating event node inside a sub-process, you are terminating just that sub-process and top level continues.

6.4.2.2. Throwing error event

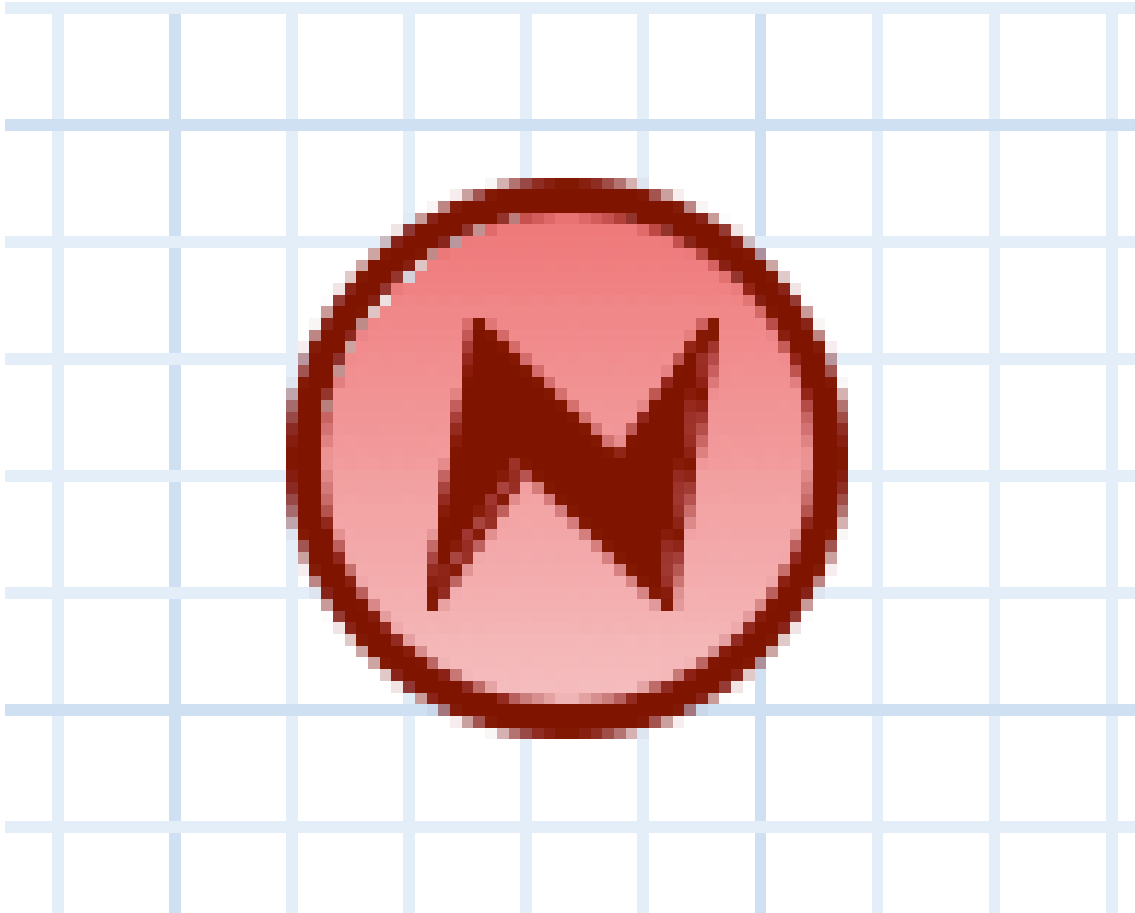


Figure 6.16. Throwing error event

An Error Event can be used to signal an exceptional condition in the process. It should have one incoming connection and no outgoing connections. When an Error Event is reached in the process, it will throw an error with the given name. The process will search for an appropriate error handler that is capable of handling this kind of fault. If no error handler is found, the process instance will be aborted. An Error Event contains the following properties:

- *Id*: The id of the node (which is unique within one node container).
- *Name*: The display name of the node.
- *FaultName*: The name of the fault. This name is used to search for appropriate exception handlers that are capable of handling this kind of fault.
- *FaultVariable*: The name of the variable that contains the data associated with this fault. This data is also passed on to the exception handler (if one is found).

Error handlers can be specified using boundary events.

6.4.3. Intermediate events

6.4.3.1. Catching timer event

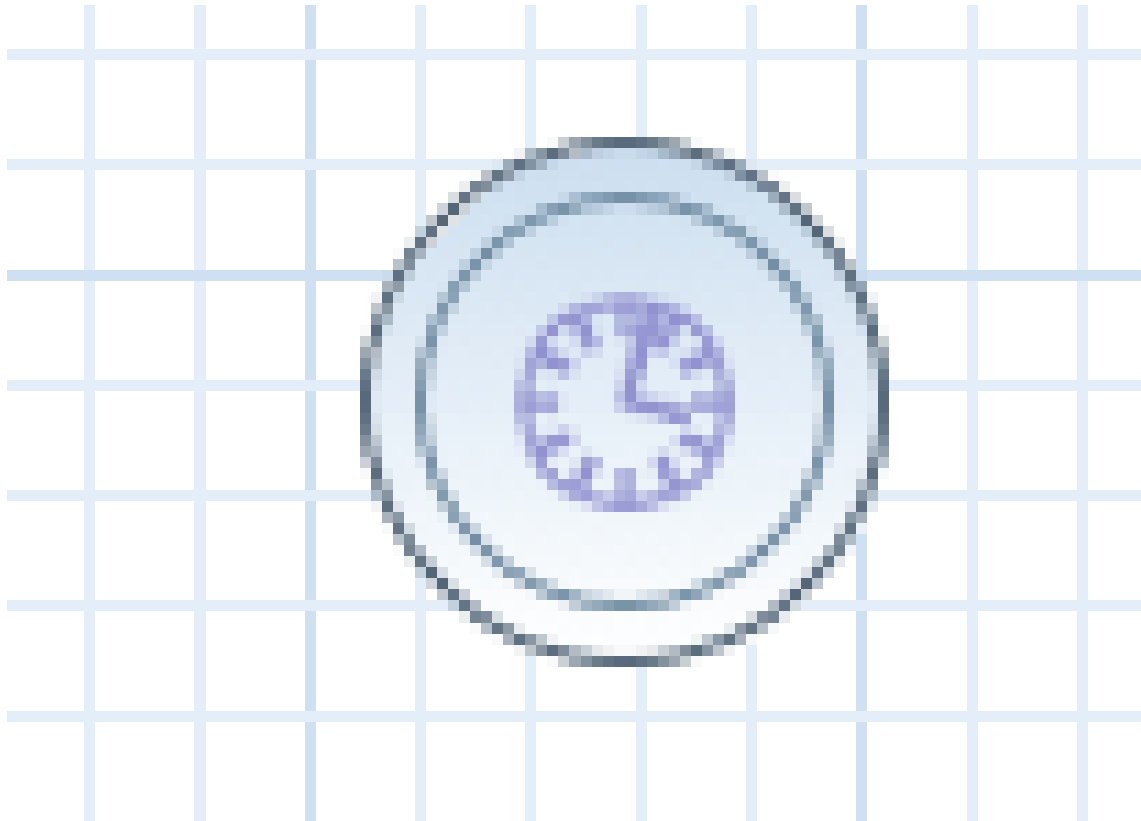


Figure 6.17. Catching timer event

Represents a timer that can trigger one or multiple times after a given period of time. A Timer Event should have one incoming connection and one outgoing connection. The timer delay specifies how long the timer should wait before triggering the first time. When a Timer Event is reached in the process, it will start the associated timer. The timer is canceled if the timer node is canceled (e.g., by completing or aborting the enclosing process instance). Consult the section “???” for more information. The Timer Event contains the following properties:

- *Id*: The id of the node (which is unique within one node container).
- *Name*: The display name of the node.
- *Timer delay*: The delay that the node should wait before triggering the first time. The expression should be of the form `[#d][#h][#m][#s][#[ms]]`. This allows you to specify the number of days, hours, minutes, seconds and milliseconds (which is the default if you don't specify anything). For example, the expression "1h" will wait one hour before triggering the timer. The expression could also use `#{expr}` to dynamically derive the delay based on some process vari-

able. Expr in this case could be a process variable, or a more complex expression based on a process variable (e.g. `myVariable.getValue()`). It does support CRON like expression as well.

- *Timer period:* The period between two subsequent triggers. If the period is 0, the timer should only be triggered once. The expression should be of the form `[#d][#h][#m][#s][#ms]`. You can specify the number of days, hours, minutes, seconds and milliseconds (which is the default if you don't specify anything). For example, the expression "1h" will wait one hour before triggering the timer again. The expression could also use `{expr}` to dynamically derive the period based on some process variable. Expr in this case could be a process variable, or a more complex expression based on a process variable (e.g. `myVariable.getValue()`).

Timer events could also be specified as boundary events on sub-processes and tasks that are not automatic tasks like script task that have no wait state as timer will not have a change to fire before task completion.

6.4.3.2. Catching signal event

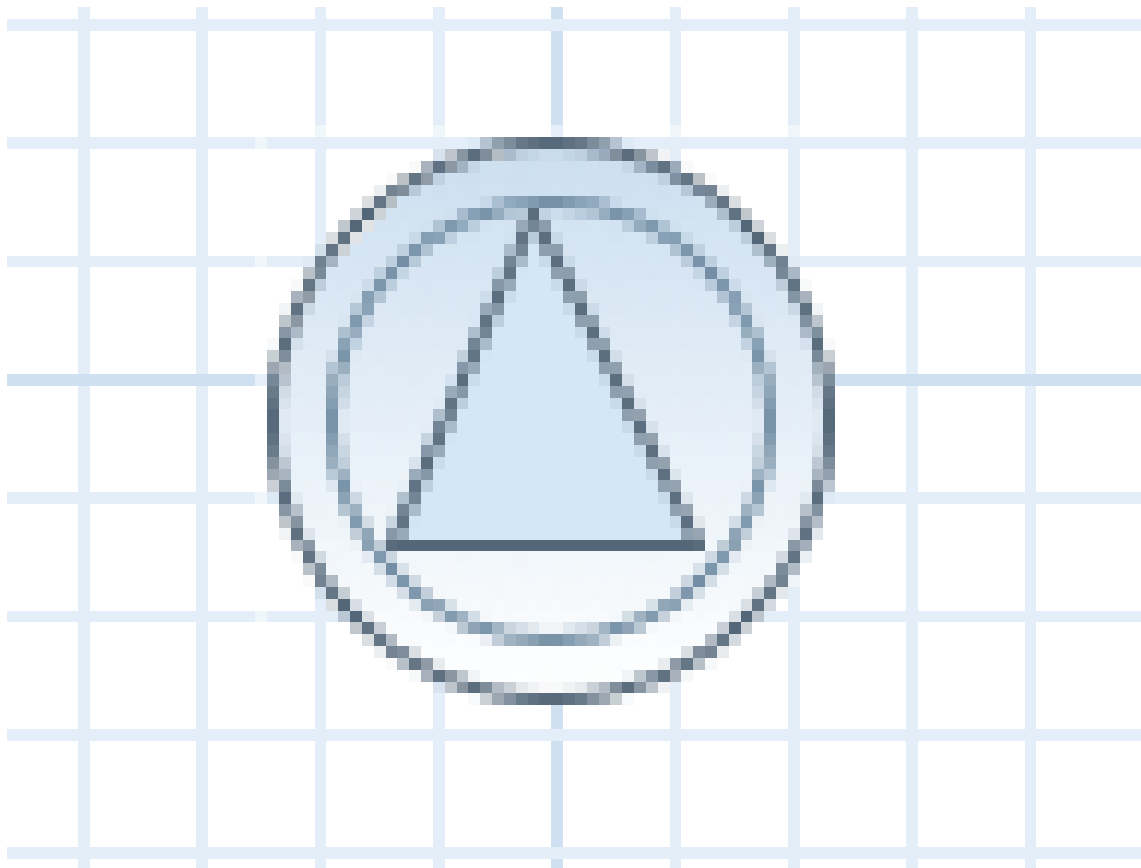


Figure 6.18. Catching signal event

A Signal Event can be used to respond to internal or external events during the execution of the process. A Signal Event should have one incoming connections and one outgoing connection. It specifies the type of event that is expected. Whenever that type of event is detected, the node connected to this event node will be triggered. It contains the following properties:

- *Id*: The id of the node (which is unique within one node container).
- *Name*: The display name of the node.
- *EventType*: The type of event that is expected.
- *VariableName*: The name of the variable that will contain the data associated with this event (if any) when this event occurs.

A process instance can be signaled that a specific event occurred using

```
ksession.signalEvent(eventType, data, processInstanceId)
```

This will trigger all (active) signal event nodes in the given process instance that are waiting for that event type. Data related to the event can be passed using the data parameter. If the event node specifies a variable name, this data will be copied to that variable when the event occurs.

It is also possible to use event nodes inside sub-processes. These event nodes will however only be active when the sub-process is active.

You can also generate a signal from inside a process instance. A script (in a script task or using on entry or on exit actions) can use

```
kcontext.getKieRuntime().signalEvent(eventType, data, kcontext.getProcessInstance().getId());
```

A throwing signal event could also be used to model the signaling of an event.

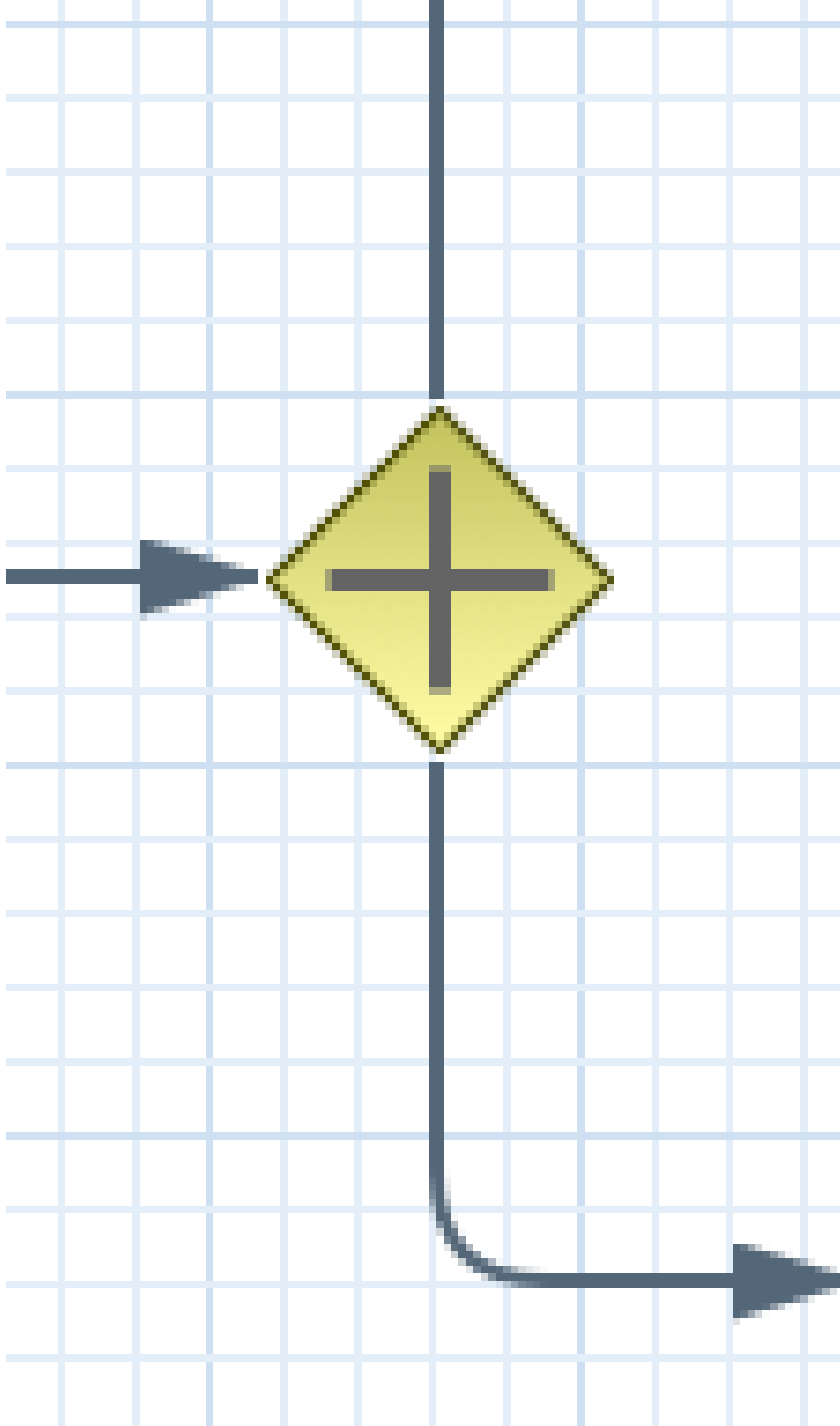


Figure 6.19. Diverging gateway

Allows you to create branches in your process. A Diverging Gateway should have one incoming connection and two or more outgoing connections. There are three types of gateway nodes currently supported:

- **AND** or parallel means that the control flow will continue in all outgoing connections simultaneously.
- **XOR** or exclusive means that exactly one of the outgoing connections will be chosen. The decision is made by evaluating the constraints that are linked to each of the outgoing connections. The constraint with the *lowest* priority number that evaluates to true is selected. Constraints can be specified using different dialects. Note that you should always make sure that at least one of the outgoing connections will evaluate to true at runtime (the engine will throw an exception at runtime if it cannot find at least one outgoing connection).
- **OR** or inclusive means that all outgoing connections whose condition evaluates to true are selected. Conditions are similar to the exclusive gateway, except that no priorities are taken into account. Note that you should make sure that at least one of the outgoing connections will evaluate to true at runtime because the engine will throw an exception at runtime if it cannot determine an outgoing connection.

It contains the following properties:

- *Id*: The id of the node (which is unique within one node container).
- *Name*: The display name of the node.
- *Type*: The type of the split node, i.e., AND, XOR or OR (see above).
- *Constraints*: The constraints linked to each of the outgoing connections (in case of an exclusive or inclusive gateway).

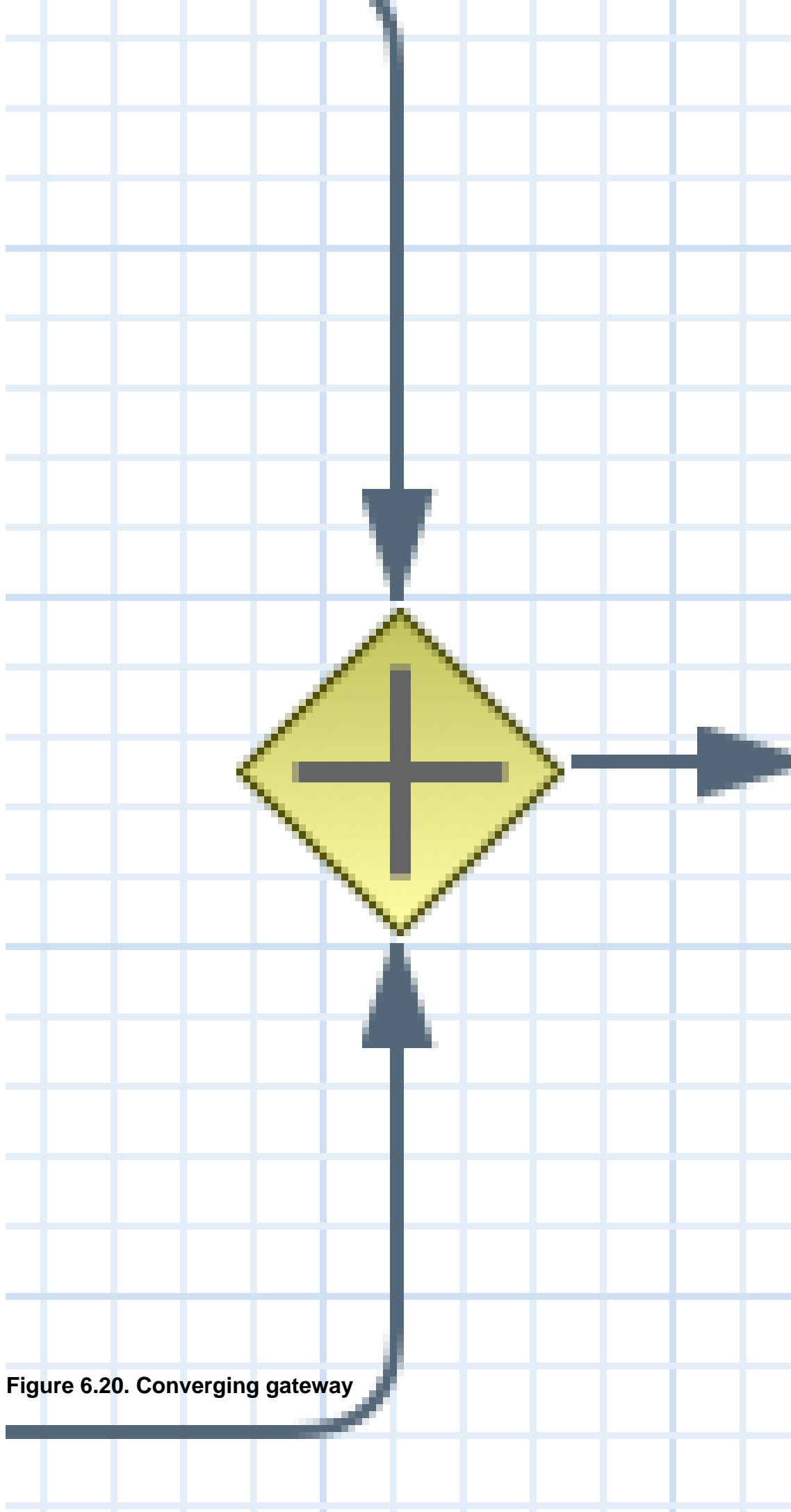


Figure 6.20. Converging gateway

Allows you to synchronize multiple branches. A Converging Gateway should have two or more incoming connections and one outgoing connection. There are three types of splits currently supported:

- AND or parallel means that it will wait until *all* incoming branches are completed before continuing.
- XOR or exclusive means that it continues as soon as *one* of its incoming branches has been completed. If it is triggered from more than one incoming connection, it will trigger the next node for each of those triggers.
- OR or inclusive means that it continues as soon as *all direct active paths* of its incoming branches has been completed. This is complex merge behaviour that is described in BPMN2 specification but in most cases it means that OR join will wait for all active flows that started in OR split. Some advanced cases (including other gateways in between or repeatable timers) will be causing different "direct active path" calculation.

It contains the following properties:

- *Id*: The id of the node (which is unique within one node container).
- *Name*: The display name of the node.
- *Type*: The type of the Join node, i.e. AND, OR or XOR.

6.6. Others

6.6.1. Variables

While the flow chart focuses on specifying the control flow of the process, it is usually also necessary to look at the process from a data perspective. Throughout the execution of a process, data can be retrieved, stored, passed on and used.

For storing runtime data, during the execution of the process, process variables can be used. A variable is defined by a name and a data type. This could be a basic data type, such as boolean, int, or String, or any kind of Object subclass (it must implement Serializable interface). Variables can be defined inside a variable *scope*. The top-level scope is the variable scope of the process itself. Subscopes can be defined using a Sub-Process. Variables that are defined in a subscope are only accessible for nodes within that scope.

Whenever a variable is accessed, the process will search for the appropriate variable scope that defines the variable. Nesting of variable scopes is allowed. A node will always search for a variable in its parent container. If the variable cannot be found, it will look in that one's parent container, and so on, until the process instance itself is reached. If the variable cannot be found, a read access yields null, and a write access produces an error message, with the process continuing its execution.

Variables can be used in various ways:

- Process-level variables can be set when starting a process by providing a map of parameters to the invocation of the `startProcess` method. These parameters will be set as variables on the process scope.
- Script actions can access variables directly, simply by using the name of the variable as a local parameter in their script. For example, if the process defines a variable of type "org.jbpm.Person" in the process, a script in the process could access this directly:

```
// call method on the process variable "person"
person.setAge(10);
```

Changing the value of a variable in a script can be done through the knowledge context:

```
kcontext.setVariable(variableName, value);
```

- Service tasks (and reusable sub-processes) can pass the value of process variables to the outside world (or another process instance) by mapping the variable to an outgoing parameter. For example, the parameter mapping of a service task could define that the value of the process variable `x` should be mapped to a task parameter `y` right before the service is being invoked. You can also inject the value of process variable into a hard-coded parameter String using `#{expression}`. For example, the description of a human task could be defined as `You need to contact person #{person.getName()}` (where `person` is a process variable), which will replace this expression by the actual name of the person when the service needs to be invoked. Similarly results of a service (or reusable sub-process) can also be copied back to a variable using a result mapping.
- Various other nodes can also access data. Event nodes for example can store the data associated to the event in a variable, etc. Check the properties of the different node types for more information.
- Process variables can be accessed also from the Java code of your application. It is done by casting of `ProcessInstance` to `WorkflowProcessInstance`. See the following example:

```
variable = ((WorkflowProcessInstance) processInstance).getVariable("variableName");
```

To list all the process variables see the following code snippet:

```
org.jbpm.process.instance.ProcessInstance processInstance = ...;
VariableScopeInstance variableScope = (VariableScopeInstance) processInstance.getContextInstance(VariableScope.
```

```
Map<String, Object> variables = variableScope.getVariables();
```

Note that when you use persistence then you have to use a command based approach to get all process variables:

```
Map<String, Object> variables = ksession.execute(new GenericCommand<Map<String, Object>>() {
    public Map<String, Object> execute(Context context) {
        KieSession ksession = ((KnowledgeCommandContext) context).getStatefulKnowledgeSession();
        org.jbpm.process.instance.ProcessInstance processInstance = (org.jbpm.process.instance.ProcessInstance)
        VariableScopeInstance variableScope = (VariableScopeInstance) processInstance.getContextInstance(VariableScopeInstance.class);
        Map<String, Object> variables = variableScope.getVariables();
        return variables;
    }
});
```

Finally, processes (and rules) all have access to globals, i.e. globally defined variables and data in the Knowledge Session. Globals are directly accessible in actions just like variables. Globals need to be defined as part of the process before they can be used. You can for example define globals by clicking the globals button when specifying an action script in the Eclipse action property editor. You can also set the value of a global from the outside using `ksession.setGlobal(name, value)` or from inside process scripts using `kcontext.getKieRuntime().setGlobal(name, value);`

6.6.2. Scripts

Action scripts can be used in different ways:

- Within a Script Task,
- As entry or exit actions, with a number of nodes.

Actions have access to globals and the variables that are defined for the process and the pre-defined variable `kcontext`. This variable is of type `ProcessContext` [<http://docs.jboss.org/jbpm/v6.0.1/javadocs/org/kie/api/runtime/process/ProcessContext.html>] and can be used for several tasks:

- Getting the current node instance (if applicable). The node instance could be queried for data, such as its name and type. You can also cancel the current node instance.

```
NodeInstance node = kcontext.getNodeInstance();
String name = node.getNodeName();
```

- Getting the current process instance. A process instance can be queried for data (name, id, processId, etc.), aborted or signaled an internal event.

```
ProcessInstance proc = kcontext.getProcessInstance();
```

```
proc.signalEvent( type, eventObject );
```

- Getting or setting the value of variables.
- Accessing the Knowledge Runtime allows you do things like starting a process, signaling (external) events, inserting data, etc.

jBPM supports multiple dialects, like Java, JavaScript and MVEL. Java actions should be valid Java code, same for JavaScript. MVEL actions can use the business scripting language MVEL to express the action. MVEL accepts any valid Java code but additionally provides support for nested accesses of parameters (e.g., `person.name` instead of `person.getName()`), and many other scripting improvements. Thus, MVEL expressions are more convenient for the business user. For example, an action that prints out the name of the person in the "requester" variable of the process would look like this:

```
// Java dialectSystem.out.println( person.getName() );// JavaScript dialectprint(person.name +
'\n');// MVEL dialectSystem.out.println( person.name );
dialectSystem.out.println( person.getName()

);// JavaScript
dialectprint(person.name +

'\n');// MVEL
dialectSystem.out.println( person.name
);
```

6.6.3. Constraints

Constraints can be used in various locations in your processes, for example in a diverging gateway. jBPM supports two types of constraints:

- *Code constraints* are boolean expressions, evaluated directly whenever they are reached. We support multiple dialects for expressing these code constraints: Java, JavaScript and MVEL. All code constraints have direct access to the globals and variables defined in the process. Here is an example of a valid Java code constraint, `person` being a variable in the process:

```
return person.getAge() > 20;
```

A similar example of a valid MVEL code constraint is:

```
return person.age > 20;
```

And for JavaScript:

```
person.age > 20
```

- *Rule constraints* are equals to normal Drools rule conditions. They use the Drools Rule Language syntax to express possibly complex constraints. These rules can, like any other rule, refer to data in the Working Memory. They can also refer to globals directly. Here is an example of a valid rule constraint:

```
Person( age > 20 )
```

This tests for a person older than 20 being in the Working Memory.

Rule constraints do not have direct access to variables defined inside the process. It is however possible to refer to the current process instance inside a rule constraint, by adding the process instance to the Working Memory and matching for the process instance in your rule constraint. We have added special logic to make sure that a variable `processInstance` of type `WorkflowProcessInstance` will only match to the current process instance and not to other process instances in the Working Memory. Note that you are however responsible yourself to insert the process instance into the session and, possibly, to update it, for example, using Java code or an on-entry or on-exit or explicit action in your process. The following example of a rule constraint will search for a person with the same name as the value stored in the variable "name" of the process:

```
processInstance      :      WorkflowProcessInstance()Person(      name      ==
( processInstance.getVariable("name") ) )# add more constraints here ...
WorkflowProcessInstance()Person( name == ( processInstance.getVariable("name")
) )# add more constraints
```

6.6.4. Timers

Timers wait for a predefined amount of time, before triggering, once or repeatedly. They can be used to trigger certain logic after a certain period, or to repeat some action at regular intervals.

6.6.4.1. Configure timer with delay and period

A Timer node is set up with a delay and a period. The delay specifies the amount of time to wait after node activation before triggering the timer the first time. The period defines the time between subsequent trigger activations. A period of 0 results in a one-shot timer.

The (period and delay) expression should be of the form `[#d][#h][#m][#s][#ms]`. You can specify the amount of days, hours, minutes, seconds and milliseconds (which is the default if you don't specify anything). For example, the expression "1h" will wait one hour before triggering the timer (again).

6.6.4.2. Configure timer with CRON like expression

Timer events can be configured with CRON like expression when `timeCycle` is used as timer event definition. Important is that the language attribute of `timeCycle` definition must be set to *cron*. With that such cycle of a timer is controlled in the same way as CRON jobs. CRON like expression is supported for:

- start event timers
- intermediate event timers
- boundary event timers

Following is an example of a definition of a boundary timer with CRON like expression

```
<bpmn2:boundaryEvent id="1" name="Send Update Timer" attachedToRef="_77A94B54-8B7C-4F8A-84EE-
C1D310A343A6" cancelActivity="false">
  <bpmn2:outgoing>2</bpmn2:outgoing>
  <bpmn2:timerEventDefinition id="_erIyiJZ7EeSDh8PHobjSSA">
    <bpmn2:timeCycle xsi:type="bpmn2:tFormalExpression" id="_erIyizz7EeSDh8PHobjSSA"
language="cron">0/1 * * * * ?</bpmn2:timeCycle>
  </bpmn2:timerEventDefinition>
</bpmn2:boundaryEvent>
```

This timer will fire every second and will continue until activity this boundary event is attached to is active.

6.6.4.3. Configure timer ISO-8601 date format

since version 6 timers can be configured with valid ISO8601 [http://en.wikipedia.org/wiki/ISO_8601] date format that supports both one shot timers and repeatable timers. Timers can be defined as date and time representation, time duration or repeating intervals

- Date - 2013-12-24T20:00:00.000+02:00 - fires exactly at Christmas Eve at 8PM
- Duration - PT1S - fires once after 1 second
- Repeatable intervals - R/PT1S - fires every second, no limit, alternatively R5/PT1S will fire 5 times every second

6.6.4.4. Configure timer with process variables

In addition to two configuration options above timers can be specified using process variable that can consists of string representation of ether delay and period or ISO8601 date format. By specifying `#{variable}` engine will dynamically extract process variable and use it as timer expression.

The timer service is responsible for making sure that timers get triggered at the appropriate times. Timers can also be canceled, meaning that the timer will no longer be triggered.

Timers can be used in two ways inside a process:

- A Timer Event may be added to the process flow. Its activation starts the timer, and when it triggers, once or repeatedly, it activates the Timer node's successor. Subsequently, the outgoing connection of a timer with a positive period is triggered multiple times. Canceling a Timer node also cancels the associated timer, after which no more triggers will occur.
- Timers can be associated with a Sub-Process or tasks as a boundary event.

6.7. Process Fluent API

While it is recommended to define processes using the graphical editor or the underlying XML (to shield yourself from internal APIs), it is also possible to define a process using the Process API directly. The most important process model elements are defined in the packages `org.jbpm.workflow.core` and `org.jbpm.workflow.core.node`. A "fluent API" is provided that allows you to easily construct processes in a readable manner using factories. At the end, you can validate the process that you were constructing manually.

6.7.1. Example

This is a simple example of a basic process with a script task only:

```
RuleFlowProcessFactory factory =
    RuleFlowProcessFactory.createProcess("org.jbpm.HelloWorld");
factory
    // Header
    .name("HelloWorldProcess")
    .version("1.0")
    .packageName("org.jbpm")
    // Nodes
    .startNode(1).name("Start").done()
    .actionNode(2).name("Action")
        .action("java", "System.out.println(\"Hello World\");").done()
    .endNode(3).name("End").done()
    // Connections
    .connection(1, 2)
    .connection(2, 3);
RuleFlowProcess process = factory.validate().getProcess();

KieServices ks = KieServices.Factory.get();
KieFileSystem kfs = ks.newKieFileSystem();
Resource resource = ks.getResources().newByteArrayResource(
    XmlBPMNProcessDumper.INSTANCE.dump(process).getBytes());
resource.setSourcePath("helloworld.bpmn2");
kfs.write(resource);
ReleaseId releaseId = ks.newReleaseId("org.jbpm", "helloworld", "1.0");
kfs.generateAndWritePomXML(releaseId);
ks.newKieBuilder(kfs).buildAll();
ks.newKieContainer(releaseId).newKieSession().startProcess("org.jbpm.HelloWorld");
```

You can see that we start by calling the static `createProcess()` method from the `RuleFlowProcessFactory` class. This method creates a new process with the given id and returns the `RuleFlowProcessFactory` that can be used to create the process. A typical process consists of three parts. The header part comprises global elements like the name of the process, imports, variables, etc. The nodes section contains all the different nodes that are part of the process. The connections section finally links these nodes to each other to create a flow chart.

In this example, the header contains the name and the version of the process and the package name. After that, you can start adding nodes to the current process. If you have auto-completion you can see that you have different methods to create each of the supported node types at your disposal.

When you start adding nodes to the process, in this example by calling the `startNode()`, `actionNode()` and `endNode()` methods, you can see that these methods return a specific `NodeFactory`, that allows you to set the properties of that node. Once you have finished configuring that specific node, the `done()` method returns you to the current `RuleFlowProcessFactory` so you can add more nodes, if necessary.

When you are finished adding nodes, you must connect them by creating connections between them. This can be done by calling the method `connection`, which will link previously created nodes.

Finally, you can validate the generated process by calling the `validate()` method and retrieve the created `RuleFlowProcess` object.

6.8. Testing

Even though business processes aren't code (we even recommend you to make them as high-level as possible and to avoid adding implementation details), they also have a life cycle like other development artefacts. And since business processes can be updated dynamically, testing them (so that you don't break any use cases when doing a modification) is really important as well.

6.8.1. Unit testing

When unit testing your process, you test whether the process behaves as expected in specific use cases, for example test the output based on the existing input. To simplify unit testing, jBPM includes a helper class called **JbpmJUnitBaseTestCase** (in the `jbpm-test` module) that you can use to greatly simplify your JUnit testing, by offering:

- helper methods to create a new `RuntimeManager` and `RuntimeEngine` for a given (set of) process(es)
 - you can select whether you want to use persistence or not
- assert statements to check
 - the state of a process instance (active, completed, aborted)

- which node instances are currently active
- which nodes have been triggered (to check the path that has been followed)
- get the value of variables

For example, consider the following "hello world" process containing a start event, a script task and an end event. The following JUnit test will create a new session, start the process and then verify whether the process instance completed successfully and whether these three nodes have been executed.

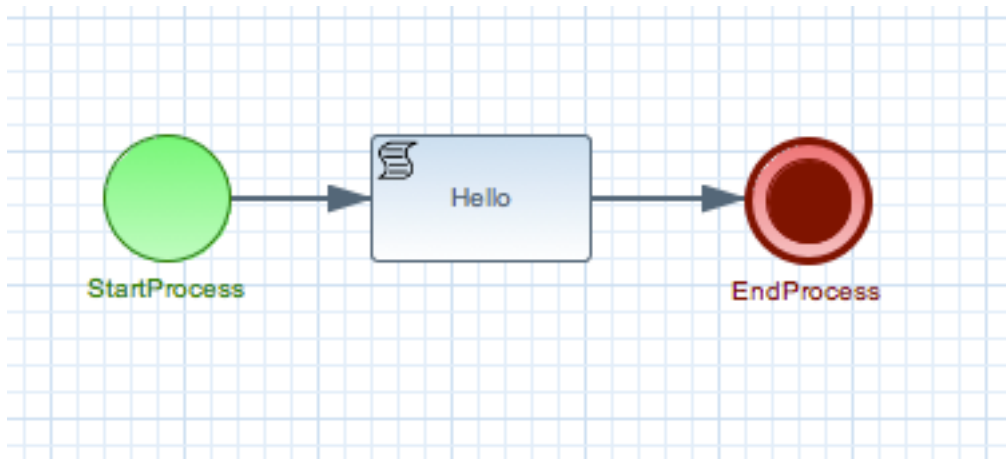


Figure 6.21.

```
public class ProcessPersistenceTest extends JbpmJUnitBaseTestCase {

    public ProcessPersistenceTest() {
        // setup data source, enable persistence
        super(true, true);
    }

    @Test
    public void testProcess() {
        // create runtime manager with single process - hello.bpmn
        createRuntimeManager("hello.bpmn");

        // take RuntimeManager to work with process engine
        RuntimeEngine runtimeEngine = getRuntimeEngine();

        // get access to KieSession instance
        KieSession ksession = runtimeEngine.getKieSession();

        // start process
        ProcessInstance processInstance = ksession.startProcess("com.sample.bpmn.hello");

        // check whether the process instance has completed successfully
        assertProcessInstanceCompleted(processInstance.getId(), ksession);

        // check what nodes have been triggered
    }
}
```

```
        assertNodeTriggered(processInstance.getId(), "StartProcess", "Hello", "EndProcess");
    }
}
```

JbpmJUnitBaseTestCase acts as base test case class that shall be used for jBPM related tests. It provides four usage areas:

- JUnit life cycle methods
 - setUp: executed @Before and configures data source and EntityManagerFactory, cleans up Singleton's session id
 - tearDown: executed @After and clears out history, closes EntityManagerFactory and data source, disposes RuntimeEngines and RuntimeManager
- Knowledge Base and KnowledgeSession management methods
 - createRuntimeManager creates RuntimeManager for given set of assets and selected strategy
 - disposeRuntimeManager disposes RuntimeManager currently active in the scope of test
 - getRuntimeEngine creates new RuntimeEngine for given context
- Assertions
 - assertProcessInstanceCompleted
 - assertProcessInstanceAborted
 - assertProcessInstanceActive
 - assertNodeActive
 - assertNodeTriggered
 - assertProcessVarExists
 - assertNodeExists
 - assertVersionEquals
 - assertProcessNameEquals
- Helper methods
 - getDs - returns currently configured data source
 - getEmf - returns currently configured EntityManagerFactory
 - getTestWorkItemHandler - returns test work item handler that might be registered in addition to what is registered by default

- clearHistory - clears history log
- setupPoolingDataSource - sets up data source

JbpmJUnitBaseTestCase supports all three predefined RuntimeManager strategies as part of the unit testing. It's enough to specify which strategy shall be used whenever creating runtime manager as part of single test:

```
public class ProcessHumanTaskTest extends JbpmJUnitBaseTestCase {

    private static final Logger logger = LoggerFactory.getLogger(ProcessHumanTaskTest.class);

    public ProcessHumanTaskTest() {
        super(true, false);
    }

    @Test
    public void testProcessProcessInstanceStrategy() {
        RuntimeManager manager = createRuntimeManager(Strategy.PROCESS_INSTANCE, "manager", "humantask.bpmn");
        RuntimeEngine runtimeEngine = getRuntimeEngine(ProcessInstanceIdContext.get());
        KieSession ksession = runtimeEngine.getKieSession();
        TaskService taskService = runtimeEngine.getTaskService();

        int ksessionID = ksession.getId();
        ProcessInstance processInstance = ksession.startProcess("com.sample.bpmn.hello");

        assertProcessInstanceActive(processInstance.getId(), ksession);
        assertNodeTriggered(processInstance.getId(), "Start", "Task 1");

        manager.disposeRuntimeEngine(runtimeEngine);
        runtimeEngine = getRuntimeEngine(ProcessInstanceIdContext.get(processInstance.getId()));

        ksession = runtimeEngine.getKieSession();
        taskService = runtimeEngine.getTaskService();

        assertEquals(ksessionID, ksession.getId());

        // let john execute Task 1
        List<TaskSummary> list = taskService.getTasksAssignedAsPotentialOwner("john", "en-UK");
        TaskSummary task = list.get(0);
        logger.info("John is executing task {}", task.getName());
        taskService.start(task.getId(), "john");
        taskService.complete(task.getId(), "john", null);

        assertNodeTriggered(processInstance.getId(), "Task 2");

        // let mary execute Task 2
        list = taskService.getTasksAssignedAsPotentialOwner("mary", "en-UK");
        task = list.get(0);
        logger.info("Mary is executing task {}", task.getName());
        taskService.start(task.getId(), "mary");
        taskService.complete(task.getId(), "mary", null);

        assertNodeTriggered(processInstance.getId(), "End");
        assertProcessInstanceCompleted(processInstance.getId(), ksession);
    }
}
```

}

Above is more complete example that uses `PerProcessInstance` runtime manager strategy and uses task service to deal with user tasks.

6.8.1.1. Testing integration with external services

Real-life business processes typically include the invocation of external services (like for example a human task service, an email server or your own domain-specific services). One of the advantages of our domain-specific process approach is that you can specify yourself how to actually execute your own domain-specific nodes, by registering a handler. And this handler can be different depending on your context, allowing you to use testing handlers for unit testing your process. When you are unit testing your business process, you can register test handlers that then verify whether specific services are requested correctly, and provide test responses for those services. For example, imagine you have an email node or a human task as part of your process. When unit testing, you don't want to send out an actual email but rather test whether the email that is requested contains the correct information (for example the right to email, a personalized body, etc.).

A `TestWorkItemHandler` is provided by default that can be registered to collect all work items (a work item represents one unit of work, like for example sending one specific email or invoking one specific service and contains all the data related to that task) for a given type. This test handler can then be queried during unit testing to check whether specific work was actually requested during the execution of the process and that the data associated with the work was correct.

The following example describes how a process that sends out an email could be tested. This test case in particular will test whether an exception is raised when the email could not be sent (which is simulated by notifying the engine that the sending the email could not be completed). The test case uses a test handler that simply registers when an email was requested (and allows you to test the data related to the email like from, to, etc.). Once the engine has been notified the email could not be sent (using `abortWorkItem(...)`), the unit test verifies that the process handles this case successfully by logging this and generating an error, which aborts the process instance in this case.

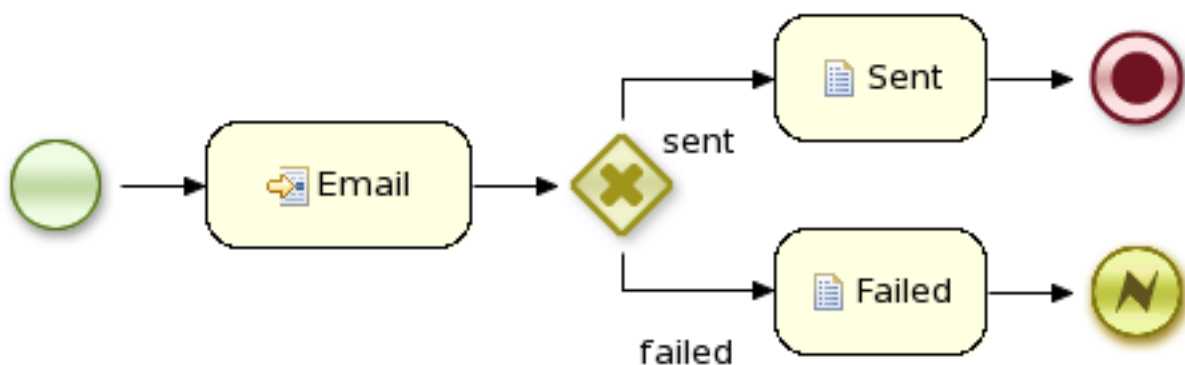


Figure 6.22.

```
public void testProcess2() {

    // create runtime manager with single process - hello.bpmn
    createRuntimeManager("sample-process.bpmn");
    // take RuntimeManager to work with process engine
    RuntimeEngine runtimeEngine = getRuntimeEngine();

    // get access to KieSession instance
    KieSession ksession = runtimeEngine.getKieSession();

    // register a test handler for "Email"
    TestWorkItemHandler testHandler = getTestWorkItemHandler();

    ksession.getWorkItemManager().registerWorkItemHandler("Email", testHandler);

    // start the process
    ProcessInstance processInstance = ksession.startProcess("com.sample.bpmn.hello2");

    assertProcessInstanceActive(processInstance.getId(), ksession);
    assertNodeTriggered(processInstance.getId(), "StartProcess", "Email");

    // check whether the email has been requested
    WorkItem workItem = testHandler.getWorkItem();
    assertNotNull(workItem);
    assertEquals("Email", workItem.getName());
    assertEquals("me@mail.com", workItem.getParameter("From"));
    assertEquals("you@mail.com", workItem.getParameter("To"));

    // notify the engine the email has been sent
    ksession.getWorkItemManager().abortWorkItem(workItem.getId());
    assertProcessInstanceAborted(processInstance.getId(), ksession);
    assertNodeTriggered(processInstance.getId(), "Gateway", "Failed", "Error");

}
```

6.8.1.2. Configuring persistence

You can configure whether you want to execute the JUnit tests using persistence or not. By default, the JUnit tests will use persistence, meaning that the state of all process instances will be stored in a (in-memory H2) database (which is started by the JUnit test during setup) and a history log will be used to check assertions related to execution history. When persistence is not used, process instances will only live in memory and an in-memory logger is used for history assertions.

Persistence (and setup of data source) is controlled by the super constructor and allows following

- default, no arg constructor - the most simple test case configuration (does NOT initialize data source and does NOT configure session persistence) - this is usually used for in memory process management, without human task interaction
- super(boolean, boolean) - allows to explicitly configure persistence and data source. This is the most common way of bootstrapping test cases for jBPM

- `super(true, false)` - to execute with in memory process management with human tasks persistence
- `super(true, true)` - to execute with persistent process management with human tasks persistence
- `super(boolean, boolean, string)` - same as `super(boolean, boolean)` but allows to use another persistence unit name than default (`org.jbpm.persistence.jpjpa`)

```
public class ProcessHumanTaskTest extends JbpmJUnitBaseTestCase {  
  
    private static final Logger logger = LoggerFactory.getLogger(ProcessHumanTaskTest.class);  
  
    public ProcessHumanTaskTest() {  
        // configure this tests to not use persistence for process engine but still use it  
        for human tasks  
        super(true, false);  
    }  
}
```

Chapter 7. Human Tasks

7.1. Introduction

An important aspect of business processes is human task management. While some of the work performed in a process can be executed automatically, some tasks need to be executed by human actors.

jBPM supports a special human task node inside processes for modeling this interaction with human users. This human task node allows process designers to define the properties related to the task that the human actor needs to execute, like for example the type of task, the actor(s), or the data associated with the task.

jBPM also includes a so-called human task service, a back-end service that manages the life cycle of these tasks at runtime. The jBPM implementation is based on the WS-HumanTask specification. Note however that this implementation is fully pluggable, meaning that users can integrate their own human task solution if necessary.

In order to have human actors participate in your processes, you first need to (1) include human task nodes inside your process to model the interaction with human actors, (2) integrate a task management component (like for example the WS-HumanTask based implementation provided by jBPM) and (3) have end users interact with a human task client to request their task list and claim and complete the tasks assigned to them. Each of these three elements will be discussed in more detail in the next sections.

7.2. Using User Tasks in our Processes

jBPM supports the use of human tasks inside processes using a special User Task node defined by the BPMN2 Specification (as shown in the figure above). A User Task node represents an atomic task that needs to be executed by a human actor.



[Although jBPM has a special user task node for including human tasks inside a process, human tasks are considered the same as any other kind of external service that needs to be invoked and are therefore simply implemented as a domain-specific service. See the chapter on domain-specific processes to learn more about this.]

A User Task node contains the following core properties:

- **Actors:** The actors that are responsible for executing the human task. A list of actor id's can be specified using a comma (',') as separator.
- **Group:** The group id that is responsible for executing the human task. A list of group id's can be specified using a comma (',') as separator.
- **Name:** The display name of the node.
- **TaskName:** The name of the human task. This name is used to link the task to a Form. It also represent the internal name of the Task that can be used for other purposes.
- **DataInputSet:** all the input variables that the task will receive to work on. Usually you will be interested in copying variables from the scope of the process to the scope of the task. (Look at the data mappings section for an example)
- **DataOutputSet:** all the output variables that will be generated by the execution of the task. Here you specify all the name of the variables in the context of the task that you are interested to copy to the context of the process. (Look at the data mappings section for an example)
- **Assignments:** here you specify which process variable will be linked to each Data Input and Data Output mapping. (Look at the data mappings section for an example)

You can edit these variables in the properties view (see below) when selecting the User Task node.

Name ▲	Value
Core Properties	
Actors	
Assignments	name->in_name,out_age->age,out_mail->mail...
DataInputSet	GroupId:Object,Comment:Object,in_name:String
DataOutputSet	out_name:String,out_age:Integer,out_mail:String,out_s...
Groups	HR
Name	HR Interview
Task Name	HRInterview
TaskType	User
Extra Properties	
Graphical Settings	
Simulation Properties	

A User Task node also contains the following extra properties:

- **Comment:** A comment associated with the human task. Here you can use expressions.
- **Content:** The data associated with this task.
- **Priority:** An integer indicating the priority of the human task.
- **Skippable:** Specifies whether the human task can be skipped, i.e., whether the actor may decide not to execute the task.
- **On entry and on exit actions:** Action scripts that are executed upon entry and exit of this node, respectively.

Extra Properties	
Comment	Candidate: #{name}
Content	
Created by	
Documentation	
Locale	
Multiple Inst...	false
Notifications	
On Entry Act...	
On Exit Acti...	
Priority	
Reassignment	
Script Langu...	java
Skippable	

An integer indicating the priority of the human task

7.2.1. Swimlanes

User tasks can be used in combination with swimlanes to assign multiple human tasks to the same actor. Whenever the first task in a swimlane is created, and that task has an actorId specified, that actorId will be assigned to (all other tasks of) that swimlane as well. Note that this would override the actorId of subsequent tasks in that swimlane (if specified), so only the actorId of the first human task in a swimlane will be taken into account, all others will then take the actorId as assigned in the first one.



Warning

ActorId assignment will work only when there is single actor specified. Since ActorId field can contain multiple actors (john,mary,peter) auto assignment for the first task will not be performed when multiple values are found.

Whenever a human task that is part of a swimlane is completed, the actorId of that swimlane is set to the actorId that executed that human task. This allows for example to assign a human task to a group of users, and to assign future tasks of that swimlane to the user that claimed the first task. This will also automatically change the assignment of tasks if at some point one of the tasks is reassigned to another user.

7.3. Data Mappings

Human tasks typically present some data related to the task that needs to be performed to the actor that is executing the task and usually also request the actor to provide some result data related to the execution of the task. Task forms are typically used to present this data to the actor and request results.

The data that will be used by the Task needs to be specified when we define the User Task in our Process. In order to do that we need to define which data will be copied from the process context to the task context. Notice that the data is copied, so it can be modified inside the Task context but it will not affect the process variables unless we decide to copy back the value from the task to the process context.

Most of the times Forms are used to display data to the end user. Allowing them to generate/create new data that will be propagated to the process context to be used by future activities. In order to decide how the information flow from the process to a particular task and from the task to the process we need to define which pieces of information will be automatically copied by the process engine. The following sections shows how to do these mappings by configuring the DataInputSet, DataOutputSet and the Assignments properties of a User Task.

Let's start defining the Task **DataInputSet**:

Add Data Input				
	Name	Standard Type	Custom Type	
1	GroupId	Object		
2	Comment	Object		
3	in_name	String		

Both GroupId and Comment are automatically generated, so you don't need to worry about that. In this case the only user defined Data Input is called: **in_name**. This means that the task will be receiving information from the process context and internally this variable will be called in_name. The type is also specified here.

In the **Data Outputs** represent the data that will be generated by the tasks. In this case we have two variables of type String called: **out_name** and **out_mail** and two Integer variables called: **out_age** and **out_score** are defined. This means that inside the task context we will need to set the value to these variables.

Add Data Output			
	Name	Standard Type	Custom Type
1	out_name	String	⊘
2	out_age	Integer	⊘
3	out_mail	String	⊘
4	out_score	Integer	⊘

Finally all the connections with the process context needs to be done in the **Data Assignments**. The main idea here is to define how Data Inputs and Data Outputs will be associated with process variables.

Add Assignment				
	From Object	Assignment Type	To Object	To Value
1	name	is mapped to	in_name	⊘
2	out_age	is mapped to	age	⊘
3	out_mail	is mapped to	mail	⊘
4	out_score	is mapped to	hr_score	⊘

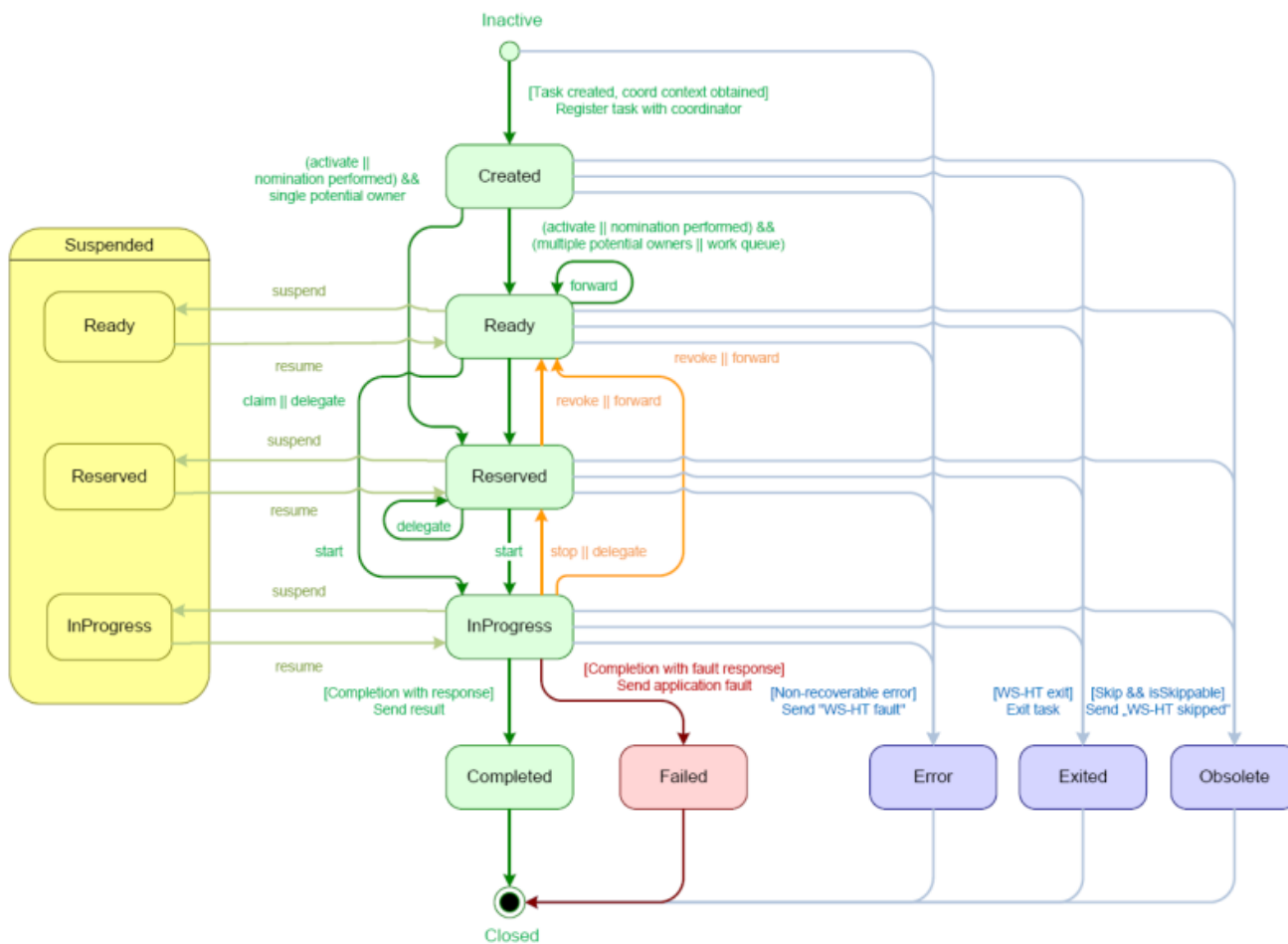
As shown in the previous screenshot, the assignments between the process variables (in this case (**name**, **age**, **mail** and **hr_score**)) and the Data Inputs and Outputs are done in the Data Assignments screen. Notice that the example uses a convention that makes it easy to know which is an internal Task variables (Data Input/Output) using the "in_" and "out_" prefix to the variable names. Using this convention you can quickly understand the Assignments screen. The first row maps the process variable called **name** to the data input called **in_name**. The second row maps the data output called **out_mail** to the process variable called **mail**, and so on.

These mappings at runtime will automatically copy the variables content from one context (process and task) to the other automatically for us.

7.4. Task Lifecycle

From the perspective of a process, when a user task node is encountered during the execution, a human task is created. The process will then only leave the user task node when the associated human task has been completed or aborted.

The human task itself usually has a complete life cycle itself as well. For details beyond what is described below, please check out the WS-HumanTask specification. The following diagram is from the WS-HumanTask specification and describes the human task life cycle.



A newly created task starts in the "Created" stage. Usually, it will then automatically become "Ready", after which the task will show up on the task list of all the actors that are allowed to execute the task. The task will stay "Ready" until one of these actors claims the task, indicating that he or she will be executing it.

When a user then eventually claims the task, the status will change to "Reserved". Note that a task that only has one potential (specific) actor will automatically be assigned to that actor upon creation of the task. When the user who has claimed the task starts executing it, the task status will change from "Reserved" to "InProgress".

Lastly, once the user has performed and completed the task, the task status will change to "Completed". In this step, the user can optionally specify the result data related to the task. If the task could not be completed, the user could also indicate this by using a fault response, possibly including fault data, in which case the status would change to "Failed".

While the life cycle explained above is the normal life cycle, the specification also describes a number of other life cycle methods, including:

- Delegating or forwarding a task, so that the task is assigned to another actor
- Revoking a task, so that it is no longer claimed by one specific actor but is (re)available to all actors allowed to take it
- Temporarily suspending and resuming a task
- Stopping a task in progress
- Skipping a task (if the task has been marked as skippable), in which case the task will not be executed

7.5. Task Permissions

Only users associated with a specific task are allowed to modify or retrieve information about the task. This allows users to create a jBPM workflow with multiple tasks and yet still be assured of both the confidentiality and integrity of the task status and information associated with a task.

Some task operations will end up throwing a `org.jbpm.services.task.exception.PermissionDeniedException` when used with information about an unauthorized user. For example, when a user is trying to directly modify the task (for example, by trying to claim or complete the task), the `PermissionDeniedException` will be thrown if that user does not have the correct role for that operation. Furthermore, a user will not be able to view or retrieve tasks that the user is not involved with, especially if this is via the jBPM Console or KIE Workbench applications.

User 'Administrator' and group 'Administrators' are automatically added to each Human Task.

7.5.1. Task Permissions Matrix

The permissions matrix below summarizes the actions that specific user roles are allowed to do. On the left side, possible operations are listed while user roles are listed across the top of the matrix.

The cells of the permissions matrix contain one of three possible characters, each of which indicate the user role permissions for that operation:

- a "+" indicates that the user role CAN do the specified operation
- a "-" indicates that the user role MAY NOT do the specified operation

- a "_" indicates that the user role MAY NOT do the specified operation, and that it is also not an operation that matches the user's role ("not applicable")

Furthermore, the following words or abbreviations in the table header refer to the following roles:

Table 7.1. Task roles in the permissions table

Word	Role	Description
Initiator	Task Initiator	The user who creates the task instance
Stakeholder	Task Stakeholder	The user involved in the task: this user can influence the progress of a task, by performing administrative actions on the task instance
Potential	Potential Owner	The user who can claim the task before it has been claimed, or after it has been released or forward: only tasks that have the status "Ready" may be claimed; a potential owner becomes the actual owner of a task by claiming the task
Actual	Actual Owner	The user who has claimed the task and will progress the task to completion or failure
Administrator	Business Administrator	A "super user" who may modify the status or progress of a task at any point in a task's lifecycle

User roles are assigned to users by the definition of the task in the jBPM (BPMN2) process definition.

Permissions Matrices. The following matrix describes the authorizations for all operations which modify a task:

Table 7.2. Main operations permissions matrix

Operation\Role	Initiator	Stakeholder	Potential	Actual	Administrator
activate	+	+	-	-	+
claim	-	+	+	-	+

Opera-tion\Role	Initiator	Stakeholder	Potential	Actual	Administra-tor
complete	-	+	-	+	+
delegate	+	+	+	+	+
fail	-	+	-	+	+
forward	+	+	+	+	+
nominate	+	+	+	+	+
release	+	+	+	+	+
remove	-	-	-	-	+
resume	+	+	+	+	+
skip	+	+	+	+	+
start	-	+	+	+	+
stop	-	+	-	+	+
suspend	+	+	+	+	+

The matrix below describes the authorizations used when retrieving task information. In short, it says that all users which have any role with regards to the specific task, are allowed to see the task. This applies to all operations that are used to retrieve any type of information about the task.

Table 7.3. Retrieval operations permissions matrix

Opera-tion\Role	Initiator	Stakeholder	Potential	Actual	Administra-tor
<i>get</i>	+	+	+	+	+

7.6. Task Service and The Process Engine

As far as the jBPM engine is concerned, human tasks are similar to any other external service that needs to be invoked and are implemented as a domain-specific service. (For more on domain-specific services, see the chapter on them here.) Because a human task is an example of such a domain-specific service, the process itself only contains a high-level, abstract description of the human task to be executed and a work item handler that is responsible for binding this (abstract) task to a specific implementation.

Users can plug in any human task service implementation, such as the one that's provided by jBPM, or they may register their own implementation. In the next paragraphs, we will describe the human task service implementation provided by jBPM.

The jBPM project provides a default implementation of a human task service based on the WS-HumanTask specification. If you do not need to integrate jBPM with another existing implementation of a human task service, you can use this service. The jBPM implementation manages the life cycle of the tasks (creation, claiming, completion, etc.) and stores the state of all the tasks, task

lists, and other associated information. It also supports features like internationalization, calendar integration, different types of assignments, delegation, escalation and deadlines. The code for the implementation itself can be found in the `jbpm-human-task` module.

The jBPM task service implementation is based on the WS-HumanTask (WS-HT) specification. This specification defines (in detail) the model of the tasks, the life cycle, and many other features. It is very comprehensive and the first version can be found [here](#).

7.7. Task Service API

The human task service exposes a Java API for managing the life cycle of tasks. This allows clients to integrate (at a low level) with the human task service. Note that end users should probably not interact with this low-level API directly, but use one of the more user-friendly task clients (see below) instead. These clients offer a graphical user interface to request task lists, claim and complete tasks, and manage tasks in general. The task clients listed below use the Java API to internally interact with the human task service. Of course, the low-level API is also available so that developers can use it in their code to interact with the human task service directly.

A task service (interface `org.kie.api.task.TaskService`) offers the following methods (among others) for managing the life cycle of human tasks:

```
...  
  
void start( long taskId, String userId );  
  
void stop( long taskId, String userId );  
  
void release( long taskId, String userId );  
  
void suspend( long taskId, String userId );  
  
void resume( long taskId, String userId );  
  
void skip( long taskId, String userId );  
  
void delegate(long taskId, String userId, String targetUserId);  
  
void complete( long taskId, String userId, Map<String, Object> results );  
  
...
```

If you take a look at the method signatures you will notice that almost all of these methods take the following arguments:

- `taskId`: The id of the task that we are working with. This is usually extracted from the currently selected task in the user task list in the user interface.

- `userId`: The id of the user that is executing the action. This is usually the id of the user that is logged in into the application.

There is also an internal interface that you should check for more methods to interact with the Task Service, this interface is internal until it gets tested. Future version of the External (public) interface can include some of the methods proposed in the `InternalTaskService` interface. If you want to make use of the methods provided by this interface you need to manually cast to `InternalTaskService`. One method that can be useful from this interface is `getTaskContent()`:

```
Map<String, Object> getTaskContent( long taskId );
```

This method saves you from doing all the boiler plate of getting the `ContentMarshallerContext` to unmarshall the serialized version of the task content. If you only want to use the stable/public API's you can just copy what this method does:

```
Task taskById = taskQueryService.getTaskInstanceById(taskId);
Content contentById =
taskContentService.getContentById(taskById.getTaskData().getDocumentContentId());
ContentMarshallerContext context = getMarshallerContext(taskById);
Object unmarshalledObject
= ContentMarshallerHelper.unmarshall(contentById.getContent(), context.getEnvironment(),
context.getClassloader());
if (!(unmarshalledObject instanceof Map)) {
    throw new IllegalStateException(" The Task Content Needs to be a Map in order
to use this method and it was: "+unmarshalledObject.getClass());
}
Map<String, Object> content = (Map<String, Object>) unmarshalledObject;
return content;
```

Because the content of the Task can be any Object, the previous method assume that you are storing a Map of objects to work. If you are storing other than a Map you should do the correspondent checks.

7.8. Interacting with the Task Service

In order to get access to the Task Service API it is recommended to let the Runtime Manager to make sure that everything is setup correctly. Look at the Runtime Manager section for more information. From the API perspective you should be doing something like this:

```
...
RuntimeEngine engine = runtimeManager.getRuntimeEngine(EmptyContext.get());
KieSession kieSession = engine.getKieSession();
```

```
// Start a process
kieSession.startProcess("CustomersRelationship.customers", params);
// Do Task Operations
TaskService taskService = engine.getTaskService();
List<TaskSummary> tasksAssignedAsPotentialOwner =
taskService.getTasksAssignedAsPotentialOwner("mary", "en-UK");

// Claim Task
taskService.claim(taskSummary.getId(), "mary");
// Start Task
taskService.start(taskSummary.getId(), "mary");

...
```

If you use this approach, there is no need to register the Task Service with the Process Engine. The Runtime Manager will do that for you automatically. If you don't use the Runtime Manager, you will be responsible for setting the `LocalHTWorkItemHandler` in the session in order to get the Task Service notifying the Process Engine when a task is completed, or the Process Engine notifying that a task has been created.

In jBPM 6.x the Task Service runs locally to the Process and Rule Engine and for that reason multiple light clients can be created for different Process and Rule Engine's instances. All the clients will be sharing the same database (backend storage for the tasks).

Chapter 8. Persistence and Transactions

8.1. Process Instance State

jBPM allows the persistent storage of certain information. This chapter describes these different types of persistence, and how to configure them. An example of the information stored is the process runtime state. Storing the process runtime state is necessary in order to be able to continue execution of a process instance at any point, if something goes wrong. Also, the process definitions themselves, and the history information (logs of current and previous process states already) can also be persisted.

8.1.1. Runtime State

Whenever a process is started, a process instance is created, which represents the execution of the process in that specific context. For example, when executing a process that specifies how to process a sales order, one process instance is created for each sales request. The process instance represents the current execution state in that specific context, and contains all the information related to that process instance. Note that it only contains the (minimal) runtime state that is needed to continue the execution of that process instance at some later time, but it does not include information about the history of that process instance if that information is no longer needed in the process instance.

The runtime state of an executing process can be made persistent, for example, in a database. This allows to restore the state of execution of all running processes in case of unexpected failure, or to temporarily remove running instances from memory and restore them at some later time. jBPM allows you to plug in different persistence strategies. By default, if you do not configure the process engine otherwise, process instances are not made persistent.

If you configure the engine to use persistence, it will automatically store the runtime state into the database. You do not have to trigger persistence yourself, the engine will take care of this when persistence is enabled. Whenever you invoke the engine, it will make sure that any changes are stored at the end of that invocation, at so-called safe points. Whenever something goes wrong and you restore the engine from the database, you also should not reload the process instances and trigger them manually to resume execution, as process instances will automatically resume execution if they are triggered, like for example by a timer expiring, the completion of a task that was requested by that process instance, or a signal being sent to the process instance. The engine will automatically reload process instances on demand.

The runtime persistence data should in general be considered internal, meaning that you probably should not try to access these database tables directly and especially not try to modify these directly (as changing the runtime state of process instances without the engine knowing might have unexpected side-effects). In most cases where information about the current execution state

of process instances is required, the use of a history log is mostly recommended (see below). In some cases, it might still be useful to for example query the internal database tables directly, but you should only do this if you know what you are doing.

8.1.1.1. Binary Persistence

jBPM uses a binary persistence mechanism, otherwise known as marshalling, which converts the state of the process instance into a binary dataset. When you use persistence with jBPM, this mechanism is used to save or retrieve the process instance state from the database. The same mechanism is also applied to the session state and any work item states.

When the process instance state is persisted, two things happen:

- First, the process instance information is transformed into a binary blob. For performance reasons, a custom serialization mechanism is used and not normal Java serialization.
- This blob is then stored, alongside other metadata about this process instance. This metadata includes, among other things, the process instance id, process id, and the process start date.

Apart from the process instance state, the session itself can also store some state, such as the state of timer jobs, or the session data that any business rules would be evaluated over. This session state is stored separately as a binary blob, along with the id of the session and some metadata. You can always restore session state by reloading the session with the given id. The session id can be retrieved using `ksession.getId()`.

Note that the process instance binary datasets are usually relatively small, as they only contain the minimal execution state of the process instance. For a simple process instance, this usually contains one or a few node instances, i.e., any node that is currently executing, and any existing variable values.

As a result of jBPM using marshalling, the data model is both simple and small:

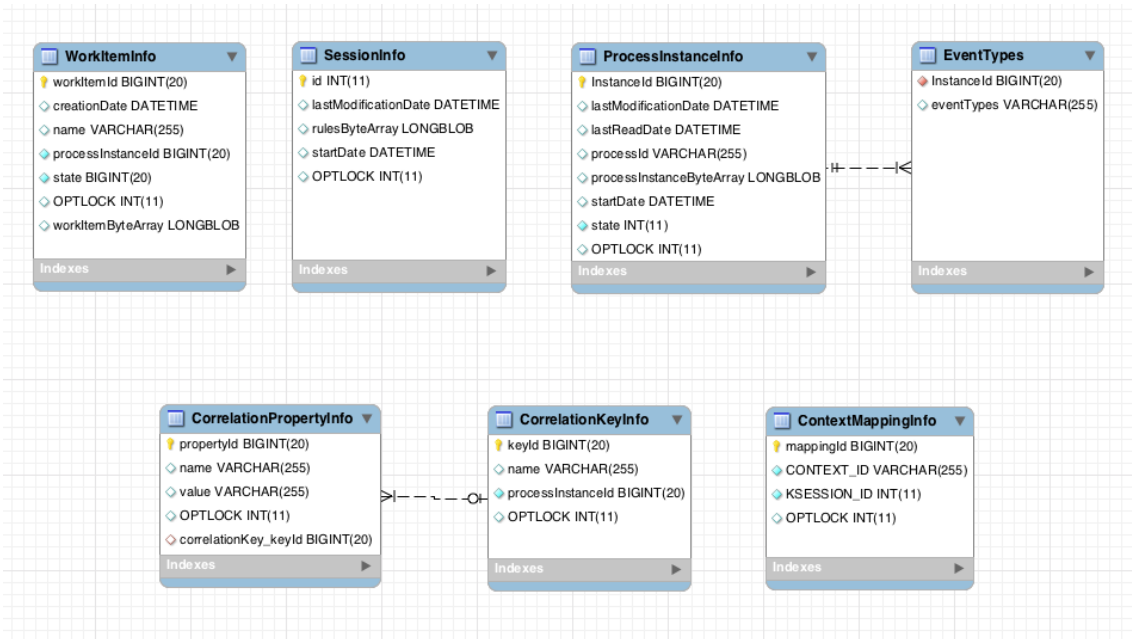


Figure 8.1. jBPM data model

[images/Chapter-Persistence/jbpm_schema.png]

The `sessioninfo` entity contains the state of the (knowledge) session in which the jBPM process instance is running.

Table 8.1. SessionInfo

Field	Description	Nullable
<code>id</code>	The primary key.	NOT NULL
<code>lastmodificationdate</code>	The last time that the entity was saved to the database	
<code>rulesbytearray</code>	The binary dataset containing the state of the session	NOT NULL
<code>startdate</code>	The start time of the session	
<code>optlock</code>	The version field that serves as its optimistic lock value	

The `processinstanceinfo` entity contains the state of the jBPM process instance.

Table 8.2. ProcessInstanceInfo

Field	Description	Nullable
<code>instanceid</code>	The primary key	NOT NULL
<code>lastmodificationdate</code>	The last time that the entity was saved to the database	

Field	Description	Nullable
lastreaddate	The last time that the entity was retrieved (read) from the database	
processid	The name (id) of the process	
processinstancebytearray	This is the binary dataset containing the state of the process instance	NOT NULL
startdate	The start time of the process	
state	An integer representing the state of the process instance	NOT NULL
optlock	The version field that serves as its optimistic lock value	

The `eventtypes` entity contains information about events that a process instance will undergo or has undergone.

Table 8.3. EventTypes

Field	Description	Nullable
instanceid	This references the <code>processinstanceinfo</code> primary key and there is a foreign key constraint on this column.	NOT NULL
eventTypes	A text field related to an event that the process has undergone.	

The `workiteminfo` entity contains the state of a work item.

Table 8.4. WorkItemInfo

Field	Description	Nullable
workitemid	The primary key	NOT NULL
creationDate	The name of the work item	
name	The name of the work item	
processinstanceid	The (primary key) id of the process: there is no foreign key constraint on this field.	NOT NULL
state	An integer representing the state of the work item	NOT NULL

Field	Description	Nullable
optlock	The version field that serves as its optimistic lock value	
workitembytearray	This is the binary dataset containing the state of the work item	NOT NULL

The `CorrelationKeyInfo` entity contains information about correlation keys assigned to given process instance - loose relationship as this table is considered optional used only when correlation capabilities are required.

Table 8.5. CorrelationKeyInfo

Field	Description	Nullable
keyid	The primary key	NOT NULL
name	assigned name of the correlation key	
processinstanceid	The id of the process instance which is assigned to this correlation key	NOT NULL
optlock	The version field that serves as its optimistic lock value	

The `CorrelationPropertyInfo` entity contains information about correlation properties for given correlation key that is assigned to given process instance.

Table 8.6. CorrelationPropertyInfo

Field	Description	Nullable
propertyid	The primary key	NOT NULL
name	The name of the property	
value	The value of the property	NOT NULL
optlock	The version field that serves as its optimistic lock value	
correlationKey-keyid	Foreign key to map to correlation key	NOT NULL

The `ContextMappingInfo` entity contains information about contextual information mapped to ksession. This is an internal part of `RuntimeManager` and can be considered optional when `RuntimeManager` is not used.

Table 8.7. ContextMappingInfo

Field	Description	Nullable
mappingid	The primary key	NOT NULL
context_id	Identifier of the context	NOT NULL
ksession_id	Identifier of the ksession mapped to this context	NOT NULL
optlock	The version field that serves as its optimistic lock value	

8.1.1.2. Safe Points

The state of a process instance is stored at so-called "safe points" during the execution of the process engine. Whenever a process instance is executing (for example when it started or continuing from a previous wait state, the engine executes the process instance until no more actions can be performed (meaning that the process instance either has completed (or was aborted), or that it has reached a wait state in all of its parallel paths). At that point, the engine has reached the next safe state, and the state of the process instance (and all other process instances that might have been affected) is stored persistently.

8.2. Audit Log

In many cases it will be useful (if not necessary) to store information *about* the execution of process instances, so that this information can be used afterwards. For example, sometimes we want to verify which actions have been executed for a particular process instance, or in general, we want to be able to monitor and analyze the efficiency of a particular process.

However, storing history information in the runtime database can result in the database rapidly increasing in size, not to mention the fact that monitoring and analysis queries might influence the performance of your runtime engine. This is why process execution history information can be stored separately.

This history log of execution information is created based on events that the process engine generates during execution. This is possible because the jBPM runtime engine provides a generic mechanism to listen to events. The necessary information can easily be extracted from these events and then persisted to a database. Filters can also be used to limit the scope of the logged information.

8.2.1. The jBPM Audit data model

The jbpm-audit module contains an event listener that stores process-related information in a database using JPA. The data model itself contains three entities, one for process instance information, one for node instance information, and one for (process) variable instance information.

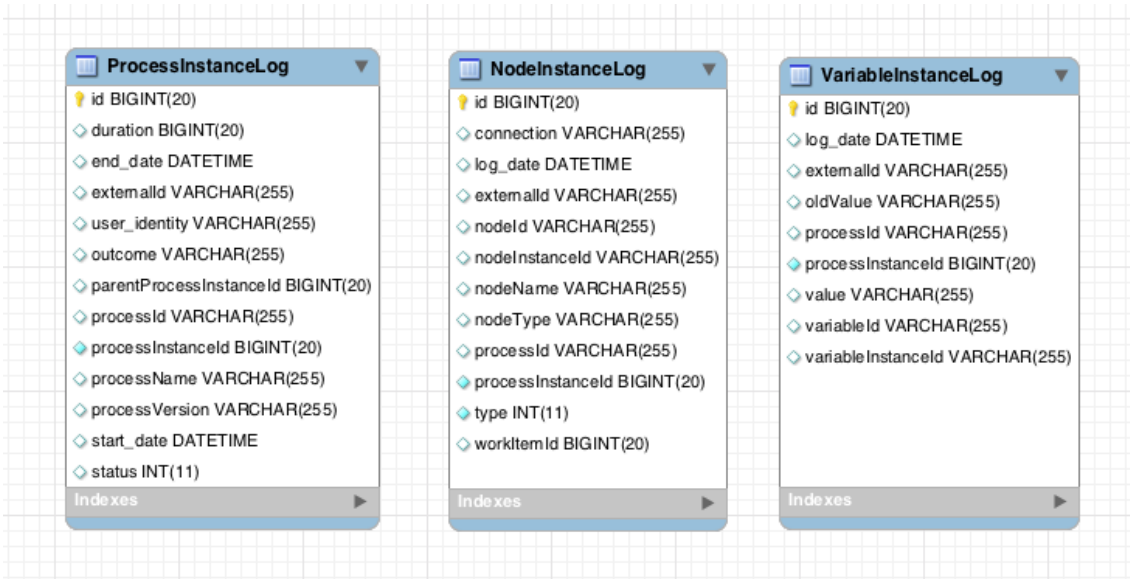


Figure 8.2. jBPM Audit data model

The `ProcessInstanceLog` table contains the basic log information about a process instance.

Table 8.8. ProcessInstanceLog

Field	Description	Nullable
<code>id</code>	The primary key and id of the log entity	NOT NULL
<code>duration</code>	Actual duration of this process instance since its start date	
<code>end_date</code>	When applicable, the end date of the process instance	
<code>externalId</code>	Optional external identifier used to correlate to some elements - e.g. deployment id	
<code>user_identity</code>	Optional identifier of the user who started the process instance	
<code>outcome</code>	The outcome of the process instance, for instance error code in case of process instance was finished with error event	
<code>parentProcessInstanceId</code>	The process instance id of the parent process instance if any	

Field	Description	Nullable
processid	The id of the process	
processinstanceid	The process instance id	NOT NULL
processname	The name of the process	
processversion	The version of the process	
start_date	The start date of the process instance	
status	The status of process instance that maps to process instance state	

The `NodeInstanceLog` table contains more information about which nodes were actually executed inside each process instance. Whenever a node instance is entered from one of its incoming connections or is exited through one of its outgoing connections, that information is stored in this table.

Table 8.9. NodeInstanceLog

Field	Description	Nullable
id	The primary key and id of the log entity	NOT NULL
connection	Actual identifier of the sequence flow that led to this node instance	
log_date	The date of the event	
externalId	Optional external identifier used to correlate to some elements - e.g. deployment id	
nodeid	The node id of the corresponding node in the process definition	
nodeinstanceid	The node instance id	
nodename	The name of the node	
nodetype	The type of the node	
processid	The id of the process that the process instance is executing	
processinstanceid	The process instance id	NOT NULL
type	The type of the event (0 = enter, 1 = exit)	NOT NULL

Field	Description	Nullable
workItemId	Optional - only for certain node types - The identifier of work item	

The `VariableInstanceLog` table contains information about changes in variable instances. The default is to only generate log entries when (after) a variable changes. It's also possible to log entries before the variable (value) changes.

Table 8.10. VariableInstanceLog

Field	Description	Nullable
id	The primary key and id of the log entity	NOT NULL
externalId	Optional external identifier used to correlate to some elements - e.g. deployment id	
log_date	The date of the event	
processid	The id of the process that the process instance is executing	
processinstanceid	The process instance id	NOT NULL
oldvalue	The previous value of the variable at the time that the log is made	
value	The value of the variable at the time that the log is made	
variableid	The variable id in the process definition	
variableinstanceid	The id of the variable instance	

8.2.2. Storing Process Events in a Database

To log process history information in a database like this, you need to register the logger on your session like this:

```
EntityManagerFactory emf = ...;
StatefulKnowledgeSession ksession = ...;
AbstractAuditLogger auditLogger = AuditLoggerFactory.newJPAInstance(emf);
ksession.addProcessEventListener(auditLogger);

// invoke methods one your session here
```

To specify the database where the information should be stored, modify the file `persistence.xml` file to include the audit log classes as well (ProcessInstanceLog, NodeInstanceLog and VariableInstanceLog), as shown below.

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>

<persistence
  version="2.0"
  xsi:schemaLocation="http://java.sun.com/xml/ns/persistence http://java.sun.com/xml/ns/
persistence/persistence_2_0.xsd
  http://java.sun.com/xml/ns/persistence/orm http://java.sun.com/xml/ns/persistence/
orm_2_0.xsd"
  xmlns="http://java.sun.com/xml/ns/persistence"
  xmlns:orm="http://java.sun.com/xml/ns/persistence/orm"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">

  <persistence-unit name="org.jbpm.persistence.jpa" transaction-type="JTA">
    <provider>org.hibernate.ejb.HibernatePersistence</provider>
    <jta-data-source>jdbc/jbpm-ds</jta-data-source>
    <mapping-file>META-INF/JBPMorm.xml</mapping-file>
    <class>org.drools.persistence.info.SessionInfo</class>
    <class>org.jbpm.persistence.processinstance.ProcessInstanceInfo</class>
    <class>org.drools.persistence.info.WorkItemInfo</class>
    <class>org.jbpm.persistence.correlation.CorrelationKeyInfo</class>
    <class>org.jbpm.persistence.correlation.CorrelationPropertyInfo</class>
    <class>org.jbpm.runtime.manager.impl.jpa.ContextMappingInfo</class>

    <class>org.jbpm.process.audit.ProcessInstanceLog</class>
    <class>org.jbpm.process.audit.NodeInstanceLog</class>
    <class>org.jbpm.process.audit.VariableInstanceLog</class>

    <properties>
      <property name="hibernate.dialect" value="org.hibernate.dialect.H2Dialect"/>
      <property name="hibernate.max_fetch_depth" value="3"/>
      <property name="hibernate.hbm2ddl.auto" value="update"/>
      <property name="hibernate.show_sql" value="true"/>
      <property name="hibernate.transaction.jta.platform"
        value="org.hibernate.service.jta.platform.internal.BitronixJtaPlatform"/>
    </properties>
  </persistence-unit>
</persistence>
```

All this information can easily be queried and used in a lot of different use cases, ranging from creating a history log for one specific process instance to analyzing the performance of all instances of a specific process.

This audit log should only be considered a default implementation. We don't know what information you need to store for analysis afterwards, and for performance reasons it is recommended to only

store the relevant data. Depending on your use cases, you might define your own data model for storing the information you need, and use the process event listeners to extract that information.

8.2.3. Storing Process Events in a JMS queue for further processing

Process events are stored in the database synchronously and within the same transaction as actual process instance execution. That obviously takes some time especially in highly loaded systems and might have some impact on the database when both history log and runtime data are kept in the same database. To provide an alternative option for storing process events, a JMS based logger has been provided. It can be configured to submit messages to JMS queue instead of directly persisting them in the database. It can be configured to be transactional as well to avoid issues with inconsistent data in case of process engine transaction is rolled back.

```
ConnectionFactory factory = ...;
Queue queue = ...;
StatefulKnowledgeSession ksession = ...;
Map<String, Object> jmsProps = new HashMap<String, Object>();
jmsProps.put("jbpm.audit.jms.transacted", true);
jmsProps.put("jbpm.audit.jms.connection.factory", factory);
jmsProps.put("jbpm.audit.jms.queue", queue);
AbstractAuditLogger auditLogger = AuditLoggerFactory.newInstance(Type.JMS, session, jmsProps);
ksession.addProcessEventListener(auditLogger);

// invoke methods on your session here
```

This is just one of possible ways to configure JMS audit logger, see javadocs for `AuditLoggerFactory` for more details.

8.2.4. Variables auditing

Process and task variables are stored in audit tables by default although there are stored in simplest possible way - by creating string representation of the variable - `variable.toString()`. In many cases this is enough as even for custom classes used as variables users can implement custom `toString()` method that produces expected "view" of the variable.

Though this might not cover all needs, especially when there is a need for efficient queries by variables (both task and process). Let's take as an example a `Person` object that has following structure:

```
public class Person implements Serializable{
    private static final long serialVersionUID =
    -5172443495317321032L;
    private String name;
    private int age;
    public Person(String
    name, int age) {
        this.name = name;
        this.age = age;
    }
    public String getName()
    {
        return name;
    }
    public void setName(String name) {
        this.name = name;
    }
    public int getAge() {
        return age;
    }
    public void setAge(int
    age) {
        this.age = age;
    }
}
```

```
age) {      this.age = age;    }    @Override    public String toString() {      return
"Person [name=" + name + ", age=" + age + "];    }    }

plements Serializable{    private static final
long serialVersionUID = -5172443495317321032L;
private String name;
private int
age;    public Person(String
name, int age) {
this.name = name;
this.age
= age;    }
public String getName() {

return name;
}    public
void setName(String name) {
this.name
= name;
}
public int getAge() {

return age;
}    public
void setAge(int age) {
this.age
= age;
}    @Override
public String toString() {      return "Person [name=" + name + ", age="
+ age + "];    }    }
```

while at first look this seems to be sufficient as the `toString()` methods provide human readable format it does not make it easy to be searched by. As searching through strings like "Person [name="john", age="34"] to find people with age 34 would make data base query very inefficient.

To solve the problem variable audit has been based on `VariableIndexers` that are responsible for extracting relevant parts of the variable that will be stored in audit log.

```
/**
 * Variable indexer that allows to transform variable instance into other representation (usually
 string)
 * to be able to use it for queries.
 *
 * @param <V> type of the object that will represent indexed variable
 */
public interface VariableIndexer<V> {

    /**
     * Tests if given variable shall be indexed by this indexer
     *
     * NOTE: only one indexer can be used for given variable
     */
}
```



```
*
 * @param variable variable to be indexed
 * @return true if variable should be indexed with this indexer
 */
boolean accept(Object variable);

/**
 * Performs index/transform operation of the variable. Result of this operation can be
 * either single value or list of values to support complex type separation.
 * For example when variable is of type Person that has name, address phone indexer could
 * build three entries out of it to represent individual fields:
 * person = person.name
 * address = person.address.street
 * phone = person.phone
 * that will allow more advanced queries to be used to find relevant entries.
 * @param name name of the variable
 * @param variable actual variable value
 * @return
 */
List<V> index(String name, Object variable);
}
```

By default (indexer that takes the `toString()`) will produce single audit entry for single variable, so it's one to one relationship. But that's not the only option. Indexers (as can be seen in the interface) returns list of objects that are the outcome of single variable indexation. To make our person queries more efficient we could build custom indexer that would take `Person` instance and index it into separate audit entries one representing name and the other representing age.

```
public class PersonTaskVariablesIndexer implements TaskVariableIndexer {

    @Override
    public boolean accept(Object variable) {
        if (variable instanceof Person) {
            return true;
        }
        return false;
    }

    @Override
    public List<TaskVariable> index(String name, Object variable) {

        Person person = (Person) variable;
        List<TaskVariable> indexed = new ArrayList<TaskVariable>();

        TaskVariableImpl personNameVar = new TaskVariableImpl();
        personNameVar.setName("person.name");
        personNameVar.setValue(person.getName());

        indexed.add(personNameVar);

        TaskVariableImpl personAgeVar = new TaskVariableImpl();
        personAgeVar.setName("person.age");
        personAgeVar.setValue(person.getAge()+"");
    }
}
```

```
        indexed.add(personAgeVar);

        return indexed;
    }
}
```

That indexer will then be used to index Person class only and rest of variables will be indexed with default (toString()) indexer. Now when we want to find process instances or tasks that have person with age 34 we simple refer to it as

- variable name: person.age
- variable value: 34

there is not even need to use like based queries so data base can optimize the query and make it efficient even with big set of data.

Building and registering custom indexers

Indexers are supported for both process and task variables. though they are supported by different interfaces as they do produce different type of objects representing audit view of the variable. Following are the interfaces to be implemented to build custom indexers:

- process variables: org.kie.internal.process.ProcessVariableIndexer
- task variables: org.kie.internal.task.api.TaskVariableIndexer

Implementation is rather simple, just two methods to be implemented

- accept - indicates what types are handled by given indexer - note that only one indexer can index given variable - so the first that accepts it will perform the work
- index - actually does the work to index variables depending on custom requirements

Once the implementation is done, it should be packaged as jar file and following file needs to be included:

- for process variables: META-INF/services/org.kie.internal.process.ProcessVariableIndexer with list of FQCN that represent the process variable indexers (single class name per line in that file)
- for task variables: META-INF/services/org.kie.internal.task.api.TaskVariableIndexer with list of FQCN that represent the task variable indexers (single class name per line in that file)

Indexers are discovered by ServiceLoader mechanism and thus the META-INF/services files need. All found indexers will be examined whenever process or task variable is about to be in-

dexed. Only the default (toString() based) indexer is not discovered but added explicitly as last indexer to allow custom ones to take the precedence over it.

8.3. Transactions

The jBPM engine supports JTA transactions. It also supports local transactions *only* when using Spring. It does not support pure local transactions at the moment. For more information about using Spring to set up persistence, please see the Spring chapter in the Drools integration guide.

Whenever you do not provide transaction boundaries inside your application, the engine will automatically execute each method invocation on the engine in a separate transaction. If this behavior is acceptable, you don't need to do anything else. You can, however, also specify the transaction boundaries yourself. This allows you, for example, to combine multiple commands into one transaction.

You need to register a transaction manager at the environment before using user-defined transactions. The following sample code uses the Bitronix transaction manager. Next, we use the Java Transaction API (JTA) to specify transaction boundaries, as shown below:

```
// create the entity manager factory
EntityManagerFactory emf = EntityManagerFactoryManager.get().getOrCreate("org.jbpm.persistence.jpa");
TransactionManager tm = TransactionManagerServices.getTransactionManager();

// setup the runtime environment
RuntimeEnvironment environment = RuntimeEnvironmentBuilder.Factory.get()
    .newDefaultBuilder()
    .addAsset(ResourceFactory.newClassPathResource("MyProcessDefinition.bpmn2"), ResourceType.BPMN2)
    .addEnvironmentEntry(EnvironmentName.TRANSACTION_MANAGER, tm)
    .get();

// get the kie session
RuntimeManager manager = RuntimeManagerFactory.Factory.get().newPerRequestRuntimeManager(environment);
RuntimeEngine runtime = manager.getRuntimeEngine(ProcessInstanceIdContext.get());
KieSession ksession = runtime.getKieSession();

// start the transaction
UserTransaction ut = InitialContext.doLookup("java:comp/UserTransaction");
ut.begin();

// perform multiple commands inside one transaction
ksession.insert( new Person( "John Doe" ) );
ksession.startProcess("MyProcess");

// commit the transaction
ut.commit();
```

Note that, if you use Bitronix as the transaction manager, you should also add a simple `jndi.properties` file in you root classpath to register the Bitronix transaction manager in JNDI. If

you are using the `jbpm-test` module, this is already included by default. If not, create a file named `jndi.properties` with the following content:

```
java.naming.factory.initial=bitronix.tm.jndi.BitronixInitialContextFactory
```

If you would like to use a different JTA transaction manager, you can change the `persistence.xml` file to use your own transaction manager. For example, when running inside JBoss Application Server v5.x or v7.x, you can use the JBoss transaction manager. You need to change the transaction manager property in `persistence.xml` to:

```
<property name="hibernate.transaction.jta.platform" value="org.hibernate.transaction.JBossTransactionManagerLookup" />
```



Warning

Using the (runtime manager) Singleton strategy with JTA transactions (`UserTransaction` or `CMT`) is not recommended because there is a race condition when using this. This race condition can result in an `IllegalStateException` with a message similar to "Process instance XXX is disconnected."

This race condition can be avoided by explicitly synchronizing around the `KieSession` instance when invoking the transaction in the user application code.

```
synchronized (ksession) {
    try {
        tx.begin();

        // use ksession
        // application logic

        tx.commit();
    } catch (Exception e) {
        //...
    }
}
```

8.3.1. Container managed transactions

Special consideration need to be taken when embedding jBPM inside an application that executes in Container Managed Transaction (CMT) mode, for instance EJB beans. This especially applies

to application servers that does not allow accessing UserTransaction instance from JNDI when being part of container managed transaction, e.g. WebSphere Application Server. Since default implementation of transaction manager in jBPM is based on UserTransaction to get transaction status which is used to decide if transaction should be started or not, in environments that prevent accessing UserTransaction it won't do its job. To secure proper execution in CMT environments a dedicated transaction manager implementation is provided:

```
org.jbpm.persistence.jta.ContainerManagedTransactionManager
```

This transaction manager expects that transaction is active and thus will always return ACTIVE when invoking getStatus method. Operations like begin, commit, rollback are no-op methods as transaction manager runs under managed transaction and can't affect it.



Note

To make sure that container is aware of any exceptions that happened during process instance execution, user needs to ensure that exceptions thrown by the engine are propagated up to the container to properly rollback transaction.

To configure this transaction manager following must be done:

- Insert transaction manager and persistence context manager into environment prior to creating/loading session

```
Environment env = EnvironmentFactory.newEnvironment();
env.set(EnvironmentName.ENTITY_MANAGER_FACTORY, emf);
env.set(EnvironmentName.TRANSACTION_MANAGER, new ContainerManagedTransactionManager());
env.set(EnvironmentName.PERSISTENCE_CONTEXT_MANAGER, new JpaProcessPersistenceContextManager(env));
env.set(EnvironmentName.TASK_PERSISTENCE_CONTEXT_MANAGER, new JPATaskPersistenceContextManager(env));
```

- configure JPA provider (example hibernate and WebSphere)

```
<property name="hibernate.transaction.factory_class" value="org.hibernate.transaction.CMTTransactionFactory" />
<property name="hibernate.transaction.jta.platform" value="org.hibernate.service.jta.platform.internal.WebSphereJtaPlatform" />
```

With following configuration jBPM should run properly in CMT environment.

8.3.1.1. CMT dispose ksession command

Usually when running within container managed transaction disposing ksession directly will cause exceptions on transaction completion as there are some transaction synchronization registered by jBPM to clean up the state after invocation is finished. To overcome this problem specialized command has been provided `org.jbpm.persistence.jta.ContainerManagedTransactionDisposeCommand` which allows to simply execute this command instead of regular `ksession.dispose` which will ensure that ksession will be disposed at the transaction completion.

8.4. Configuration

By default, the engine does not save runtime data persistently. This means you can use the engine completely without persistence (so not even requiring an in memory database) if necessary, for example for performance reasons, or when you would like to manage persistence yourself. It is, however, possible to configure the engine to do use persistence by configuring it to do so. This usually requires adding the necessary dependencies, configuring a datasource and creating the engine with persistence configured.

8.4.1. Adding dependencies

You need to make sure the necessary dependencies are available in the classpath of your application if you want to user persistence. By default, persistence is based on the Java Persistence API (JPA) and can thus work with several persistence mechanisms. We are using Hibernate by default.

If you're using the Eclipse IDE and the jBPM Eclipse plugin, you should make sure the necessary JARs are added to your jBPM runtime directory. You don't really need to do anything (as the necessary dependencies should already be there) if you are using the jBPM runtime that is configured by default when using the jBPM installer, or if you downloaded and unzipped the jBPM runtime artifact (from the downloads) and pointed the jBPM plugin to that directory.

If you would like to manually add the necessary dependencies to your project, first of all, you need the JAR file `jbpm-persistence-jpa.jar`, as that contains code for saving the runtime state whenever necessary. Next, you also need various other dependencies, depending on the persistence solution and database you are using. For the default combination with Hibernate as the JPA persistence provider and using an H2 in-memory database and Bitronix for JTA-based transaction management, the following list of additional dependencies is needed:

- `jbpm-persistence-jpa` (org.jbpm)
- `drools-persistence-jpa` (org.drools)
- `persistence-api` (javax.persistence)
- `hibernate-entitymanager` (org.hibernate)

- hibernate-annotations (org.hibernate)
- hibernate-commons-annotations (org.hibernate)
- hibernate-core (org.hibernate)
- commons-collections (commons-collections)
- dom4j (dom4j)
- jta (javax.transaction)
- btm (org.codehaus.btm)
- javassist (javassist)
- slf4j-api (org.slf4j)
- slf4j-jdk14 (org.slf4j)
- h2 (com.h2database)
- jbpm-test (org.jbpm) for testing only, do not include it in the actual application

8.4.2. Manually configuring the engine to use persistence

You can use the `JPAKnowledgeService` to create your knowledge session. This is slightly more complex, but gives you full access to the underlying configurations. You can create a new knowledge session using `JPAKnowledgeService` based on a knowledge base, a knowledge session configuration (if necessary) and an environment. The environment needs to contain a reference to your Entity Manager Factory. For example:

```
// create the entity manager factory and register it in the environment
EntityManagerFactory emf =
    Persistence.createEntityManagerFactory( "org.jbpm.persistence.jpa" );
Environment env = KnowledgeBaseFactory.newEnvironment();
env.set( EnvironmentName.ENTITY_MANAGER_FACTORY, emf );

// create a new knowledge session that uses JPA to store the runtime state
StatefulKnowledgeSession ksession = JPAKnowledgeService.newStatefulKnowledgeSession( kbase, null, env );
int sessionId = ksession.getId();

// invoke methods on your method here
ksession.startProcess( "MyProcess" );
ksession.dispose();
```

You can also use the `JPAKnowledgeService` to recreate a session based on a specific session id:

```
// recreate the session from database using the sessionId
ksession = JPAKnowledgeService.loadStatefulKnowledgeSession(sessionId, kbase, null, env );
```

Note that we only save the minimal state that is needed to continue execution of the process instance at some later point. This means, for example, that it does not contain information about already executed nodes if that information is no longer relevant, or that process instances that have been completed or aborted are removed from the database. If you want to search for history-related information, you should use the history log, as explained later.

You need to add a persistence configuration to your classpath to configure JPA to use Hibernate and the H2 database (or your own preference), called `persistence.xml` in the META-INF directory, as shown below. For more details on how to change this for your own configuration, we refer to the JPA and Hibernate documentation for more information.

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<persistence
  version="2.0"
  xsi:schemaLocation="http://java.sun.com/xml/ns/persistence http://java.sun.com/xml/ns/
persistence/persistence_2_0.xsd
  http://java.sun.com/xml/ns/persistence/orm http://java.sun.com/xml/ns/persistence/
orm_2_0.xsd"
  xmlns="http://java.sun.com/xml/ns/persistence"
  xmlns:orm="http://java.sun.com/xml/ns/persistence/orm"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">

  <persistence-unit name="org.jbpm.persistence.jpa" transaction-type="JTA">
    <provider>org.hibernate.ejb.HibernatePersistence</provider>
    <jta-data-source>jdbc/jbpm-ds</jta-data-source>
    <mapping-file>META-INF/JBPMorm.xml</mapping-file>
    <class>org.drools.persistence.info.SessionInfo</class>
    <class>org.jbpm.persistence.processinstance.ProcessInstanceInfo</class>
    <class>org.drools.persistence.info.WorkItemInfo</class>
    <class>org.jbpm.persistence.correlation.CorrelationKeyInfo</class>
    <class>org.jbpm.persistence.correlation.CorrelationPropertyInfo</class>
    <class>org.jbpm.runtime.manager.impl.jpa.ContextMappingInfo</class>

    <properties>
      <property name="hibernate.dialect" value="org.hibernate.dialect.H2Dialect"/>
      <property name="hibernate.max_fetch_depth" value="3"/>
      <property name="hibernate.hbm2ddl.auto" value="update"/>
      <property name="hibernate.show_sql" value="true"/>
      <property name="hibernate.transaction.jta.platform"
        value="org.hibernate.service.jta.platform.internal.BitronixJtaPlatform"/>
    </properties>
  </persistence-unit>
</persistence>
```

This configuration file refers to a data source called "jdbc/jbpm-ds". If you run your application in an application server (like for example JBoss AS), these containers typically allow you to easily set up data sources using some configuration (like for example dropping a datasource configuration

file in the deploy directory). Please refer to your application server documentation to know how to do this.

For example, if you're deploying to JBoss Application Server v5.x, you can create a datasource by dropping a configuration file in the deploy directory, for example:

```
<?xml version="1.0" encoding="UTF-8"?>
<datasources>
  <local-tx-datasource>
    <jndi-name>jdbc/jbpm-ds</jndi-name>
    <connection-url>jdbc:h2:tcp://localhost/~test</connection-url>
    <driver-class>org.h2.jdbcx.JdbcDataSource</driver-class>
    <user-name>sa</user-name>
    <password></password>
  </local-tx-datasource>
</datasources>
```

If you are however executing in a simple Java environment, you can use the `JBPMHelper` class to do this for you (see below for tests only) or the following code fragment could be used to set up a data source (where we are using the H2 in-memory database in combination with Bitronix in this case).

```
PoolingDataSource ds = new PoolingDataSource();
ds.setUniqueName("jdbc/jbpm-ds");
ds.setClassName("bitronix.tm.resource.jdbc.lrc.LrcXADataSource");
ds.setMaxPoolSize(3);
ds.setAllowLocalTransactions(true);
ds.getDriverProperties().put("user", "sa");
ds.getDriverProperties().put("password", "sasa");
ds.getDriverProperties().put("URL", "jdbc:h2:mem:jbpm-db");
ds.getDriverProperties().put("driverClassName", "org.h2.Driver");
ds.init();
```

8.4.3. Configuring the engine to use persistence using `JBPMHelper` - for tests only

You need to configure the jBPM engine to use persistence, usually simply by using the appropriate constructor when creating your session. There are various ways to create a session (as we have tried to make this as easy as possible for you and have several utility classes for you, depending for example if you are trying to write a process JUnit test).

The easiest way to do this is to use the `jbpm-test` module that allows you to easily create and test your processes. The `JBPMHelper` class has a method to create a session, and uses a configuration file to configure this session, like whether you want to use persistence, the datasource to use, etc. The helper class will then do all the setup and configuration for you.

To configure persistence, create a `jbpm.properties` file and configure the following properties (note that the example below are the default properties, using an H2 in-memory database with persistence enabled, if you are fine with all of these properties, you don't need to add new properties file, as it will then use these properties by default):

```
# for creating a datasource
persistence.datasource.name=jdbc/jbpm-ds
persistence.datasource.user=sa
persistence.datasource.password=
persistence.datasource.url=jdbc:h2:tcp://localhost/~ /jbpm-db
persistence.datasource.driverClassName=org.h2.Driver

# for configuring persistence of the session
persistence.enabled=true
persistence.persistenceunit.name=org.jbpm.persistence.jpa
persistence.persistenceunit.dialect=org.hibernate.dialect.H2Dialect

# for configuring the human task service
taskservice.enabled=true
taskservice.datasource.name=org.jbpm.task
taskservice.usergroupcallback=org.jbpm.services.task.identity.JBossUserGroupCallbackImpl
taskservice.usergroupmapping=classpath:/usergroups.properties
```

If you want to use persistence, you must make sure that the datasource (that you specified in the `jbpm.properties` file) is initialized correctly. This means that the database itself must be up and running, and the datasource should be registered using the correct name. If you would like to use an H2 in-memory database (which is usually very easy to do some testing), you can use the `JBPMHelper` class to start up this database, using:

```
JBPMHelper.startH2Server();
```

To register the datasource (this is something you always need to do, even if you're not using H2 as your database, check below for more options on how to configure your datasource), use:

```
JBPMHelper.setupDataSource();
```

Next, you can use the `JBPMHelper` class to create your session (after creating your knowledge base, which is identical to the case when you are not using persistence):

```
StatefulKnowledgeSession ksession = JBPMHelper.newStatefulKnowledgeSession(kbase);
```

Once you have done that, you can just call methods on this `ksession` (like `startProcess`) and the engine will persist all runtime state in the created datasource.

You can also use the `JBPMHelper` class to recreate your session (by restoring its state from the database, by passing in the session id (that you can retrieve using `ksession.getId()`):

```
StatefulKnowledgeSession ksession = JBPMHelper.loadStatefulKnowledgeSession(kbase, sessionId);
```

Part III. Workbench

How to use the web-based Workbench

Chapter 9. Workbench

9.1. Installation

9.1.1. War installation

Use the `war` from the workbench distribution zip that corresponds to your application server. The differences between these `war` files are mainly superficial. For example, some JARs might be excluded if the application server already supplies them.

- `eap6_4`: tailored for Red Hat JBoss Enterprise Application Platform 6.4
- `tomcat7`: tailored for Apache Tomcat 7



Note

Apache Tomcat requires additional configuration to correctly install the Workbench. Please consult the `README.md` in the `war` for the most up to date procedure.

- `was8`: tailored for IBM WebSphere Application Server 8
- `weblogic12`: tailored for Oracle WebLogic Server 12c



Note

Oracle WebLogic requires additional configuration to correctly install the Workbench. Please consult the `README.md` in the `war` for the most up to date procedure.

- `wildfly8`: tailored for Red Hat JBoss Wildfly 8

9.1.2. Workbench data

The workbench stores its data, by default in the directory `$WORKING_DIRECTORY/.niogit`, for example `wildfly-8.0.0.Final/bin/.niogit`, but it can be overridden with the system property `-Dorg.uberfire.nio.git.dir`.



Note

In production, make sure to back up the workbench data directory.

9.1.3. System properties

Here's a list of all system properties:

- `org.uberfire.nio.git.dir`: Location of the directory `.niogit`. Default: working directory
- `org.uberfire.nio.git.daemon.enabled`: Enables/disables git daemon. Default: `true`
- `org.uberfire.nio.git.daemon.host`: If git daemon enabled, uses this property as local host identifier. Default: `localhost`
- `org.uberfire.nio.git.daemon.port`: If git daemon enabled, uses this property as port number. Default: `9418`
- `org.uberfire.nio.git.ssh.enabled`: Enables/disables ssh daemon. Default: `true`
- `org.uberfire.nio.git.ssh.host`: If ssh daemon enabled, uses this property as local host identifier. Default: `localhost`
- `org.uberfire.nio.git.ssh.port`: If ssh daemon enabled, uses this property as port number. Default: `8001`
- `org.uberfire.nio.git.ssh.cert.dir`: Location of the directory `.security` where local certificates will be stored. Default: working directory
- `org.uberfire.nio.git.ssh.passphrase`: Passphrase to access your Operating Systems public keystore when cloning git repositories with scp style URLs; e.g. `git@github.com:user/repository.git`.
- `org.uberfire.metadata.index.dir`: Place where Lucene `.index` folder will be stored. Default: working directory
- `org.uberfire.cluster.id`: Name of the helix cluster, for example: `kie-cluster`
- `org.uberfire.cluster.zk`: Connection string to zookeeper. This is of the form `host1:port1,host2:port2,host3:port3`, for example: `localhost:2188`
- `org.uberfire.cluster.local.id`: Unique id of the helix cluster node, note that ':' is replaced with '_', for example: `node1_12345`
- `org.uberfire.cluster.vfs.lock`: Name of the resource defined on helix cluster, for example: `kie-vfs`
- `org.uberfire.cluster.autostart`: Delays VFS clustering until the application is fully initialized to avoid conflicts when all cluster members create local clones. Default: `false`
- `org.uberfire.sys.repo.monitor.disabled`: Disable configuration monitor (do not disable unless you know what you're doing). Default: `false`
- `org.uberfire.secure.key`: Secret password used by password encryption. Default: `org.uberfire.admin`

- `org.uberfire.secure.alg`: Crypto algorithm used by password encryption. Default: `PBEWithMD5AndDES`
- `org.uberfire.domain`: security-domain name used by uberfire. Default: `ApplicationRealm`
- `org.guvnor.m2repo.dir`: Place where Maven repository folder will be stored. Default: `working-directory/repositories/kie`
- `org.guvnor.project.gav.check.disabled`: Disable GAV checks. Default: `false`
- `org.kie.example.repositories`: Folder from where demo repositories will be cloned. The demo repositories need to have been obtained and placed in this folder. Demo repositories can be obtained from the `kie-wb-6.2.0-SNAPSHOT-example-repositories.zip` artifact. This System Property takes precedence over `org.kie.demo` and `org.kie.example`. Default: `Not used`.
- `org.kie.demo`: Enables external clone of a demo application from GitHub. This System Property takes precedence over `org.kie.example`. Default: `true`
- `org.kie.example`: Enables example structure composed by Repository, Organization Unit and Project. Default: `false`
- `org.kie.build.disable-project-explorer`: Disable automatic build of selected Project in Project Explorer. Default: `false`

To change one of these system properties in a WildFly or JBoss EAP cluster:

1. Edit the file `$JBOSS_HOME/domain/configuration/host.xml`.
2. Locate the XML elements `server` that belong to the `main-server-group` and add a system property, for example:

```
<system-properties>
  <property name="org.uberfire.nio.git.dir" value="..." boot-time="false"/>
  ...
</system-properties>
```

9.1.4. Trouble shooting

9.1.4.1. Loading.. does not disappear and Workbench fails to show

There have been reports that Firewalls in between the server and the browser can interfere with Server Sent Events (SSE) used by the Workbench.

The issue results in the "Loading.." spinner remaining visible and the Workbench failing to materialize.

The workaround is to disable the Workbench's use of Server Sent Events by adding file `/WEB-INF/classes/ErraiService.properties` to the exploded WAR containing the value `errai.bus.enable_sse_support=false`. Re-package the WAR and re-deploy.

9.2. Quick Start

These steps help you get started with minimum of effort.

They should not be a substitute for reading the documentation in full.

9.2.1. Add repository

Create a new repository to hold your project by selecting the Administration Perspective.

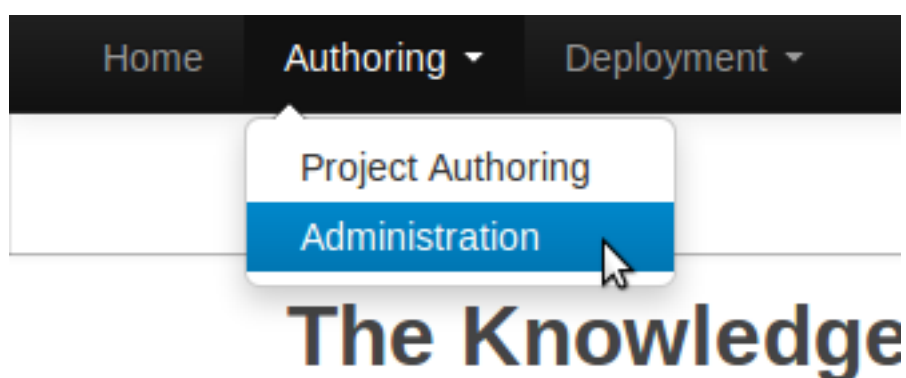


Figure 9.1. Selecting Administration perspective

Select the "New repository" option from the menu.

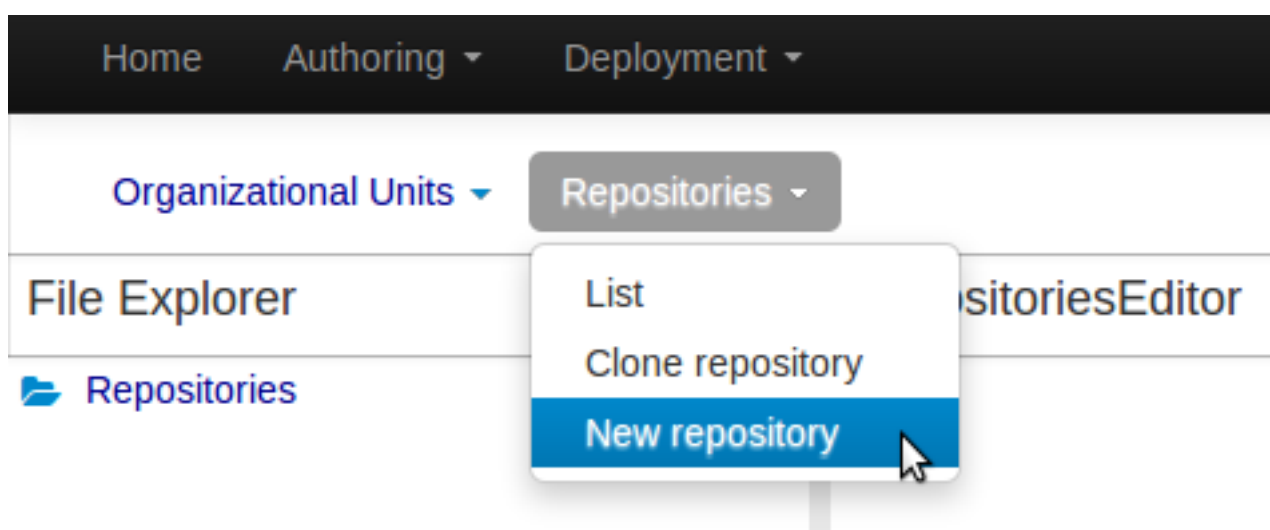


Figure 9.2. Creating new repository

Enter the required information.

New Repository ✕

✓ **Basic Settings**
Managed Repository Settings

* **Repository Name**

* **In Organizational Unit**
 ▼

Managed Repository
A managed repository provides project-level version control and project branches for managing the release cycle.

Figure 9.3. Entering repository information step 1/2

New Repository

✓ Basic Settings
✓ Managed Repository Settings

Repository Type:

Single-project Repository
Create a single managed project in this repository. Use this option for simple or self-contained projects.

Multi-project Repository
Integrate multiple projects to create a larger application. The projects in this repository will be managed together, and will all increment version numbers together.

Project Branches:

Automatically Configure Branches (master/dev/release)

Project Settings:

* Name
myExampleRepository

Description
enter project description

* Group
demo

* Artifact
myExampleRepository

* Version
1.0.0-SNAPSHOT

< Previous Next > Cancel **Finish**

Figure 9.4. Entering repository information step 2/2 (only for managed repositories)

9.2.2. Add project

Select the Authoring Perspective to create a new project.

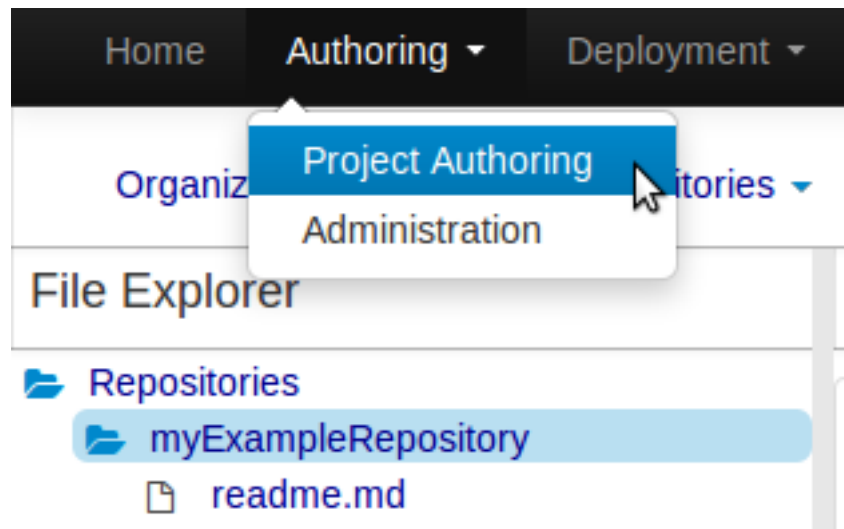


Figure 9.5. Selecting Authoring perspective

Select "Project" from the "New Item" menu.

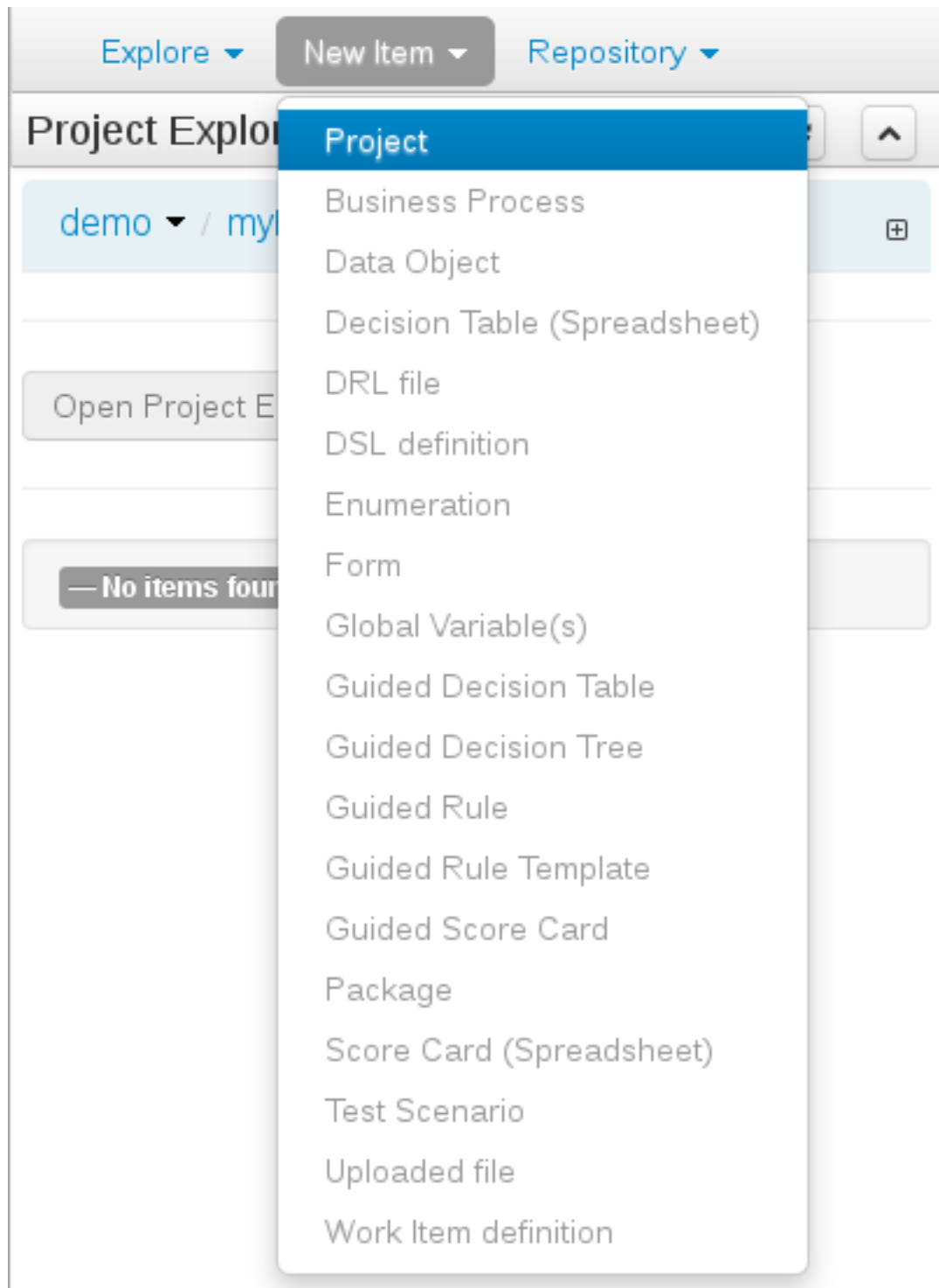


Figure 9.6. Creating new project

Enter a project name first.

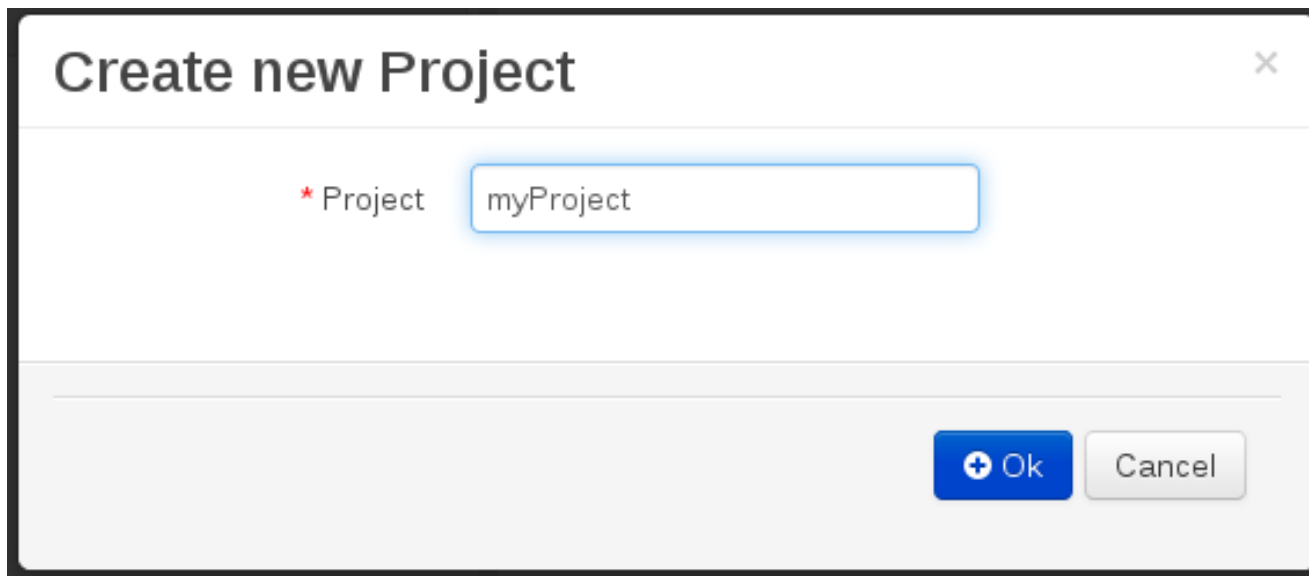


Figure 9.7 shows a dialog box titled "Create new Project". The dialog has a close button (X) in the top right corner. Below the title bar, there is a label "* Project" followed by a text input field containing the text "myProject". At the bottom right of the dialog, there are two buttons: a blue "Ok" button with a plus sign icon and a grey "Cancel" button.

Figure 9.7. Entering project name

Enter the project details next.

- Group ID follows Maven conventions.
- Artifact ID is pre-populated from the project name.
- Version is set as 1.0 by default.

New Project

New Project Wizard

Project General Settings

Project Name: myProject

Project Description: Insert a project description for documentation purposes ...

Group artifact version

Group ID: Enter Group ID... (Invalid Group ID format) Example: com.myorganization.myprojects

Artifact ID: myProject Example: MyProject

Version: 1.0 Example: 1.0.0

< Previous Next > Cancel Finish

Figure 9.8. Entering project details

9.2.3. Define Data Model

After a project has been created you need to define Types to be used by your rules.

Select "Data Object" from the "New Item" menu.



Note

You can also use types contained in existing JARs.

Please consult the full documentation for details.

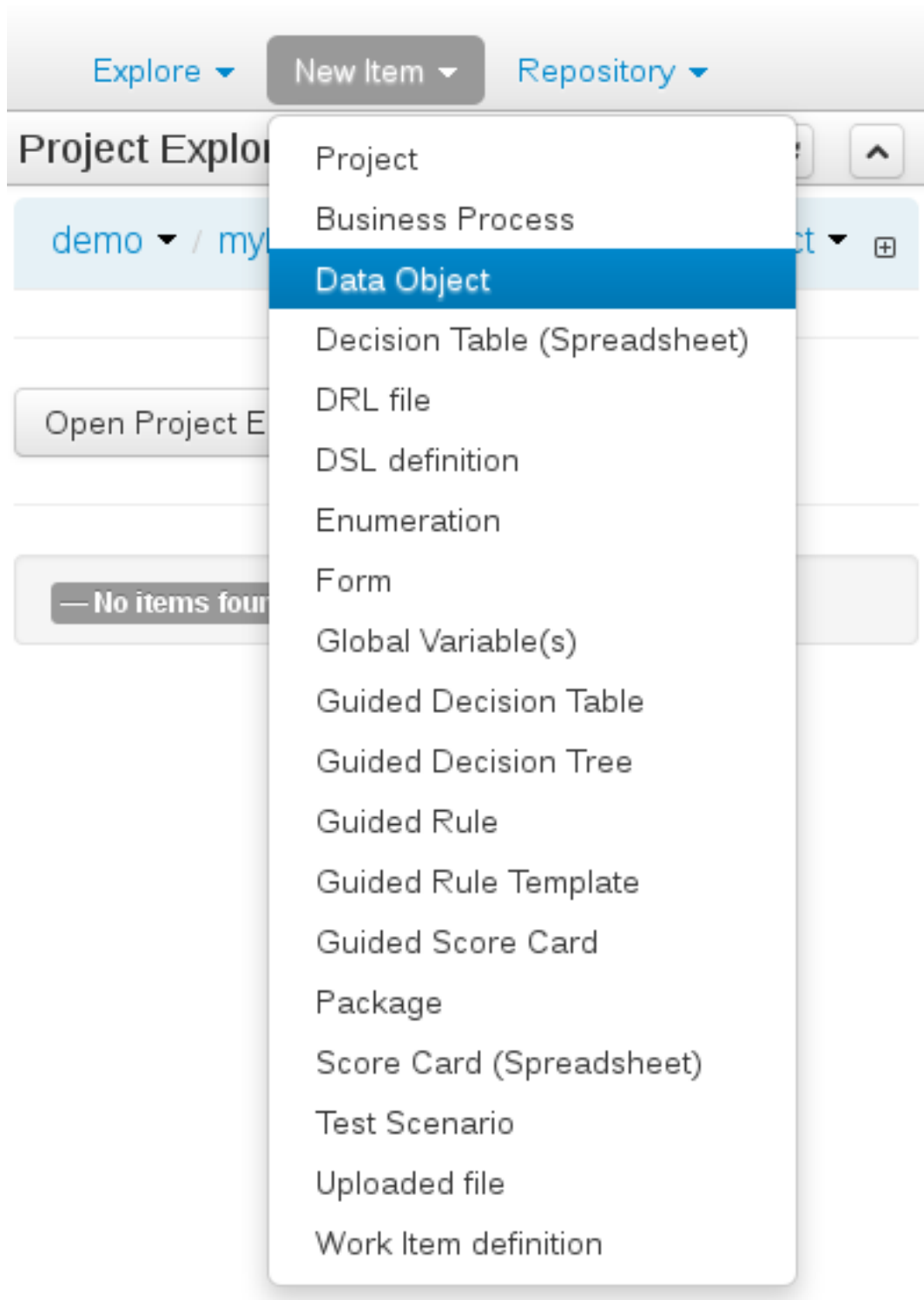


Figure 9.9. Creating "Data Object"

Set the name and select a package for the new type.

Create new Data Object ×

* Data Object

Package

Figure 9.10. Creating a new type

Set field name and type and click on "Create" to create a field for the type.

MyExampleType.java - Data Objects

Save

Create new field

*Id Label

*Type List

org.anstis.myproject.MyExampleType

Position	Identifier	Label	Type
The data object is empty			

Figure 9.11. Click "Create" and add the field

Click "Save" to update the model.

MyExampleType.java - Data Objects Save Delete Rename Copy Validate Latest Version

Create new field

*Id Label

*Type List

org.anstis.myproject.MyExampleType

Position	Identifier	Label	Type
0	myField		Integer

Data Object **Field**

Identifier

Label

Description

Type

Equals

Position

Figure 9.12. Clicking "Save"

9.2.4. Define Rule

Select "DRL file" (for example) from the "New Item" menu.

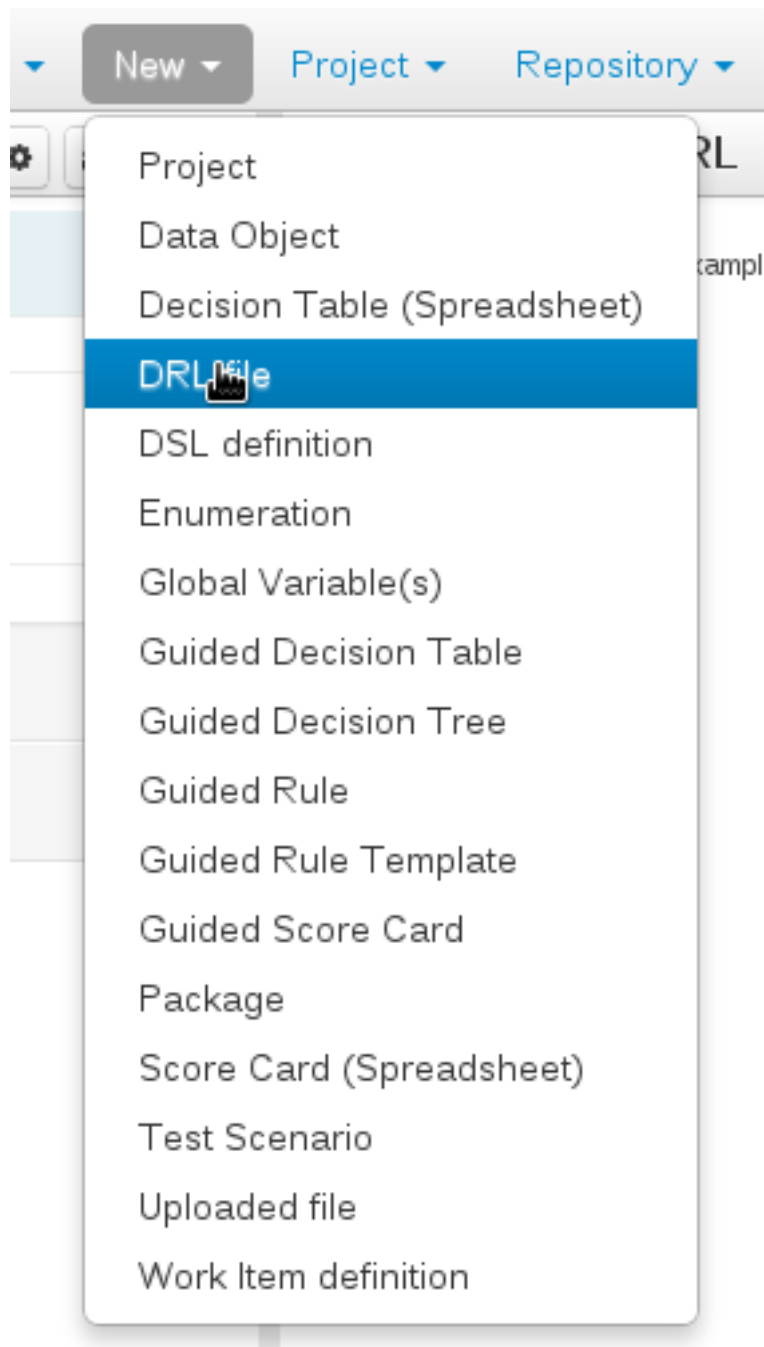


Figure 9.13. Selecting "DRL file" from the "New Item" menu

Enter a file name for the new rule.

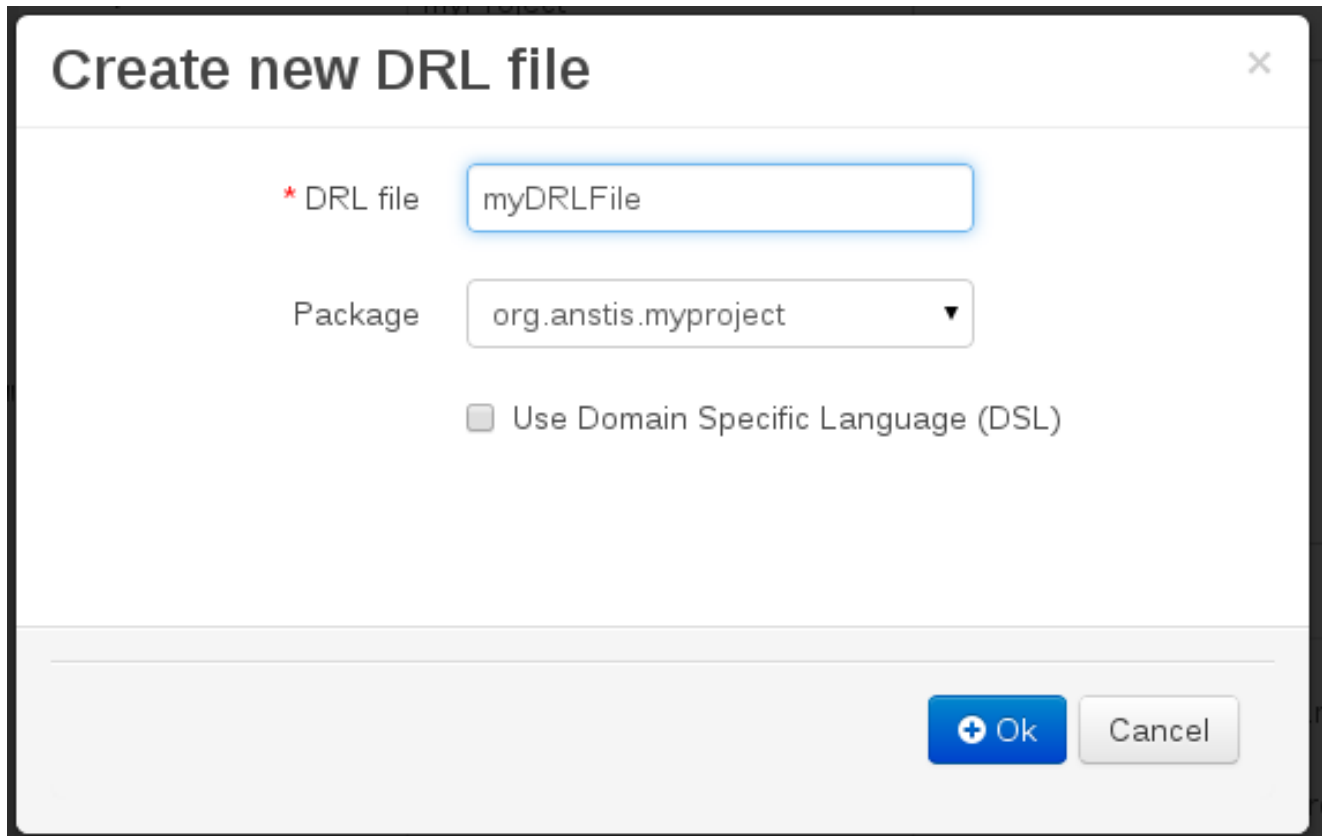


Figure 9.14. Entering file name for rule

Enter a definition for the rule.

The definition process differs from asset type to asset type.

The full documentation has details about the different editors.

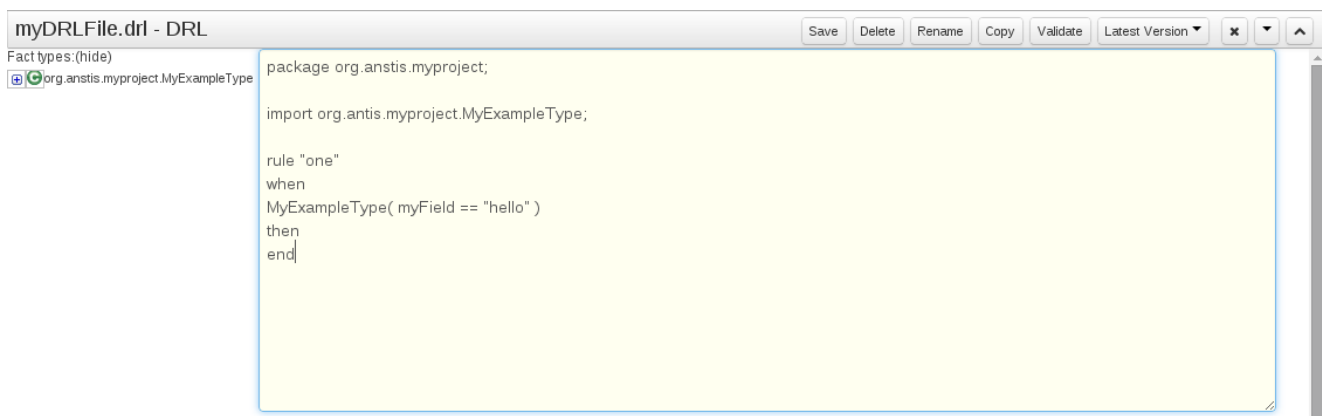


Figure 9.15. Defining a rule

Once the rule has been defined it will need to be saved.

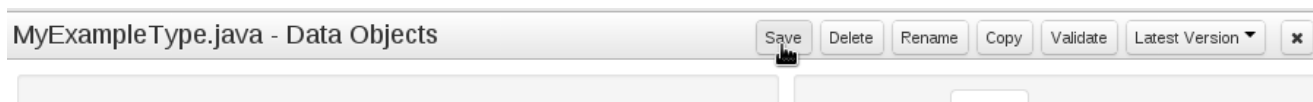


Figure 9.16. Saving the rule

9.2.5. Build and Deploy

Once rules have been defined within a project; the project can be built and deployed to the Workbench's Maven Artifact Repository.

To build a project select the "Project Editor" from the "Project" menu.

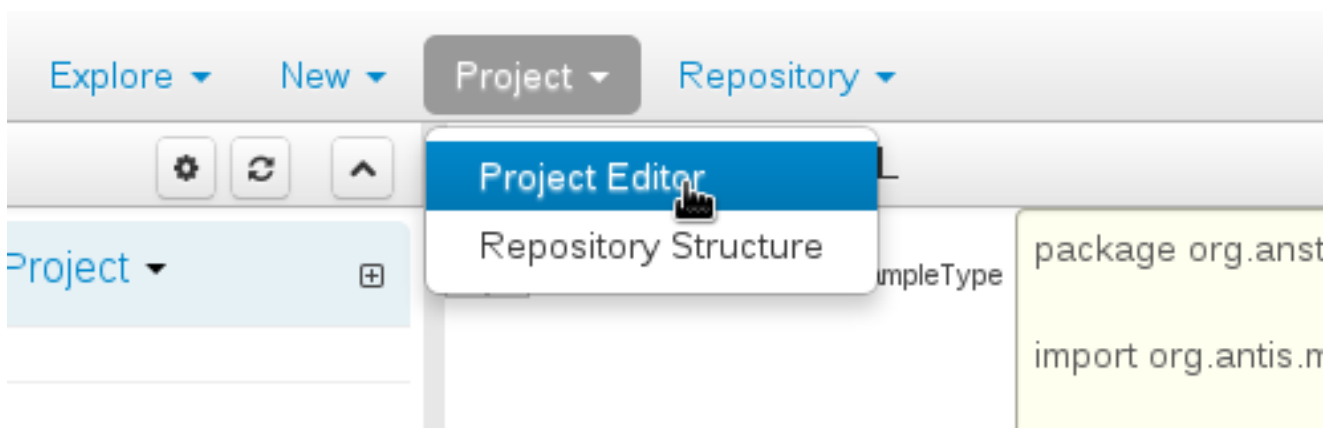


Figure 9.17. Selecting "Project Editor"

Click "Build and Deploy" to build the project and deploy it to the Workbench's Maven Artifact Repository.

When you select Build & Deploy the workbench will deploy to any repositories defined in the Dependency Management section of the pom in your workbench project. You can edit the pom.xml file associated with your workbench project under the Repository View of the project explorer. Details on dependency management in maven can be found here : <http://maven.apache.org/guides/introduction/introduction-to-dependency-mechanism.html>

If there are errors during the build process they will be reported in the "Problems Panel".

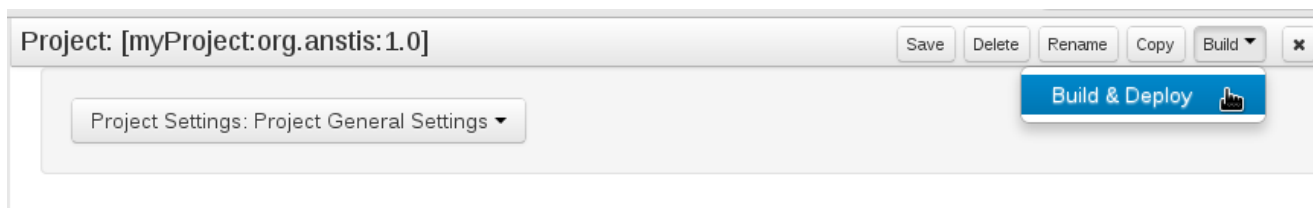


Figure 9.18. Building and deploying a project

Now the project has been built and deployed; it can be referenced from your own projects as any other Maven Artifact.

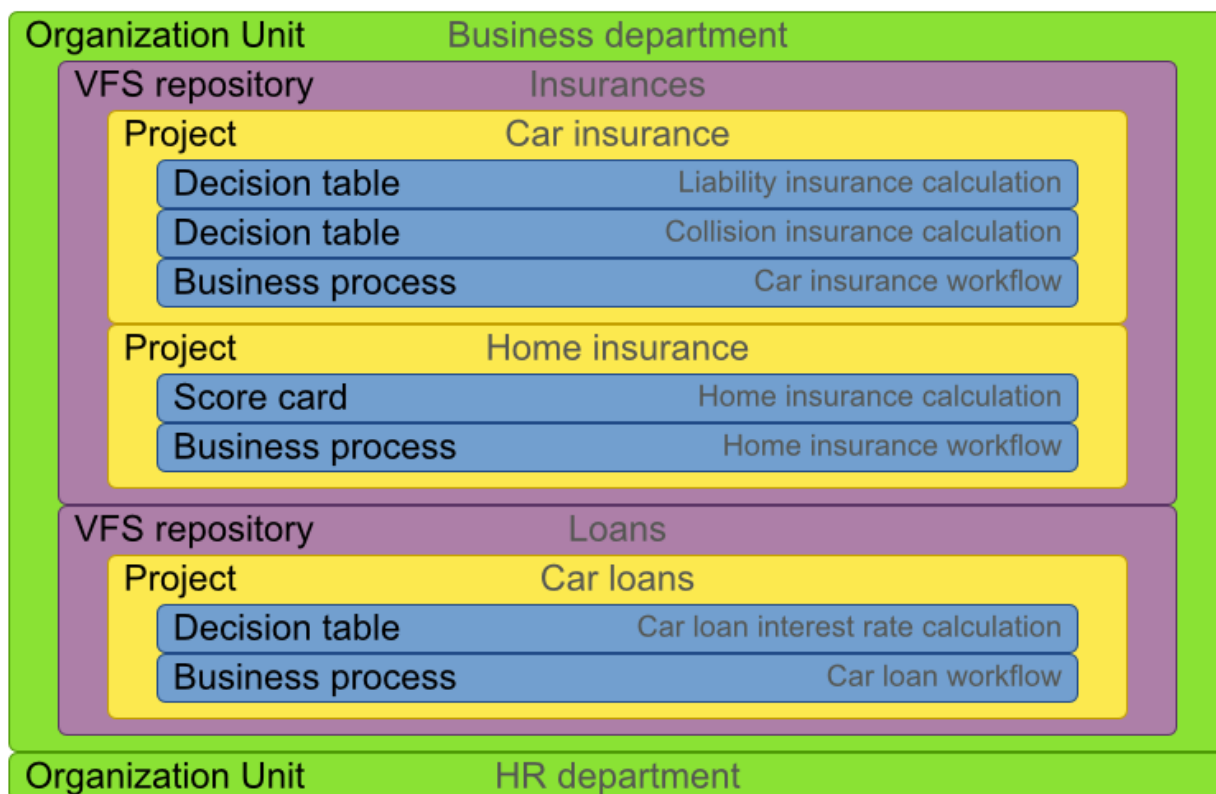
The full documentation contains details about integrating projects with your own applications.

9.3. Administration

9.3.1. Administration overview

A workbench is structured with Organization Units, VFS repositories and projects:

Workbench structure overview



9.3.2. Organizational unit

Organization units are useful to model departments and divisions.

An organization unit can hold multiple repositories.

Organizational Unit Manager

The screenshot displays the 'Organizational Unit Manager' interface. It consists of three main panels:

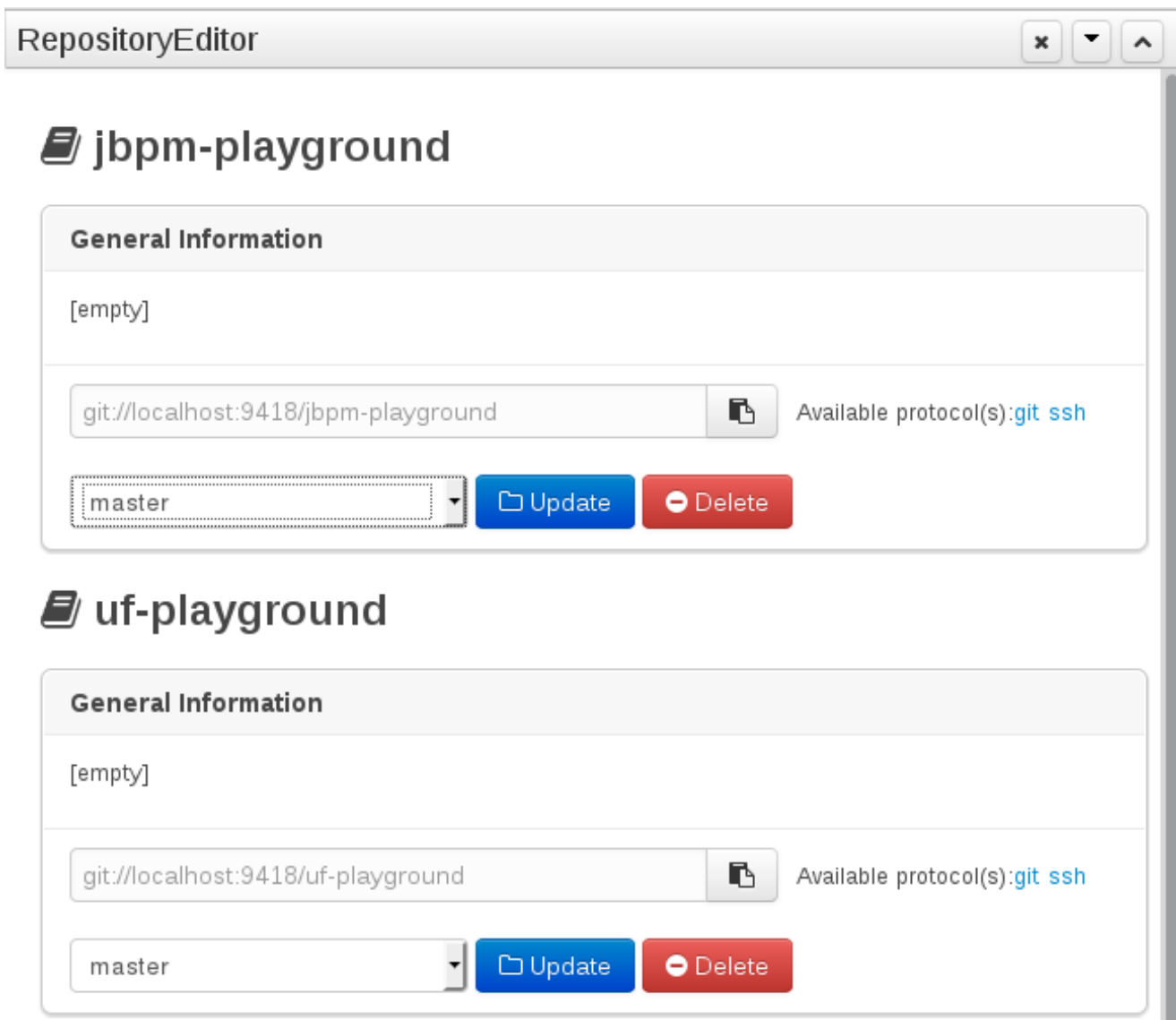
- Organizational Units:** A list containing 'Accounting department', 'Business department', and 'Human Resources department'. The 'Business department' is currently selected.
- Associated repositories:** A list containing 'Insurances' and 'Loans'. 'Insurances' is highlighted in orange.
- Available repositories:** A panel displaying '-- No Repositories available --'.

Below the 'Organizational Units' panel, there are three buttons: '+ Add' (blue), 'Edit' (grey with a pencil icon), and '- Delete' (red). Between the 'Associated repositories' and 'Available repositories' panels, there are two arrow buttons: a left-pointing arrow and a right-pointing arrow.

9.3.3. Repositories

Repositories are the place where assets are stored and each repository is organized by projects and belongs to a single organization unit.

Repositories are in fact a Virtual File System based storage, that by default uses GIT as backend. Such setup allows workbench to work with multiple backends and, in the same time, take full advantage of backend specifics features like in GIT case versioning, branching and even external access.



The screenshot shows the RepositoryEditor window with two repository entries. Each entry has a 'General Information' section. The first entry, 'jbpm-playground', has a status of '[empty]', a URL of 'git://localhost:9418/jbpm-playground', and a dropdown menu set to 'master'. The second entry, 'uf-playground', also has a status of '[empty]', a URL of 'git://localhost:9418/uf-playground', and a dropdown menu set to 'master'. Both entries have 'Update' and 'Delete' buttons. The available protocols are listed as 'git ssh'.

A new repository can be created from scratch or cloned from an existing repository.

One of the biggest advantage of using GIT as backend is the ability to clone a repository from external and use your preferred tools to edit and build your assets.



Warning

Never clone your repositories directly from `.niogit` directory. Use always the available protocol(s) displayed in repositories editor.

9.3.3.1. Repository Editor

One additional advantage to use GIT as backend is the possibility to revert your repository to a previous state. You can do it directly from the repository editor by browsing its commit history and clicking the **Revert** button.

RepositoryEditor [Insurances]

financial / **Insurances**

General Information

[empty]

git://localhost:9418/Insurances Available protocol(s): git ssh

Commit History

removing unnecessary files - those were added due a vfs bug, already fixed Alexandre Porcelli - 2013-10-24 1:03 AM	Revert
kie-commons merge into uberfire forces package renaming David Gutierrez - 2013-10-16 1:35 PM	Revert
moved test related projects to a new repo: https://github.com/guvnorngtestuser1/guvnorng-testground jervisliu - 2013-09-29 8:24 AM	Revert
package org.mortgages was removed from <type></type> tags of test scenarios Walter Medvedeo - 2013-09-25 12:23 PM	Revert
package org.mortgages was removed from <type></type> tags Walter Medvedeo - 2013-09-25 11:56 AM	Revert

9.4. Configuration

9.4.1. User management

The workbench authenticates its users against the application server's authentication and authorization (JAAS).

On JBoss EAP and WildFly, add a user with the script `$JBOSS_HOME/bin/add-user.sh` (or `.bat`):

```
$ ./add-user.sh
// Type: Application User
// Realm: empty (defaults to ApplicationRealm)
// Role: admin
```

There is no need to restart the application server.

9.4.2. Roles

The Workbench uses the following roles:

- admin

- analyst
- developer
- manager
- user

9.4.2.1. Admin

Administrates the BPMS system.

- Manages users
- Manages VFS Repositories
- Has full access to make any changes necessary

9.4.2.2. Developer

Developer can do almost everything admin can do, except clone repositories.

- Manages rules, models, process flows, forms and dashboards
- Manages the asset repository
- Can create, build and deploy projects
- Can use the JBDS connection to view processes

9.4.2.3. Analyst

Analyst is a weaker version of developer and does not have access to the asset repository or the ability to deploy projects.

9.4.2.4. Business user

Daily user of the system to take actions on business tasks that are required for the processes to continue forward. Works primarily with the task lists.

- Does process management
- Handles tasks and dashboards

9.4.2.5. Manager/Viewer-only User

Viewer of the system that is interested in statistics around the business processes and their performance, business indicators, and other reporting of the system and people who interact with the system.

- Only has access to dashboards

9.4.3. Restricting access to repositories

It is possible to restrict access to repositories using roles and organizational groups. To let an user access a repository.

The user either has to belong into a role that has access to the repository or to a role that belongs into an organizational group that has access to the repository. These restrictions can be managed with the command line config tool.

9.4.4. Command line config tool

Provides capabilities to manage the system repository from command line. System repository contains the data about general workbench settings: how editors behave, organizational groups, security and other settings that are not editable by the user. System repository exists in the .niogit folder, next to all the repositories that have been created or cloned into the workbench.

9.4.4.1. Config Tool Modes

- Online (default and recommended) - Connects to the Git repository on startup, using Git server provided by the KIE Workbench. All changes are made locally and published to upstream when:
 - "push-changes" command is explicitly executed
 - "exit" is used to close the tool
- Offline - Creates and manipulates system repository directly on the server (no discard option)

9.4.4.2. Available Commands

Table 9.1. Available Commands

exit	Publishes local changes, cleans up temporary directories and quits the command line tool
discard	Discards local changes without publishing them, cleans up temporary directories and quits the command line tool
help	Prints a list of available commands
list-repo	List available repositories
list-org-units	List available organizational units
list-deployment	List available deployments
create-org-unit	Creates new organizational unit
remove-org-unit	Removes existing organizational unit

add-deployment	Adds new deployment unit
remove-deployment	Removes existing deployment
create-repo	Creates new git repository
remove-repo	Removes existing repository (only from config)
add-repo-org-unit	Adds repository to the organizational unit
remove-repo-org-unit	Removes repository from the organizational unit
add-role-repo	Adds role(s) to repository
remove-role-repo	Removes role(s) from repository
add-role-org-unit	Adds role(s) to organizational unit
remove-role-org-unit	Removes role(s) from organizational unit
add-role-project	Adds role(s) to project
remove-role-project	Removes role(s) from project
push-changes	Pushes changes to upstream repository (only in online mode)

9.4.4.3. How to use

The tool can be found from `kie-config-cli- $\{version\}$ -dist.zip`. Execute the `kie-config-cli.sh` script and by default it will start in online mode asking for a Git url to connect to (the default value is `ssh://localhost/system`). To connect to a remote server, replace the host and port with appropriate values, e.g. `ssh://kie-wb-host/system`.

```
./kie-config-cli.sh
```

To operate in offline mode, append the `offline` parameter to the `kie-config-cli.sh` command. This will change the behaviour and ask for a folder where the `.niogit` (system repository) is. If `.niogit` does not yet exist, the folder value can be left empty and a brand new setup is created.

```
./kie-config-cli.sh offline
```

9.5. Introduction

9.5.1. Log in and log out

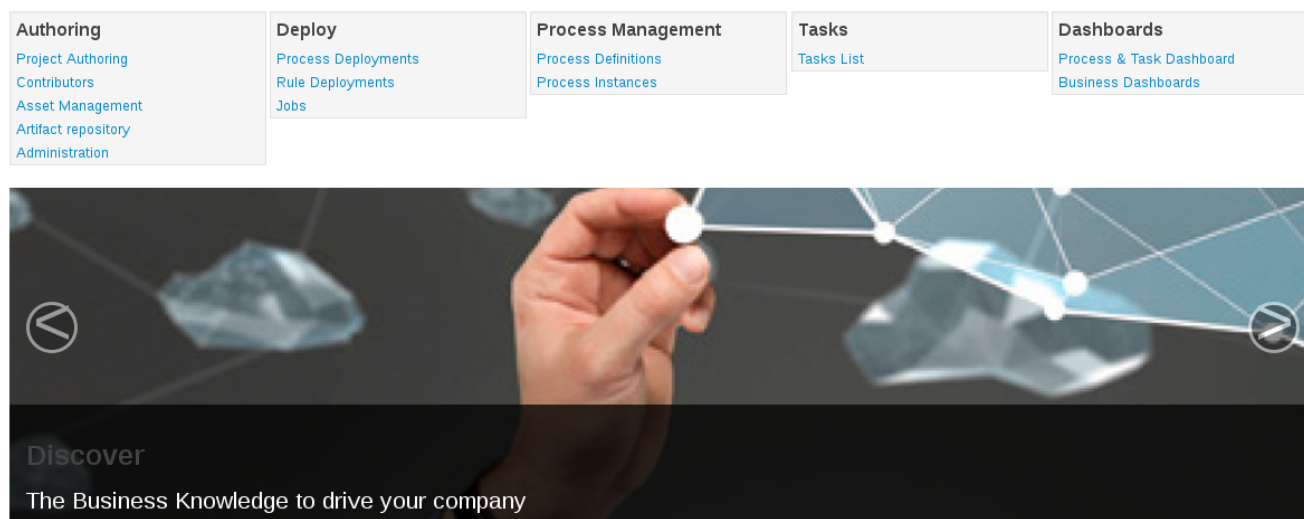
Create a user with the role `admin` and log in with those credentials.

After successfully logging in, the account username is displayed at the top right. Click on it to review the roles of the current account.

9.5.2. Home screen

After logging in, the home screen shows. The actual content of the home screen depends on the workbench variant (Drools, jBPM, ...).

The Knowledge Life Cycle



9.5.3. Workbench concepts

The Workbench is comprised of different logical entities:

- Part

A Part is a screen or editor with which the user can interact to perform operations.

Example Parts are "Project Explorer", "Project Editor", "Guided Rule Editor" etc. Parts can be repositioned.

- Panel

A Panel is a container for one or more Parts.

Panels can be resized.

- Perspective

A perspective is a logical grouping of related Panels and Parts.

The user can switch between perspectives by clicking on one of the top-level menu items; such as "Home", "Authoring", "Deploy" etc.

9.5.4. Initial layout

The Workbench consists of three main sections to begin; however its layout and content can be changed.

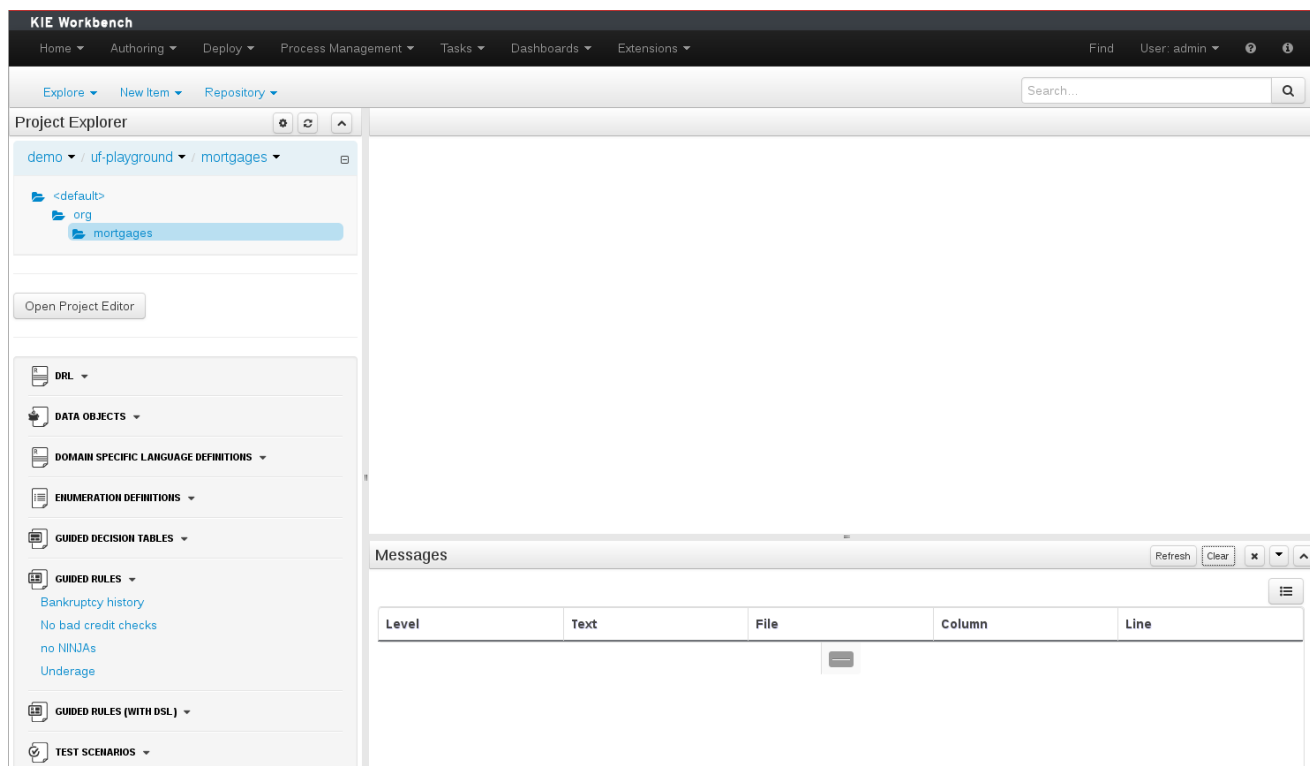


Figure 9.19. The Workbench

The initial Workbench shows the following components:-

- Project Explorer

This provides the ability for the user to browse their configuration; of Organizational Units (in the above "example" is the Organizational Unit), Repositories (in the above "uf-playground" is the Repository) and Project (in the above "mortgages" is the Project).

- Problems

This provides the user will real-time feedback about errors in the active Project.

- Empty space

This empty space will contain an editor for assets selected from the Project Explorer.

Other screens will also occupy this space by default; such as the Project Editor.

9.6. Changing the layout

The default layout may not be suitable for a user. Panels can therefore be either resized or repositioned.

This, for example, could be useful when running tests; as the test definition and rule can be repositioned side-by-side.

9.6.1. Resizing

The following screenshot shows a Panel being resized.

Move the mouse pointer over the panel splitter (a grey horizontal or vertical line in between panels).

The cursor will change indicating it is positioned correctly over the splitter. Press and hold the left mouse button and drag the splitter to the required position; then release the left mouse button.

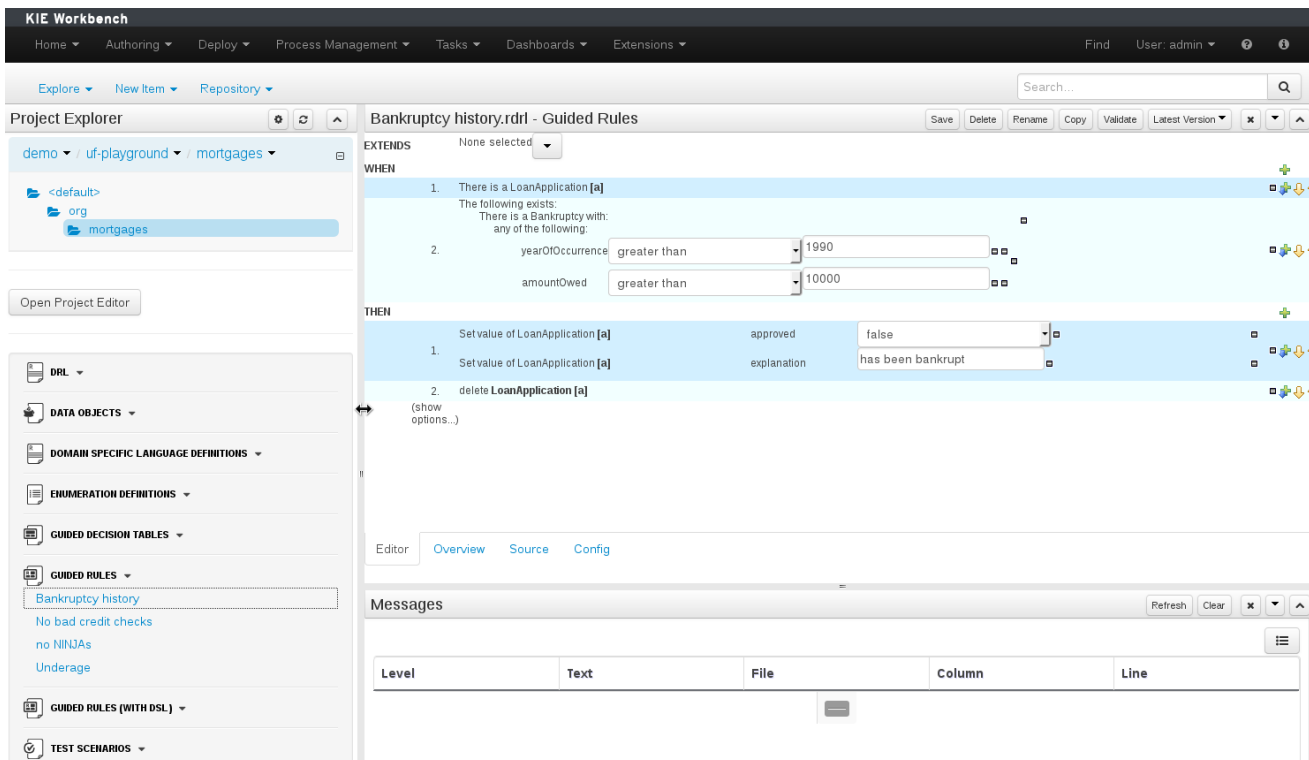


Figure 9.20. Resizing

9.6.2. Repositioning

The following screenshot shows a Panel being repositioned.

Move the mouse pointer over the Panel title ("Guided Editor [No bad credit checks]" in this example).

The cursor will change indicating it is positioned correctly over the Panel title. Press and hold the left mouse button. Drag the mouse to the required location. The target position is indicated with a pale blue rectangle. Different positions can be chosen by hovering the mouse pointer over the different blue arrows.

Workbench

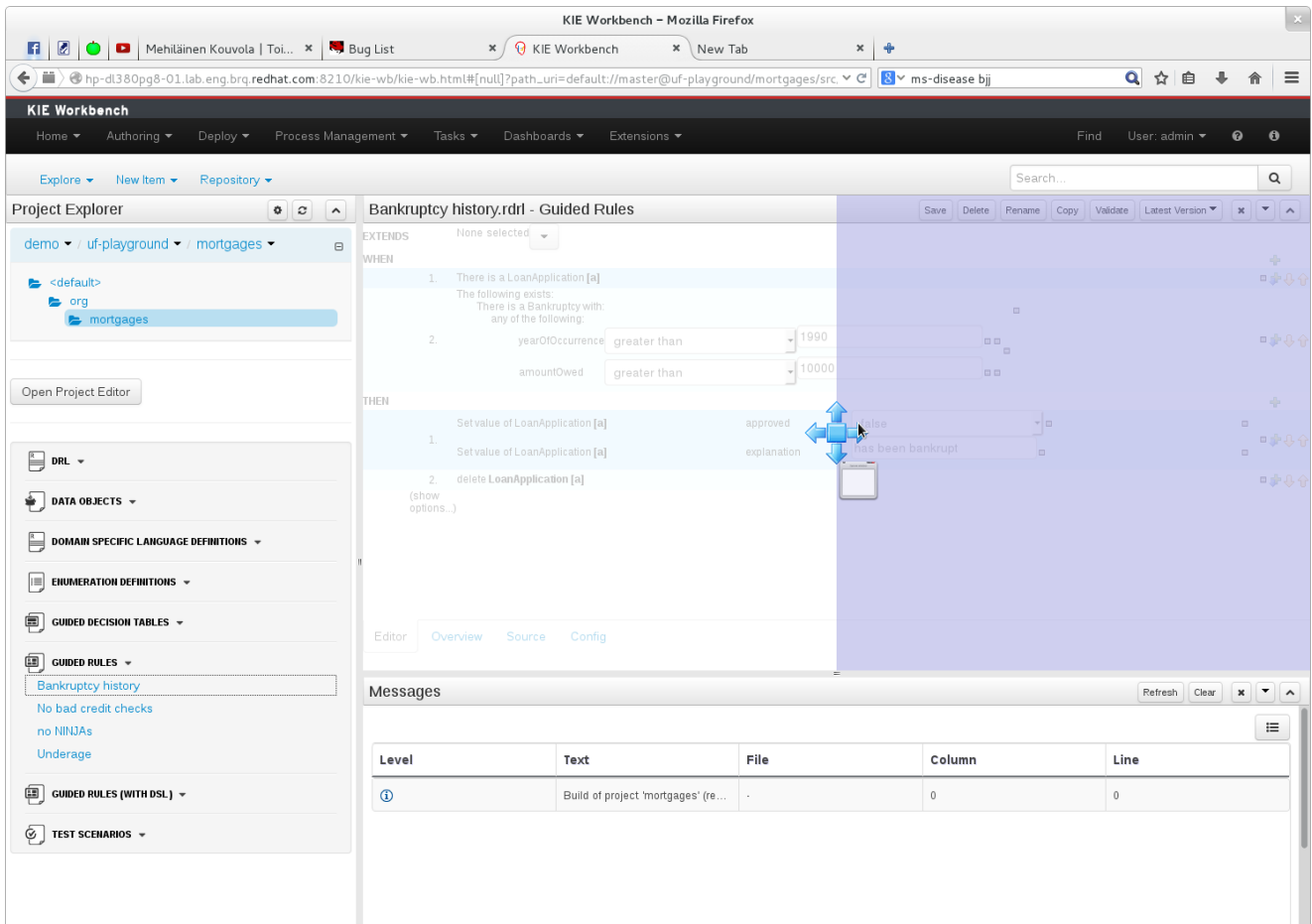


Figure 9.21. Repositioning - dragging

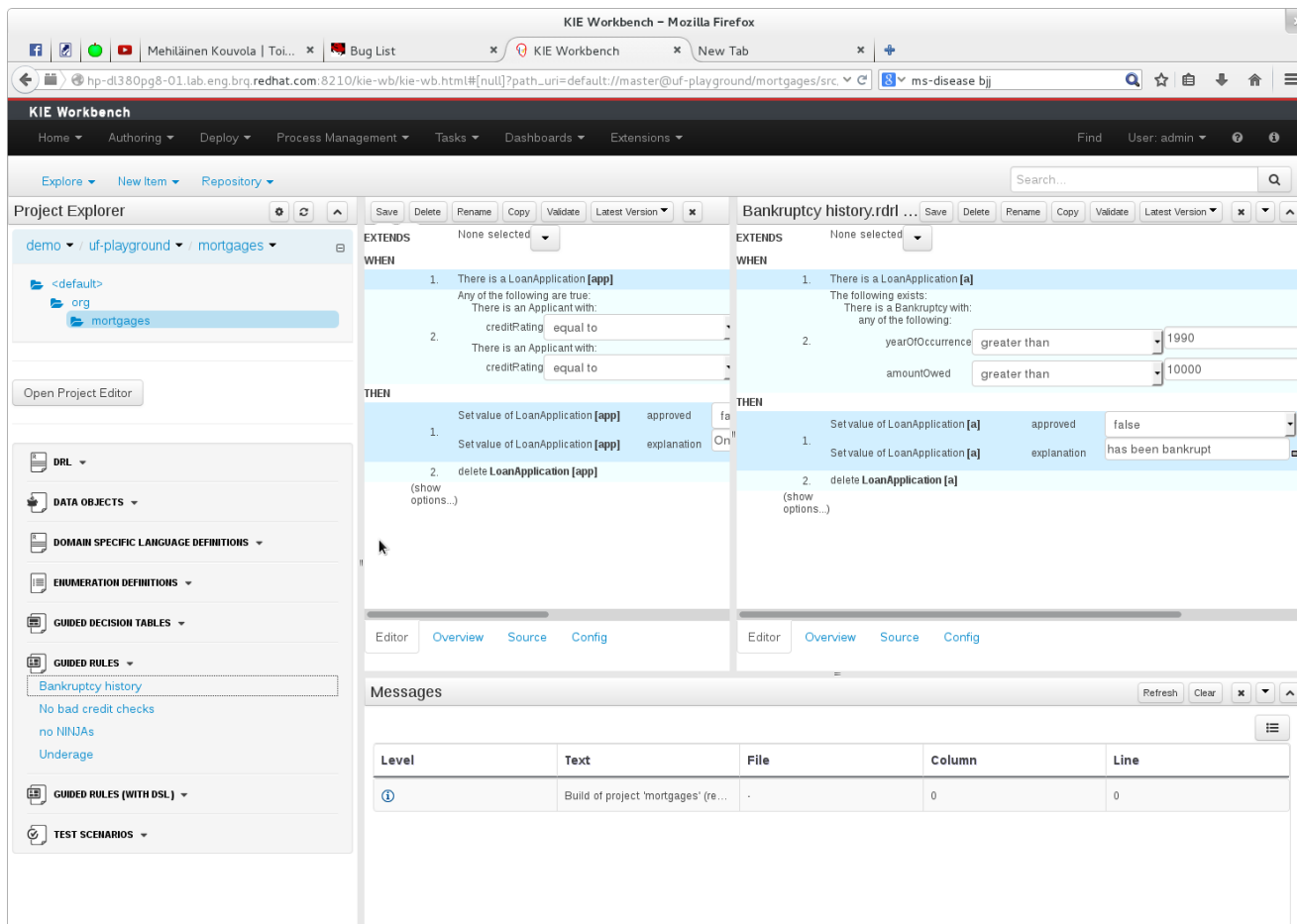


Figure 9.22. Repositioning - complete

9.7. Authoring

9.7.1. Artifact Repository

Projects often need external artifacts in their classpath in order to build, for example a domain model JARs. The artifact repository holds those artifacts.

The Artifact Repository is a full blown Maven repository. It follows the semantics of a Maven remote repository: all snapshots are timestamped. But it is often stored on the local hard drive.

By default the artifact repository is stored under `$WORKING_DIRECTORY/repositories/kie`, but it can be overridden with the system property `-Dorg.guvnor.m2repo.dir`. There is only 1 Maven repository per installation.

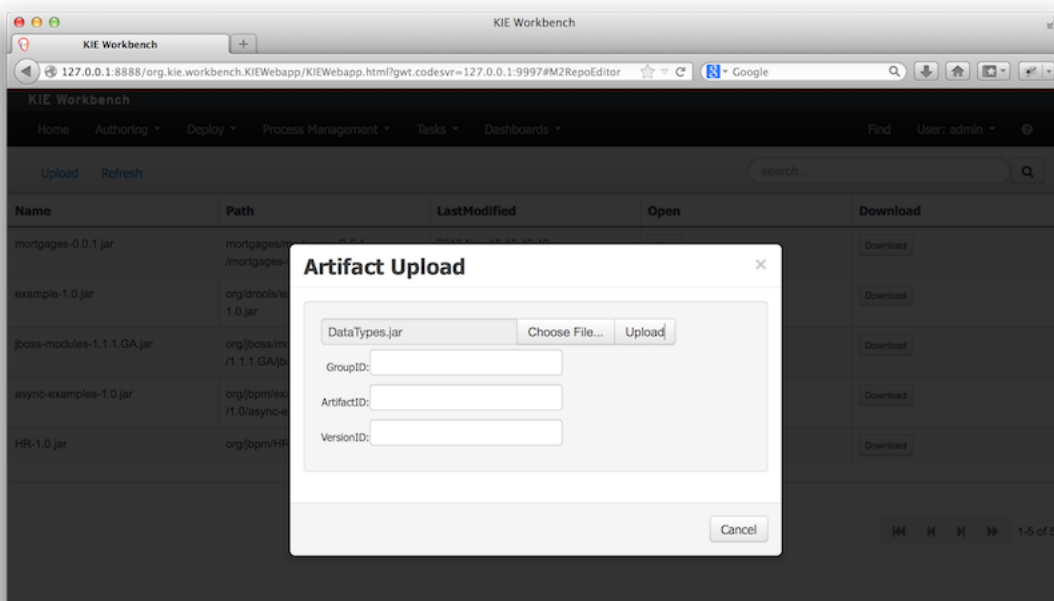
The Artifact Repository screen shows a list of the artifacts in the Maven repository:

Name	Path	LastModified	Open	Download
mortgages-0.0.1.jar	mortgages/mortgages/0.0.1/mortgages-0.0.1.jar	2013 Nov 16 15:46:40	Open	Download
example-1.0.jar	org/drools/example/1.0/example-1.0.jar	2013 Nov 16 15:08:26	Open	Download
jboss-modules-1.1.1.GA.jar	org/jboss/modules/jboss-modules/1.1.1.GA/jboss-modules-1.1.1.GA.jar	2013 Nov 16 15:07:18	Open	Download
async-examples-1.0.jar	org/jbpm/example/async-examples/1.0/async-examples-1.0.jar	2013 Nov 16 16:14:33	Open	Download
HR-1.0.jar	org/jbpm/HR/1.0/HR-1.0.jar	2013 Nov 16 16:14:13	Open	Download


1-5 of 5

To add a new artifact to that Maven repository, either:

- Use the upload button and select a JAR. If the JAR contains a POM file under META-INF/maven (which every JAR build by Maven has), no further information is needed. Otherwise, a groupId, artifactId and version need be given too.



- Using Maven, `mvn deploy` to that Maven repository. Refresh the list to make it show up.

 **Note**

This remote Maven repository is relatively simple. It does not support proxying, mirroring, ... like Nexus or Archiva.

9.7.2. Asset Editor

The Asset Editor is the principle component of the workbench User-Interface. It consists of two main views Editor and Overview.

- The views

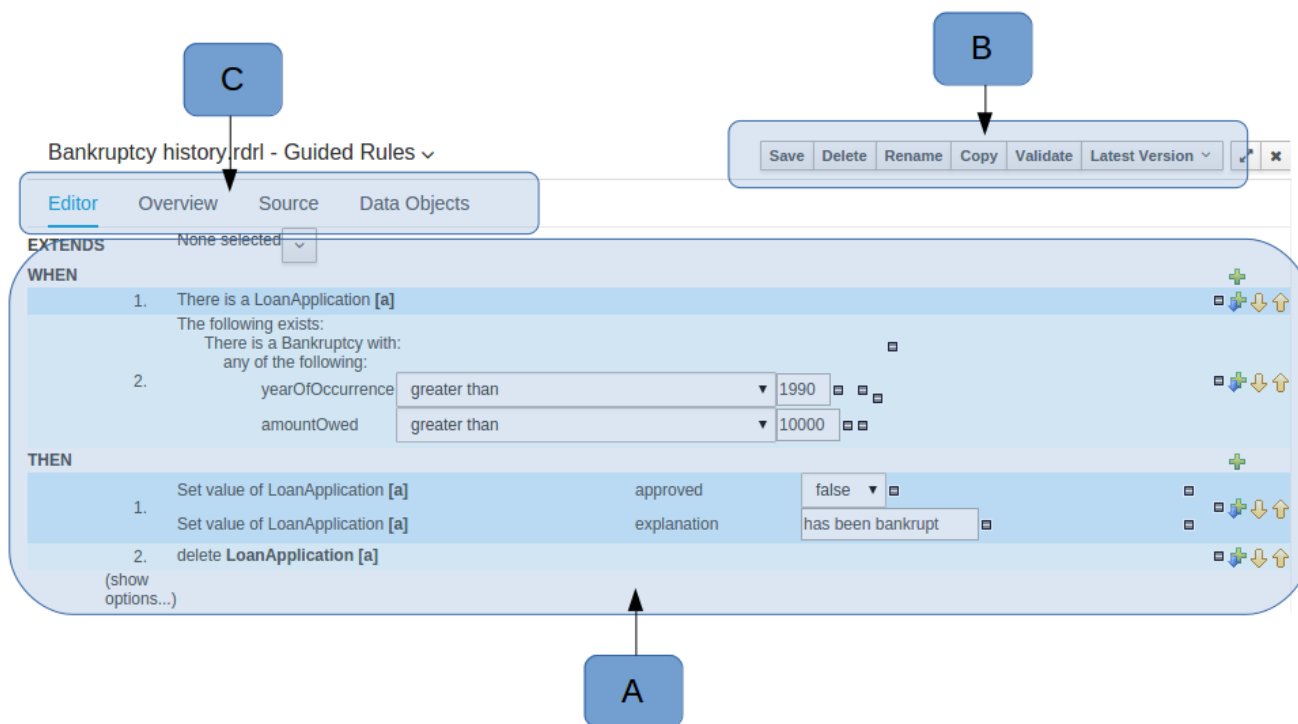



Figure 9.23. The Asset Editor - Editor tab

- A : The editing area - exactly what form the editor takes depends on the Asset type. An asset can only be edited by one user at a time to avoid conflicts. When a user begins to edit an asset, a lock will automatically be acquired. This is indicated by a lock symbol appearing on the asset title bar as well as in the project explorer view (see Section 9.7.4, “Project Explorer” for details). If a user starts editing an already locked asset a pop-up notification will appear to inform the user that the asset can't currently be edited, as it is being worked on by another user. Changes will be prevented until the editing user saves or closes the asset, or logs out of the workbench. Session timeouts will also cause locks to be released. Every user further has the option to force a lock release, if required (see the Metadata section below).
- B : This menu bar contains various actions for the Asset; such as Save, Rename, Copy etc. Note that saving, renaming and deleting are deactivated if the asset is locked by a different user.
- C : Different views for asset content or asset information.
 - Editor shows the main editor for the asset

- Overview contains the metadata and conversation views for this editor. Explained in more detail below.
- Source shows the asset in plain DRL. Note: This tab is only visible if the asset content can be generated into DRL.
- Data Objects contains the model available for authoring. By default only Data Objects that reside within the same package as the asset are available for authoring. Data Objects outside of this package can be imported to become available for authoring the asset.

Editor Overview Source Data Objects



By default only Data Objects within the same package as the asset are available for authoring. Additional Data Objects can be imported from other packages.

+ New item

Type	Remove
org.mortgages.Applicant	
org.mortgages.Bankruptcy	
org.mortgages.IncomeSource	
org.mortgages.LoanApplication	
java.lang.String	🗑 Remove

Figure 9.24. The Asset Editor - Data Objects tab

- Overview
 - A : General information about the asset and the asset's description.
 - "Type:" The format name of the type of Asset.
 - "Description:" Description for the asset.
 - "Used in projects:" Names the projects where this rule is used.
 - "Last Modified:" Who made the last change and when.
 - "Created on:" Who created the asset and when.
 - B : Version history for the asset. Selecting a version loads the selected version into this editor.

- C : Meta data (from the "Dublin Core" standard)
- D : Comments regarding the development of the Asset can be recorded here.

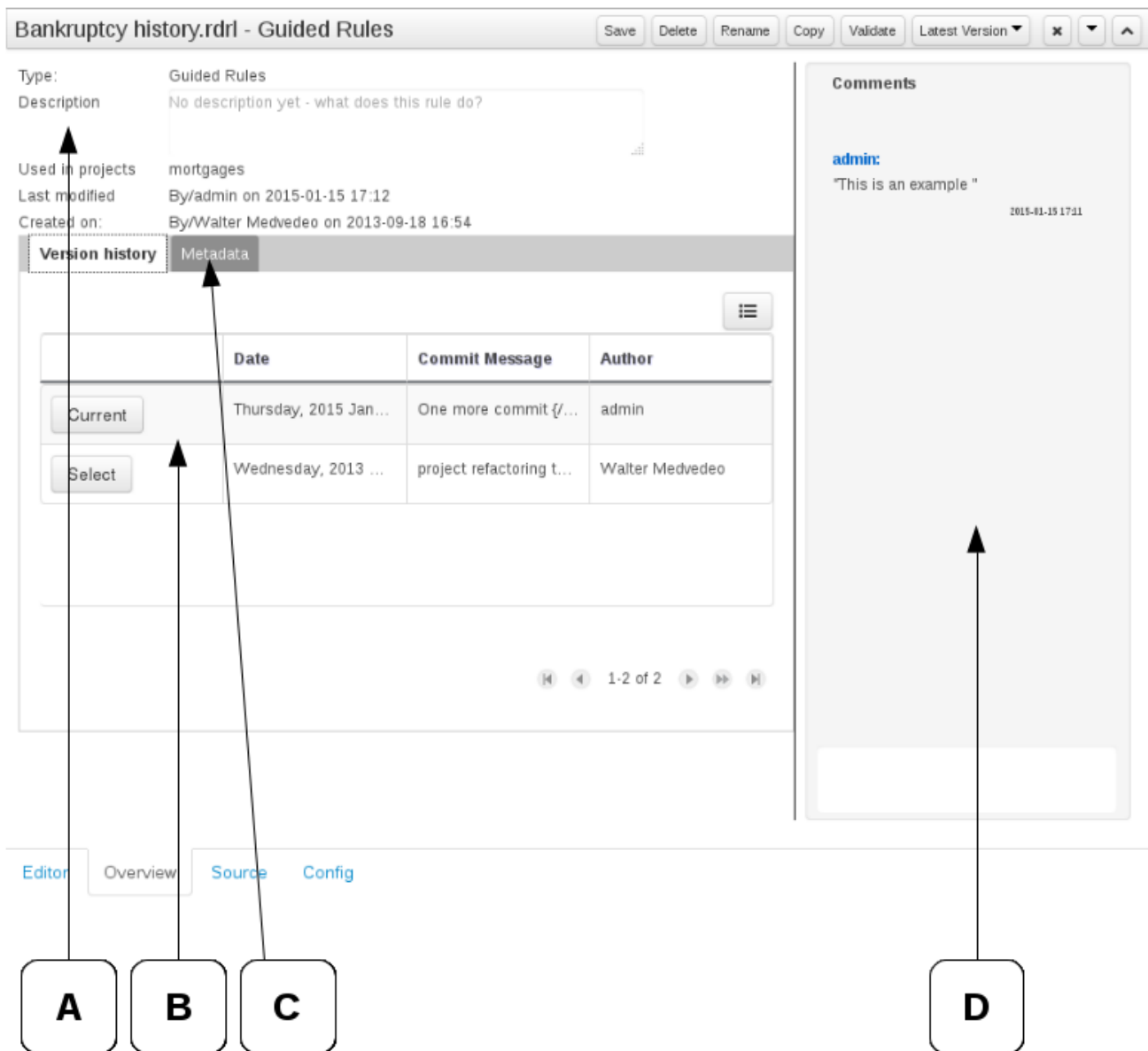


Figure 9.25. The Asset Editor - Overview tab

- Metadata
- A : Meta data:-
 - "Tags:" A tagging system for grouping the assets.
 - "Note:" A comment made when the Asset was last updated (i.e. why a change was made)
 - "URI:" URI to the asset inside the Git repository.

"Subject/Type/External link/Source" : Other miscellaneous meta data for the Asset.

"Lock status" : Shows the lock status of the asset and, if locked, allows to force unlocking the asset.

The screenshot shows the 'Metadata' tab in the Workbench interface. It features a 'Version history' tab on the left and a 'Metadata' tab on the right. The 'Metadata' tab contains several fields and a button:

- Tags:** A text input field followed by a blue button labeled 'Add a new tag/s'.
- Note:** A text field containing the text 'project refactoring to use mortgages package'.
- URI:** A text field containing the text 'git://master@uf-playground/mortgages/src/main/resources/org/mortgages/Dummy%20rule.drl'.
- Subject:** A text input field.
- Type:** A text input field.
- External link:** A text input field.
- Source:** A text input field.
- Lock status:** A text field containing the text 'Locked by admin' followed by a button with a padlock icon and the text 'Force unlock asset'.

Figure 9.26. The Metadata tab

- Locking

The Workbench supports pessimistic locking of assets. When one User starts editing an asset it is locked to change by other Users. The lock is held until a period of inactivity lapses, the Editor is closed or the application stopped and restarted. Locks can also be forcibly removed on the MetaData section of the Overview tab.

A "padlock" icon is shown in the Editor's title bar and beside the asset in the Project Explorer when an asset is locked.

🔒 Pricing loans.gdst - Guided Decision Tables
Save
Delete
Rename
Copy
Validate
Latest Version ▾
✕
▾
⬆

All the rules inherit: None selected ▾

+ Decision table
This asset is currently being edited by admin. Once they commit their changes, you will be able to edit the asset. ✕

Add row...
Otherwise
Audit log

#	Description	amount min	amount max	period	deposit max	income	Loan approved	LMI
+	1	131000	200000	30	20000	Asset	true	0
+	2	10000	100000	20	2000	Job	true	0
+	3	100001	130000	20	3000	Job	true	10

Editor
Overview
Source
Config

Figure 9.27. The Asset Editor - Locked assets cannot be edited by other users

9.7.3. Tags Editor

Tags allow assets to be labelled with any number of tags that you define. These tags can be used to filter assets on the Project Explorer enabling "Tag filtering".

9.7.3.1. Creating Tags

To create tags you simply have to write them on the Tags input and press the "Add new Tag/s" button. The Tag Editor allows creating tags one by one or writing more than one separated with a white space.

Version history	Metadata
Tags	<input type="text" value="tag1 tag2"/> <input type="button" value="Add new tag/s"/>
Note:	Update Applicant.java
URI:	git://master@uf-playground/mortgages/src/main/java/org/mortgages/Applicant.java
Subject:	<input type="text"/>
Type:	<input type="text"/>
External link:	<input type="text"/>
Source:	<input type="text"/>
Lock status:	Not locked <input type="button" value="Force unlock asset"/>

Figure 9.28. Creating Tags

Once you created new Tags they will appear over the Editor allowing you to remove them by pressing on them if you want.

Version history	Metadata
Tags	<input type="button" value="tag1"/> <input type="button" value="tag2"/> <input type="text"/> <input type="button" value="Add new tag/s"/>
Note:	Update Applicant.java
URI:	git://master@uf-playground/mortgages/src/main/java/org/mortgages/Applicant.java
Subject:	<input type="text"/>
Type:	<input type="text"/>
External link:	<input type="text"/>
Source:	<input type="text"/>
Lock status:	Not locked <input type="button" value="Force unlock asset"/>

Figure 9.29. Existing Tags

9.7.4. Project Explorer

The Project Explorer provides the ability to browse different Organizational Units, Repositories, Projects and their files.

9.7.4.1. Initial view

The initial view could be empty when first opened.

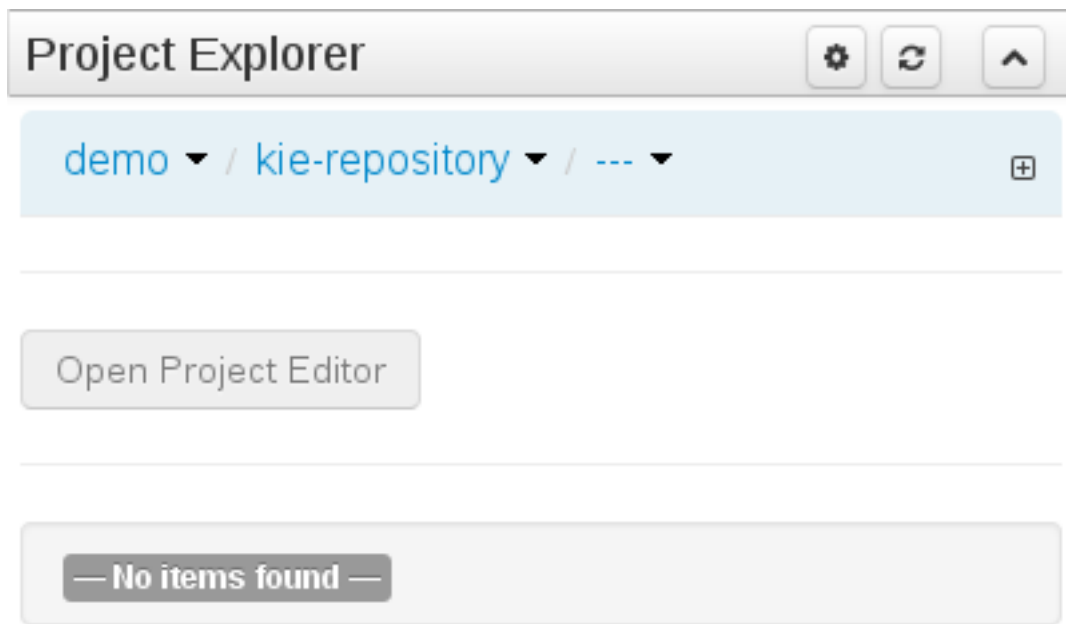


Figure 9.30. An empty initial view

The user may have to select an Organizational Unit, Repository and Project from the drop-down boxes.

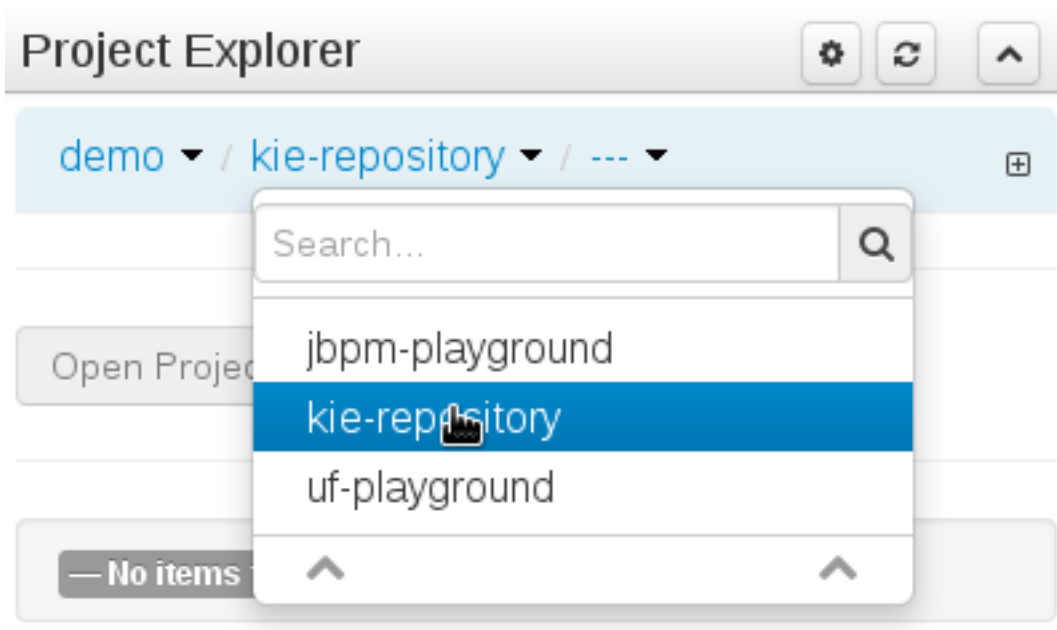


Figure 9.31. Selecting a repository

The default configuration hides Package details from view.

In order to reveal packages click on the icon as indicated in the following screen-shot.

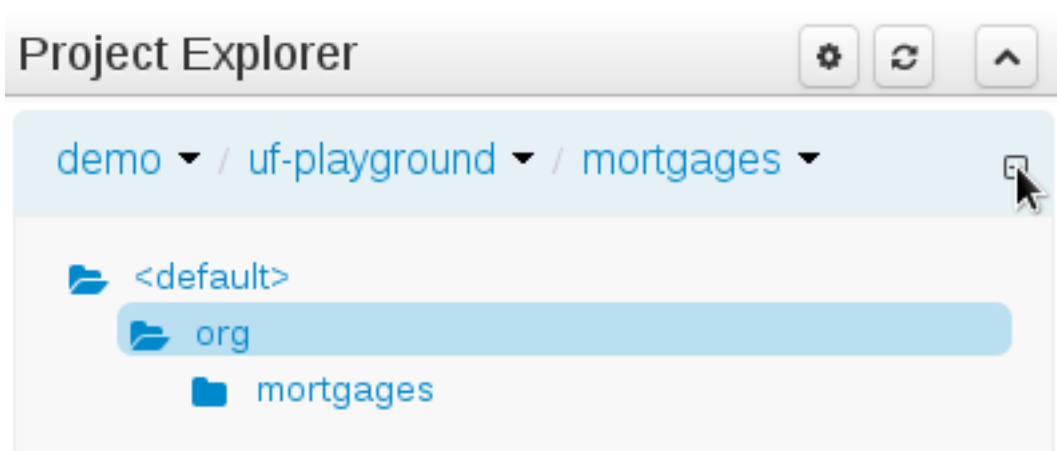


Figure 9.32. Showing packages

After a suitable combination of Organizational Unit, Repository, Project and Package have been selected the Project Explorer will show the contents. The exact combination of selections depends wholly on the structures defined within the Workbench installation and projects. Each section contains groups of related files. If a file is currently being edited by another user, a lock symbol will be displayed in front of the file name. The symbol is blue in case the lock is owned by the currently authenticated user, otherwise black. Moving the mouse pointer over the lock symbol will display a tooltip providing the name of the user who is currently editing the file (and therefore owning the lock). To learn more about locking see Section 9.7.2, “Asset Editor” for details.

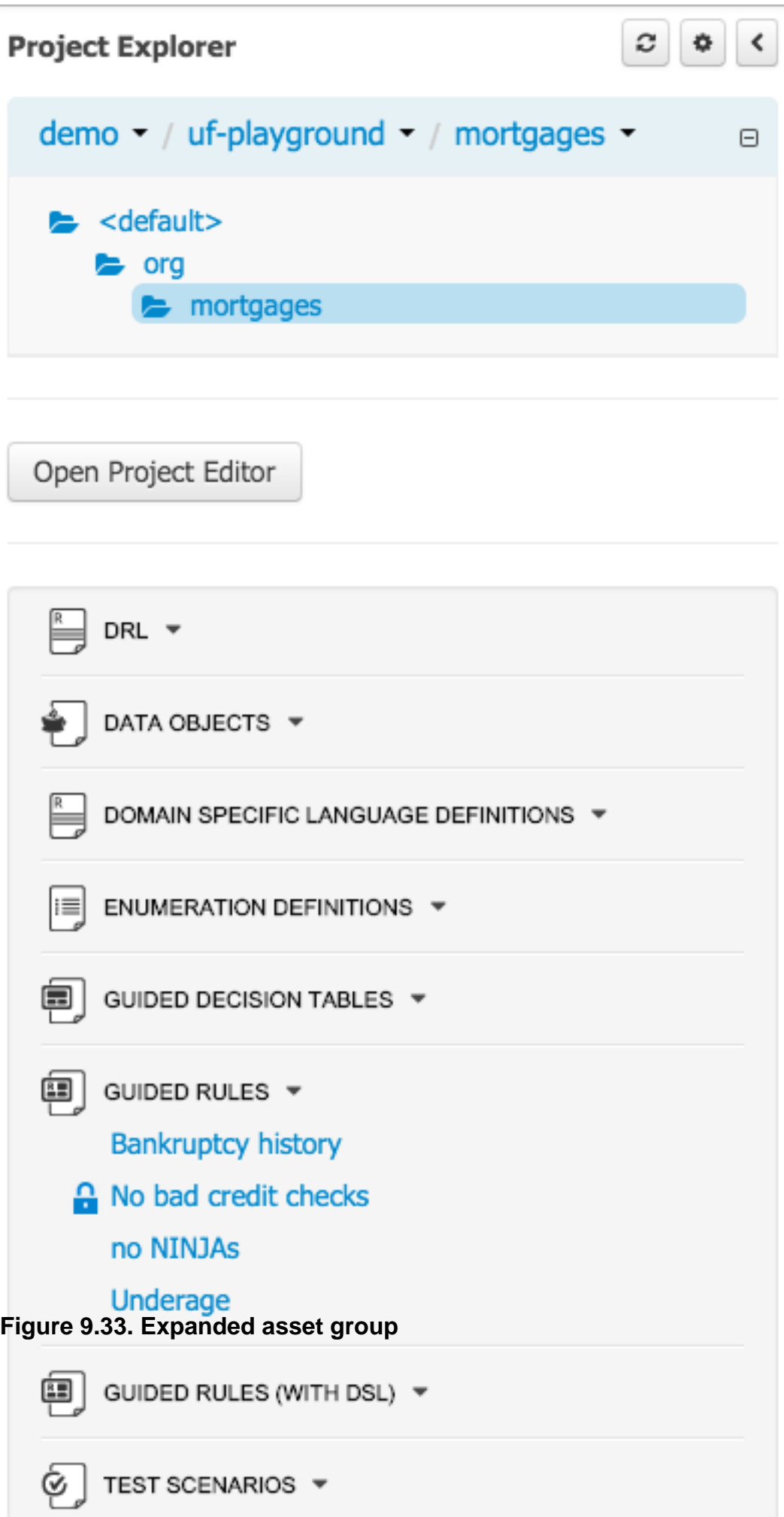


Figure 9.33. Expanded asset group

9.7.4.2. Different views

Project Explorer supports multiple views.

- Project View

A simplified view of the underlying project structure. Certain system files are hidden from view.

- Repository View

A complete view of the underlying project structure including all files; either user-defined or system generated.

Views can be selected by clicking on the icon within the Project Explorer, as shown below.

Both Project and Repository Views can be further refined by selecting either "Show as Folders" or "Show as Links".

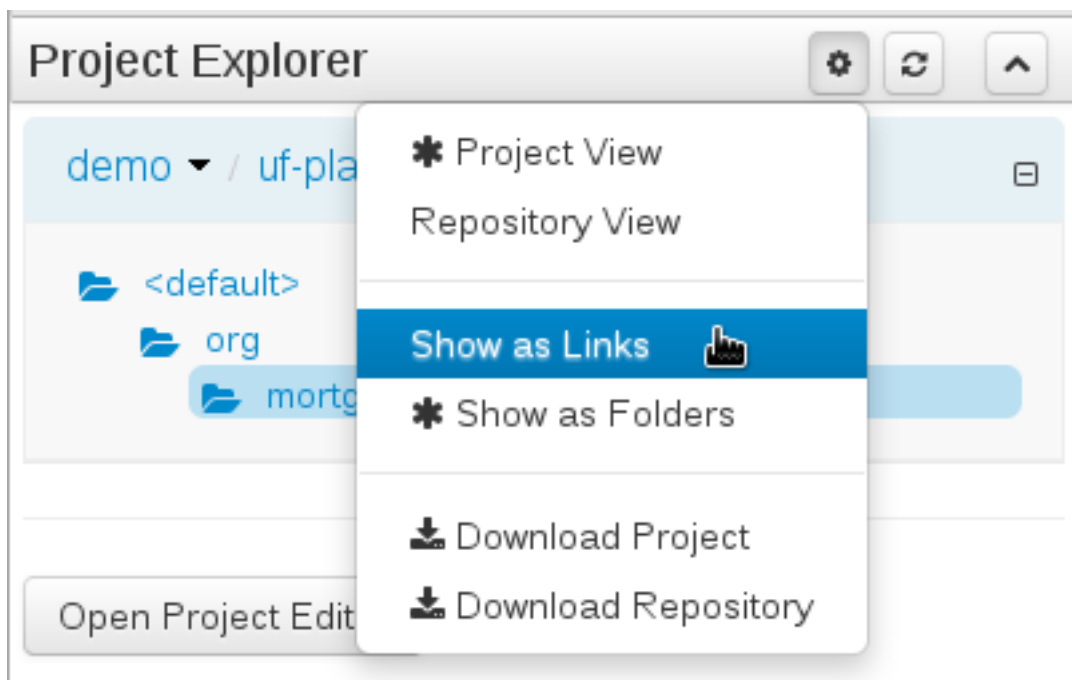


Figure 9.34. Switching view

9.7.4.2.1. Project View examples

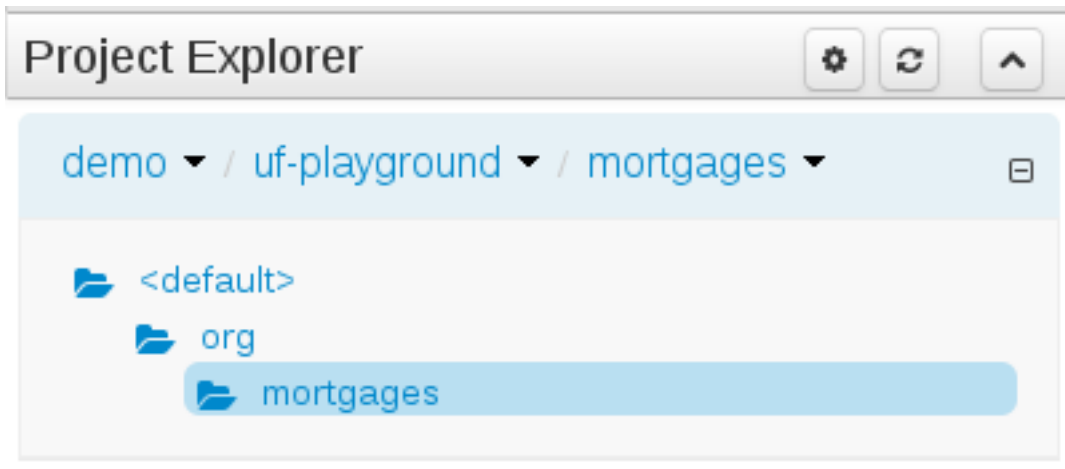


Figure 9.35. Project View - Folders

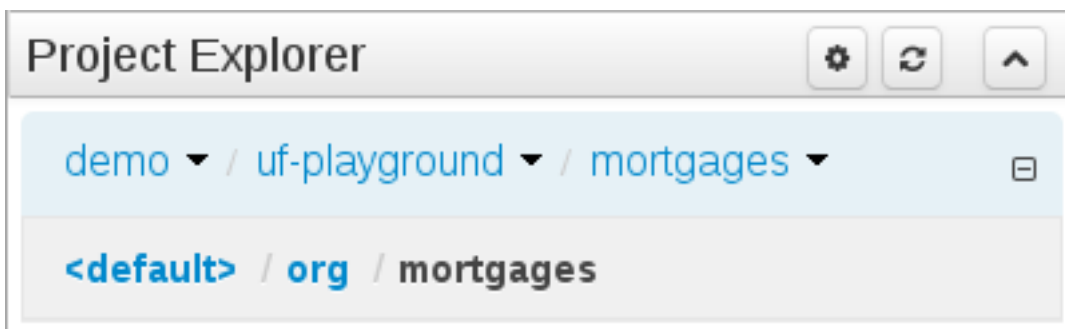


Figure 9.36. Project View - Links

9.7.4.2.2. Repository View examples

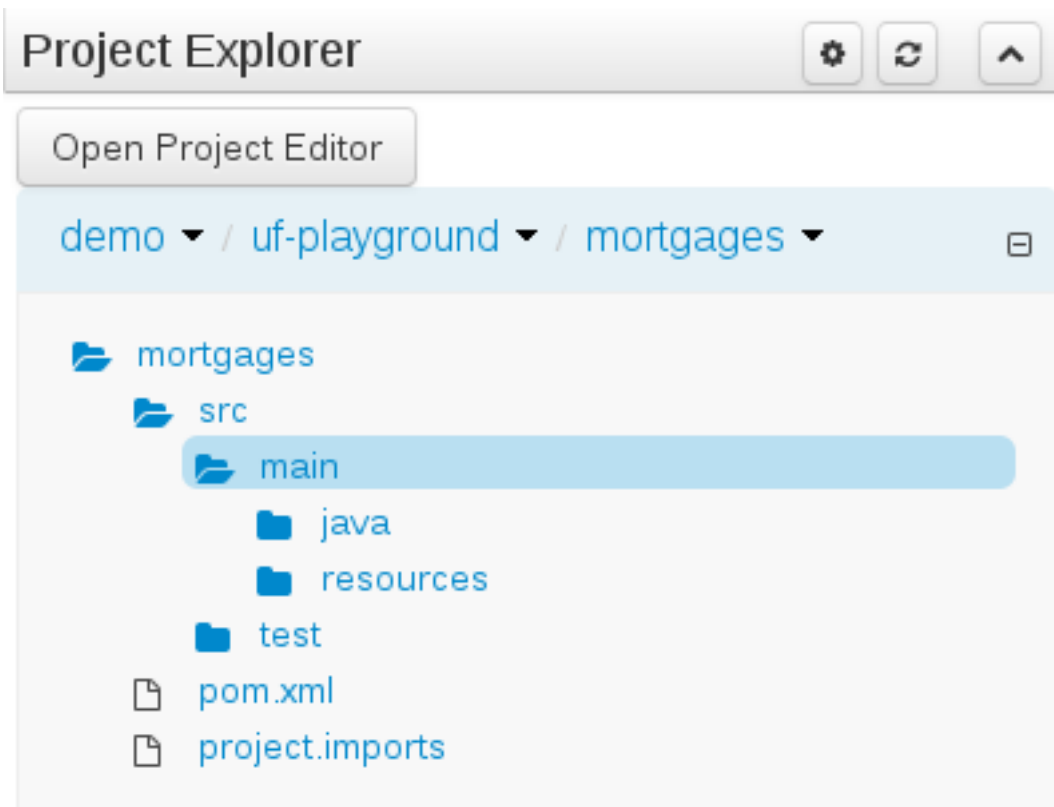


Figure 9.37. Repository View - Folders

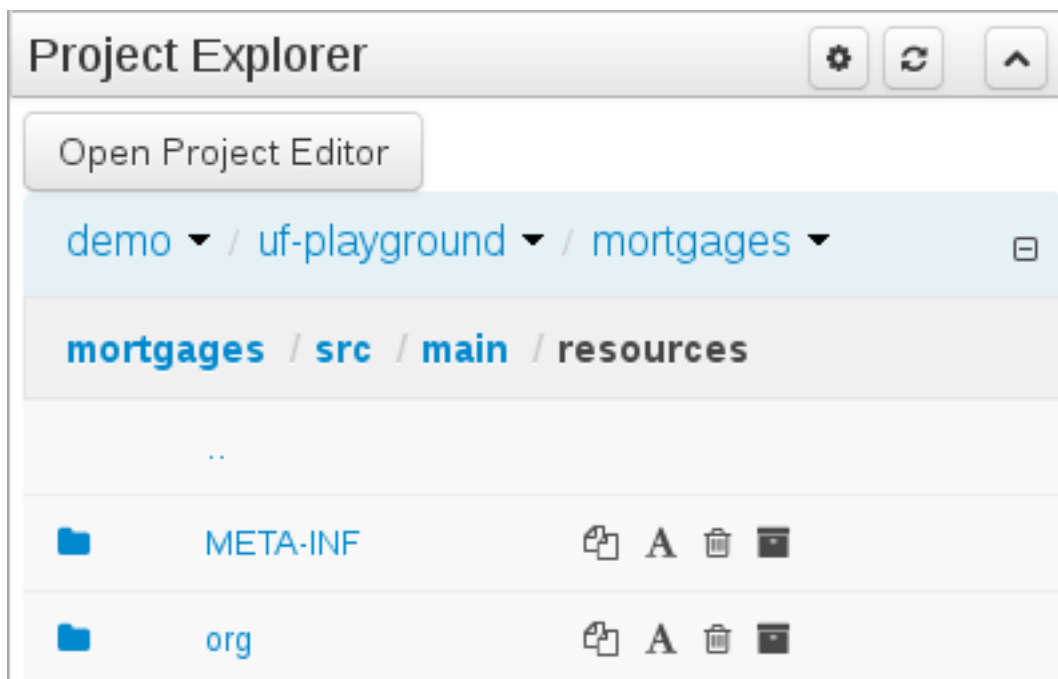


Figure 9.38. Repository View - Links

9.7.4.3. Download Project or Repository

Download Download and Download Repository make it possible to download the project or repository as a zip file.

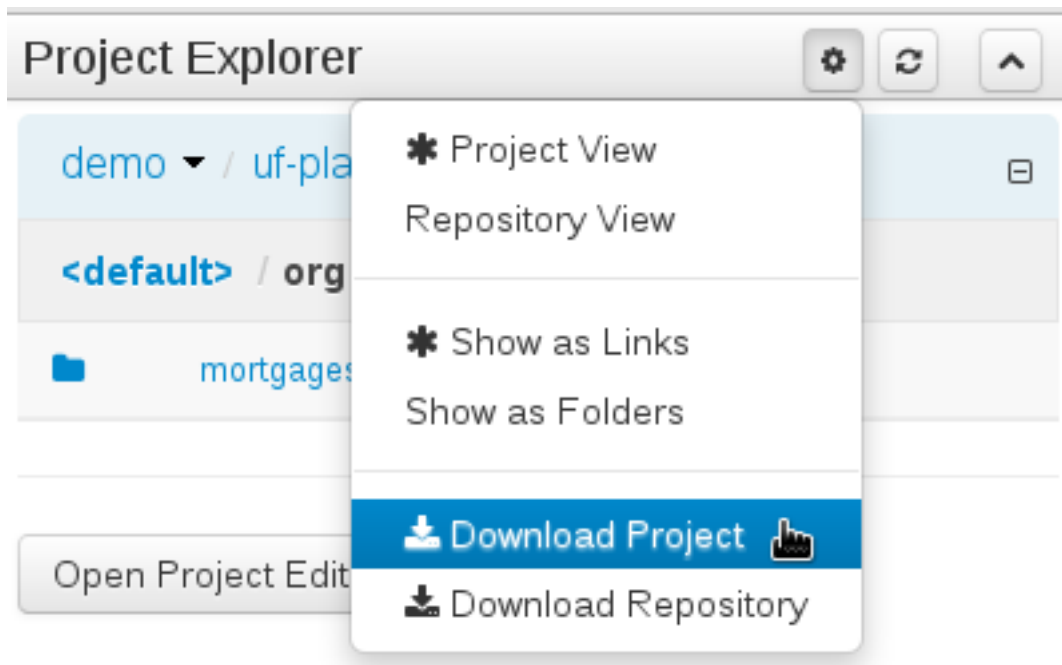


Figure 9.39. Repository and Project Downloads

9.7.4.4. Branch selector

A branch selector will be visible if the repository has more than a single branch.

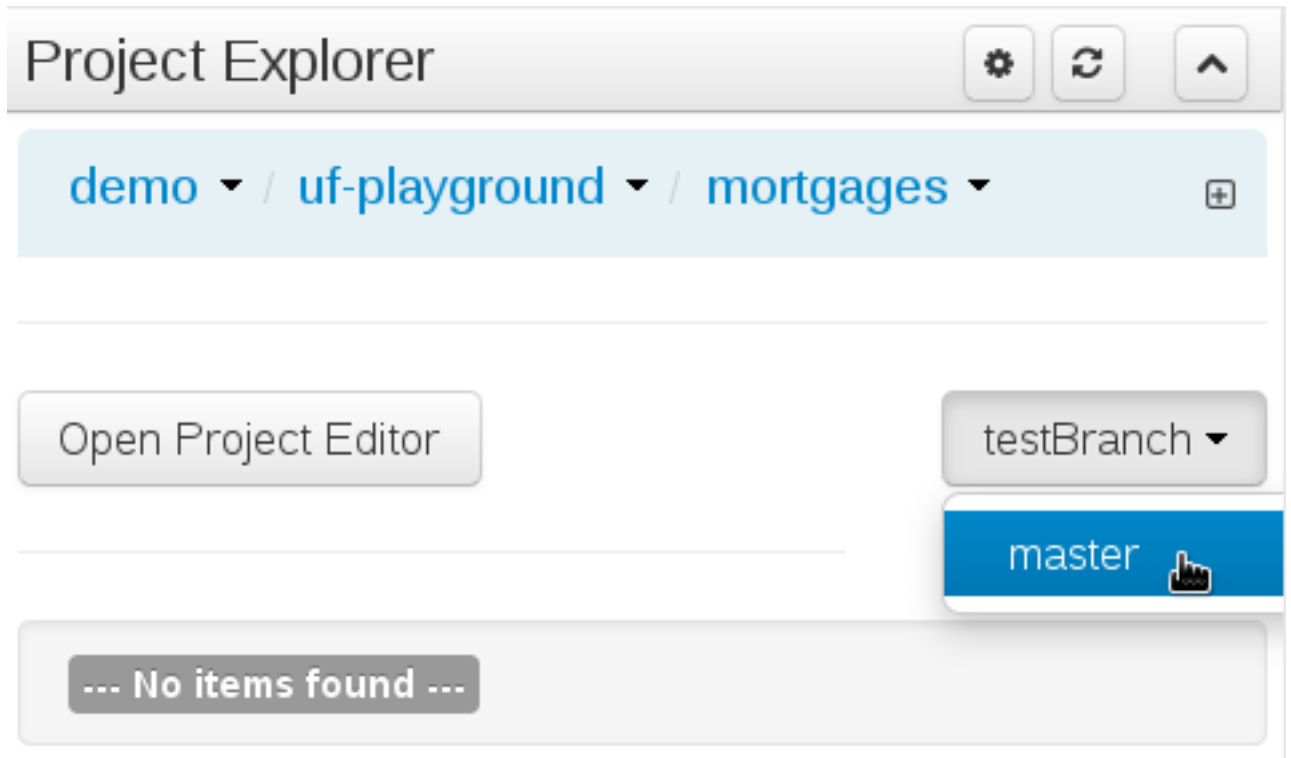


Figure 9.40. Branch selector

9.7.4.5. Filtering by Tag

To make easy view the elements on packages that contain a lot of assets, is possible to enabling the Tag filter, whichs allows you to filter the assets by their tags.

To see how to add tags to an asset look at: Section 9.7.3, "Tags Editor"

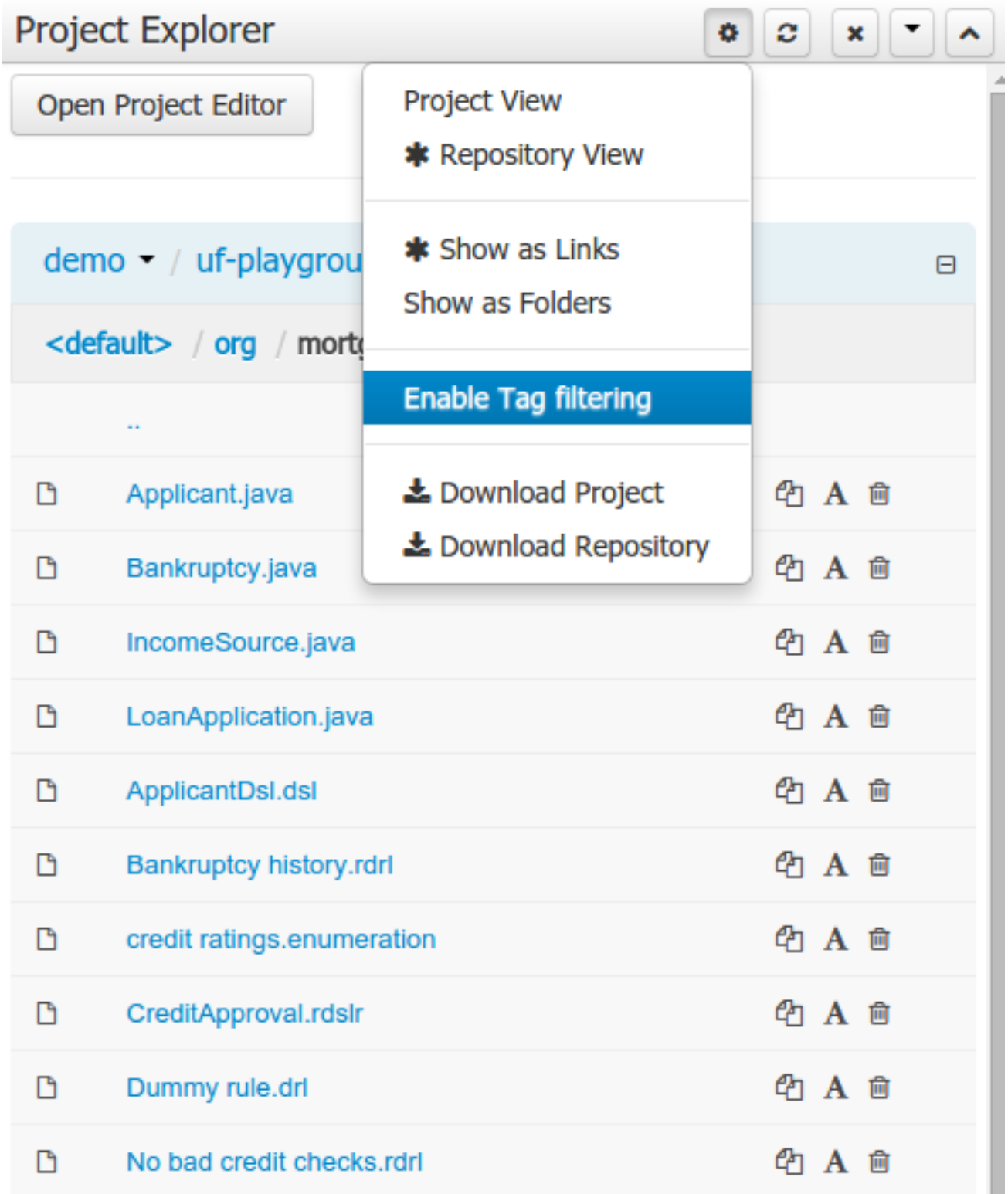


Figure 9.41. Enabling Filter by Tag

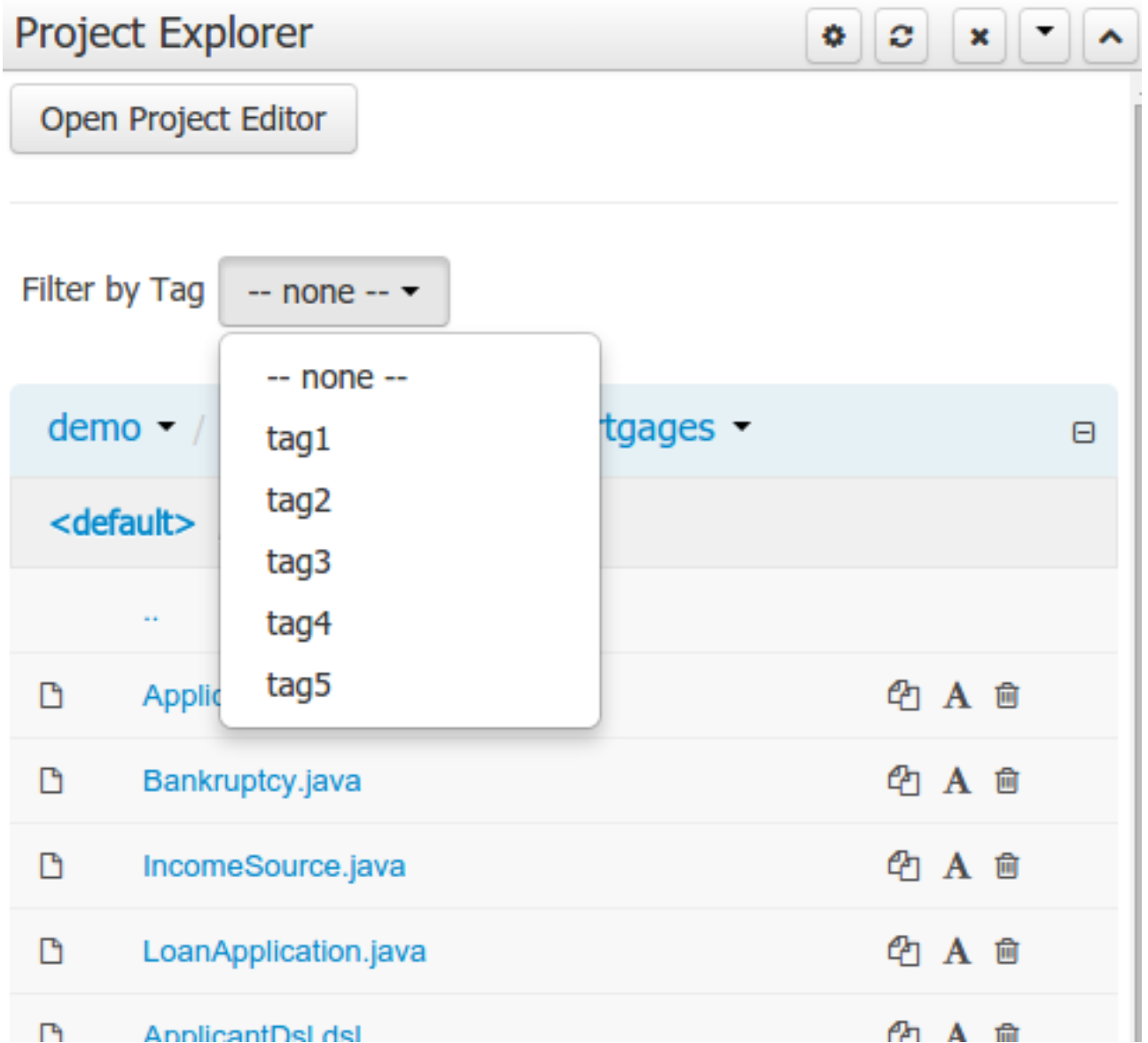


Figure 9.42. Filter by Tag

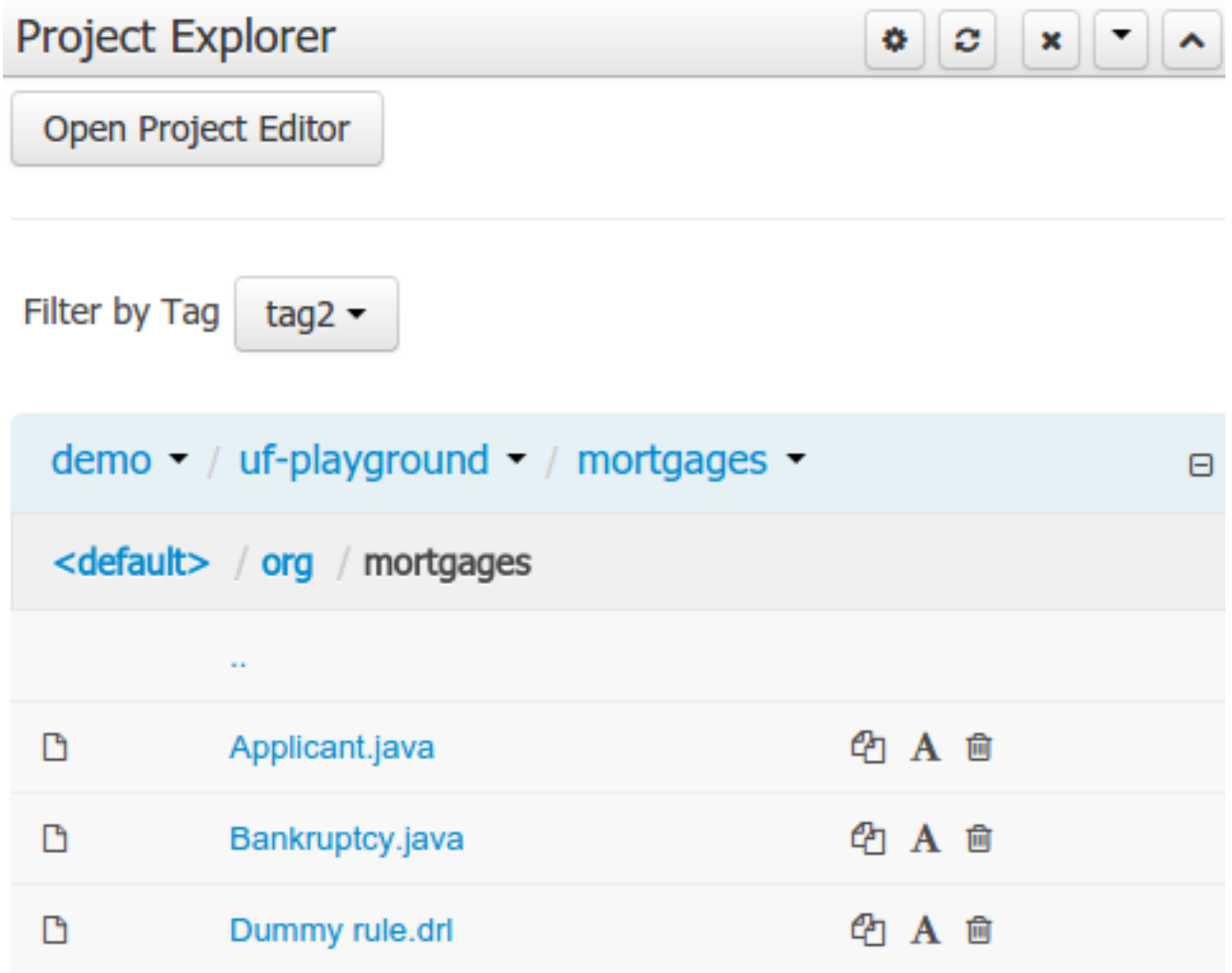


Figure 9.43. Filtering by Tag

9.7.4.6. Copy, Rename, Delete and Download Actions

Copy, rename and delete actions are available on *Links* mode, for packages (in of Project View) and for files and directories as well (in Repository View). Download action is available for directories. Download downloads the selected the selected directory as a zip file.

- A : Copy
- B : Rename
- C : Delete
- D : Download

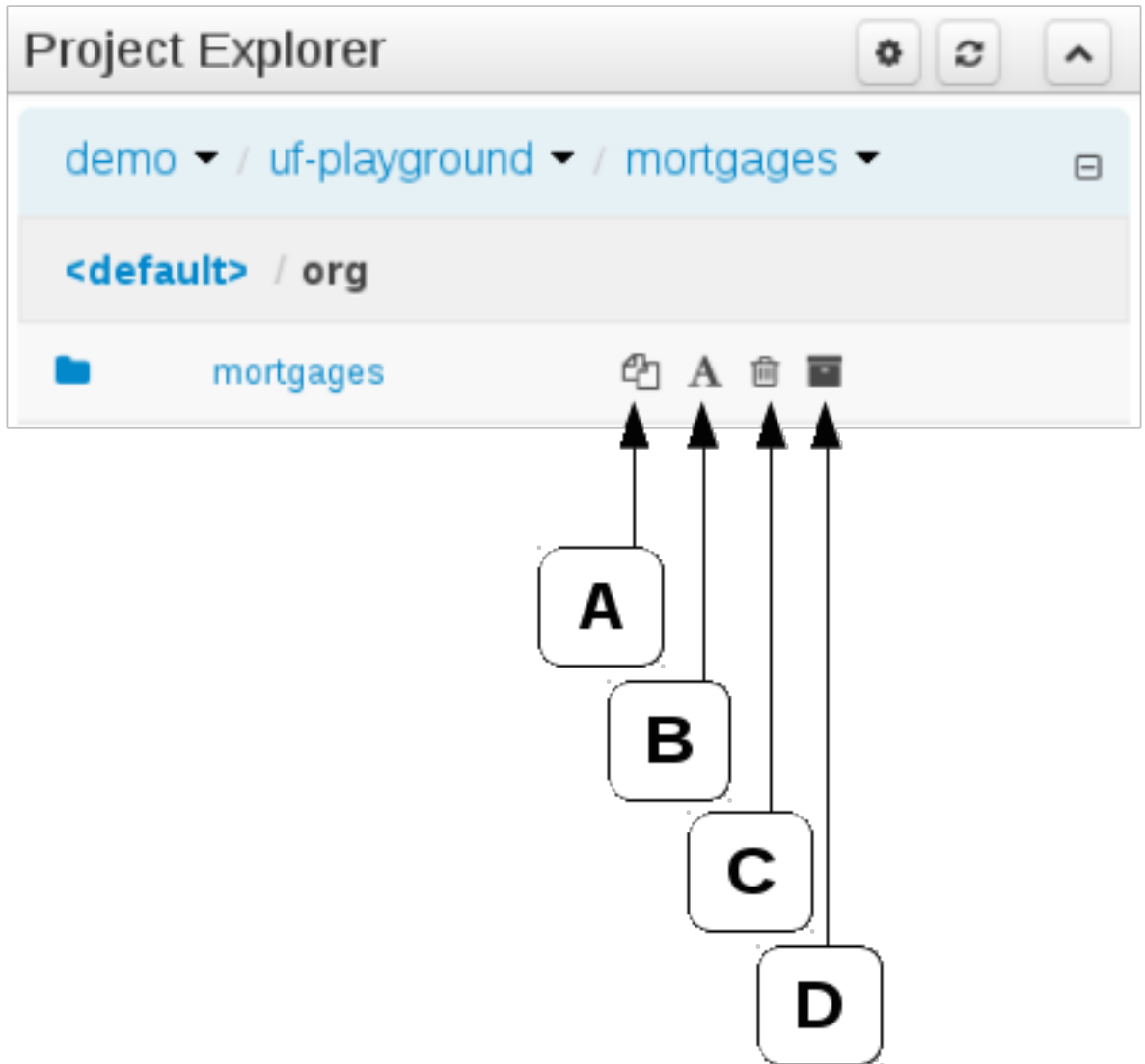


Figure 9.44. Project View - Package actions

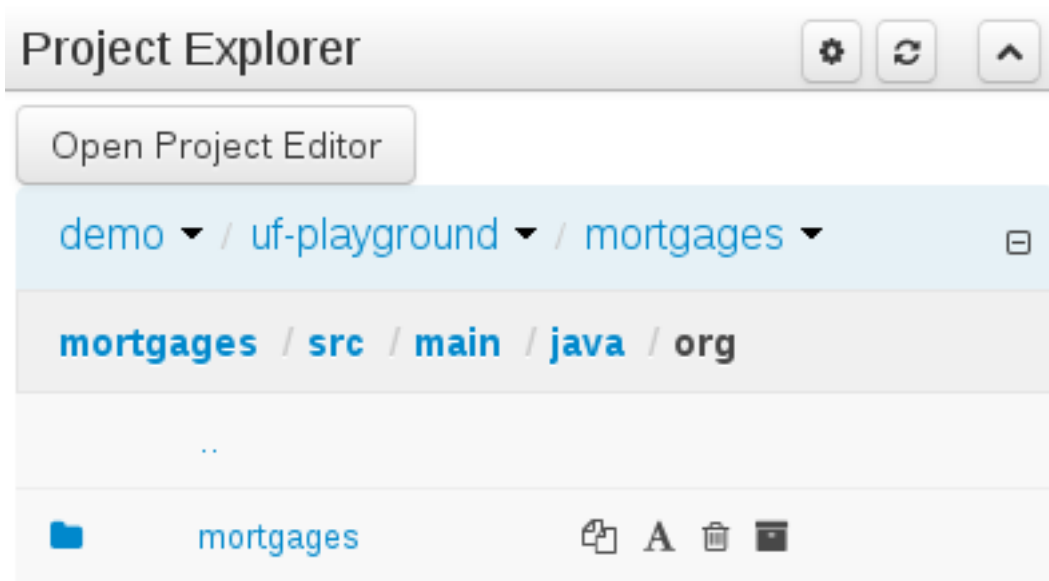




Figure 9.45. Repository View - Files and directories actions

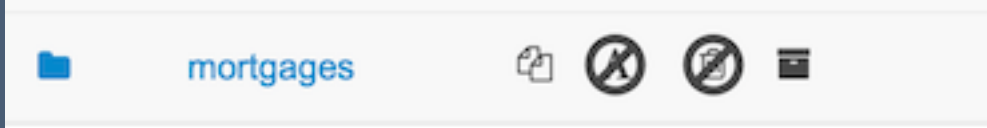
 **Warning**

Workbench roadmap includes a refactoring and an impact analyses tools, but currently doesn't have it. Until both tools are provided make sure that your changes (copy/rename/delete) on packages, files or directories doesn't have a major impact on your project.

In cases that your change had an unexcepted impact, Workbench allows you to restore your repository using the Repository editor.

 **Important**

Files locked by other users as well as directories that contain such files cannot be renamed or deleted until the corresponding locks are released. If that is the case the rename and delete symbols will be deactivated. To learn more about locking see Section 9.7.2, "Asset Editor" for details.

The image shows a close-up of the 'mortgages' folder entry in the Project Explorer. The folder name is 'mortgages'. The toolbar icons for copy, rename, and delete are all crossed out with a red 'X', indicating they are disabled. The refresh icon remains active.

9.7.5. Project Editor

The Project Editor screen can be accessed from Project Explorer. Project Editor shows the settings for the currently active project.

Unlike most of the workbench editors, project editor edits more than one file. Showing everything that is needed for configuring the KIE project in one place.

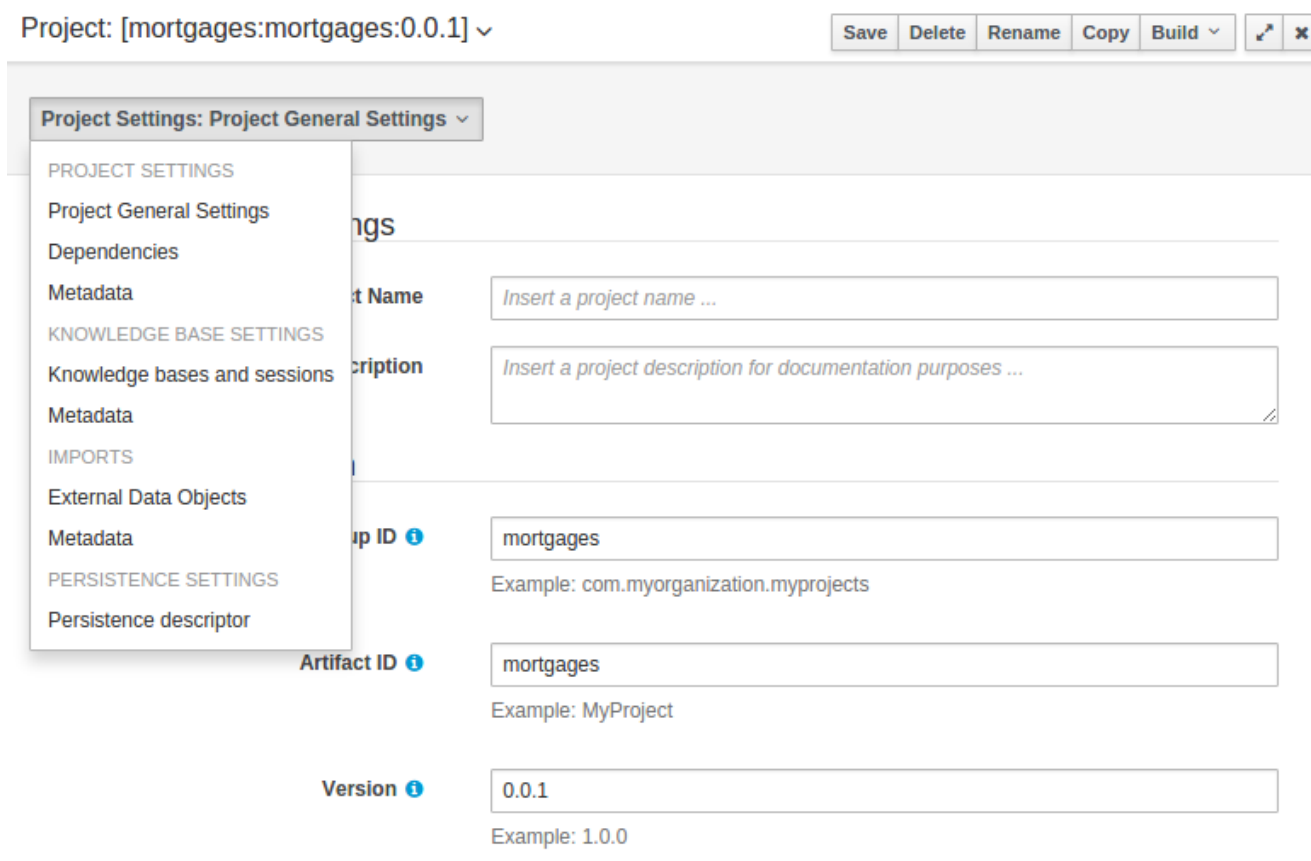


Figure 9.46. Project Screen and the different views

9.7.5.1. Build & Deploy

Build & Deploy builds the current project and deploys the KJAR into the workbench internal Maven repository.

9.7.5.2. Project Settings

Project Settings edits the pom.xml file used by Maven.

9.7.5.2.1. Project General Settings

General settings provide tools for project name and GAV-data (Group, Artifact, Version). GAV values are used as identifiers to differentiate projects and versions of the same project.

Project: [mortgages:mortgages:0.0.1] Save Delete Rename Copy Build ↕ ✕

Project Settings: Project General Settings ▾

Project General Settings

Project Name

Project Description

Group artifact version

Group ID
Example: com.myorganization.myprojects

Artifact ID
Example: MyProject

Version
Example: 1.0.0

Figure 9.47. Project Settings

9.7.5.2.2. Dependencies

The project may have any number of either internal or external dependencies. Dependency is a project that has been built and deployed to a Maven repository. Internal dependencies are projects build and deployed in the same workbench as the project. External dependencies are retrieved from repositories outside of the current workbench. Each dependency uses the GAV-values to specify the project name and version that is used by the project.

Dependencies: Dependencies list ▾

Dependencies Add Add from repository

Group ID	Artifact ID	Version	Package white list	Delete
mortgages	mortgages	0.0.1	Packages not included	Delete

Figure 9.48. Dependencies

9.7.5.2.2.1. Package Name White List

Classes and declared types in white listed packages show up as Data Objects that can be imported in assets. The full list is stored in package-name-white-list file that is stored in each project root.

Package white list has three modes:

- All packages included: Every package defined in this jar is white listed.
- Packages not included: None of the packages listed in this jar are white listed.
- Some packages included: Only part of the packages in the jar are white listed.

9.7.5.2.3. Metadata

Metadata for the pom.xml file.

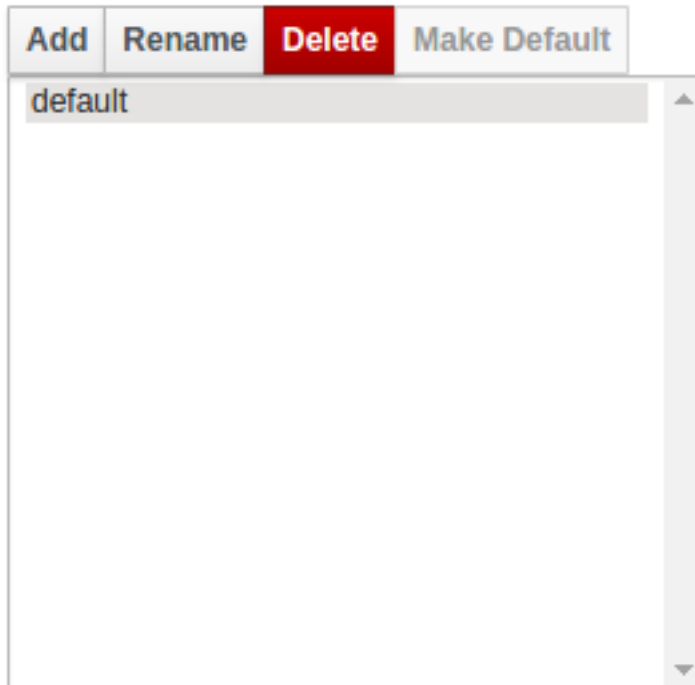
9.7.5.3. Knowledge Base Settings

Knowledge Base Settings edits the kmodule.xml file used by Drools.

Knowledge Base Settings: Knowledge bases and sessions ▾

Add Rename **Delete** Make Default

default



default

Included Knowledge Bases

Add **Delete**

kbase1
kbase2



Packages

Add **Delete**

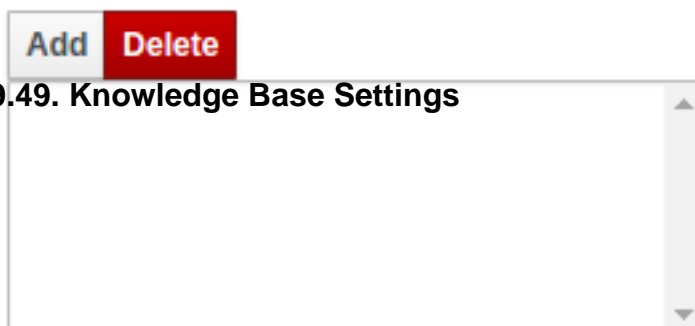


Figure 9.49. Knowledge Base Settings

**Note**

For more information about the Knowledge Base properties, check the Drools Expert documentation for `kmodule.xml`.

9.7.5.3.1. Knowledge bases and sessions

Knowledge bases and sessions lists the knowledge bases and the knowledge sessions specified for the project.

9.7.5.3.1.1. Knowledge base list

Lists all the knowledge bases by name. Only one knowledge base can be set as default.

9.7.5.3.1.2. Knowledge base properties

Knowledge base can include other knowledge bases. The models, rules and any other content in the included knowledge base will be visible and usable by the currently selected knowledge base.

Rules and models are stored in packages. The packages property specifies what packages are included into this knowledge base.

Equals behavior is explained in the Drools Expert part of the documentation.

Event processing mode is explained in the Drools Fusion part of the documentation.

9.7.5.3.1.3. Knowledge sessions

The table lists all the knowledge sessions in the selected knowledge base. There can be only one default of each type. The types are stateless and stateful. Clicking the pen-icon opens a popup that shows more properties for the knowledge session.

9.7.5.3.2. Metadata

Metadata for the `kmodule.xml`

9.7.5.4. Imports

Settings edits the `project.imports` file used by the workbench editors.

Imports: External Data Objects ▾

 External Data Objects are Data Objects not explicitly defined within a Project or Project's dependencies that a rule author may need available. They are usually provided by the Java runtime. For example `java.util.List`.

+ New item

Type	Remove
<code>java.util.List</code>	
<code>java.lang.String</code>	

Figure 9.50. Imports

9.7.5.4.1. External Data Objects

Data Objects provided by the Java Runtime environment may need to be registered to be available to rule authoring where such Data Objects are not implicitly available as part of an existing Data Object defined within the Workbench or a Project dependency. For example an Author may want to define a rule that checks for `java.util.ArrayList` in Working Memory. If a domain Data Object has a field of type `java.util.ArrayList` there is no need create a registrar.

9.7.5.4.2. Metadata

Metadata for the project.imports file.

9.7.5.5. Duplicate GAV detection

When performing any of the following operations a check is now made against all Maven Repositories, resolved for the Project, for whether the Project's GroupId, ArtifactId and Version pre-exist. If a clash is found the operation is prevented; although this can be overridden by Users with the `admin` role.



Note

The feature can be disabled by setting the System Property `org.guvnor.project.gav.check.disabled` to `true`.

Resolved repositories are those discovered in:-

- The Project's POM `<repositories>` section (or any parent POM).
- The Project's POM `<distributionManagement>` section.
- Maven's global `settings.xml` configuration file.

Affected operations:-

- Creation of new Managed Repositories.
- Saving a Project definition with the Project Editor.
- Adding new Modules to a Managed Multi-Module Repository.
- Saving the `pom.xml` file.
- Build & installing a Project with the Project Editor.
- Build & deploying a Project with the Project Editor.
- Asset Management operations building, installing or deploying Projects.
- REST operations creating, installing or deploying Projects.

Users with the `Admin` role can override the list of Repositories checked using the "Repositories" settings in the Project Editor.

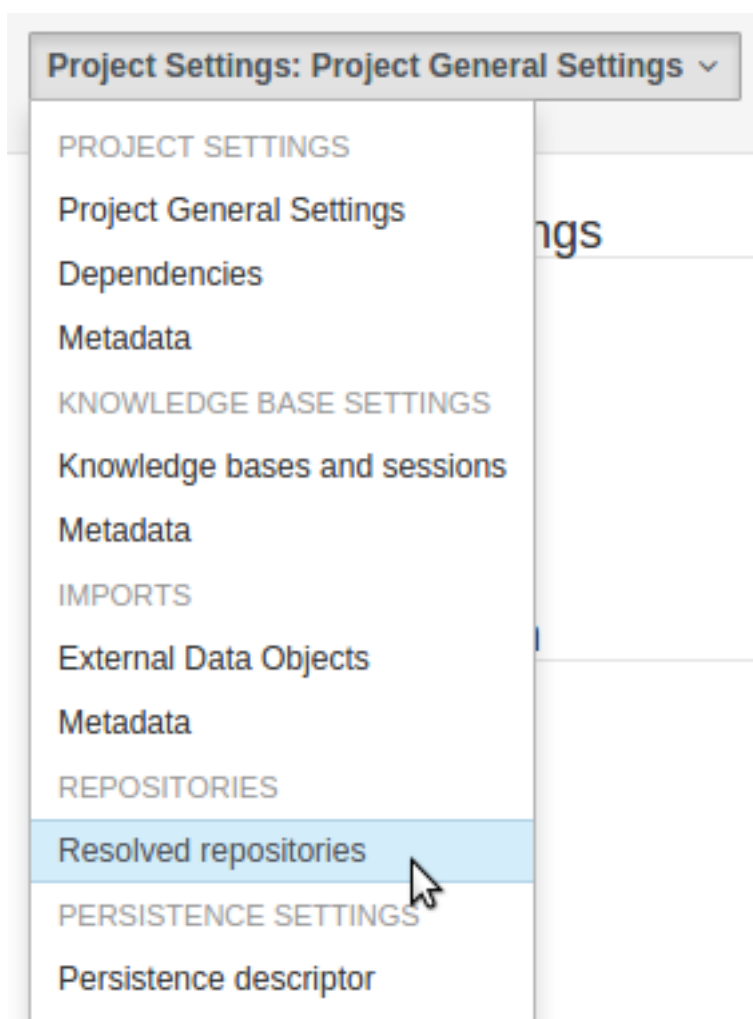



Figure 9.51. Project Editor - Viewing resolved Repositories


Repositories: Resolved repositories ▾


 These are the Maven Repositories resolved for the Project from the Project's pom, the Project's Distribution Management configuration and Maven's global settings.

Include	Id	URL	Source
<input checked="" type="checkbox"/>	local	/home/manstis/.m2/repository	Local
<input checked="" type="checkbox"/>	jboss-developer-repository-group	https://repository.jboss.org/nexus/content/groups/developer/	Maven settings
<input checked="" type="checkbox"/>	jboss-origin-repository-group	https://origin-repository.jboss.org/nexus/content/groups/ea/	Maven settings
<input checked="" type="checkbox"/>	jboss-public-repository-group	http://repository.jboss.org/nexus/content/groups/public/	Maven settings

Figure 9.52. Project Editor - The list of resolved Repositories

Conflicting Repositories ✕


 The following Repositories already contain Artifact "mortgages:mortgages:0.0.1".

Id	URL	Source
local	/home/manstis/.m2/repository	Local

+ Ok
Override

Figure 9.53. Duplicate GAV detected

9.7.6. Validation

The Workbench provides a common and consistent service for users to understand whether files authored within the environment are valid.

9.7.6.1. Problem Panel

The Problems Panel shows real-time validation results of assets within a Project.

When a Project is selected from the Project Explorer the Problems Panel will refresh with validation results of the chosen Project.

When files are created, saved or deleted the Problems Panel content will update to show either new validation errors, or remove existing if a file was deleted.

Here an invalid DRL file has been created and saved.

The Problems Panel shows the validation errors.

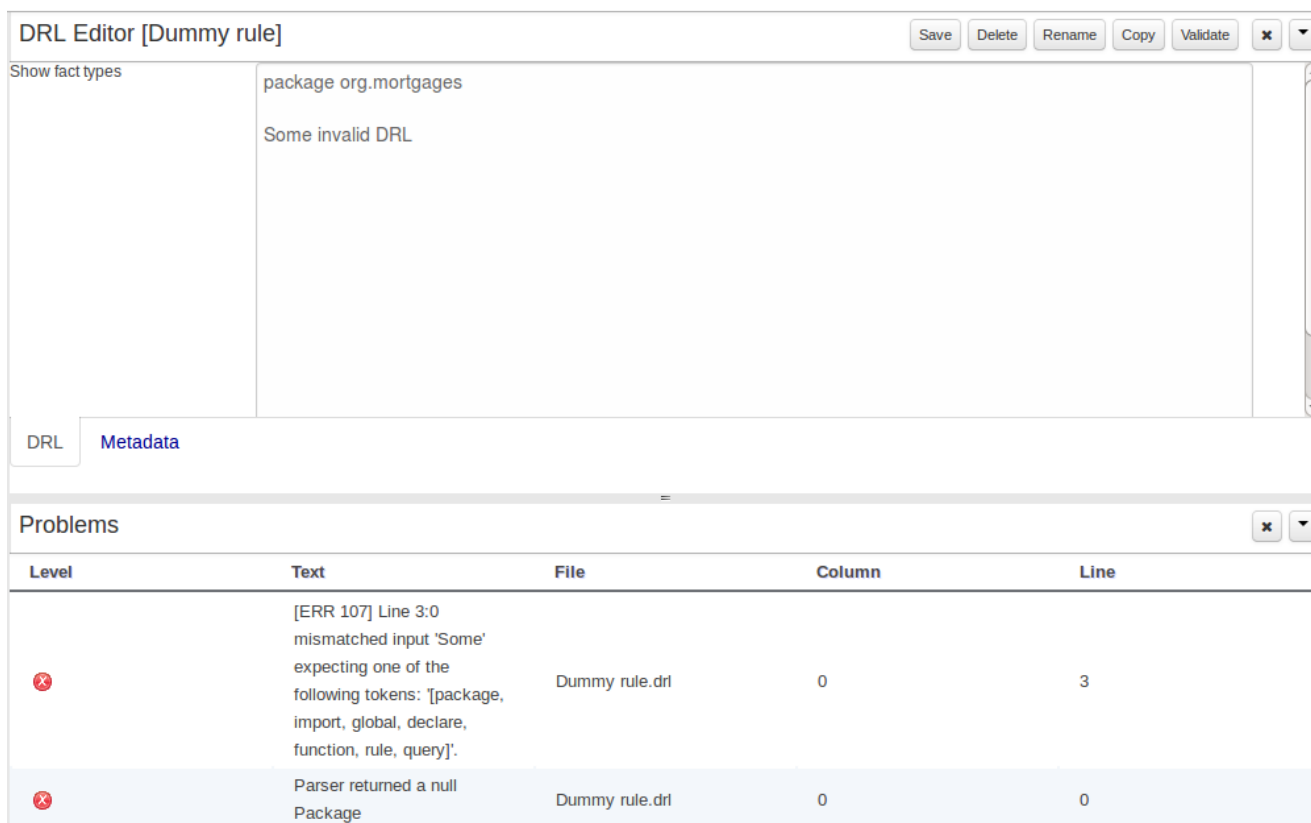


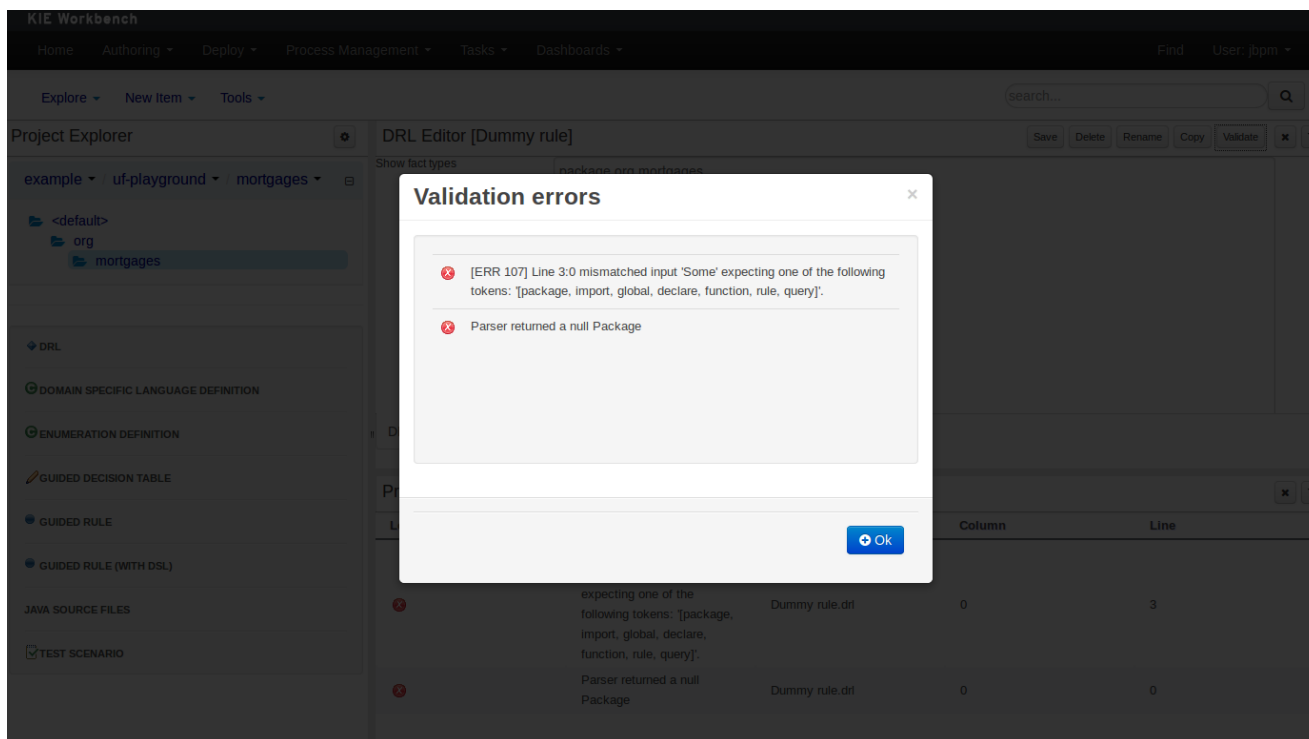
Figure 9.54. The Problems Panel

9.7.6.2. On demand validation

It is not always desirable to save a file in order to determine whether it is in a valid state.

All of the file editors provide the ability to validate the content before it is saved.

Clicking on the 'Validate' button shows validation errors, if any.



9.7.7. Data Modeller

9.7.7.1. First steps to create a data model

By default, a data model is always constrained to the context of a project. For the purpose of this tutorial, we will assume that a correctly configured project already exists and the authoring perspective is open.

To start the creation of a data model inside a project, take the following steps:

1. From the home panel, select the authoring perspective and use the project explorer to browse to the given project.

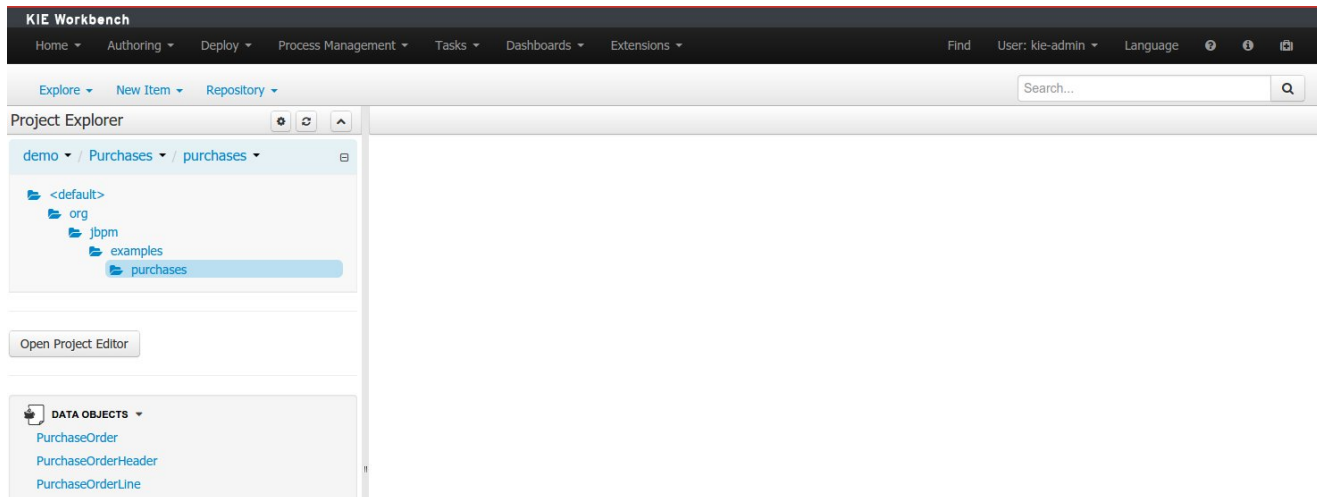


Figure 9.55. Go to authoring perspective and select a project

2. Open the Data Modeller tool by clicking on a Data Object file, or using the "New Item -> Data Object" menu option.



Figure 9.56. Click on a Data Object

This will start up the Data Modeller tool, which has the following general aspect:

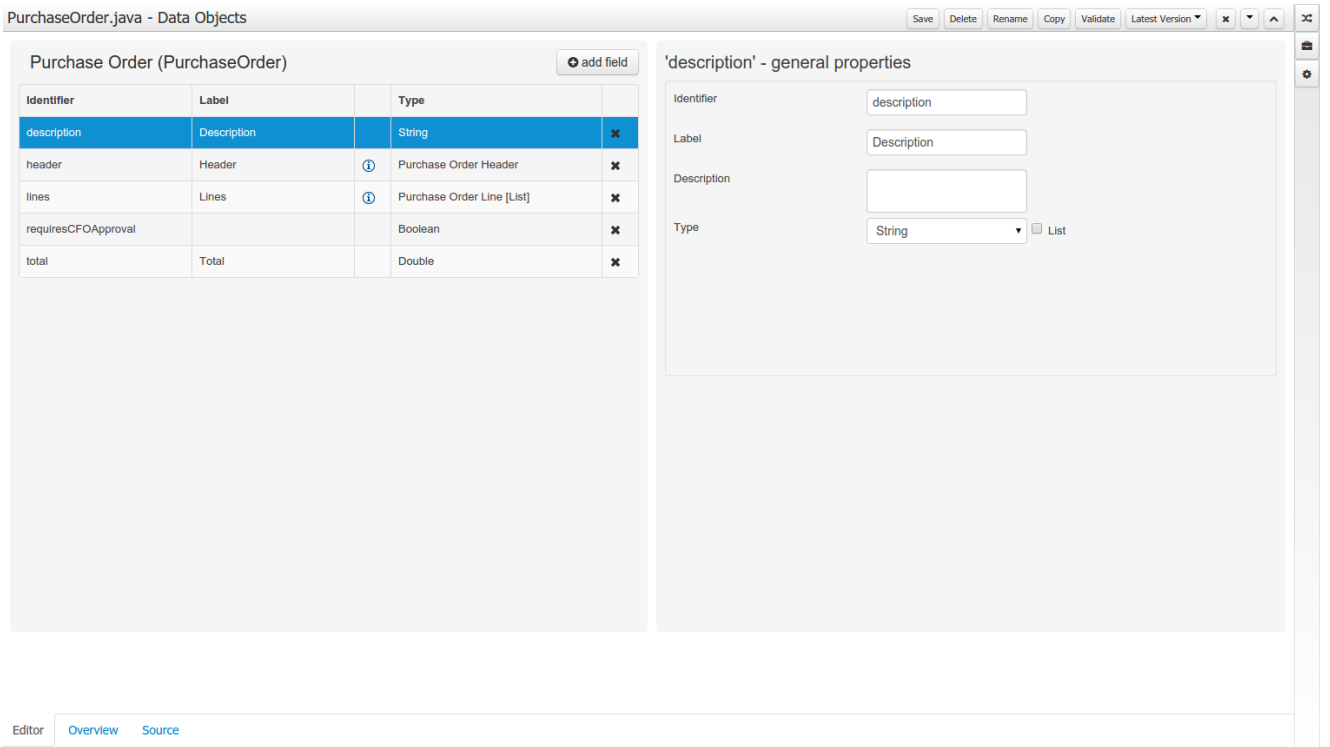


Figure 9.57. Data modeller overview

The "Editor" tab is divided into the following sections:

- The new field section is dedicated to the creation of new fields, and is opened when the "add field" button is pressed.

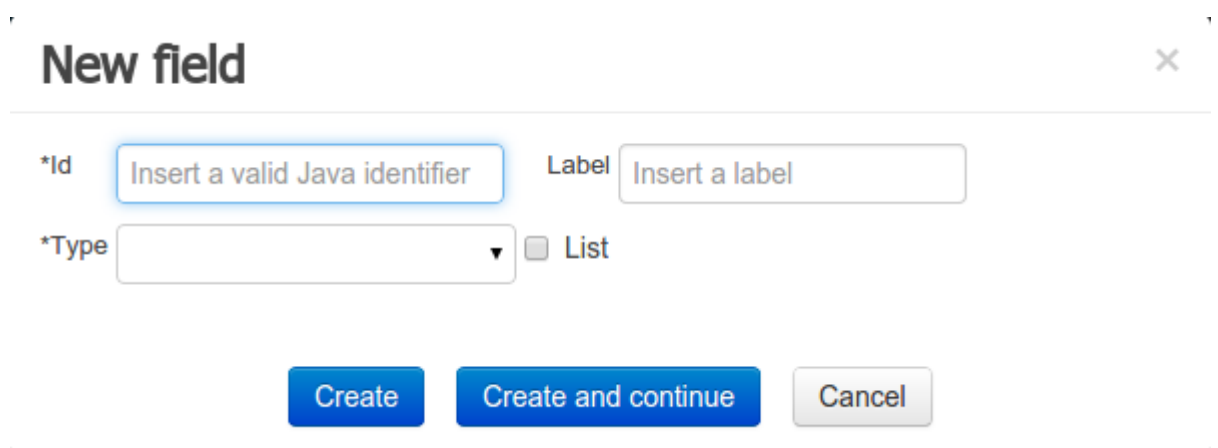


Figure 9.58. New field creation

- The Data Object's "field browser" section displays a list with the data object fields.

Purchase Order (PurchaseOrder) + add field

Identifier	Label		Type	
description	Description		String	✕
header	Header	i	Purchase Order Header	✕
lines	Lines	i	Purchase Order Line [List]	✕
requiresCFOApproval			Boolean	✕
total	Total		Double	✕

Figure 9.59. The Data Object's field browser

- The "Data Object / Field general properties" section. This is the rightmost section of the Data Modeller editor and visualizes the "Data Object" or "Field" general properties, depending on user selection.

Data Object general properties can be selected by clicking on the Data Object Selector.

Purchase Order (PurchaseOrder) + add field

Identifier	Label		Type	
description	Description		String	✕
header	Header	i	Purchase Order Header	✕

Figure 9.60. Data Object selector

'Purchase Order (PurchaseOrder)' - general properties

Identifier	<input type="text" value="PurchaseOrder"/>
Label	<input type="text" value="Purchase Order"/>
Description	<input type="text"/>
Package	<input type="text" value="org.jbpm.examples.purc"/> +
Superclass	<input type="text" value="java.lang.Object"/> ▼

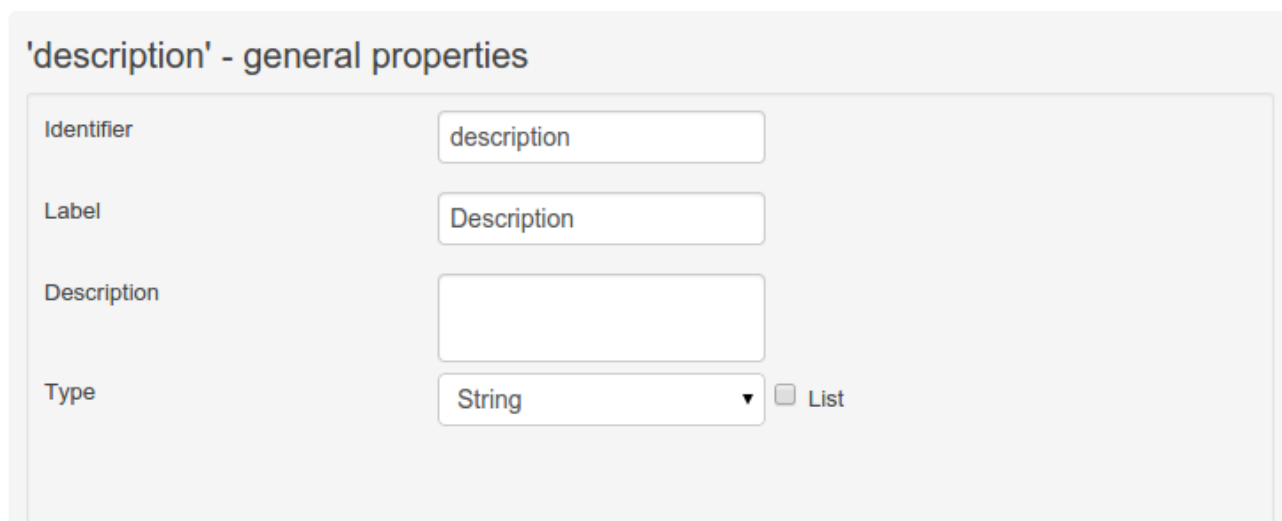
Figure 9.61. Data Object general properties

Field general properties can be selected by clicking on a field.

Purchase Order (PurchaseOrder) + add field

Identifier	Label		Type	
description	Description		String	✕
header	Header	<i>i</i>	Purchase Order Header	✕

Figure 9.62. Field selector



'description' - general properties

Identifier	<input type="text" value="description"/>
Label	<input type="text" value="Description"/>
Description	<input type="text"/>
Type	<input type="text" value="String"/> <input type="checkbox"/> List

Figure 9.63. Field general properties

- On workbench's right side a new "Tool Bar" is provided that enables the selection of different context sensitive tool windows that will let the user do domain specific configurations. Currently three tool windows are provided for the following domains "Drools & jBPM", "Persistence" and "Advanced" configurations.



Figure 9.64. Data modeller Tool Bar

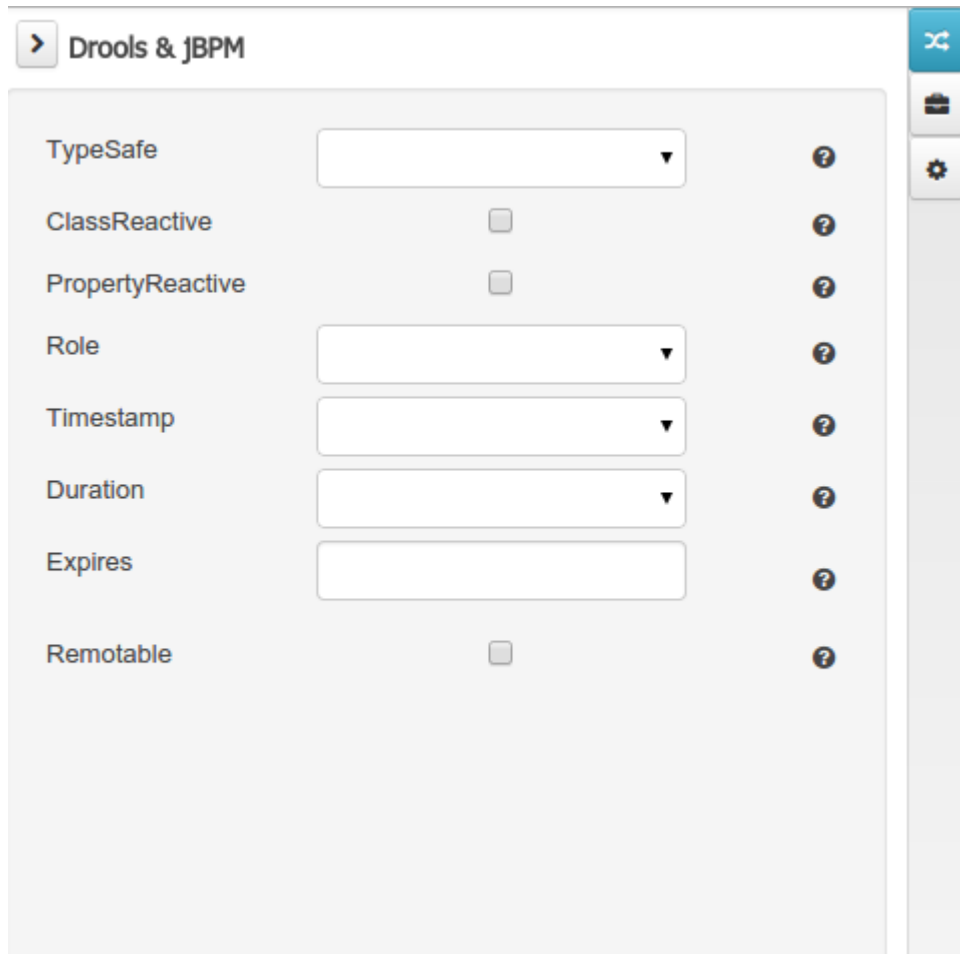


Figure 9.65. Drools & jBPM tool window

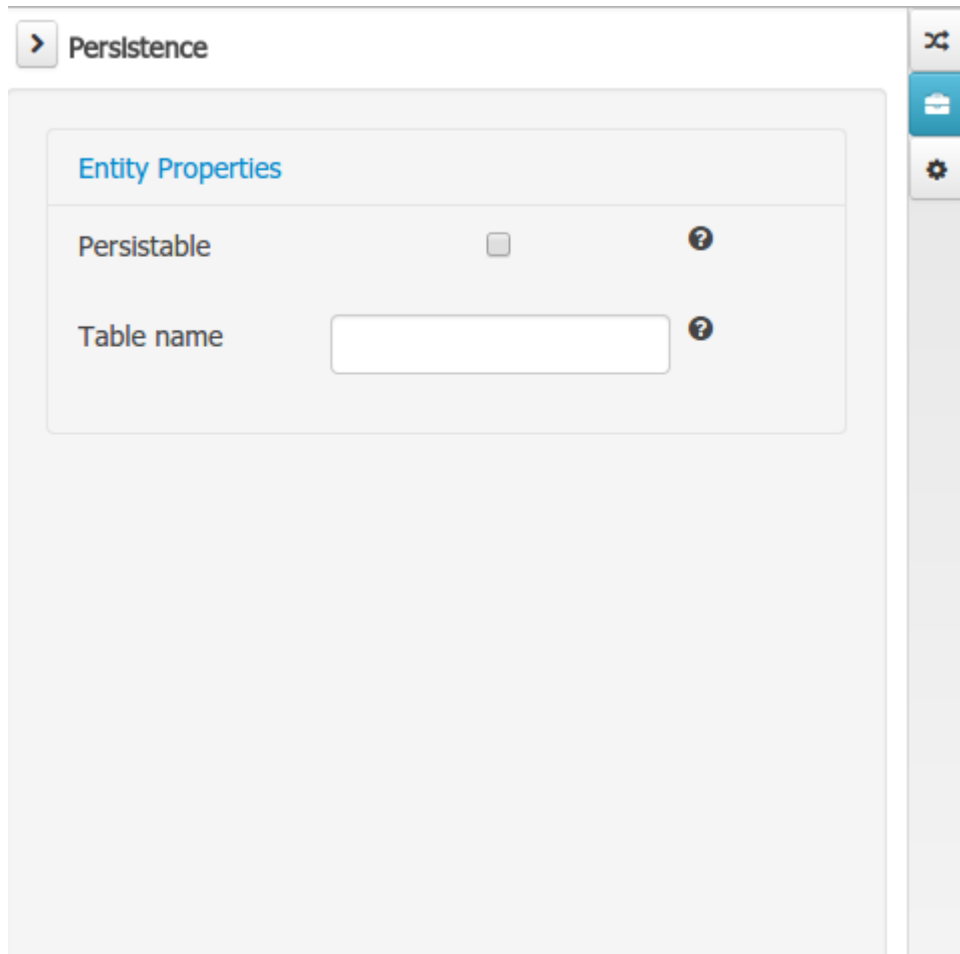


Figure 9.66. Persistence tool window

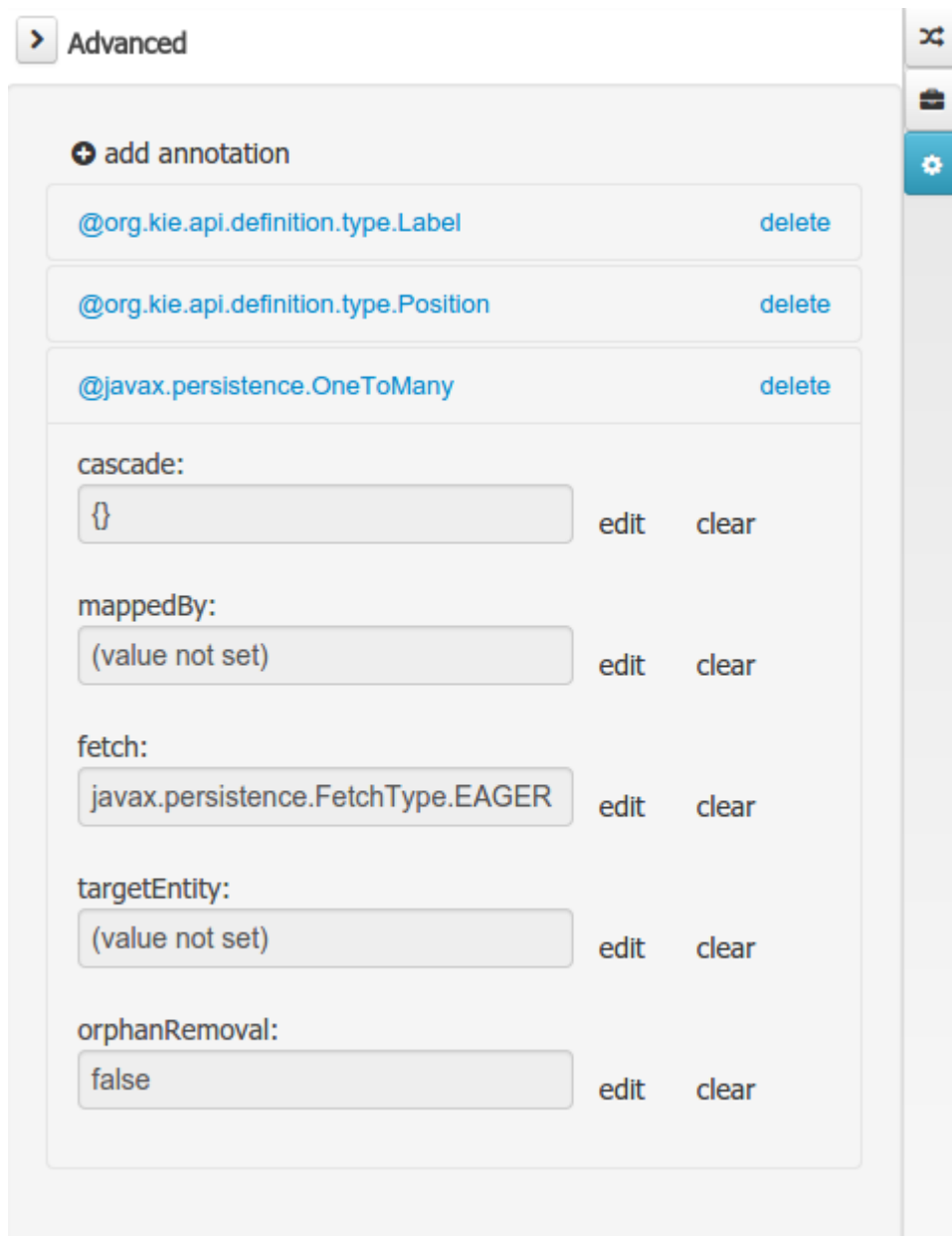
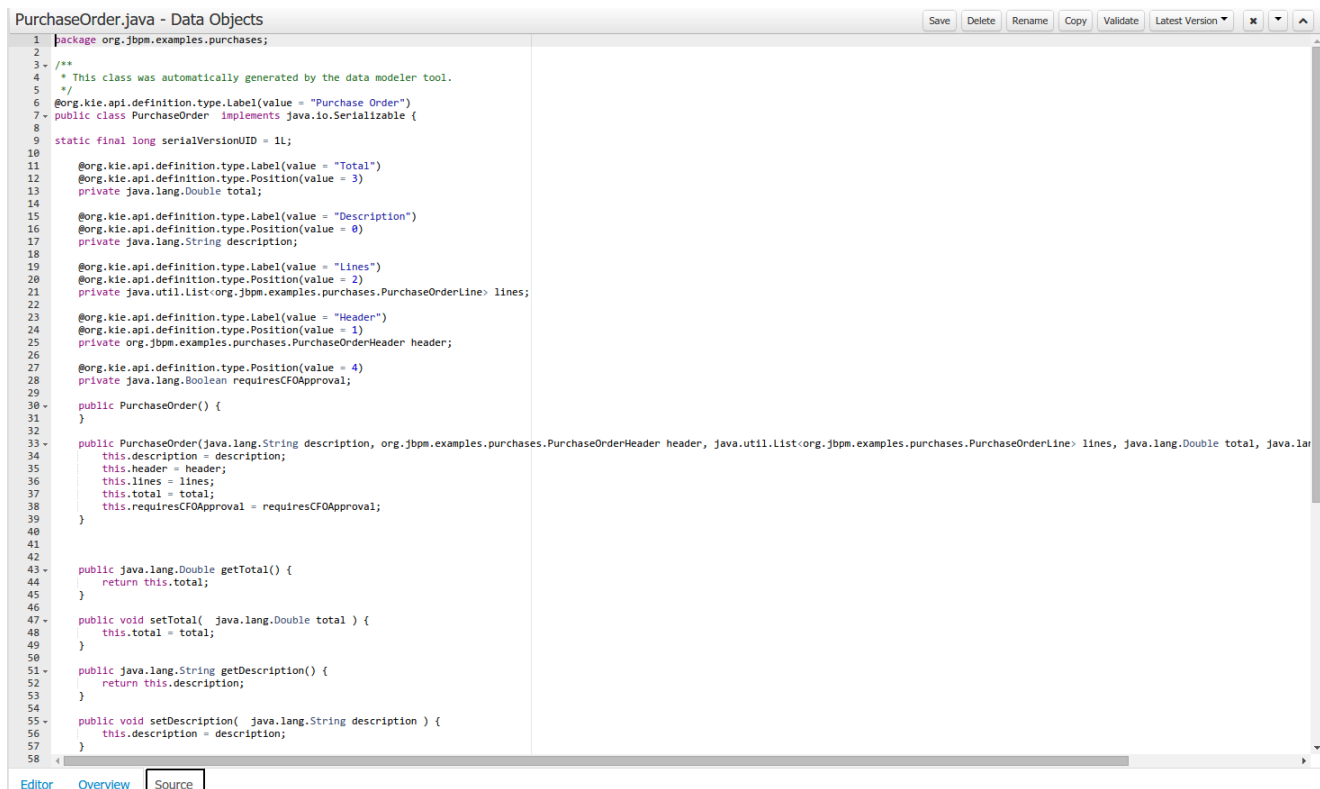


Figure 9.67. Advanced tool window

The "Source" tab shows an editor that allows the visualization and modification of the generated java code.

- Round trip between the "Editor" and "Source" tabs is possible, and also source code preservation is provided. It means that not matter where the Java code was generated (e.g. Eclipse, Data modeller), the data modeller will only update the necessary code blocks to maintain the model updated.



```
1 package org.jbpm.examples.purchases;
2
3 /**
4  * This class was automatically generated by the data modeler tool.
5  */
6 @org.kie.api.definition.type.Label(value = "Purchase Order")
7 public class PurchaseOrder implements java.io.Serializable {
8
9     static final long serialVersionUID = 1L;
10
11     @org.kie.api.definition.type.Label(value = "Total")
12     @org.kie.api.definition.type.Position(value = 3)
13     private java.lang.Double total;
14
15     @org.kie.api.definition.type.Label(value = "Description")
16     @org.kie.api.definition.type.Position(value = 0)
17     private java.lang.String description;
18
19     @org.kie.api.definition.type.Label(value = "Lines")
20     @org.kie.api.definition.type.Position(value = 2)
21     private java.util.List<org.jbpm.examples.purchases.PurchaseOrderLine> lines;
22
23     @org.kie.api.definition.type.Label(value = "Header")
24     @org.kie.api.definition.type.Position(value = 1)
25     private org.jbpm.examples.purchases.PurchaseOrderHeader header;
26
27     @org.kie.api.definition.type.Position(value = 4)
28     private java.lang.Boolean requiresCFOApproval;
29
30     public PurchaseOrder() {
31     }
32
33     public PurchaseOrder(java.lang.String description, org.jbpm.examples.purchases.PurchaseOrderHeader header, java.util.List<org.jbpm.examples.purchases.PurchaseOrderLine> lines, java.lang.Double total, java.lang.Boolean requiresCFOApproval) {
34         this.description = description;
35         this.header = header;
36         this.lines = lines;
37         this.total = total;
38         this.requiresCFOApproval = requiresCFOApproval;
39     }
40
41
42
43     public java.lang.Double getTotal() {
44         return this.total;
45     }
46
47     public void setTotal( java.lang.Double total ) {
48         this.total = total;
49     }
50
51     public java.lang.String getDescription() {
52         return this.description;
53     }
54
55     public void setDescription( java.lang.String description ) {
56         this.description = description;
57     }
58 }
```

Figure 9.68. Source editor

The "Overview" tab shows the standard metadata and version information as the other workbench editors.

9.7.7.2. Data Objects

A data model consists of data objects which are a logical representation of some real-world data. Such data objects have a fixed set of modeller (or application-owned) properties, such as its internal identifier, a label, description, package etc. Besides those, a data object also has a variable set of user-defined fields, which are an abstraction of a real-world property of the type of data that this logical data object represents.

Creating a data object can be achieved using the workbench "New Item - Data Object" menu option.

Create new Data Object ✕

* Data Object

Package

Persistable ?

Figure 9.69. New Data Object menu option

Both resource name and location are mandatory parameters. When the "Ok" button is pressed a new Java file will be created and a new editor instance will be opened for the file edition. The optional "Persistable" attribute will add by default configurations on the data object in order to make it a JPA entity. Use this option if your jBPM project needs to store data object's information in a data base.

9.7.7.3. Properties & relationships

Once the data object has been created, it now has to be completed by adding user-defined properties to its definition. This can be achieved by pressing the "add field" button. The "New Field" dialog will be opened and the new field can be created by pressing the "Create" button. The "Create and continue" button will also add the new field to the Data Object, but won't close the dialog. In this way multiple fields can be created avoiding the popup opening multiple times. The following fields can (or must) be filled out:

- The field's internal identifier (mandatory). The value of this field must be unique per data object, i.e. if the proposed identifier already exists within current data object, an error message will be displayed.
- A label (optional): as with the data object definition, the user can define a user-friendly label for the data object field which is about to be created. This has no further implications on how fields from objects of this data object will be treated. If a label is defined, then this is how the field will be displayed throughout the data modeller tool.
- A field type (mandatory): each data object field needs to be assigned with a type.

This type can be either of the following:

1. A 'primitive java object' type: these include most of the object equivalents of the standard Java primitive types, such as Boolean, Short, Float, etc, as well as String, Date, BigDecimal and BigInteger.

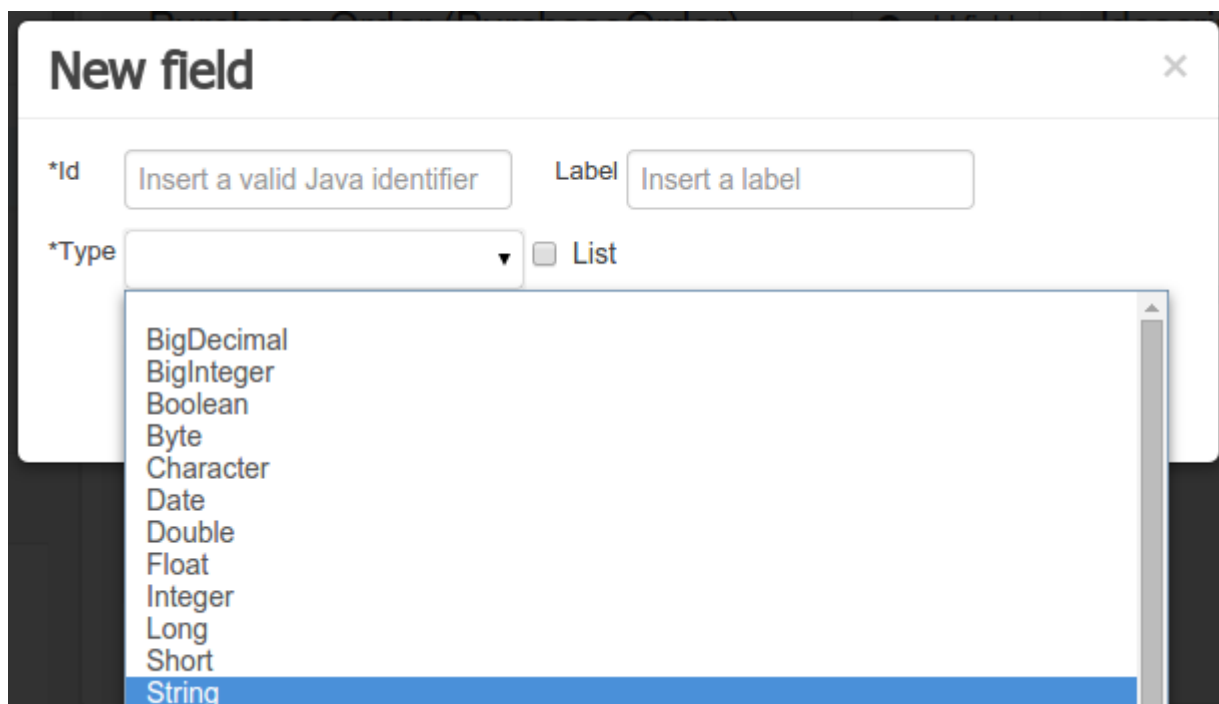


Figure 9.70. Primitive object field types

2. A 'data object' type: any user defined data object automatically becomes a candidate to be defined as a field type of another data object, thus enabling the creation of relationships between them. A data object field can be created either in 'single' or in 'multiple' form, the latter implying that the field will be defined as a collection of this type, which will be indicated by selecting "List" checkbox.

```
Purchase Order (org.jbpm.examples.purchases.PurchaseOrder)
Purchase Order Header (org.jbpm.examples.purchases.PurchaseOrderHeader)
Purchase Order Line (org.jbpm.examples.purchases.PurchaseOrderLine)
```

Figure 9.71. Data object field types

3. A 'primitive java' type: these include java primitive types byte, short, int, long, float, double, char and boolean.



Figure 9.72. Primitive field types

When finished introducing the initial information for a new field, clicking the 'Create' button will add the newly created field to the end of the data object's fields table below:

Purchase Order (PurchaseOrder) + add field

Identifier	Label		Type	
description	Description		String	✕
header	Header	i	Purchase Order Header	✕
lines	Lines	i	Purchase Order Line [List]	✕
requiresCFOApproval			Boolean	✕
total	Total		Double	✕
newField	New Field		String	✕

'newField' - general properties

Identifier:

Label:

Description:

Type: List

Figure 9.73. New field has been created

The new field will also automatically be selected in the data object's field list, and its properties will be shown in the Field general properties editor. Additionally the field properties will be loaded in the different tool windows, in this way the field will be ready for edition in whatever selected tool window.

At any time, any field (without restrictions) can be deleted from a data object definition by clicking on the corresponding 'x' icon in the data object's fields table.

9.7.7.4. Additional options

As stated before, both Data Objects as well as Fields require some of their initial properties to be set upon creation. Additionally there are three domains of properties that can be configured for a given Data Object. A domain is basically a set of properties related to a given business area.

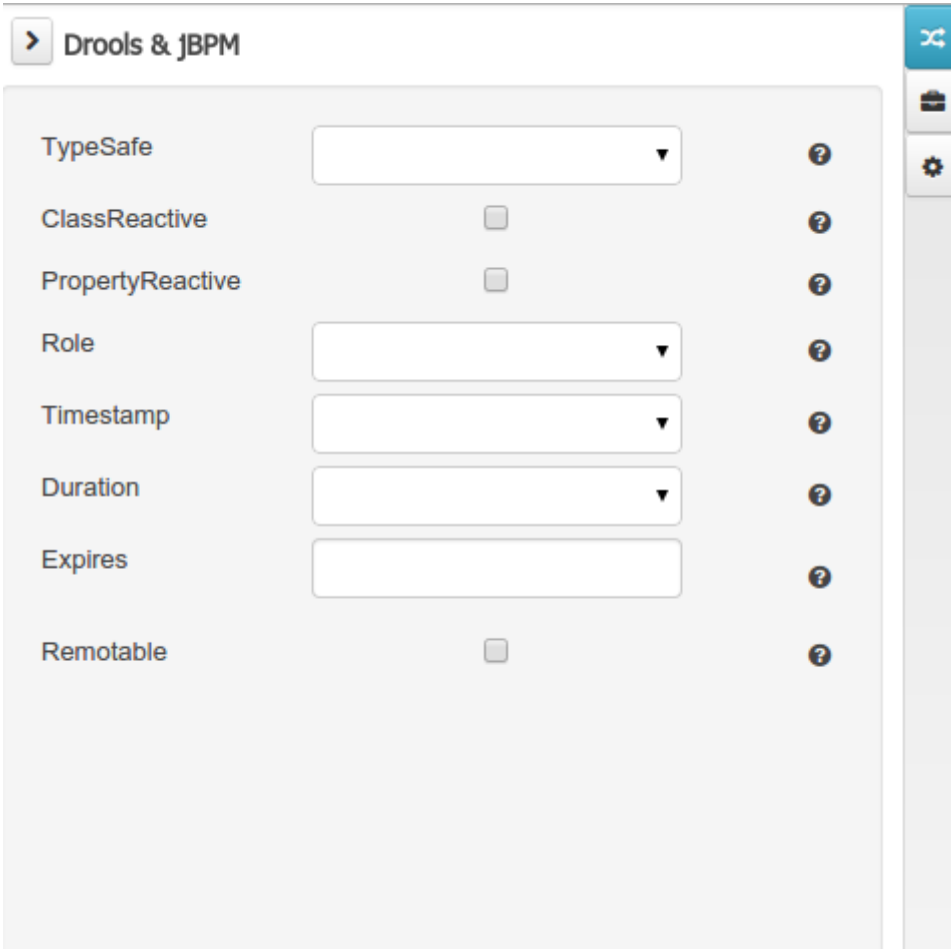
Current available domains are, "Drools & jBPM", "Persistence" and the "Advanced" domain. To work on a given domain the user should select the corresponding "Tool window" (see below) on the right side toolbar. Every tool window usually provides two editors, the "Data Object" level editor and the "Field" level editor, that will be shown depending on the last selected item, the Data Object or the Field.

9.7.7.4.1. Drools & jBPM domain

The Drools & jBPM domain editors manages the set of Data Object or Field properties related to drools applications.

9.7.7.4.1.1. Drools & jBPM object editor

The Drools & jBPM object editor manages the object level drools properties



The screenshot displays the "Drools & jBPM" tool window. It features a list of properties for a data object, each with a control element and a help icon (question mark). The properties are:

- TypeSafe: A dropdown menu.
- ClassReactive: A checkbox.
- PropertyReactive: A checkbox.
- Role: A dropdown menu.
- Timestamp: A dropdown menu.
- Duration: A dropdown menu.
- Expires: A text input field.
- Remotable: A checkbox.

On the right side of the window, there is a vertical toolbar with icons for undo, redo, and settings.

Figure 9.74. The data object's properties

- TypeSafe: this property allows to enable/disable the type safe behaviour for current type. By default all type declarations are compiled with type safety enabled. (See Drools for more information on this matter).

- **ClassReactive:** this property allows to mark this type to be treated as "Class Reactive" by the Drools engine. (See Drools for more information on this matter).
- **PropertyReactive:** this property allows to mark this type to be treated as "Property Reactive" by the Drools engine. (See Drools for more information on this matter).
- **Role:** this property allows to configure how the Drools engine should handle instances of this type: either as regular facts or as events. By default all types are handled as a regular fact, so for the time being the only value that can be set is "Event" to declare that this type should be handled as an event. (See Drools Fusion for more information on this matter).
- **Timestamp:** this property allows to configure the "timestamp" for an event, by selecting one of his attributes. If set the engine will use the timestamp from the given attribute instead of reading it from the Session Clock. If not, the engine will automatically assign a timestamp to the event. (See Drools Fusion for more information on this matter).
- **Duration:** this property allows to configure the "duration" for an event, by selecting one of his attributes. If set the engine will use the duration from the given attribute instead of using the default event duration = 0. (See Drools Fusion for more information on this matter).
- **Expires:** this property allows to configure the "time offset" for an event expiration. If set, this value must be a temporal interval in the form: [#d][#h][#m][#s][#[ms]] Where [] means an optional parameter and # means a numeric value. e.g.: 1d2h, means one day and two hours. (See Drools Fusion for more information on this matter).
- **Remotable:** If checked this property makes the Data Object available to be used with jBPM remote services as REST, JMS and WS. (See jBPM for more information on this matter).

9.7.7.4.1.2. Drools & jBPM field editor

The Drools & jBPM object editor manages the field level drools properties

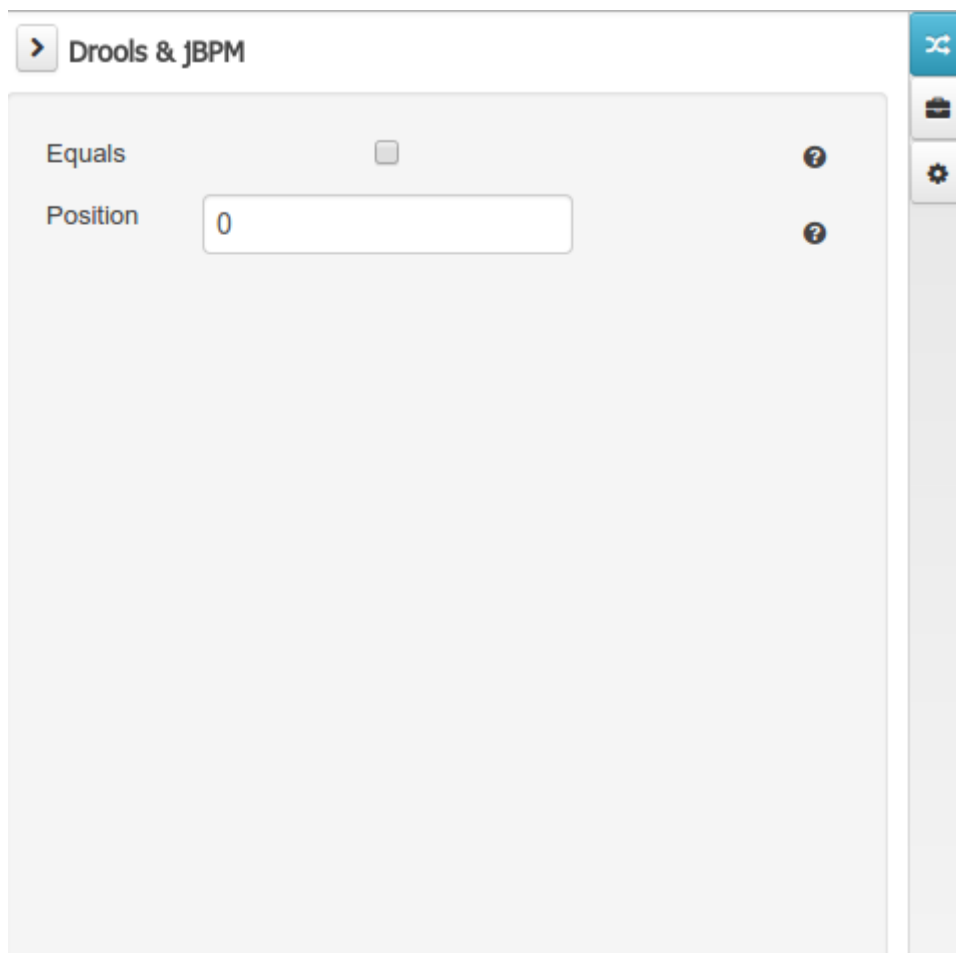


Figure 9.75. The data object's field properties

- **Equals:** checking this property for a Data Object field implies that it will be taken into account, at the code generation level, for the creation of both the `equals()` and `hashCode()` methods in the generated Java class. We will explain this in more detail in the following section.
- **Position:** this field requires a zero or positive integer. When set, this field will be interpreted by the Drools engine as a positional argument (see the section below and also the Drools documentation for more information on this subject).

9.7.7.4.2. Persistence domain

The Persistence domain editors manages the set of Data Object or Field properties related to persistence.

9.7.7.4.2.1. Persistence domain object editor

Persistence domain object editor manages the object level persistence properties

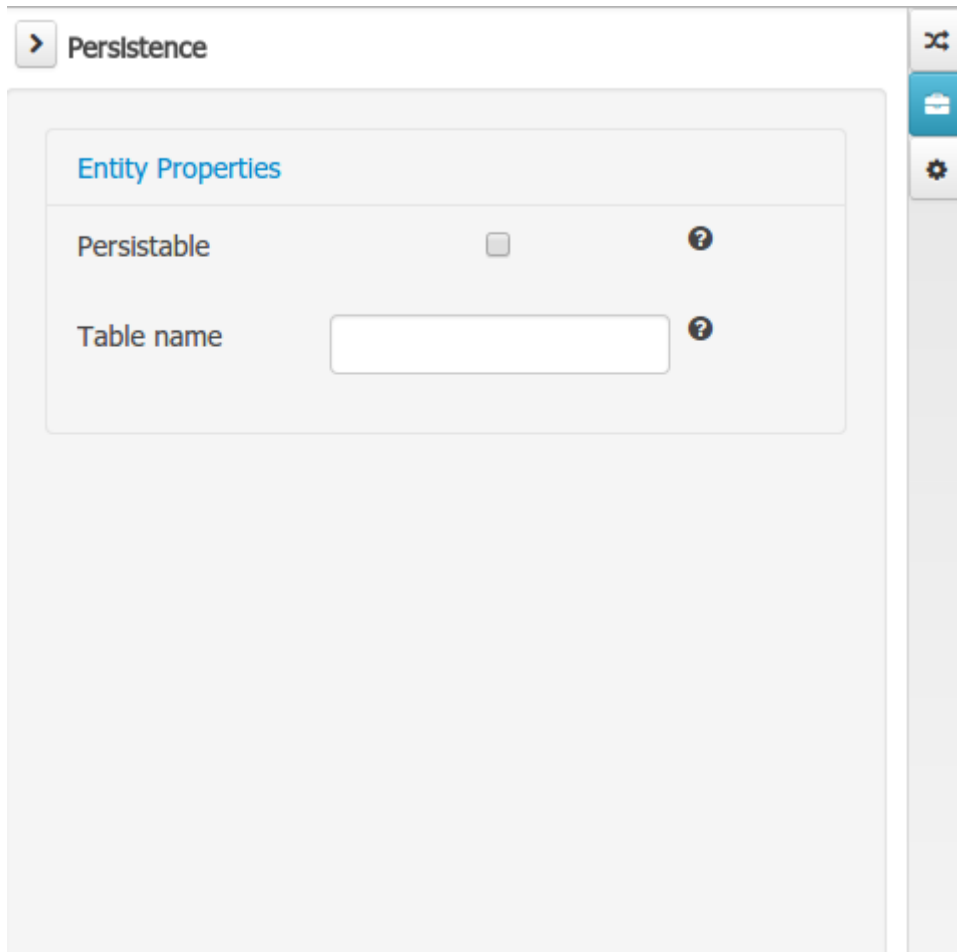


Figure 9.76. The data object's properties

- Persistable: this property allows to configure current Data Object as persistable.
- Table name: this property allows to set a user defined database table name for current Data Object.

9.7.7.4.2.2. Persistence domain field editor

The persistence domain field editor manages the field level persistence properties and is divided in three sections.

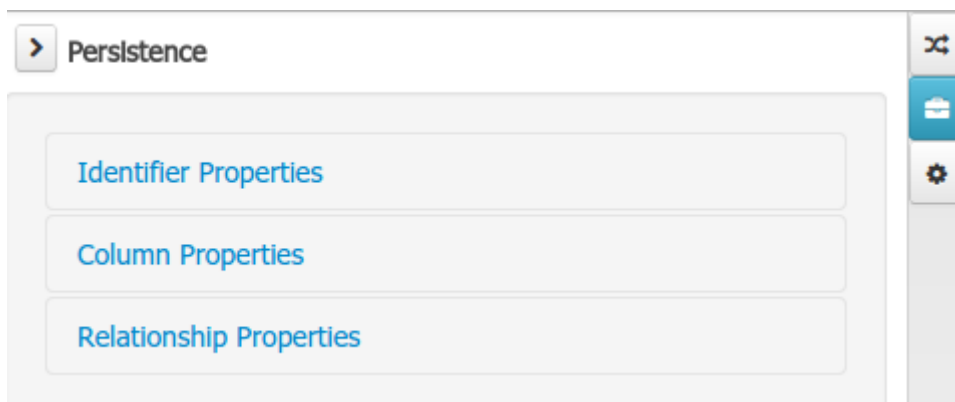


Figure 9.77. Persistence domain field editor sections

9.7.7.4.2.2.1. Identifier:

Identifier Properties	
Is Identifier	<input type="checkbox"/>
Generation strategy	NONE
Sequence Generator	NOT_SET

A persistable Data Object should have one and only one field defined as the Data Object identifier. The identifier is typically a unique number that distinguishes a given Data Object instance from all other instances of the same class.

- **Is Identifier:** marks current field as the Data Object identifier. A persistable Data Object should have one and only one field marked as identifier, and it should be a base java type, like String, Integer, Long, etc. A field that references a Data Object, or is a multiple field can not be marked as identifier. And also composite identifiers are not supported in this version. When a persistable Data Object is created an identifier field is created by default with the properly initializations, it's strongly recommended to use this identifier.
- **Generation Strategy:** the generation strategy establishes how the identifier values will be automatically generated when the Data Object instances are created and stored in a database. (e.g. by the forms associated to jBPM processes human tasks.) When the by default Identifier field is created, the generation strategy will be also automatically set and it's strongly recommended to use this configuration.

- Sequence Generator: the generator represents the seed for the values that will be used by the Generation Strategy. When the by default Identifier field is created the Sequence Generator will be also automatically generated and properly configured to be used by the Generation Strategy.

9.7.7.4.2.2.2. Column Properties:

The column properties section enables the customization of some properties of the database column that will store the field value.

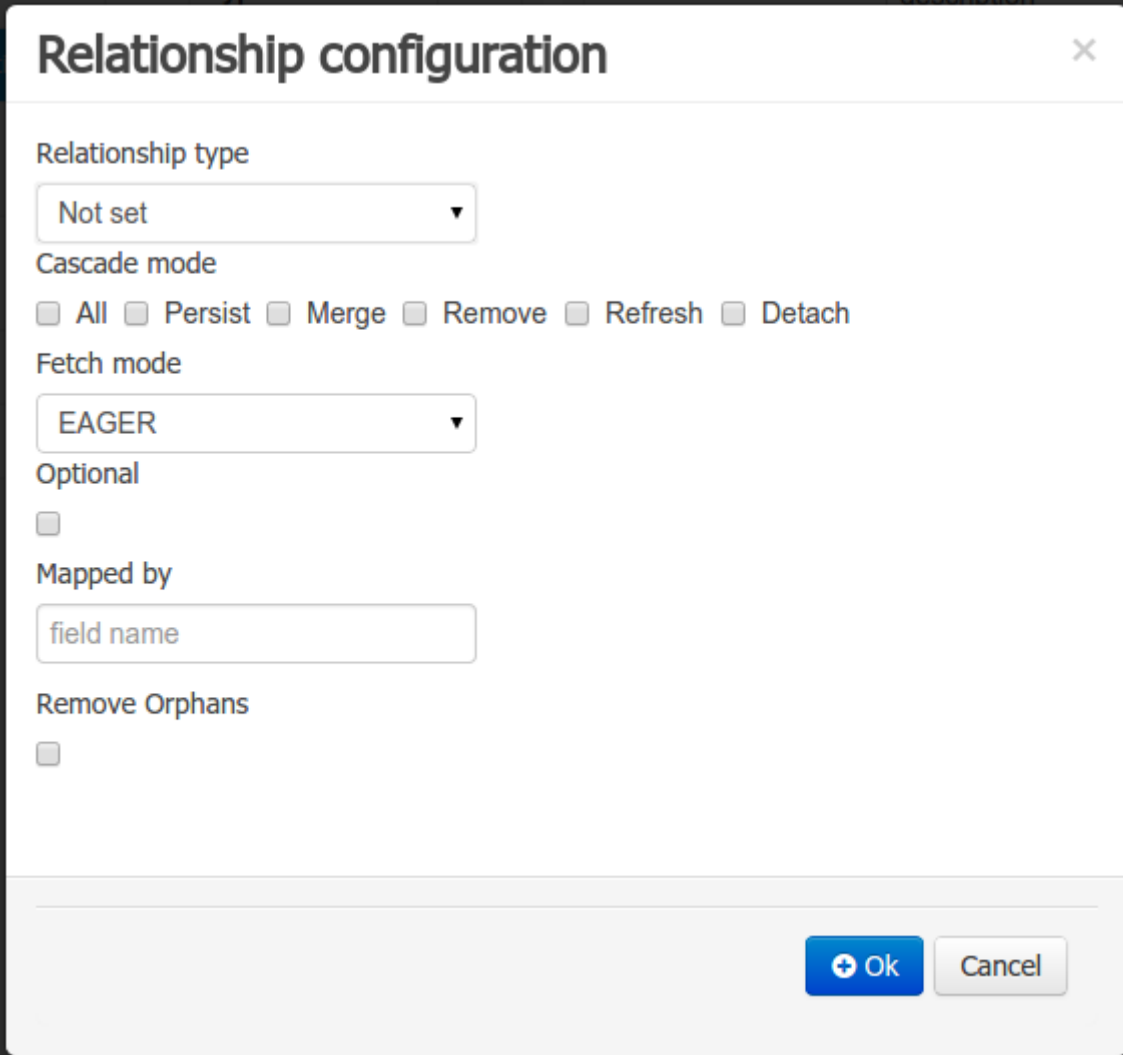
Column Properties	
Column name	<input type="text"/>
Unique	<input type="checkbox"/>
Nullable	<input checked="" type="checkbox"/>
Insertable	<input checked="" type="checkbox"/>
Updatable	<input checked="" type="checkbox"/>

- Column name: optional value that sets the database column name for the given field.
- Unique: When checked the unique property establishes that current field value should be a unique key when stored in the database. (if not set the default value is false)
- Nullable: When checked establishes that current field value can be null when stored in a database. (if not set the default value is true)
- Insertable: When checked establishes that column will be included in SQL INSERT statements generated by the persistence provider. (if not set the default value is true)
- Updatable: When checked establishes that the column will be included SQL UPDATE statements generated by the persistence provider. (if not set the default value is true)

9.7.7.4.2.2.3. Relationship Properties:

Relationship Properties	
Relationship Type	<input type="text" value="NOT_SELECTED"/>

When the field's type is a Data Object type, or a list of a Data Object type a relationship type should be set in order to let the persistence provider to manage the relation. Fortunately this relation type is automatically set when such kind of fields are added to an already marked as persistable Data Object. The relationship type is set by the following popup.



Relationship configuration

Relationship type
Not set

Cascade mode
 All Persist Merge Remove Refresh Detach

Fetch mode
EAGER

Optional

Mapped by
field name

Remove Orphans

Ok Cancel

Figure 9.78. Relationship configuration popup

- Relationship type: sets the type of relation from one of the following options:

One to one: typically used for 1:1 relations where "A is related to one instance of B", and B exists only when A exists. e.g. PurchaseOrder -> PurchaseOrderHeader (a PurchaseOrderHeader exists only if the PurchaseOrder exists)

One to many: typically used for 1:N relations where "A is related to N instances of B", and the related instances of B exists only when A exists. e.g. PurchaseOrder -> PurchaseOrderLine (a PurchaseOrderLine exists only if the PurchaseOrder exists)

Many to one: typically used for 1:1 relations where "A is related to one instance of B", and B can exist even without A. e.g. PurchaseOrder -> Client (a Client can exist in the database even without an associated PurchaseOrder)

Many to many: typically used for N:N relations where "A can be related to N instances of B, and B can be related to M instances of A at the same time", and both B and A instances can exist in the database independently of the related instances. e.g. Course -> Student. (Course can be related to N Students, and a given Student can attend to M courses)

When a field of type "Data Object" is added to a given persistable Data Object, the "Many to One" relationship type is generated by default.

And when a field of type "list of Data Object" is added to a given persistable Data Object, the "One to Many" relationship is generated by default.

- Cascade mode: Defines the set of cascadable operations that are propagated to the associated entity. The value cascade=ALL is equivalent to cascade={PERSIST, MERGE, REMOVE, REFRESH}. e.g. when A -> B, and cascade "PERSIST or ALL" is set, if A is saved, then B will be also saved.

The by default cascade mode created by the data modeller is "ALL" and it's strongly recommended to use this mode when Data Objects are being used by jBPM processes and forms.

- Fetch mode: Defines how related data will be fetched from database at reading time.

EAGER: related data will be read at the same time. e.g. If A -> B, when A is read from database B will be read at the same time.

LAZY: reading of related data will be delayed usually to the moment they are required. e.g. If PurchaseOrder -> PurchaseOrderLine the lines reading will be postponed until a method "getLines()" is invoked on a PurchaseOrder instance.

The default fetch mode created by the data modeller is "EAGER" and it's strongly recommended to use this mode when Data Objects are being used by jBPM processes and forms.

- Optional: establishes if the right side member of a relationship can be null.
- Mapped by: used for reverse relations.

9.7.7.4.3. Advanced domain

The advanced domain enables the configuration of whatever parameter set by the other domains as well as the adding of arbitrary parameters. As it will be shown in the code generation section every "Data Object / Field" parameter is represented by a java annotation. The advanced mode enables the configuration of these annotations.

9.7.7.4.3.1. Advanced domain Data Object / Field editor.

The advanced domain editor has the same shape for both Data Object and Field.

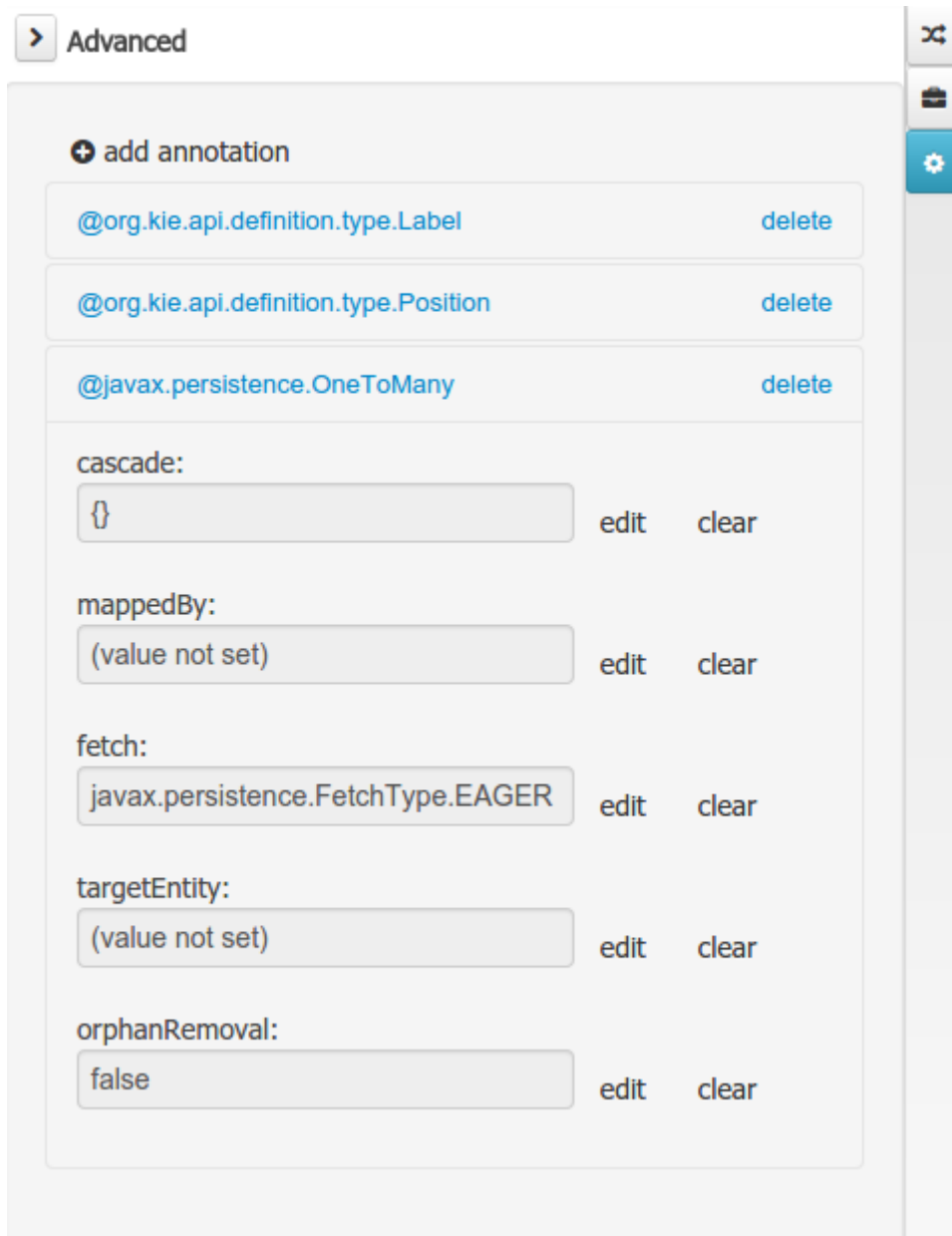


Figure 9.79. Advanced domain editor.

The following operations are available

- delete: enables the deletion of a given Data Object or Field annotation.
- clear: clears a given annotation parameter value.
- edit: enables the edition of a given annotation parameter value.
- add annotation: The add annotation button will start a wizard that will let the addition of whatever java annotation available in the project dependencies.

Add annotation wizard step #1: the first step of the wizard requires the entering of a fully qualified class name of an annotation, and by pressing the "search" button the annotation definition will be loaded into the wizard. Additionally when the annotation definition is loaded, different wizard steps will be created in order to enable the completion of the different annotation parameters. Required parameters will be marked with "*".

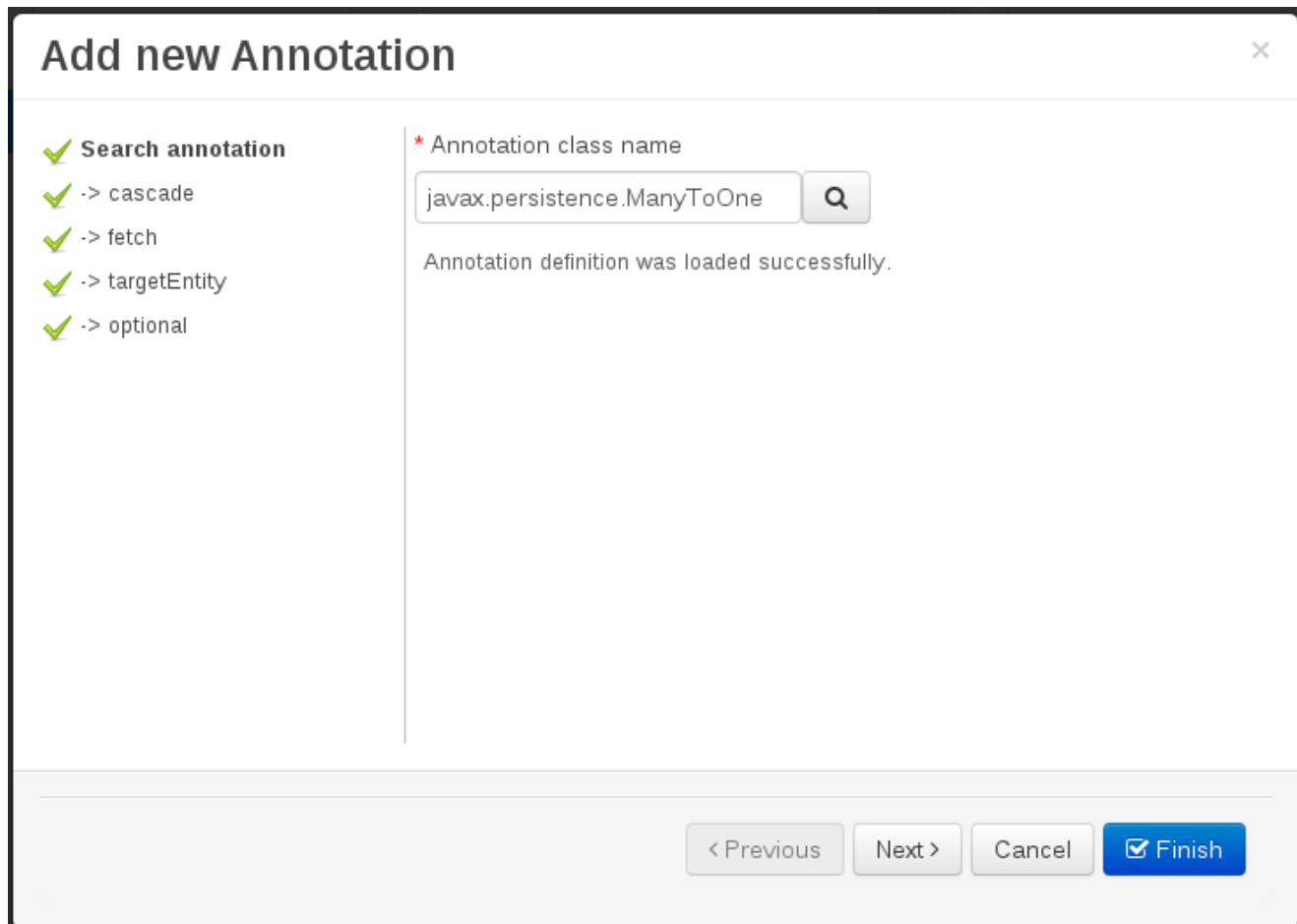


Figure 9.80. Annotation definition loaded into the wizard.

Whenever it's possible the wizard will provide a suitable editor for the given parameters.

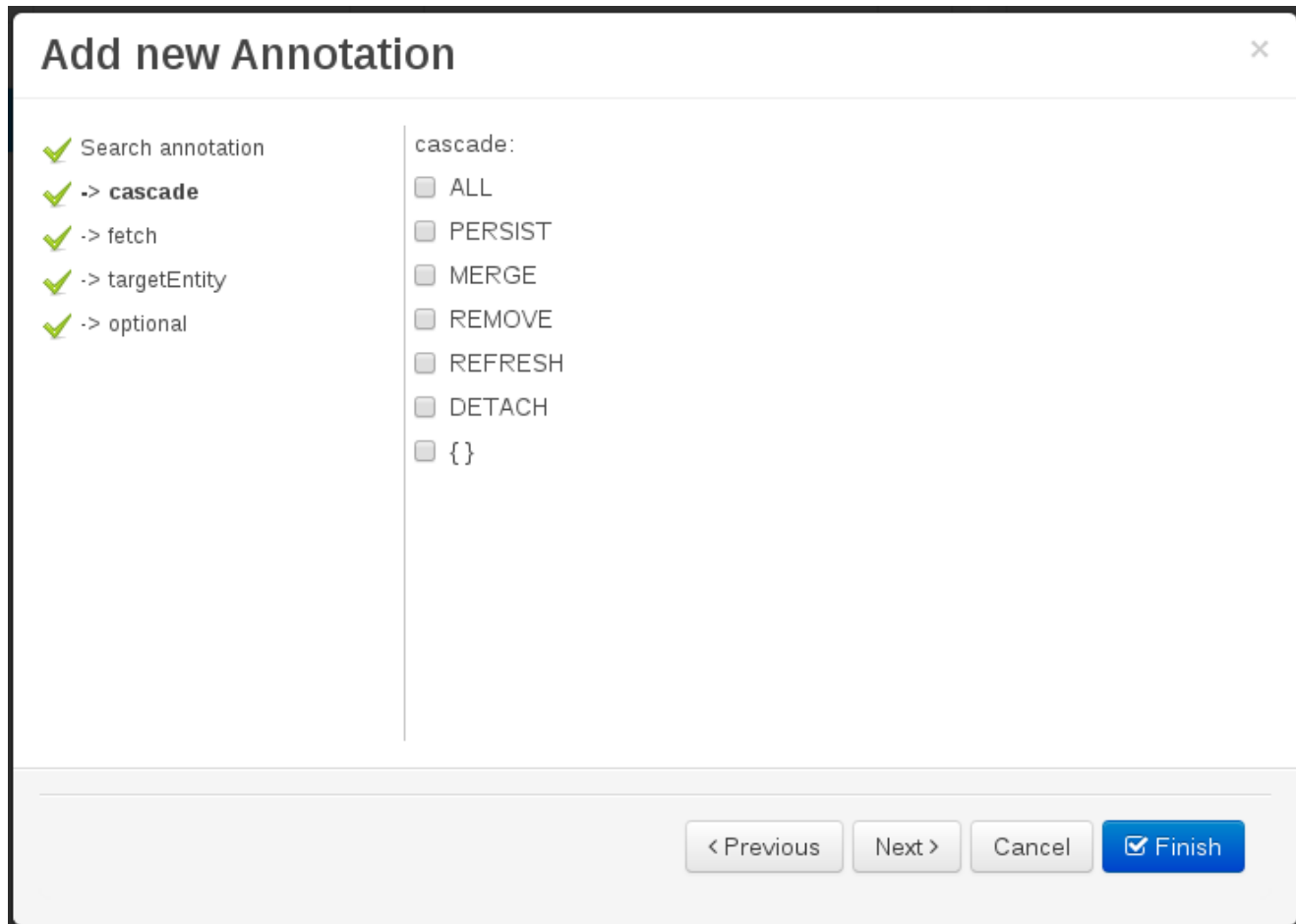


Figure 9.81. Automatically generated enum values editor for an Enumeration annotation parameter.

A generic parameter editor will be provided when it's not possible to calculate a customized editor

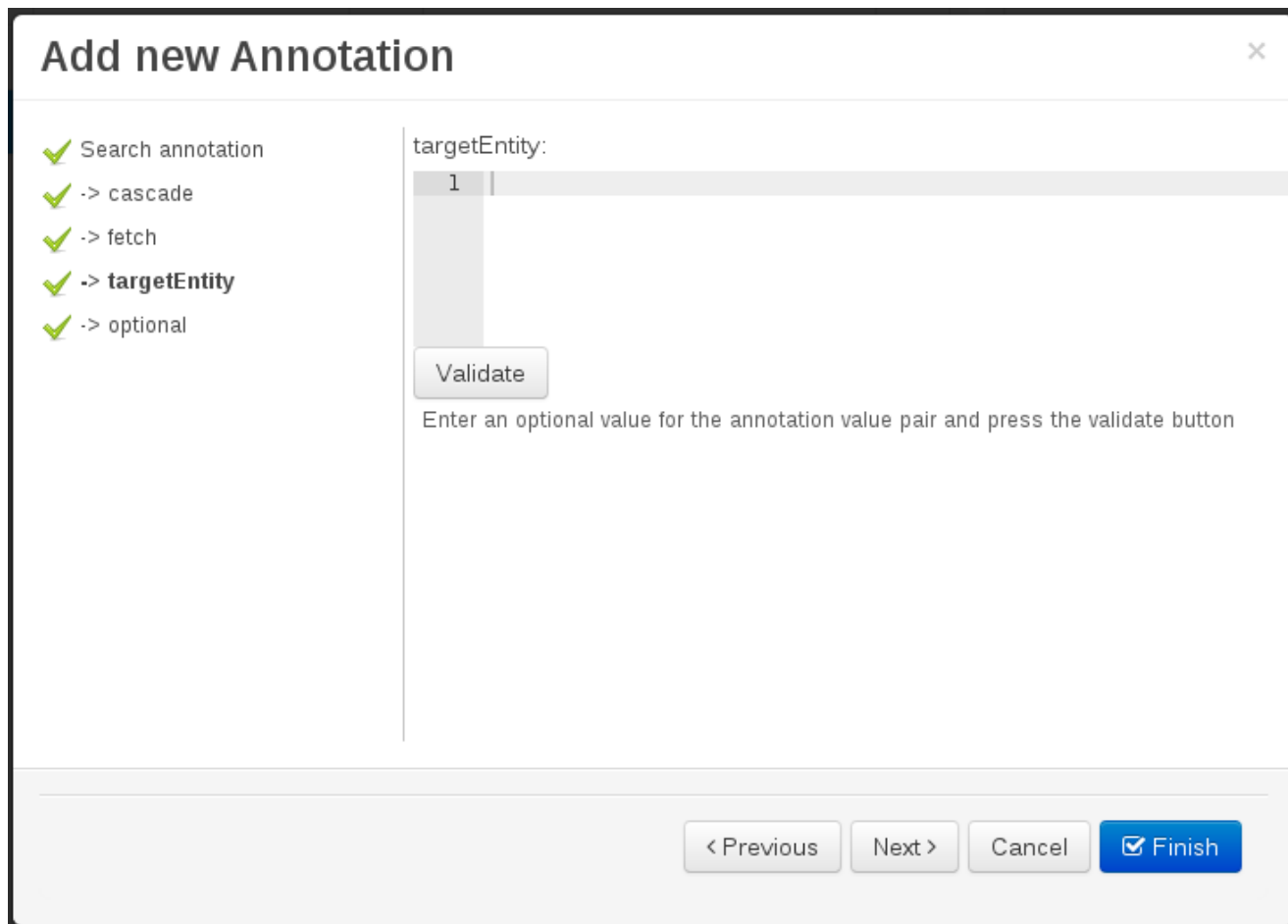


Figure 9.82. Generic annotation parameter editor

When all required parameters has been entered and validated, the finish button will be enabled and the wizard can be completed by adding the annotation to the given Data Object or Field.

9.7.7.5. Generate data model code.

The data model in itself is merely a visual tool that allows the user to define high-level data structures, for them to interact with the Drools Engine on the one hand, and the jBPM platform on the other. In order for this to become possible, these high-level visual structures have to be transformed into low-level artifacts that can effectively be consumed by these platforms. These artifacts are Java POJOs (Plain Old Java Objects), and they are generated every time the data model is saved, by pressing the "Save" button in the top Data Modeller Menu. Additionally when the user round trip between the "Editor" and "Source" tab, the code is auto generated to maintain the consistency with the Editor view and vice versa.

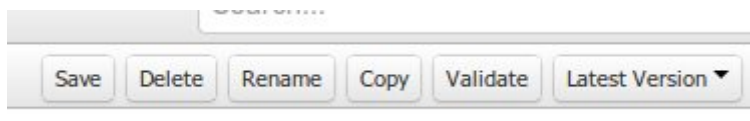


Figure 9.83. Save the data model from the top menu

The resulting code is generated according to the following transformation rules:

- The data object's identifier property will become the Java class's name. It therefore needs to be a valid Java identifier.
- The data object's package property becomes the Java class's package declaration.
- The data object's superclass property (if present) becomes the Java class's extension declaration.
- The data object's label and description properties will translate into the Java annotations "@org.kie.api.definition.type.Label" and "@org.kie.api.definition.type.Description", respectively. These annotations are merely a way of preserving the associated information, and as yet are not processed any further.
- The data object's role property (if present) will be translated into the "@org.kie.api.definition.type.Role" Java annotation, that *IS* interpreted by the application platform, in the sense that it marks this Java class as a Drools Event Fact-Type.
- The data object's type safe property (if present) will be translated into the "@org.kie.api.definition.type.TypeSafe" Java annotation. (see Drools)
- The data object's class reactive property (if present) will be translated into the "@org.kie.api.definition.type.ClassReactive" Java annotation. (see Drools)
- The data object's property reactive property (if present) will be translated into the "@org.kie.api.definition.type.PropertyReactive" Java annotation. (see Drools)
- The data object's timestamp property (if present) will be translated into the "@org.kie.api.definition.type.Timestamp" Java annotation. (see Drools)
- The data object's duration property (if present) will be translated into the "@org.kie.api.definition.type.Duration" Java annotation. (see Drools)
- The data object's expires property (if present) will be translated into the "@org.kie.api.definition.type.Expires" Java annotation. (see Drools)
- The data object's remotable property (if present) will be translated into the "@org.kie.api.remote.Remotable" Java annotation. (see jBPM)

A standard Java default (or no parameter) constructor is generated, as well as a full parameter constructor, i.e. a constructor that accepts as parameters a value for each of the data object's user-defined fields.

The data object's user-defined fields are translated into Java class fields, each one of them with its own getter and setter method, according to the following transformation rules:

- The data object field's identifier will become the Java field identifier. It therefore needs to be a valid Java identifier.
- The data object field's type is directly translated into the Java class's field type. In case the field was declared to be multiple (i.e. 'List'), then the generated field is of the "java.util.List" type.
- The equals property: when it is set for a specific field, then this class property will be annotated with the "@org.kie.api.definition.type.Key" annotation, which is interpreted by the Drools Engine, and it will 'participate' in the generated equals() method, which overwrites the equals() method of the Object class. The latter implies that if the field is a 'primitive' type, the equals method will simply compares its value with the value of the corresponding field in another instance of the class. If the field is a sub-entity or a collection type, then the equals method will make a method-call to the equals method of the corresponding data object's Java class, or of the java.util.List standard Java class, respectively.

If the equals property is checked for *ANY* of the data object's user defined fields, then this also implies that in addition to the default generated constructors another constructor is generated, accepting as parameters all of the fields that were marked with Equals. Furthermore, generation of the equals() method also implies that also the Object class's hashCode() method is overwritten, in such a manner that it will call the hashCode() methods of the corresponding Java class types (be it 'primitive' or user-defined types) for all the fields that were marked with Equals in the Data Model.

- The position property: this field property is automatically set for all user-defined fields, starting from 0, and incrementing by 1 for each subsequent new field. However the user can freely changes the position among the fields. At code generation time this property is translated into the "@org.kie.api.definition.type.Position" annotation, which can be interpreted by the Drools Engine. Also, the established property order determines the order of the constructor parameters in the generated Java class.

As an example, the generated Java class code for the Purchase Order data object, corresponding to its definition as shown in the following figure `purchase_example.jpg` is visualized in the figure at the bottom of this chapter. Note that the two of the data object's fields, namely 'header' and 'lines' were marked with Equals, and have been assigned with the positions 2 and 1, respectively).

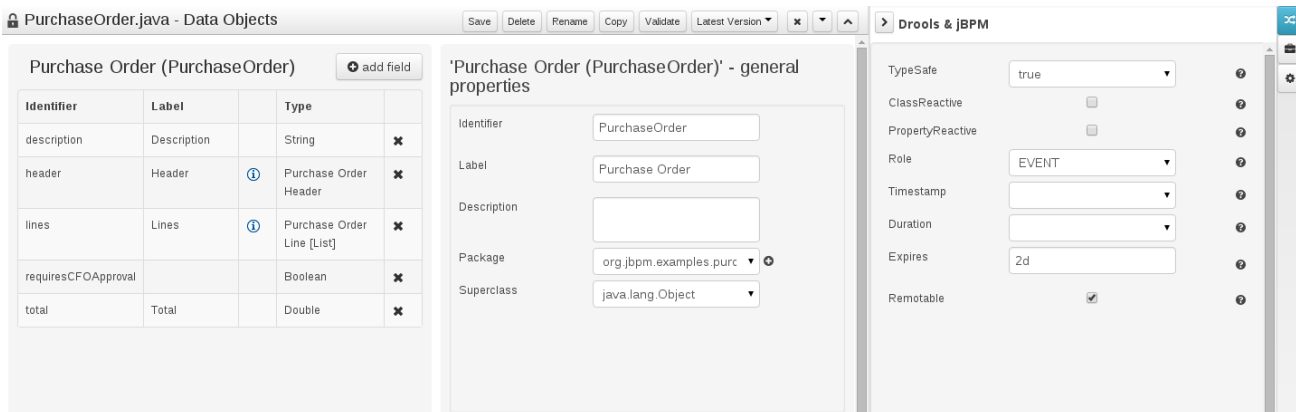


Figure 9.84. Purchase Order configuration

```

package org.jbpm.examples.purchases;

/**
 * This class was automatically generated by the data modeler tool.
 */
@org.kie.api.definition.type.Label("Purchase Order")
@org.kie.api.definition.type.TypeSafe(true)
@org.kie.api.definition.type.Role(org.kie.api.definition.type.Role.Type.EVENT)
@org.kie.api.definition.type.Expires("2d")
@org.kie.api.remote.Remotable
public class PurchaseOrder implements java.io.Serializable
{

    static final long serialVersionUID = 1L;

    @org.kie.api.definition.type.Label("Total")
    @org.kie.api.definition.type.Position(3)
    private java.lang.Double total;

    @org.kie.api.definition.type.Label("Description")
    @org.kie.api.definition.type.Position(0)
    private java.lang.String description;

    @org.kie.api.definition.type.Label("Lines")
    @org.kie.api.definition.type.Position(2)
    @org.kie.api.definition.type.Key
    private java.util.List<org.jbpm.examples.purchases.PurchaseOrderLine> lines;

    @org.kie.api.definition.type.Label("Header")
    @org.kie.api.definition.type.Position(1)
    @org.kie.api.definition.type.Key
    private org.jbpm.examples.purchases.PurchaseOrderHeader header;

    @org.kie.api.definition.type.Position(4)
    private java.lang.Boolean requiresCFOApproval;

    public PurchaseOrder()

```

```
{
}

public java.lang.Double getTotal()
{
return this.total;
}

public void setTotal(java.lang.Double total)
{
this.total = total;
}

public java.lang.String getDescription()
{
return this.description;
}

public void setDescription(java.lang.String description)
{
this.description = description;
}

public java.util.List<org.jbpm.examples.purchases.PurchaseOrderLine> getLines()
{
return this.lines;
}

public void setLines(java.util.List<org.jbpm.examples.purchases.PurchaseOrderLine> lines)
{
this.lines = lines;
}

public org.jbpm.examples.purchases.PurchaseOrderHeader getHeader()
{
return this.header;
}

public void setHeader(org.jbpm.examples.purchases.PurchaseOrderHeader header)
{
this.header = header;
}

public java.lang.Boolean getRequiresCFOApproval()
{
return this.requiresCFOApproval;
}

public void setRequiresCFOApproval(java.lang.Boolean requiresCFOApproval)
{
this.requiresCFOApproval = requiresCFOApproval;
}

public PurchaseOrder(java.lang.Double total, java.lang.String description,
java.util.List<org.jbpm.examples.purchases.PurchaseOrderLine> lines,
org.jbpm.examples.purchases.PurchaseOrderHeader header,
java.lang.Boolean requiresCFOApproval)
{
this.total = total;
```

```
    this.description = description;
    this.lines = lines;
    this.header = header;
    this.requiresCFOApproval = requiresCFOApproval;
}

public PurchaseOrder(java.lang.String description,
    org.jbpm.examples.purchases.PurchaseOrderHeader header,
    java.util.List<org.jbpm.examples.purchases.PurchaseOrderLine> lines,
    java.lang.Double total, java.lang.Boolean requiresCFOApproval)
{
    this.description = description;
    this.header = header;
    this.lines = lines;
    this.total = total;
    this.requiresCFOApproval = requiresCFOApproval;
}

public PurchaseOrder(
    java.util.List<org.jbpm.examples.purchases.PurchaseOrderLine> lines,
    org.jbpm.examples.purchases.PurchaseOrderHeader header)
{
    this.lines = lines;
    this.header = header;
}

@Override
public boolean equals(Object o)
{
    if (this == o)
        return true;
    if (o == null || getClass() != o.getClass())
        return false;
    org.jbpm.examples.purchases.PurchaseOrder that = (org.jbpm.examples.purchases.PurchaseOrder) o;
    if (lines != null ? !lines.equals(that.lines) : that.lines != null)
        return false;
    if (header != null ? !header.equals(that.header) : that.header != null)
        return false;
    return true;
}

@Override
public int hashCode()
{
    int result = 17;
    result = 31 * result + (lines != null ? lines.hashCode() : 0);
    result = 31 * result + (header != null ? header.hashCode() : 0);
    return result;
}
}
```

9.7.7.6. Using external models

Using an external model means the ability to use a set for already defined POJOs in current project context. In order to make those POJOs available a dependency to the given JAR should be added. Once the dependency has been added the external POJOs can be referenced from current project data model.

There are two ways to add a dependency to an external JAR file:

- Dependency to a JAR file already installed in current local M2 repository (typically associated the the user home).
- Dependency to a JAR file installed in current KIE Workbench/Drools Workbench "Guvnor M2 repository". (internal to the application)

9.7.7.6.1. Dependency to a JAR file in local M2 repository

To add a dependency to a JAR file in local M2 repository follow this steps.

9.7.7.6.1.1. Open the Project Editor for current project and select the Dependencies view.

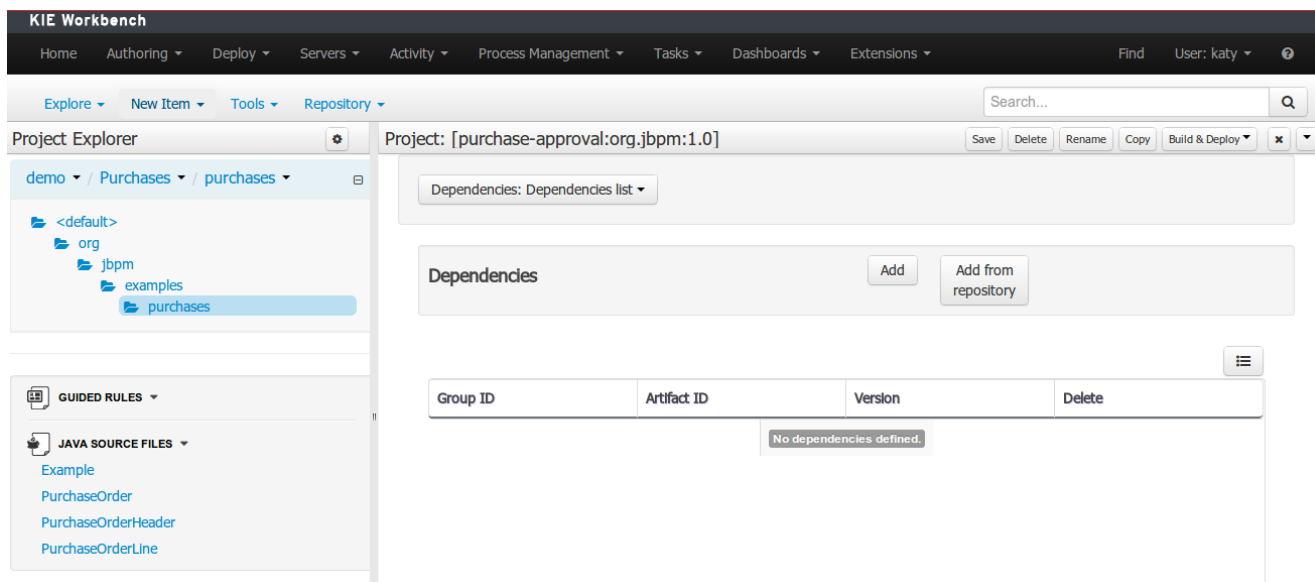


Figure 9.85. Project editor.

9.7.7.6.1.2. Click on the "Add" button to add a new dependency line.

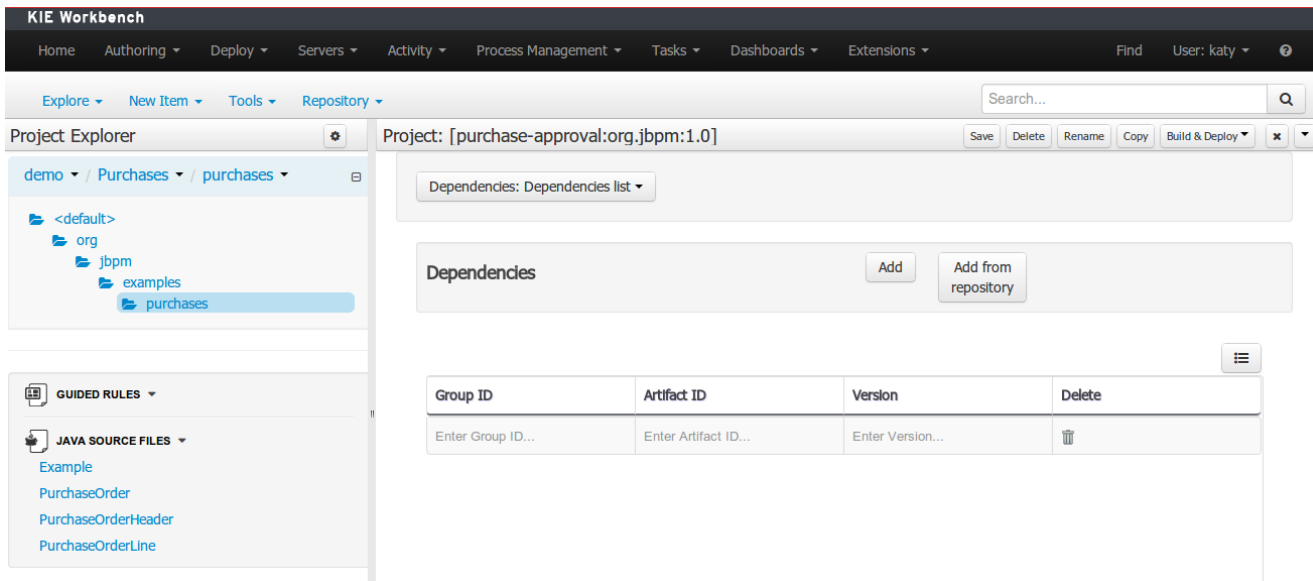


Figure 9.86. New dependency line.

9.7.7.6.1.3. Complete the GAV for the JAR file already installed in local M2 repository.

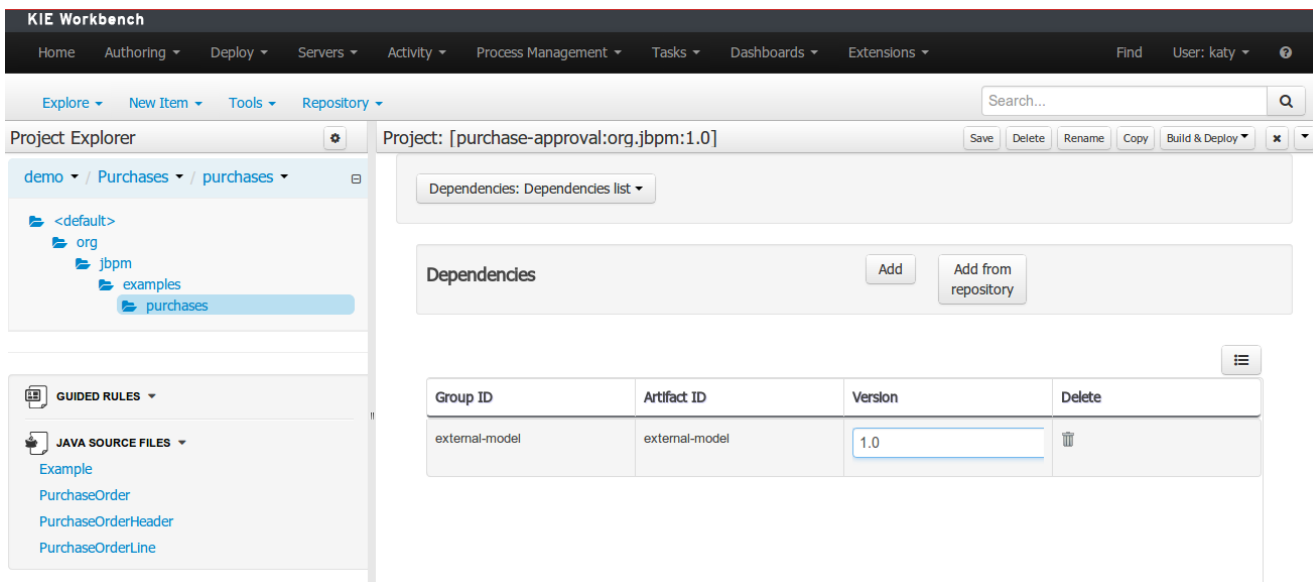


Figure 9.87. Dependency line edition.

9.7.7.6.1.4. Save the project to update its dependencies.

When project is saved the POJOs defined in the external file will be available.

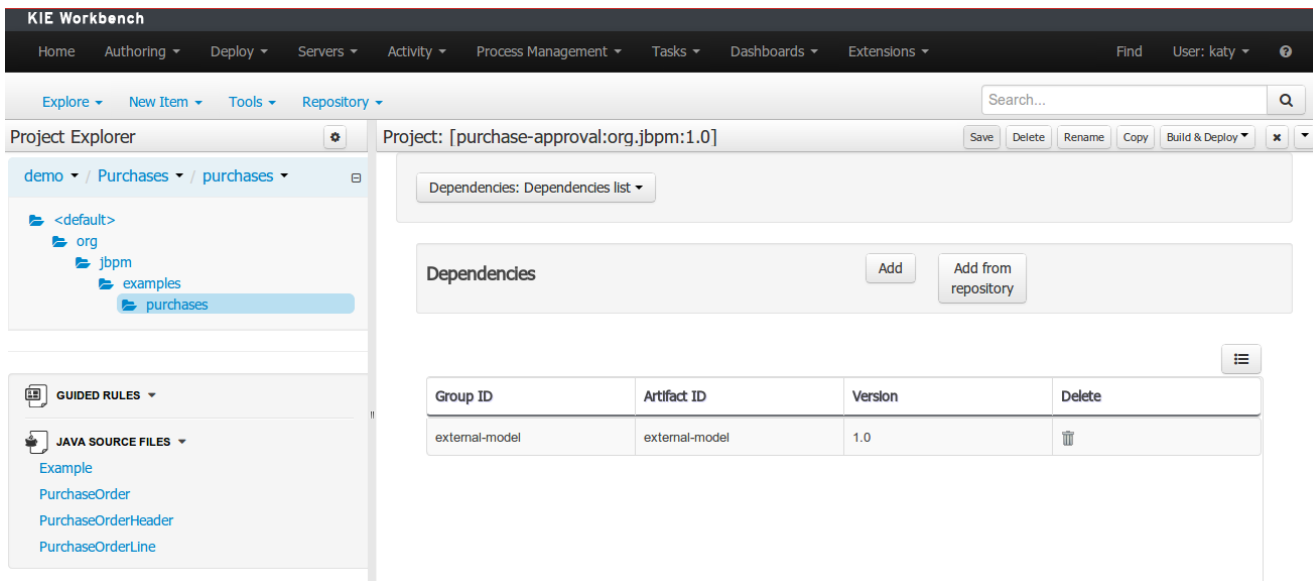


Figure 9.88. Save project.

9.7.7.6.2. Dependency to a JAR file in current "Guvnor M2 repository".

To add a dependency to a JAR file in current "Guvnor M2 repository" follow this steps.

9.7.7.6.2.1. Open the Maven Artifact Repository editor.

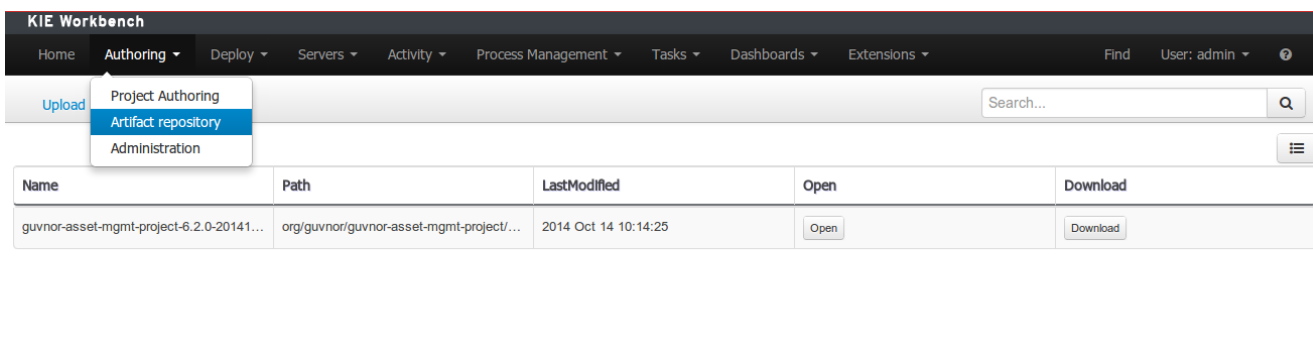


Figure 9.89. Guvnor M2 Repository editor.

9.7.7.6.2.2. Browse your local file system and select the JAR file to be uploaded using the Browse button.

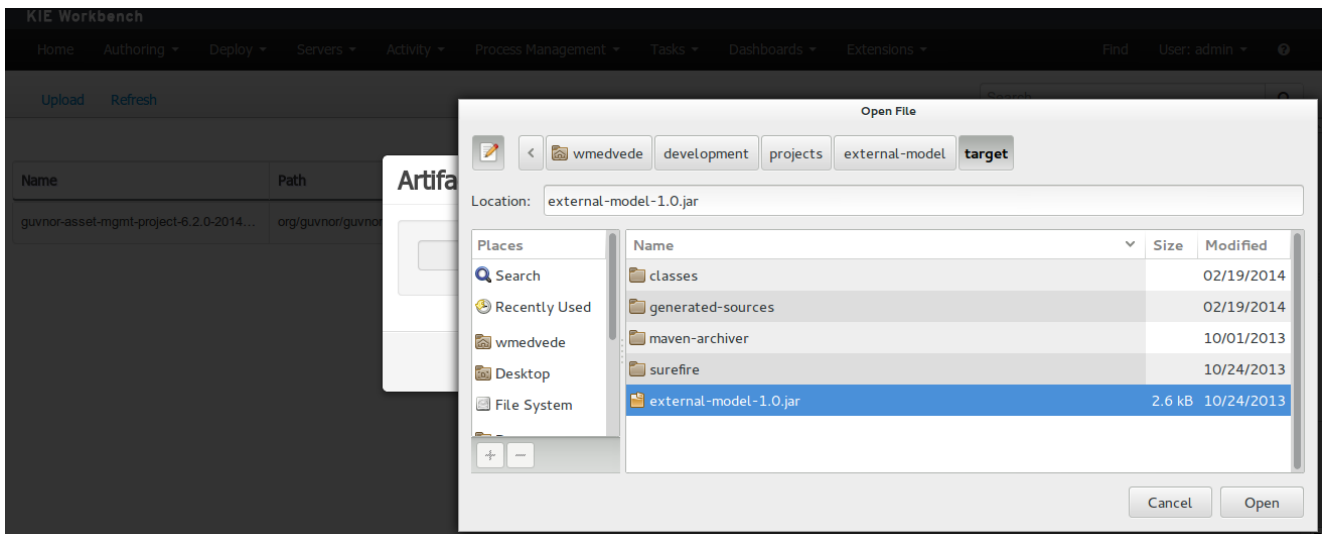


Figure 9.90. File browser.

9.7.7.6.2.3. Upload the file using the Upload button.

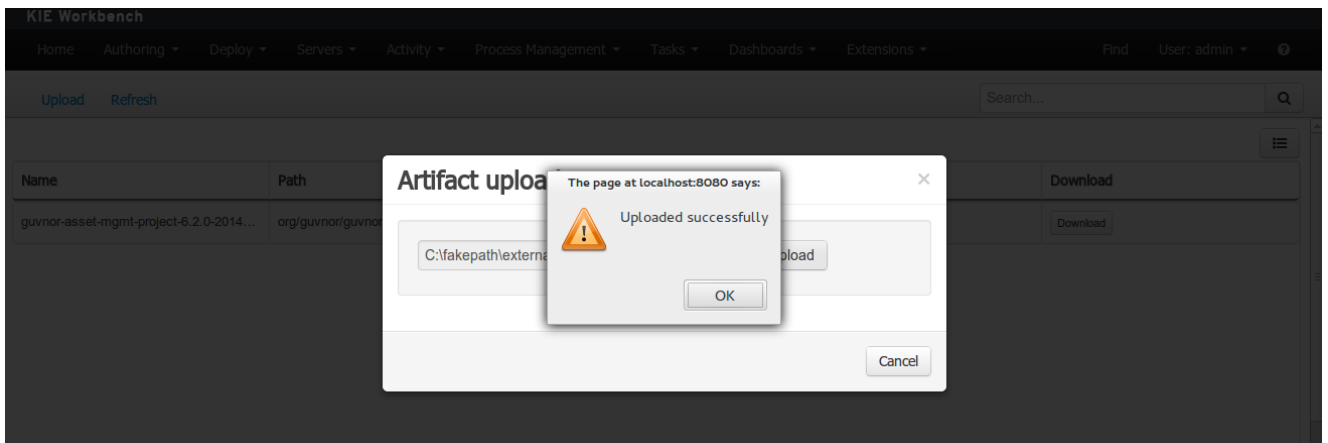


Figure 9.91. File upload success.

9.7.7.6.2.4. Guvnor M2 repository files.

Once the file has been loaded it will be displayed in the repository files list.

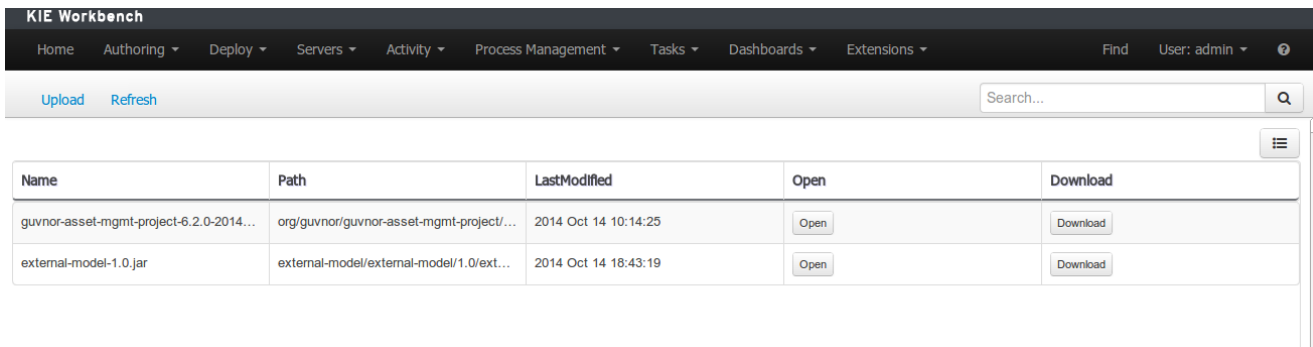


Figure 9.92. Files list.

9.7.7.6.2.5. Provide a GAV for the uploaded file (optional).

If the uploaded file is not a valid Maven JAR (don't have a pom.xml file) the system will prompt the user in order to provide a GAV for the file to be installed.

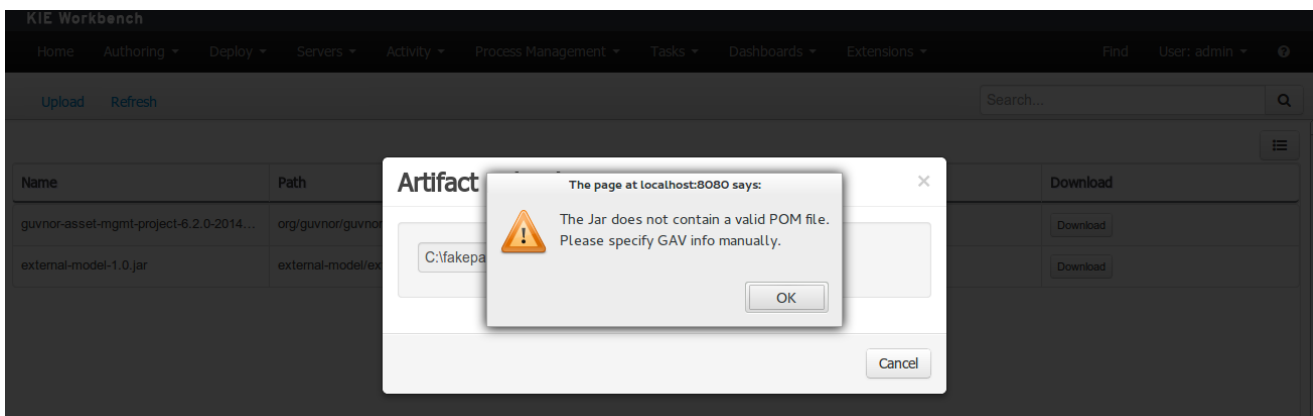


Figure 9.93. Not valid POM.

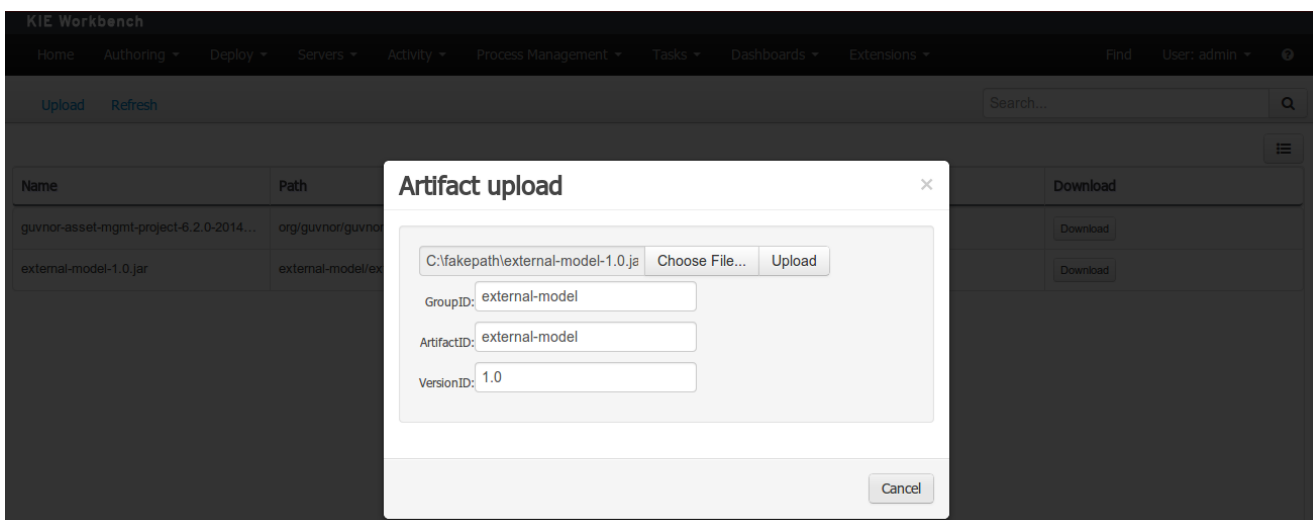


Figure 9.94. Enter GAV manually.

9.7.7.6.2.6. Add dependency from repository.

Open the project editor (see below) and click on the "Add from repository" button to open the JAR selector to see all the installed JAR files in current "Guvnor M2 repository". When the desired file is selected the project should be saved in order to make the new dependency available.

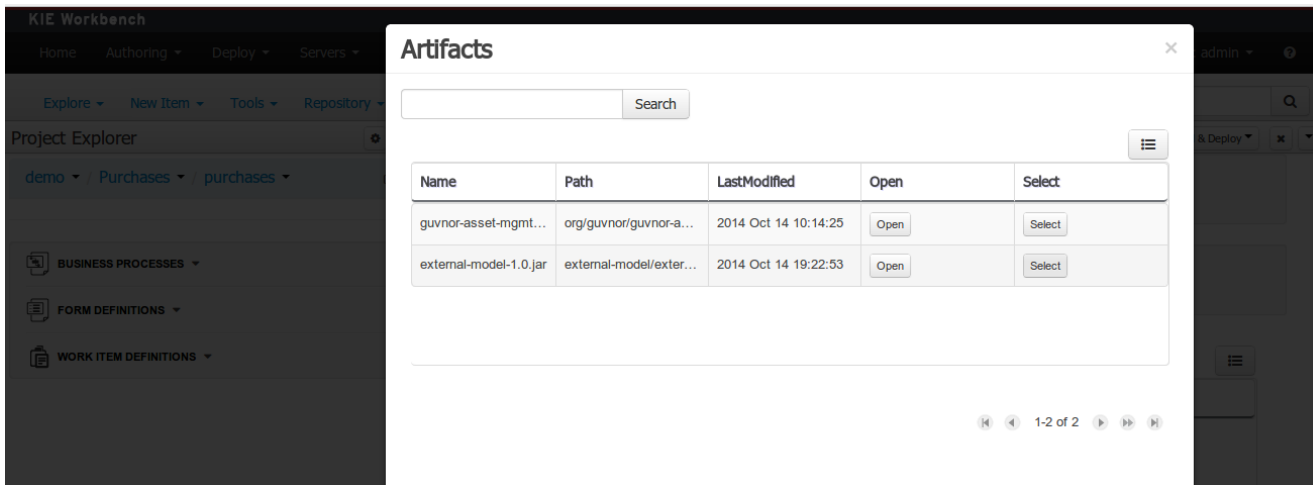


Figure 9.95. Select JAR from "Maven Artifact Repository".

9.7.7.6.3. Using the external objects

When a dependency to an external JAR has been set, the external POJOs can be used in the context of current project data model in the following ways:

- External POJOs can be extended by current model data objects.
- External POJOs can be used as field types for current model data objects.

The following screenshot shows how external objects are prefixed with the string "-ext-" in order to be quickly identified.

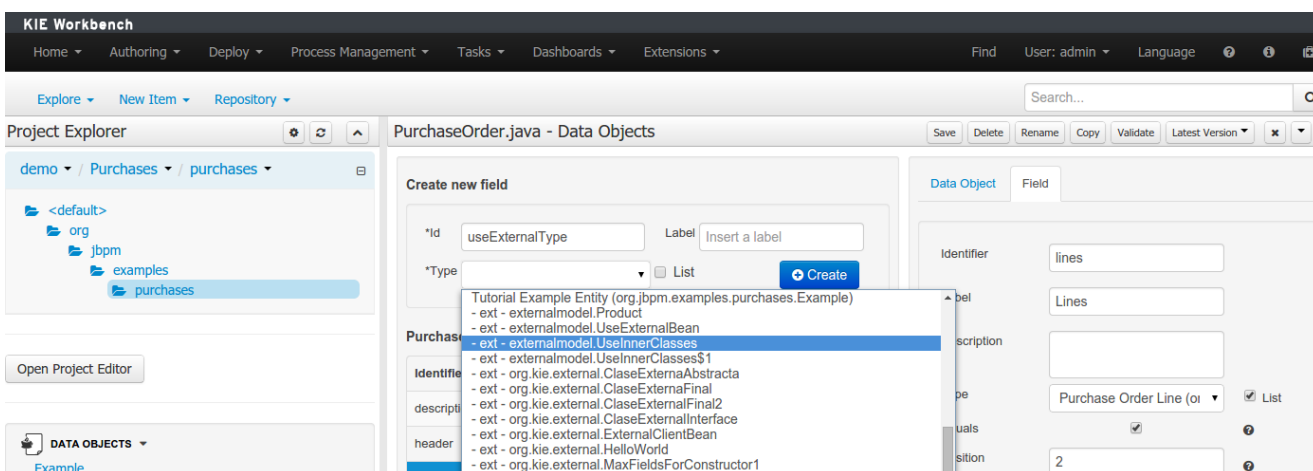


Figure 9.96. Identifying external objects.

9.7.7.7. Roundtrip and concurrency

Current version implements roundtrip and code preservation between Data modeller and Java source code. No matter where the Java code was generated (e.g. Eclipse, Data modeller), the data modeller will only create/delete/update the necessary code elements to maintain the model updated, i.e. fields, getter/setters, constructors, equals method and hashCode method. Also whatever Type or Field annotation not managed by the Data Modeler will be preserved when the Java sources are updated by the Data modeller.

Aside from code preservation, like in the other workbench editors, concurrent modification scenarios are still possible. Common scenarios are when two different users are updating the model for the same project, e.g. using the data modeller or executing a 'git push command' that modifies project sources.

From an application context's perspective, we can basically identify two different main scenarios:

9.7.7.7.1. No changes have been undertaken through the application

In this scenario the application user has basically just been navigating through the data model, without making any changes to it. Meanwhile, another user modifies the data model externally.

In this case, no immediate warning is issued to the application user. However, as soon as the user tries to make any kind of change, such as add or remove data objects or properties, or change any of the existing ones, the following pop-up will be shown:

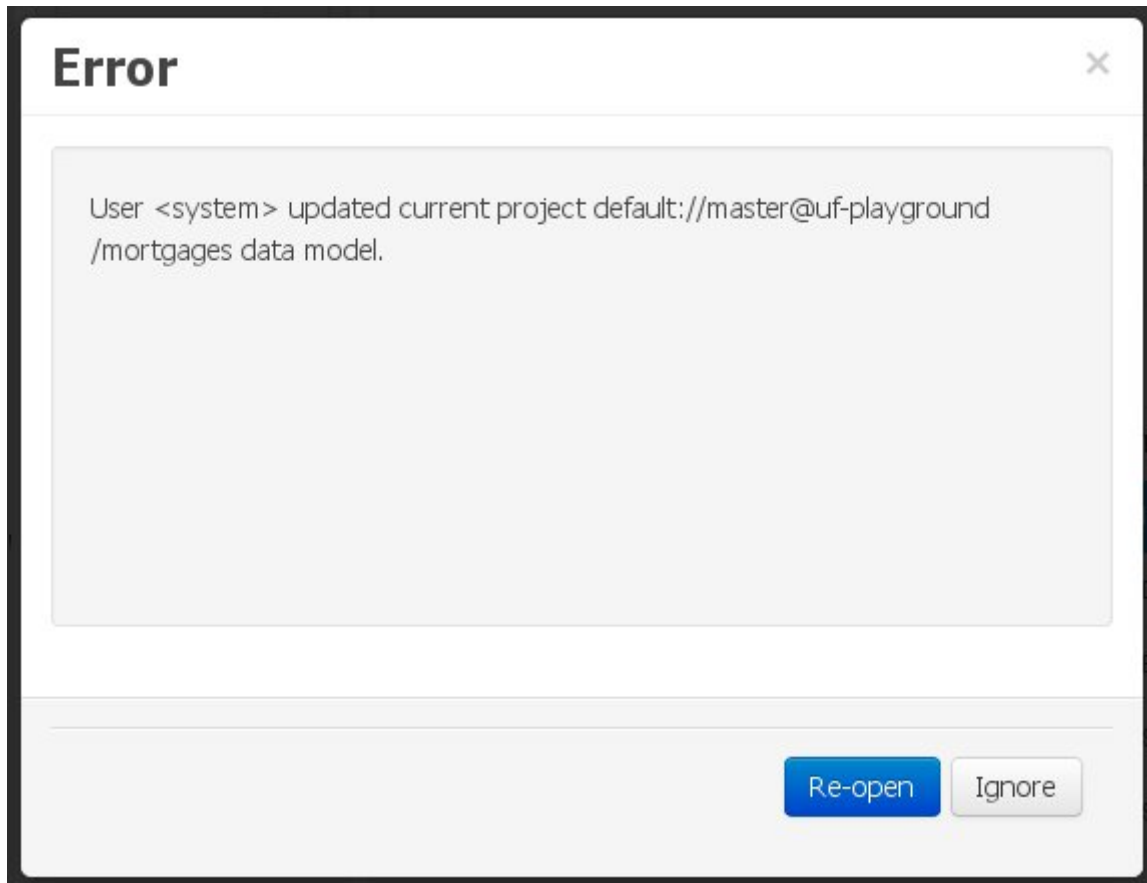


Figure 9.97. External changes warning

The user can choose to either:

- Re-open the data model, thus loading any external changes, and then perform the modification he was about to undertake, or
- Ignore any external changes, and go ahead with the modification to the model. In this case, when trying to persist these changes, another pop-up warning will be shown:

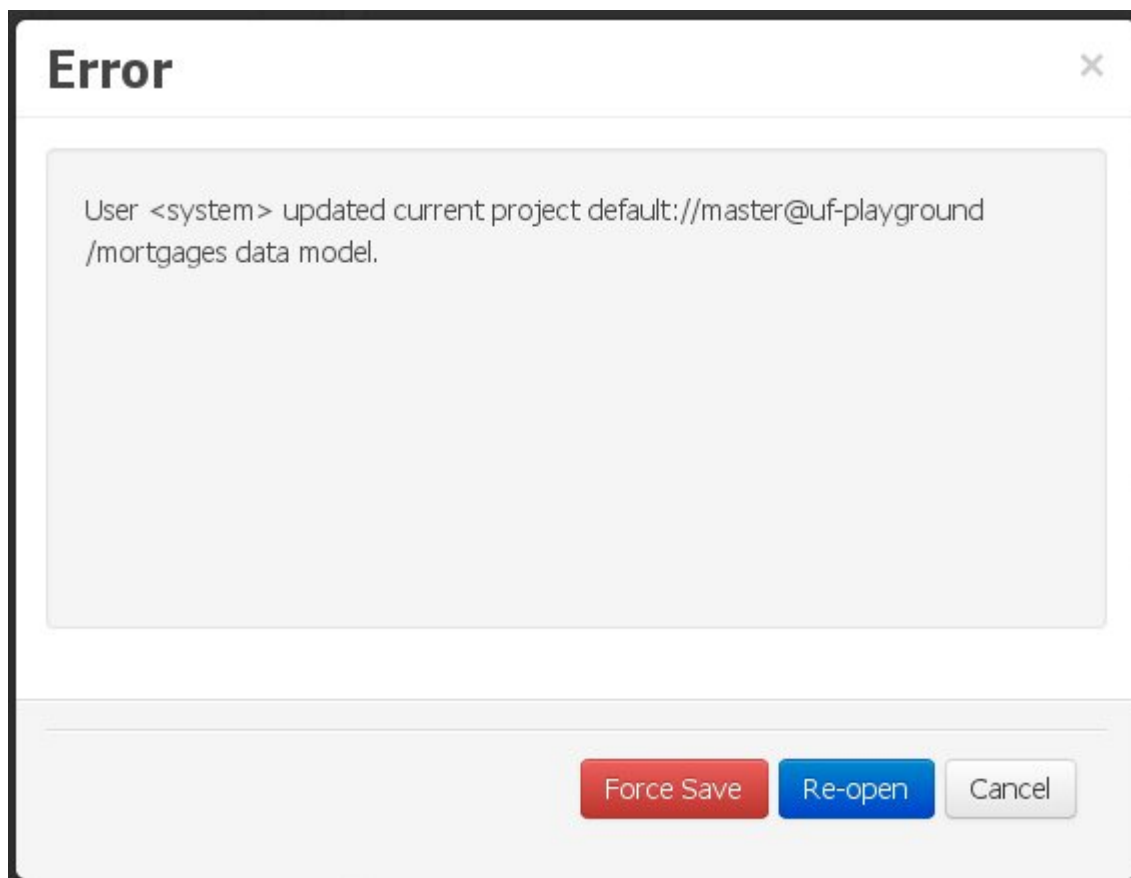



Figure 9.98. Force save / re-open

The "Force Save" option will effectively overwrite any external changes, while "Re-open" will discard any local changes and reload the model.



Warning

"Force Save" overwrites any external changes!

9.7.7.7.2. Changes have been undertaken through the application

The application user has made changes to the data model. Meanwhile, another user simultaneously modifies the data model from outside the application context.

In this alternative scenario, immediately after the external user commits his changes to the asset repository (or e.g. saves the model with the data modeller in a different session), a warning is issued to the application user:

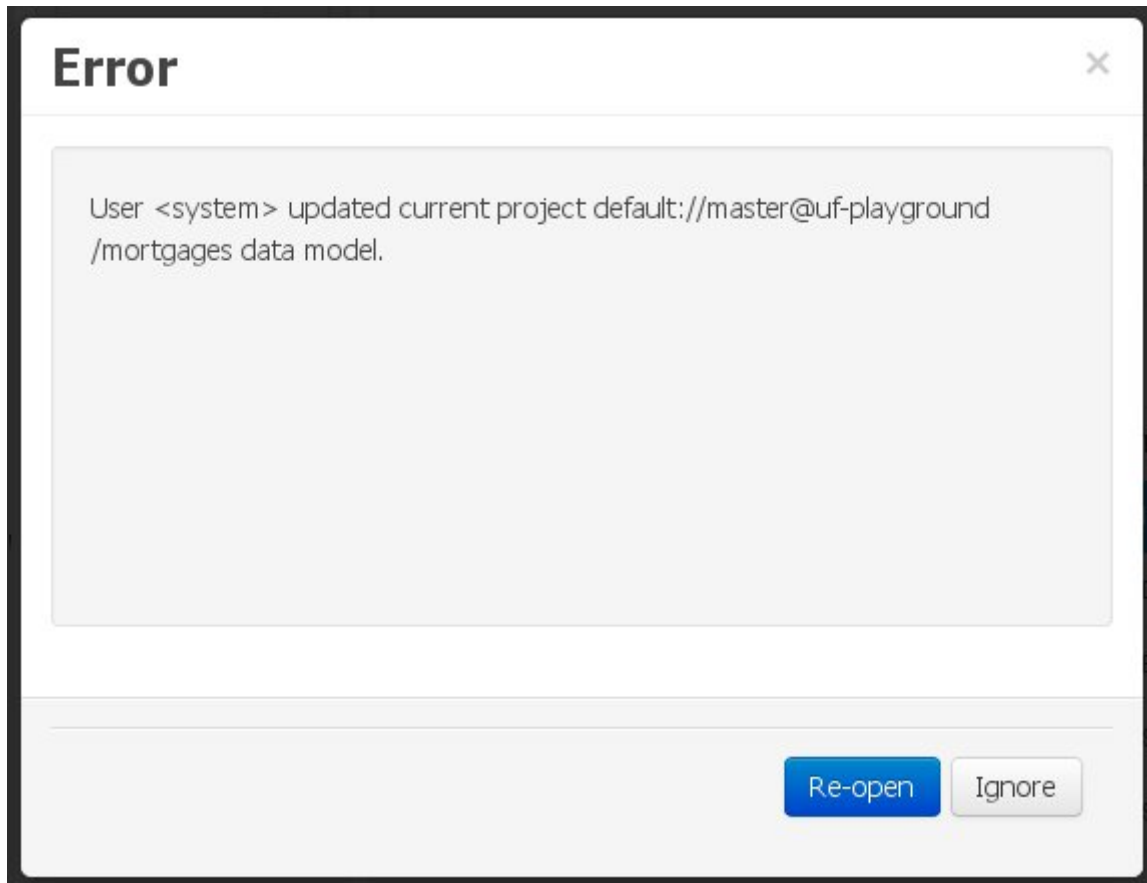


Figure 9.99. External changes warning

As with the previous scenario, the user can choose to either:

- Re-open the data model, thus losing any modifications that were made through the application, or
- Ignore any external changes, and continue working on the model.

One of the following possibilities can now occur:

- The user tries to persist the changes he made to the model by clicking the "Save" button in the data modeller top level menu. This leads to the following warning message:

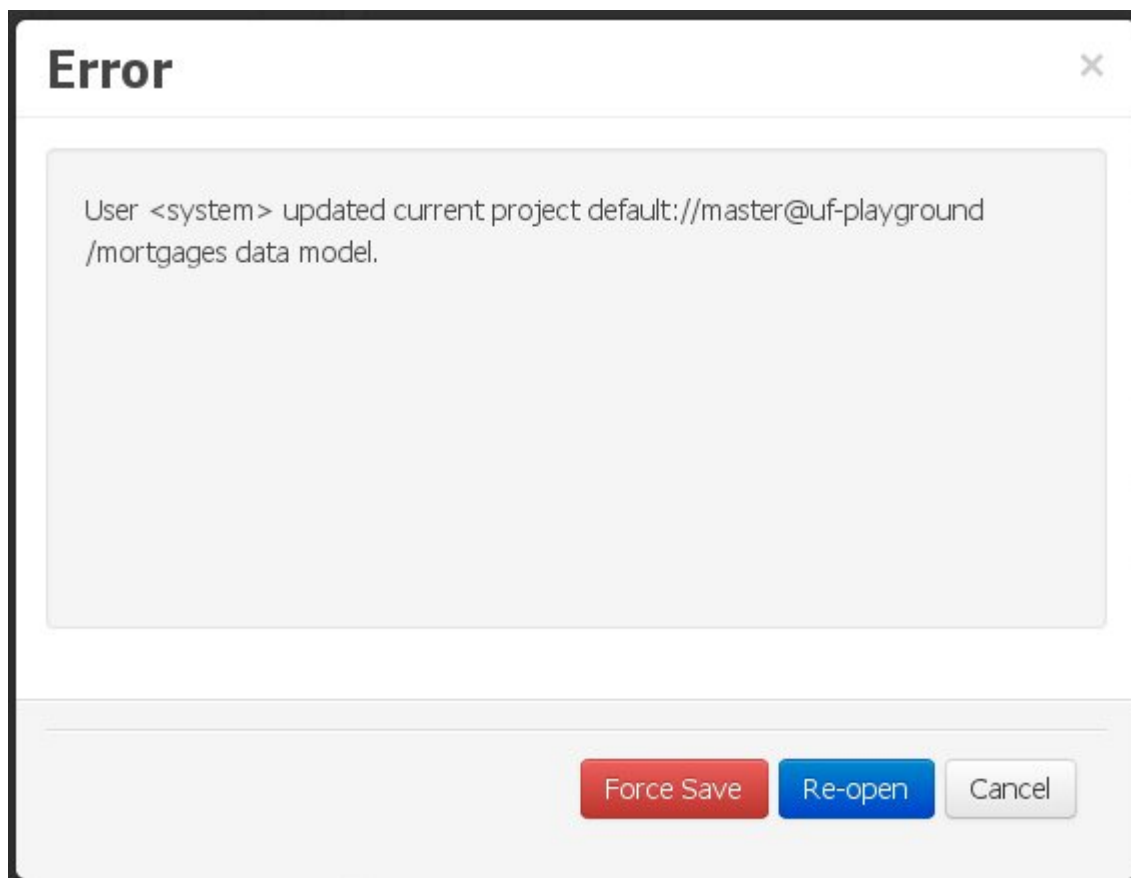


Figure 9.100. Force save / re-open

The "Force Save" option will effectively overwrite any external changes, while "Re-open" will discard any local changes and reload the model.

9.7.8. Data Sets

A **data set** is basically a set of columns populated with some rows, a matrix of data composed of timestamps, texts and numbers. A data set can be stored in different systems: a database, an excel file, in memory or in a lot of other different systems. On the other hand, a **data set definition** tells the workbench modules how such data can be accessed, read and parsed.

Notice, it's very important to make crystal clear the difference between a data set and its definition since the workbench does not take care of storing any data, it just provides an standard way to define access to those data sets regardless where the data is stored.

Let's take for instance the data stored in a remote database. A valid data set could be, for example, an entire database table or the result of an SQL query. In both cases, the database will return a bunch of columns and rows. Now, imagine we want to get access to such data to feed some charts in a new workbench perspective. First thing is to create and register a data set definition in order to indicate the following:

- where the data set is stored,
- how can be accessed, read and parsed and
- what columns contains and of which type.

This chapter introduces the available workbench tools for registering and handling data set definitions and how this definitions can be consumed in other workbench modules like, for instance, the Perspective Editor.



Note

For simplicity sake we will be using the term *data set* to refer to the actual data set definitions as *Data set* and *Data set definition* can be considered synonyms under the data set authoring context.

9.7.8.1. Data Set Authoring Perspective

Everything related to the authoring of data sets can be found under the *Data Set Authoring* perspective which is accessible from the following top level menu entry: *Extensions>Data Sets*, as shown in the following screenshot.

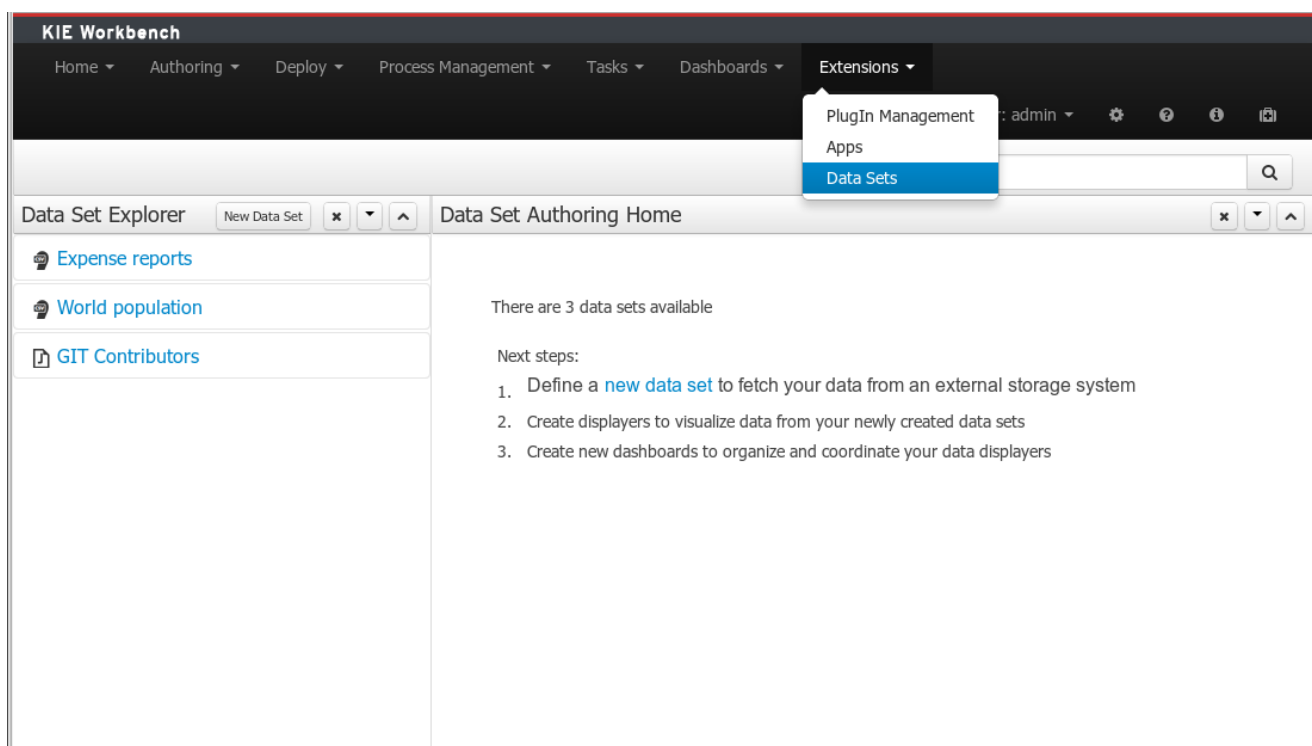


Figure 9.101. Data Set Authoring Perspective

The center panel, shows a welcome screen, whilst the left panel contains the *Data Set Explorer* listing all the data sets available



Note

This perspective is only intended to Administrator users, since defining data sets can be considered a low level task.

9.7.8.2. Data Set Explorer

The *Data Set Explorer* list the data sets present in the system. Every time the user clicks on the data set it shows a brief summary alongside the following information:

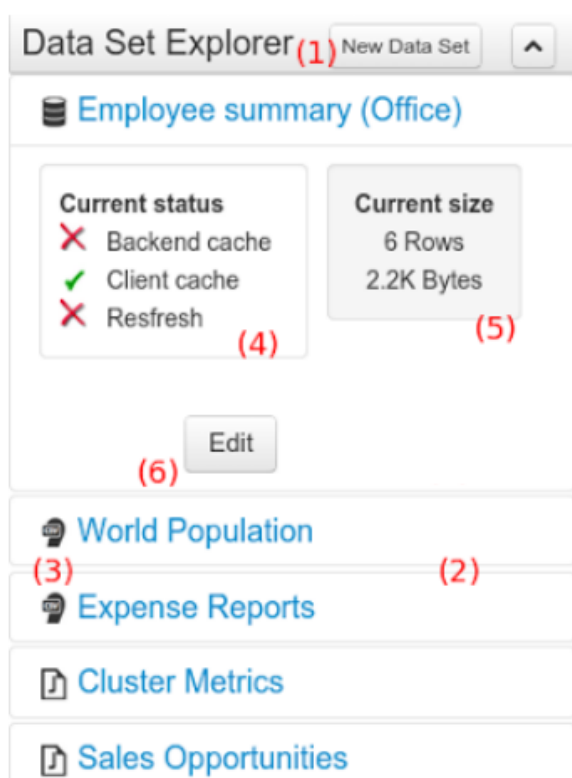


Figure 9.102. Data Set Explorer

- (1) A button for creating a new Data set
- (2) The list of currently available Data sets
- (3) An icon that represents the Data set's provider type (Bean, SQL, CSV, etc)
- (4) Details of current cache and refresh policy status
- (5) Details of current size on backend (unit as rows) and current size on client side (unit in bytes)
- (6) The button for editing the Data set. Once clicked the Data set editor screen is opened on the center panel

The next sections explain how to create, edit and fine tune data set definitions.

9.7.8.3. Data Set Creation

Clicking on the *New Data Set* button opens a new screen from which the user is able to create a new data set definition in three steps:

- *Provider type selection*

Specify the kind of the remote storage system (BEAN, SQL, CSV, ElasticSearch)

- *Provider configuration*

Specify the attributes for being able to look up data from the remote system. The configuration varies depending on the data provider type selected.

- *Data set columns & filter*

Live data preview, column types and initial filter configuration.

9.7.8.3.1. Step 1: Provider type selection

Allows the user's specify the type of data provider of the data set being created.

This screen lists all the current available data provider types and helper popovers with descriptions. Each data provider is represented with a descriptive image:



Figure 9.103. Provider type selection

Four types are currently supported:

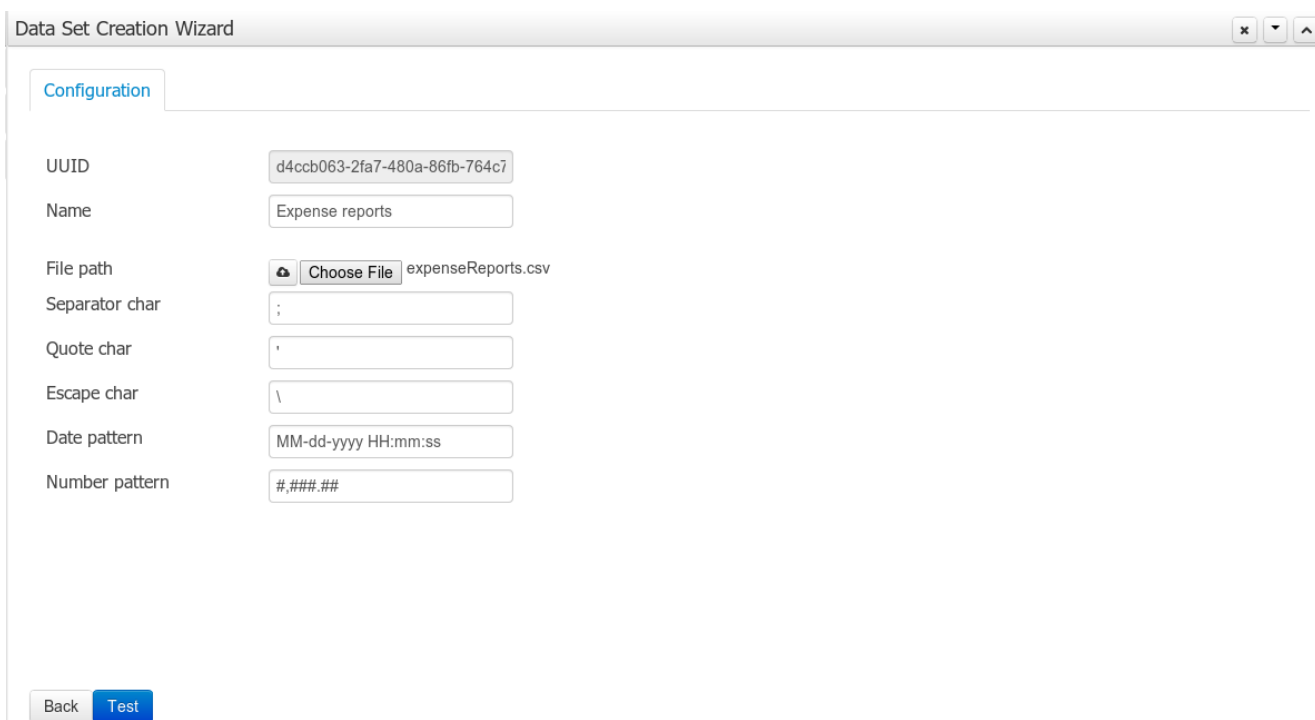
- Bean (Java class) - To generate a data set directly from Java

- SQL - For getting data from any ANSI-SQL compliant database
- CSV - To upload the contents of a remote or local CSV file
- Elastic Search - To query and get documents stored on Elastic Search nodes as data sets

Once a type is selected, click on Next button to continue with the next workflow step.

9.7.8.3.2. Step 2: Configuration

The screenshot below shows a CSV data set configuration form. Once all the required settings are filled click on Test button. The system will try to fetch a small amount of data before moving to the next workflow step.



The screenshot shows a window titled "Data Set Creation Wizard" with a "Configuration" tab. The form contains the following fields:

UUID	<input type="text" value="d4ccb063-2fa7-480a-86fb-764c7"/>
Name	<input type="text" value="Expense reports"/>
File path	<input type="button" value="Choose File"/> expenseReports.csv
Separator char	<input type="text" value=";"/>
Quote char	<input type="text" value="'"/>
Escape char	<input type="text" value="\"/>
Date pattern	<input type="text" value="MM-dd-yyyy HH:mm:ss"/>
Number pattern	<input type="text" value="#####"/>

At the bottom left, there are two buttons: "Back" and "Test".

Figure 9.104. CSV Configuration

The provider type selected in the previous step will determine which configuration settings the system asks for.

<p>Data Source <input type="text" value="java:jboss/datasources/Example1"/></p> <p>Schema <input type="text" value="MySchema01"/></p> <p>Source <input type="radio"/> Table <input checked="" type="radio"/> Query</p> <pre>select * from MyTable</pre> <p>DB Provider</p>	<p>File path <input type="button" value="Choose File"/> No file chosen</p> <p>Separator char <input type="text" value=";"/></p> <p>Quote char <input type="text" value="'"/></p> <p>Escape char <input type="text" value="\"/></p> <p>Date pattern <input type="text" value="MM-dd-yyyy HH:mm:ss"/></p> <p>Number pattern <input type="text" value="#.###.##"/></p> <p>CSV Provider</p>						
<p>Generator class <input type="text" value="org.example.MyDataSetGenerat"/></p> <p>Generator parameters</p> <table border="1"> <thead> <tr> <th>Key</th> <th>Value</th> <th>Actions</th> </tr> </thead> <tbody> <tr> <td colspan="3" style="text-align: center;">No data</td> </tr> </tbody> </table> <p><input type="button" value="+ Add"/></p> <p>Bean Provider</p>	Key	Value	Actions	No data			<p>Server URL <input type="text" value="http://localhost:9200"/></p> <p>Cluster name <input type="text" value="my_cluster"/></p> <p>Index <input type="text" value="my_index"/></p> <p>Document type <input type="text" value="my_type"/></p> <p>Elastic Search Provider</p>
Key	Value	Actions					
No data							

Figure 9.105. Configuration screen per data set type



Note

The UUID attribute is a read only field as it's generated by the system. It's only intended for usage in API calls or specific operations.

9.7.8.3.3. Step 3: Data set columns and preview

After clicking on the *Test* button (see previous step), the system executes a data set lookup test call in order to check if the remote system is up and the data is available. If everything goes ok the user will see the following screen:

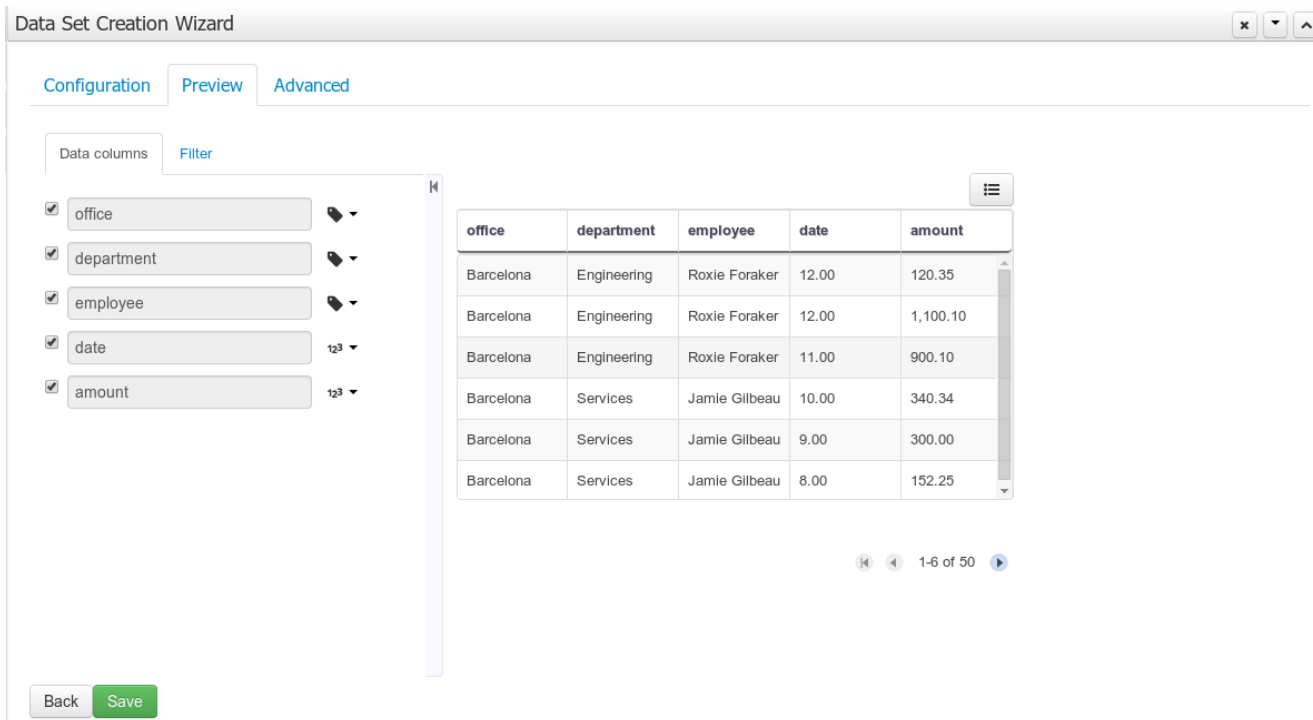


Figure 9.106. Data set preview

This screen shows a live data preview along with the columns the user wants to be part of the resulting data set. The user can also navigate through the data and apply some changes to the data set structure. Once finished, we can click on the *Save* button in order to register the new data set definition.

We can also change the configuration settings at any time just by going back to the configuration tab. We can repeat the *Configuration>Test>Preview* cycle as many times as needed until we consider it's ready to be saved.

Columns

In the *Columns* tab area the user can select what columns are part of the resulting data set definition.

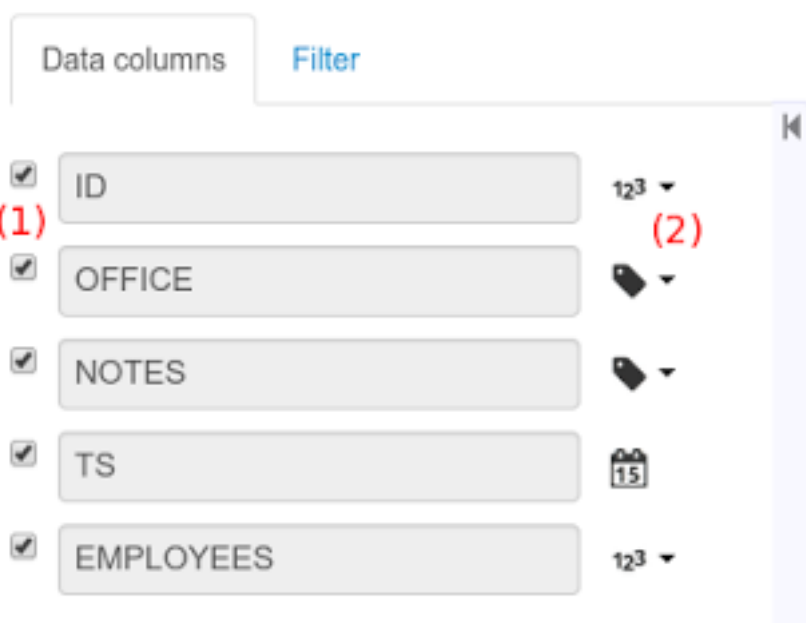


Figure 9.107. Data set columns

- (1) To add or remove columns. Select only those columns you want to be part of the resulting data set
- (2) Use the drop down image selector to change the column type

A data set may only contain columns of any of the following 4 types:

- Label - For text values supporting group operations (similar to the SQL "group by" operator) which means you can perform data lookup calls and get one row per distinct value.
- Text - For text values NOT supporting group operations. Typically for modeling large text columns such as abstracts, descriptions and the like.
- Number - For numeric values. It does support aggregation functions on data lookup calls: sum, min, max, average, count, distinct.
- Date - For date or timestamp values. It does support time based group operations by different time intervals: minute, hour, day, month, year, ...

No matter which remote system you want to retrieve data from, the resulting data set will always return a set of columns of one of the four types above. There exists, by default, a mapping between the remote system column types and the data set types. The user is able to modify the type for some columns, depending on the data provider and the column type of the remote system. The system supports the following changes to column types:

- Label <> Text - Useful when we want to enable/disable the categorization (grouping) for the target column. For instance, imagine a database table called "document" containing a large text

column called "abstract". As we do not want the system to treat such column as a "label" we might change its column type to "text". Doing so, we are optimizing the way the system handles the data set and

- Number <> Label - Useful when we want to treat numeric columns as labels. This can be used for instance to indicate that a given numeric column is not a numeric value that can be used in aggregation functions. Despite its values are stored as numbers we want to handle the column as a "label". One example of such columns are: an item's code, an appraisal id., ...



Note

BEAN data sets do not support changing column types as it's up to the developer to decide which are the concrete types for each column.

Filter

A data set definition may define a filter. The goal of the filter is to leave out rows the user does not consider necessary. The filter feature works on any data provider type and it lets the user to apply filter operations on any of the data set columns available.

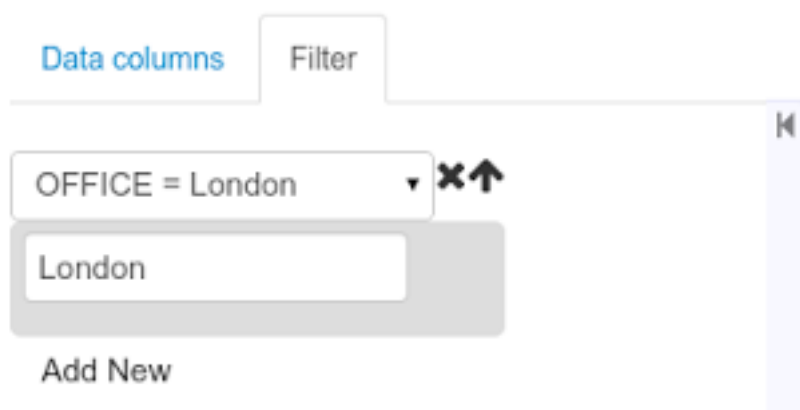


Figure 9.108. Data set filter

While adding or removing filter conditions and operations, the preview table on central area is updated with live data that reflects the current filter status.

There exists two strategies for filtering data sets and it's also important to note that choosing between the two have important implications. Imagine a dashboard with some charts feeding from an expense reports data set where such data set is built on top of an SQL table. Imagine also we only want to retrieve the expense reports from the "London" office. You may define a data set containing the filter "office=London" and then having several charts feeding from such data set. This is the recommended approach. Another option is to define a data set with no initial filter and then let the individual charts to specify their own filter. It's up to the user to decide on the best approach.

Depending on the case it might be better to define the filter at a data set level for reusing across other modules. The decision may also have impact on the performance since a filtered cached data set will have far better performance than a lot of individual non-cached data set lookup requests. (See the next section for more information about caching data sets).



Note

Notice, for SQL data sets, the user can use both the filter feature introduced or, alternatively, just add custom filter criteria to the SQL sentence. Although, the first approach is more appropriated for non technical users since they might not have the required SQL language skills.

9.7.8.4. Data set editor

To edit an existing data set definition go the data set explorer, expand the desired data set definition and click on the *Edit* button. This will cause a new editor panel to be opened and placed on the center of the screen, as shown in the next screenshot:

office	department	employee	date	amount
Barcelona	Engineering	Roxie Foraker	12.00	120.35
Barcelona	Engineering	Roxie Foraker	12.00	1,100.10
Barcelona	Engineering	Roxie Foraker	11.00	900.10
Barcelona	Services	Jamie Gilbeau	10.00	340.34
Barcelona	Services	Jamie Gilbeau	9.00	300.00
Barcelona	Services	Jamie Gilbeau	8.00	152.25

Figure 9.109. Data set definition editor

Every time we edit an item its editor is added to the center panel. We can navigate through the list of opened editors just by clicking on the down arrow icon placed at the editor's toolbar in the top right corner.



Figure 9.110. Editor selector

The editor provides all the features described in previous sections. We can change the configuration settings, test our data set definition and modify the resulting data set structure. Additionally, the editor provides some extra buttons in its toolbar:

- Save - To validate the current changes and store the data set definition.
- Delete - To remove permanently from storage the data set definition. Any client module referencing the data set may be affected.
- Validate - To check that all the required parameters exists and are correct, as well as to validate the data set can be retrieved with no issues.
- Copy - To create a brand new definition as a copy of the current one.



Note

Data set definitions are stored in the underlying GIT repository as JSON files. Any action performed is registered in the repository logs so it is possible to audit the change log later on.

9.7.8.5. Advanced settings

In the *Advanced settings* tab area the user can specify caching and refresh settings. Those are very important for making the most of the system capabilities thus improving the performance and having better application responsive levels.

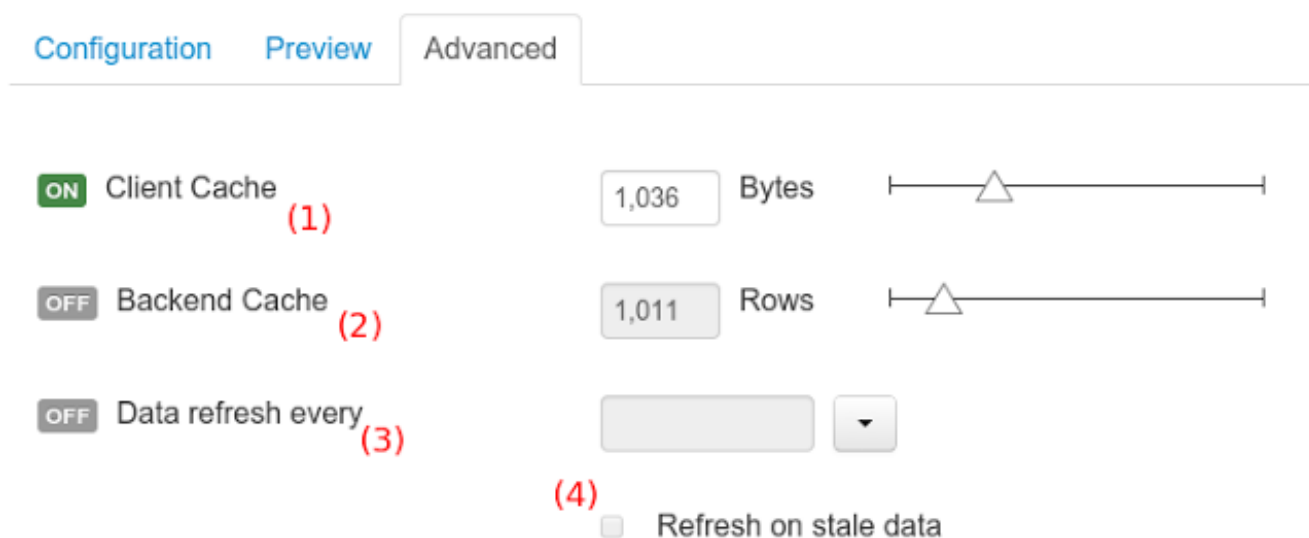


Figure 9.111. Advanced settings

- (1) To enable or disable the client cache and specify the maximum size (bytes).
- (2) To enable or disable the backend cache and specify the maximum cache size (number of rows).
- (3) To enable or disable automatic refresh for the Data set and the refresh period.
- (4) To enable or disable the refresh on stale data setting.

Let's dig into more details about the meaning of these settings.

9.7.8.6. Caching

The system provides caching mechanisms out-of-the-box for holding data sets and performing data operations using in-memory strategies. The use of these features brings a lot of advantages, like reducing the network traffic, remote system payload, processing times etc. On the other hand, it's up to the user to fine tune properly the caching settings to avoid hitting performance issues.

Two cache levels are supported:

- Client level
- Backend level

The following diagram shows how caching is involved in any data set operation:

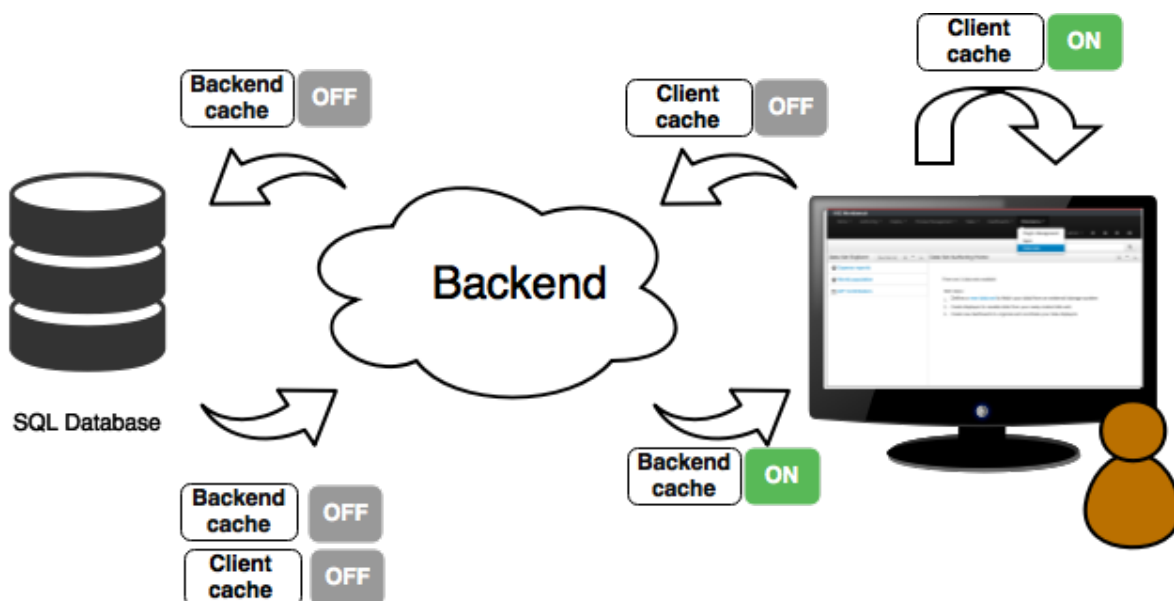


Figure 9.112. Data set caching

Any data look up call produces a resulting data set, so the use of the caching techniques determines where the data lookup calls are executed and where the resulting data set is located.

Client cache

If ON then the data set involved in a look up operation is pushed into the web browser so that all the components that feed from this data set **do not need to perform any requests to the backend** since data set operations are resolved at a client side:

- The data set is stored in the web browser's memory
- The client components feed from the data set stored in the browser
- Data set operations (grouping, aggregations, filters and sort) are processed within the web browser, by means of a Javascript data set operation engine.

If you know beforehand that your data set will remain small, you can enable the client cache. It will reduce the number of backend requests, including the requests to the storage system. On the other hand, if you consider that your data set will be quite big, disable the client cache so as to not hitting with browser issues such as slow performance or intermittent hangs.

Backend cache

Its goal is to provide a caching mechanism for data sets on backend side.

This feature allows to **reduce the number of requests to the remote storage system**, by holding the data set in memory and performing group, filter and sort operations using the in-memory engine.

It's useful for data sets that do not change very often and their size can be considered acceptable to be held and processed in memory. It can be also helpful on low latency connectivity issues with

the remote storage. On the other hand, if your data set is going to be updated frequently, it's better to disable the backend cache and perform the requests to the remote storage on each look up request, so the storage system is in charge of resolving the data set lookup request.



Note

BEAN and CSV data providers relies by default on the backend cache, as in both cases the data set must be always loaded into memory in order to resolve any data lookup operation using the in-memory engine. This is the reason why the backend settings are not visible in the Advanced settings tab.

9.7.8.7. Refresh

The refresh feature allows for the invalidation of any cached data when certain conditions are meet.

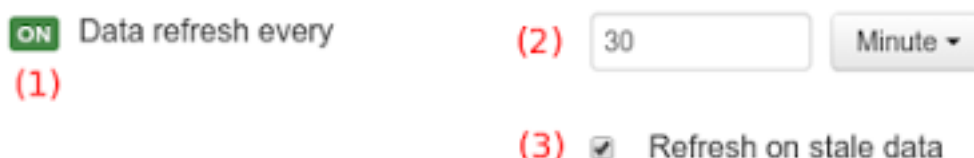


Figure 9.113. Refresh settings

- (1) To enable or disable the refresh feature.
- (2) To specify the refresh interval.
- (3) To enable or disable data set invalidation when the data is outdated.

The data set refresh policy is tightly related to data set caching, detailed in previous section. This invalidation mechanism determines the cache life-cycle.

Depending on the nature of the data there exist three main use cases:

- **Source data changes predictable** - Imagine a database being updated every night. In that case, the suggested configuration is to use a "refresh interval = 1 day" and disable "refresh on stale data". That way, the system will always invalidate the cached data set every day. This is the right configuration when we know in advance that the data is going to change.
- **Source data changes unpredictable** - On the other hand, if we do not know whether the database is updated every day, the suggested configuration is to use a "refresh interval = 1 day" and enable "refresh on stale data". If so the system, before invalidating any data, will check for modifications. On data modifications, the system will invalidate the current stale data set so that the cache is populated with fresh data on the next data set lookup call.

- **Real time scenarios** - In real time scenarios caching makes no sense as data is going to be updated constantly. In this kind of scenarios the data sent to the client has to be constantly updated, so rather than enabling the refresh settings (remember this settings affect the caching, and caching is not enabled) it's up to the clients consuming the data set to decide when to refresh. When the client is a dashboard then it's just a matter of modifying the refresh settings in the Displayer Editor configuration screen and set a proper refresh period, "refresh interval = 1 second" for example.

9.8. Embedding Workbench In Your Application

As we already know, Workbench provides a set of editors to author assets in different formats. According to asset's format a specialized editor is used.

One additional feature provided by Workbench is the ability to embed it in your own (Web) Applications thru it's **standalone** mode. So, if you want to edit rules, processes, decision tables, etc... in your own applications without switch to Workbench, you can.

In order to embed Workbench in your application all you'll need is the Workbench application deployed and running in a web/application server and, from within your own web applications, an iframe with proper HTTP query parameters as described in the following table.

Table 9.2. HTTP query parameters for standalone mode

Parameter Name	Explanation	Allow multiple values	Example
standalone	With just the presence of this parameter workbench will switch to standalone mode.	no	(none)
path	Path to the asset to be edited. Note that asset should already exists.	no	git://master@uf-playground/todo.md
perspective	Reference to an existing perspective name.	no	org.guvnor.m2repo.client.perspectives.Guv
header	Defines the name of the header that should be displayed (useful for context menu headers).	yes	ComplementNavArea



Note

Path and Perspective parameters are mutual exclusive, so can't be used together.

9.9. Asset Management

9.9.1. Asset Management Overview

This section of the documentation describes the main features included that contribute to the Asset Management functionality provided in the KIE Workbench and KIE Drools Workbench. All the features described here are entirely optional, but the usage is recommended if you are planning to have multiple projects. All the Asset Management features try to impose good practices on the repository structure that will make the maintenance, versioning and distribution of the projects simple and based on standards. All the Asset Management features are implemented using jBPM Business Processes, which means that the logic can be reused for external applications as well as adapted for domain specific requirements when needed.



Note

You must set the "kiemgmt" role to your user to be able to use the Asset Management Features

9.9.2. Managed vs Unmanaged Repositories

Since the creation of the assets management features repositories can be classified into Managed or Unmanaged.

9.9.2.1. Managed Repositories

All new assets management features are available for this type of repositories. Additionally a managed repository can be "Single Project" or "Multi Project".

A "Single Project" managed repository will contain just one Project. And a "Multi Project" managed repository can contain multiple Projects. All of them related through the same parent, and they will share the same group and version information.

9.9.2.2. Unmanaged Repositories

Assets management features are not available for this type of repositories and they basically behaves the same as the repositories created with previous workbench versions.

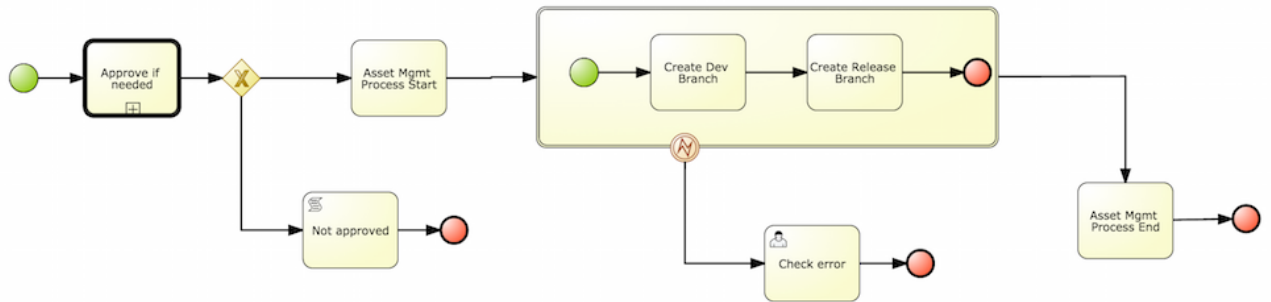
9.9.3. Asset Management Processes

There are 4 main processes which represent the stages of the Asset Management feature: Configure Repository, Promote Changes, Build and Release.

9.9.3.1. Configure Repository

The Configure Repository process is in charge of the post initialization of the repository. This process will be automatically triggered if the user selects to create a Managed Repository on the

New repository wizard. If they decide to use the governance feature the process will kick in and as soon as the repository is created. A new development and release branches will be created. Notice that the first time that this process is called, the master branch is picked and both branches (dev and release) will be based on it.

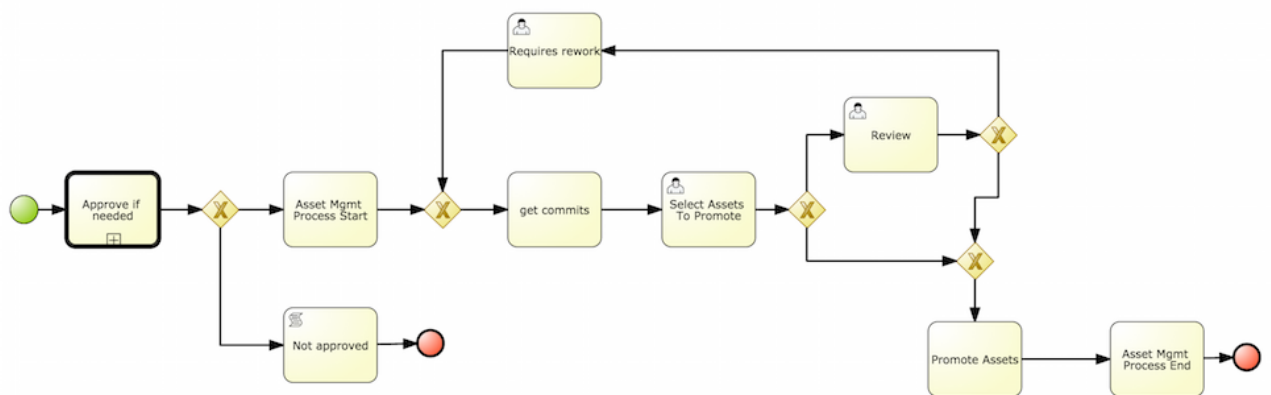


By default the asset management feature is not enabled so make sure to select Managed Repository on the New Repository Wizard. When we work inside a managed repository, the development branch is selected for the users to work on. If multiple dev branches are created, the user will need to pick one.

9.9.3.2. Promote Changes Process

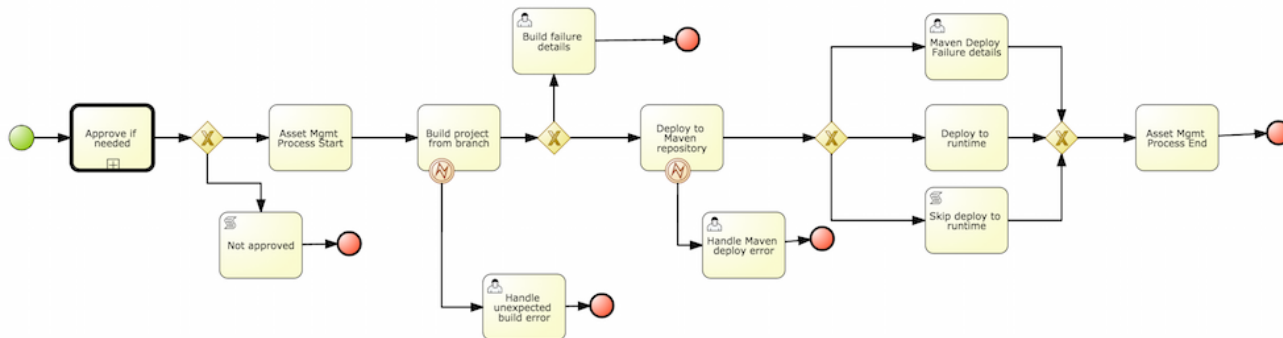
When some work is done in the developments branch and the users reach a point where the changes needs to be tested before going into production, they will start a new Promote Changes process so a more technical user can decide and review what needs to be promoted. The users belonging to the "kiemgmt" group will see a new Task in their Group Task List which will contain all the files that had being changed. The user needs to select the assets that will be promoting via the UI. The underlying process will be cherry-picking the commits selected by the user to the release branch. The user can specify that a review is needed by a more technical user.

This process can be repeated multiple times if needed before creating the artifacts for the release.



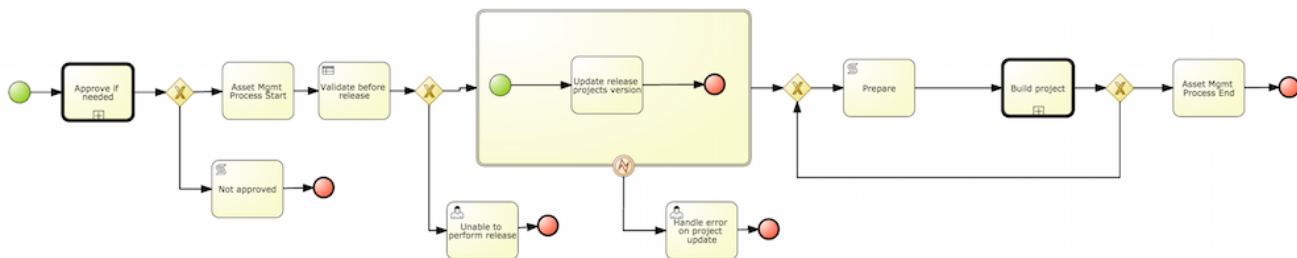
9.9.3.3. Build Process

The Build process can be triggered to build our projects from different branches. This allows us to have a more flexible way to build and deploy our projects to different runtimes.



9.9.3.4. Release Process

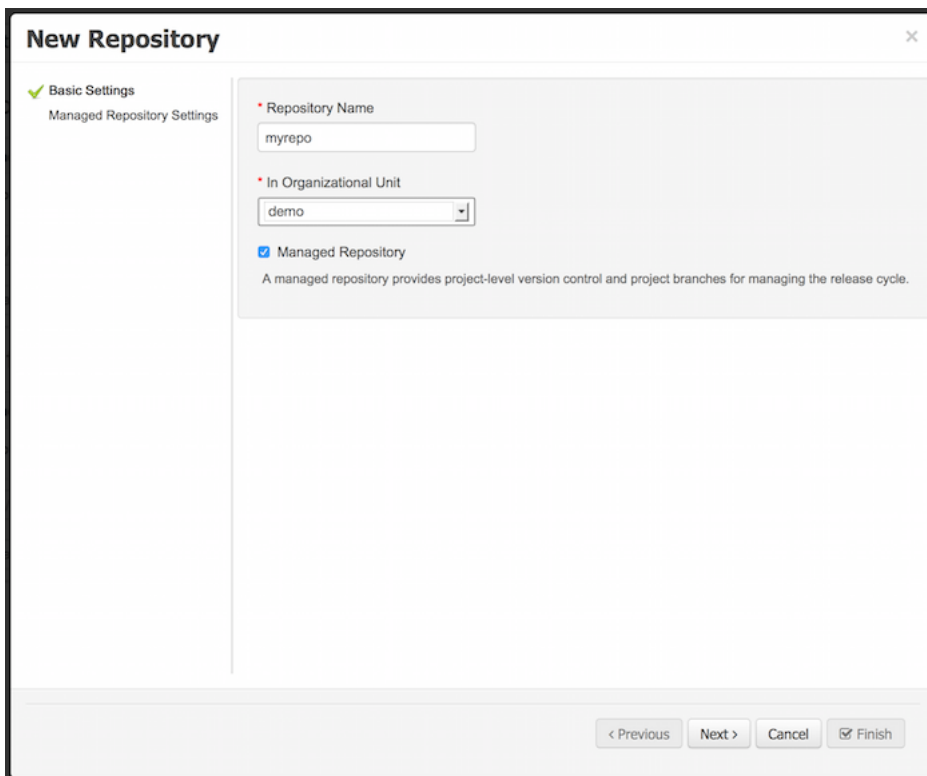
The release process is triggered at any time when the user decided that it is time to generate a release of the project that he/she is working on. This process will build the project (calling the Build Process) and it will update all the maven artifacts to the next version.



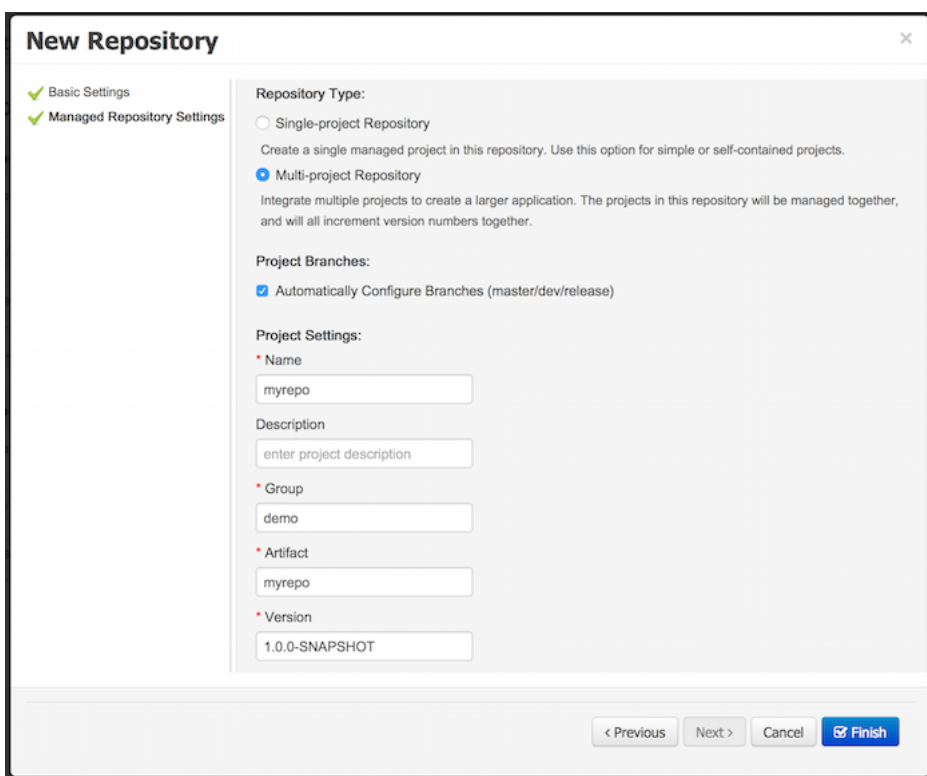
9.9.4. Usage Flow

This section describes the common usage flow for the asset management features showing all the screens involved.

The first contact with the Asset Management features starts on the Repository creation.



If the user chooses to create a Managed Repository a new page in the wizard is enabled:



When a managed repository is created the assets management configuration process is automatically launched in order to create the repository branches, and the corresponding project structure is also created.

9.9.5. Repository Structure

Once a repository has been created it can be managed through the Repository Structure Screen.

To open the Repository Structure Screen for a given repository open the Project Authoring Perspective, browse to the given repository and select the "Repository -> Repository Structure" menu option.

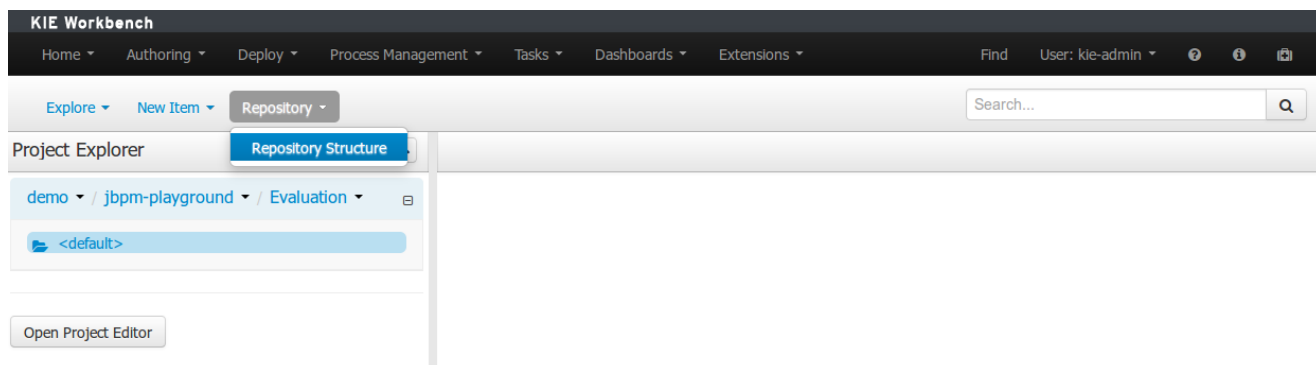


Figure 9.114. Repository Structure Menu

9.9.5.1. Single Project Managed Repository

The following picture shows an example of a single project managed repository structure.

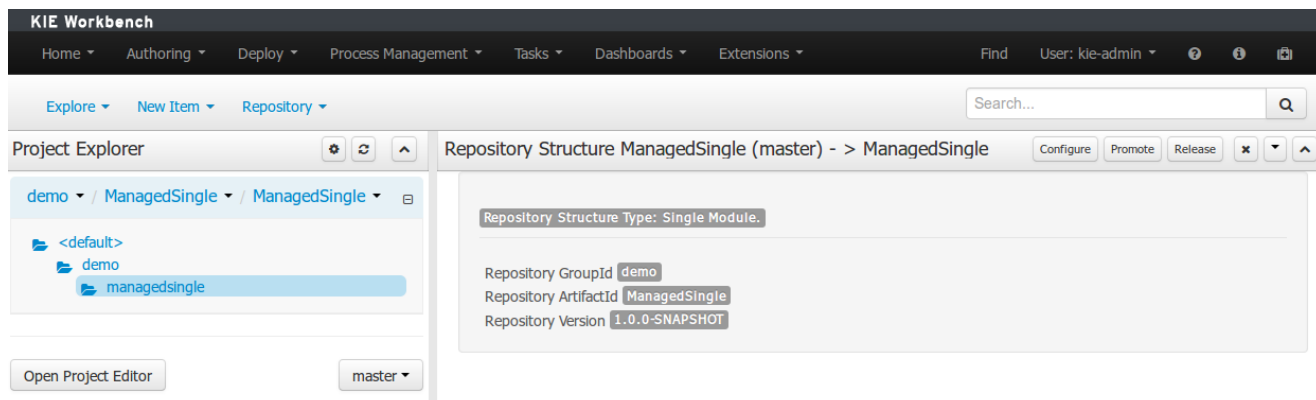


Figure 9.115. Single Project Managed Repository

9.9.5.2. Multi Project Managed Repository

The following picture shows an example of a multi project managed repository structure.

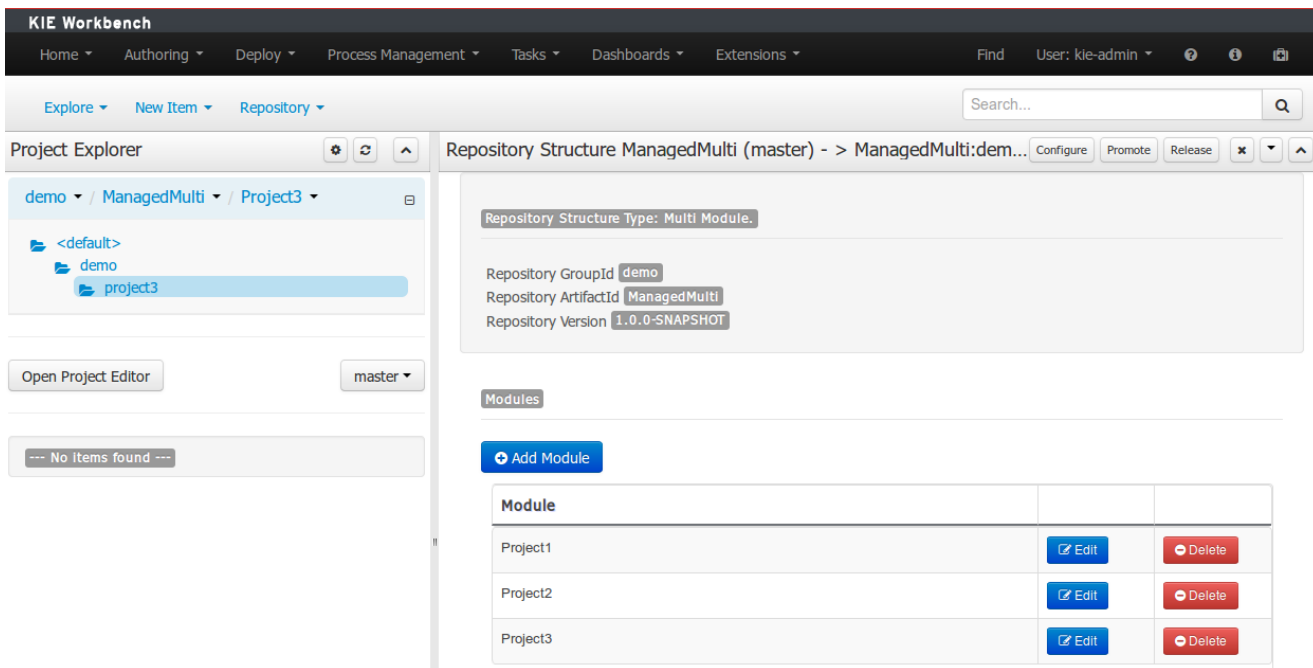


Figure 9.116. Multi Project Managed Repository

9.9.5.3. Unmanaged Repository

The following picture shows an example of an unmanaged repository structure.

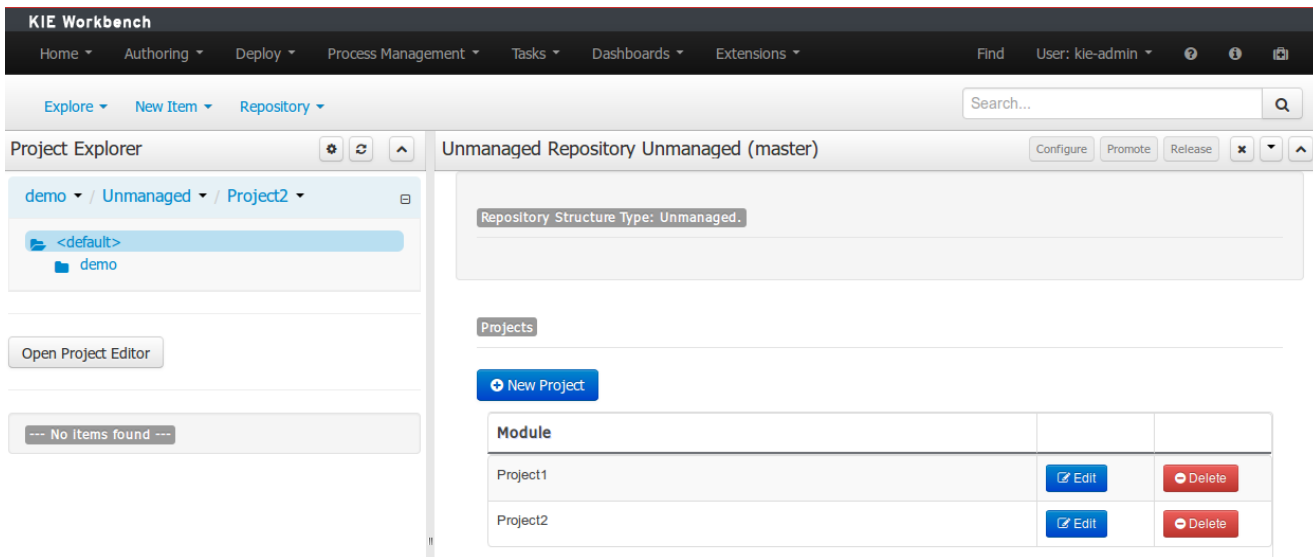


Figure 9.117. Unmanaged Repository

9.9.6. Managed Repositories Operations

The following picture shows the screen areas related to managed repositories operations.

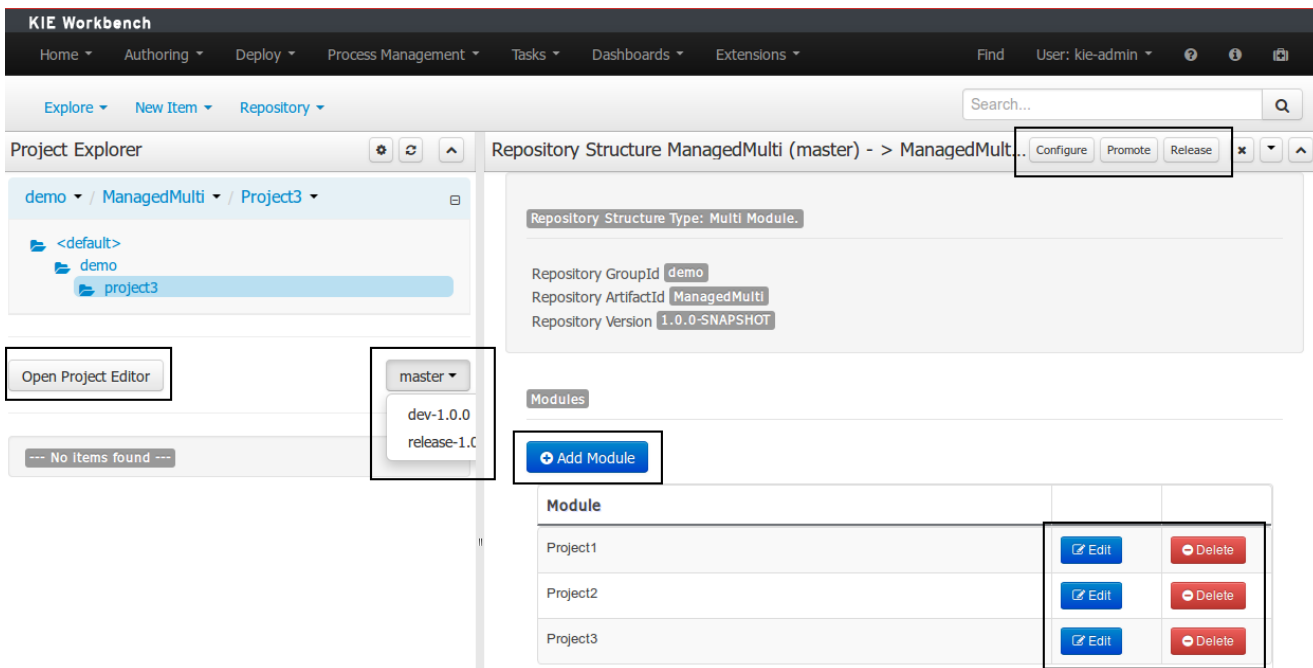


Figure 9.118. Managed Repositories Operations

9.9.6.1. Branch Selector

The branch selector lets to switch between the different branches created by the Configure Repository Process.



Figure 9.119. Branch Selector

9.9.6.2. Project Operations

From the repository structure screen it's also possible to create, edit or delete projects from current repository.

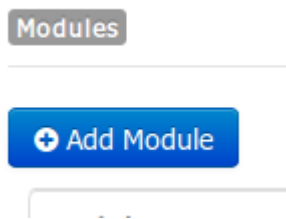


Figure 9.120. Add Project to current structure

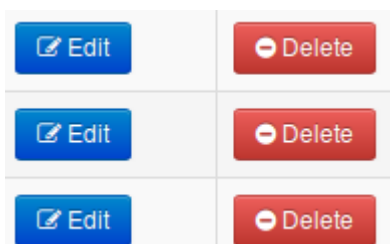


Figure 9.121. Edit/Delete projects from current structure

9.9.6.3. Launch Assets Management Processes

The assets management processes can also be launched from the Project Structure Screen.

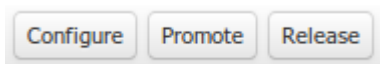


Figure 9.122. Launch Assets Management Processes

9.9.6.3.1. Launch the Configure Repository Process

Filling the parameters below a new instance of the Configure Repository can be started. (see Configure Repository Process)

Configure Repository ✕

Repository
ManagedMulti

Source Branch
dev-1.0.0

* Dev Branch
dev

The branch will be called (dev)-1.0.0-SNAPSHOT

* Release Branch
release

The branch will be called (release)-1.0.0-SNAPSHOT

* Version
1.0.0-SNAPSHOT

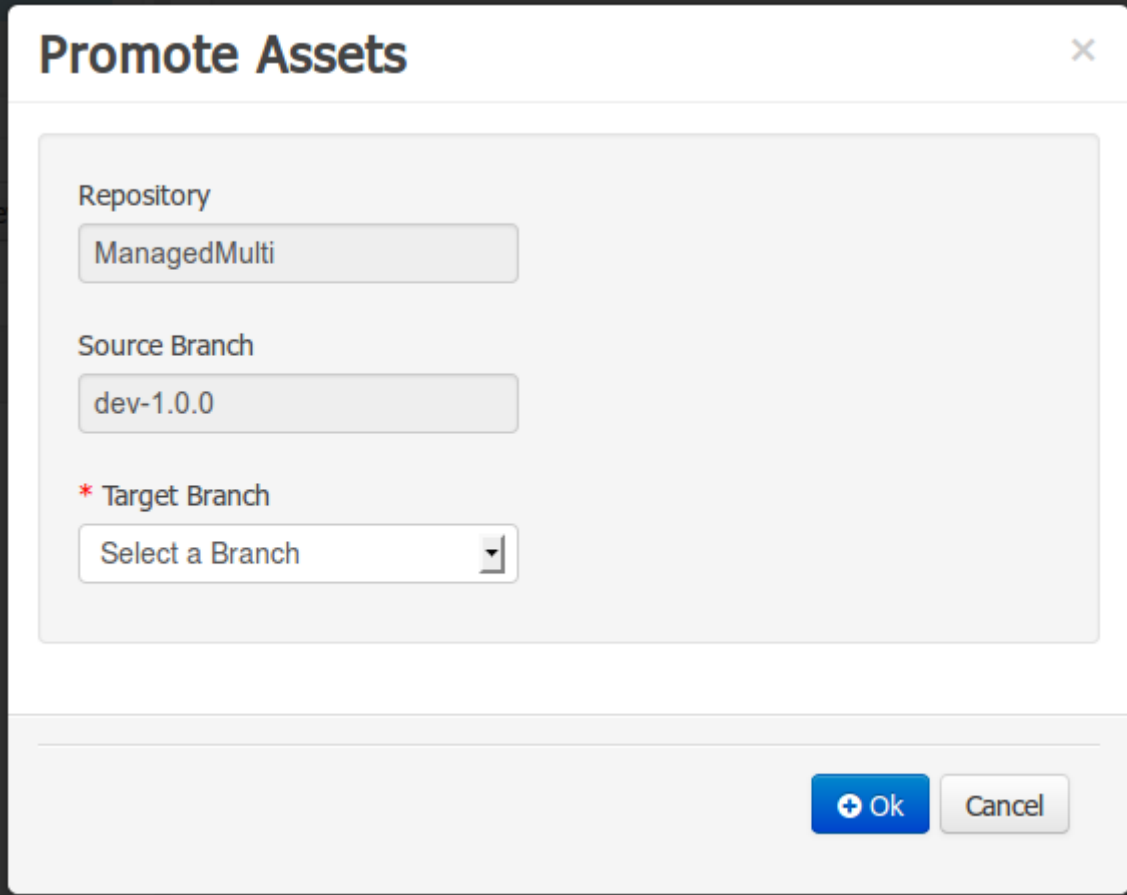
The current repository version is: 1.0.0-SNAPSHOT

Ok Cancel

Figure 9.123. Configure Repository Process Parameters

9.9.6.3.2. Launch the Promote Changes Process

Filling the parameters below a new instance of the Promote Changes Process can be started. (see Promote Changes Process)



Promote Assets ×

Repository
ManagedMulti

Source Branch
dev-1.0.0

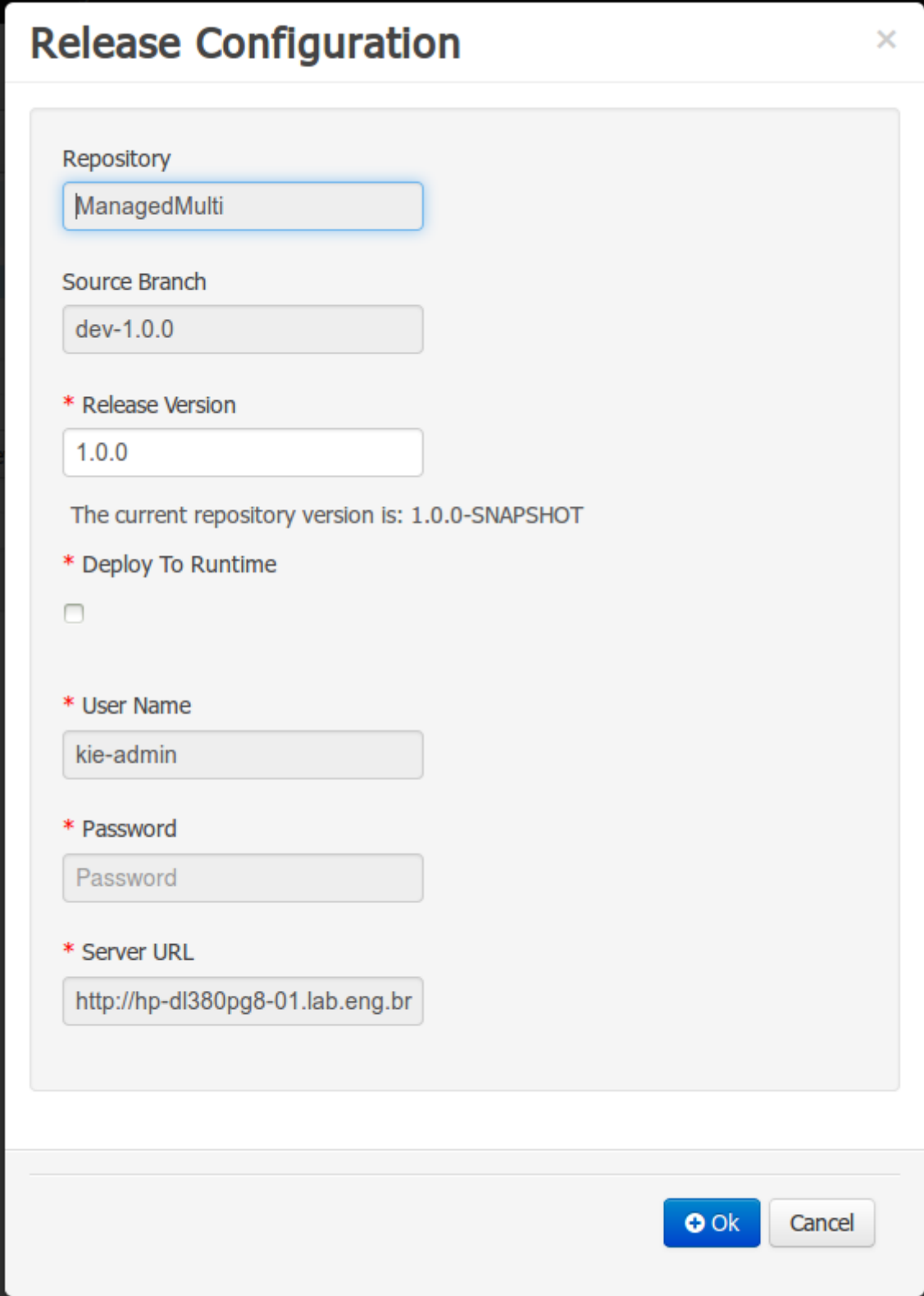
* Target Branch
Select a Branch

+ Ok Cancel

Figure 9.124. Promote Changes Process Parameters

9.9.6.3.3. Launch the Release Process

Filling the parameters below a new instance of the Release Process can be started. (see Release Process)



Release Configuration ✕

Repository
ManagedMulti

Source Branch
dev-1.0.0

* Release Version
1.0.0

The current repository version is: 1.0.0-SNAPSHOT

* Deploy To Runtime

* User Name
kie-admin

* Password
Password

* Server URL
http://hp-dl380pg8-01.lab.eng.br

+ Ok Cancel

Figure 9.125. Release Process Parameters

9.9.7. Remote APIs

TBD

Chapter 10. Workbench Integration

10.1. REST

REST API calls to Knowledge Store allow you to manage the Knowledge Store content and manipulate the static data in the repositories of the Knowledge Store. The calls are asynchronous, that is, they continue their execution after the call was performed as a job. The job ID is returned by every calls to allow after the REST API call was performed to request the job status and verify whether the job finished successfully. Parameters of these calls are provided in the form of JSON entities.

When using Java code to interface with the REST API, the classes used in POST operations or otherwise returned by various operations can be found in the `(org.kie.workbench.services:)kie-wb-common-services` JAR. All of the classes mentioned below can be found in the `org.kie.workbench.common.services.shared.rest` package in that JAR.

10.1.1. Job calls

Every Knowledge Store REST call returns its job ID after it was sent. This is necessary as the calls are asynchronous and you need to be able to reference the job to check its status as it goes through its lifecycle. During its lifecycle, a job can have the following statuses:

- **ACCEPTED**: the job was accepted and is being processed
- **BAD_REQUEST**: the request was not accepted as it contained incorrect content
- **RESOURCE_NOT_EXIST**: the requested resource (path) does not exist
- **DUPLICATE_RESOURCE**: the resource already exists
- **SERVER_ERROR**: an error on the server occurred
- **SUCCESS**: the job finished successfully
- **FAIL**: the job failed
- **DENIED**: the job was denied
- **GONE**: the job ID could not be found

A job can be GONE in the following cases:

- The job was explicitly removed
- The job finished and has been deleted from the status cache (the job is removed from status cache after the cache has reached its maximum capacity)

- The job never existed

The following `job` calls are provided:

[GET] `/jobs/{jobID}`

Returns the job status

Returns a `JobResult` instance

Example 10.1. An example (formatted) response body to the get job call on a repository clone request

```
"{
  "status": "SUCCESS",
  "jobId": "1377770574783-27",
  "result": "Alias: testInstallAndDeployProject, Scheme: git, Uri: git://
testInstallAndDeployProject",
  "lastModified": 1377770578194, "detailedResult": null
}"
```

[DELETE] `/jobs/{jobID}`

Removes the job: If the job is not yet being processed, this will remove the job from the job queue. However, this will not cancel or stop an ongoing job

Returns a `JobResult` instance

10.1.2. Repository calls

Repository calls are calls to the Knowledge Store that allow you to manage its Git repositories and their projects.

The following `repositories` calls are provided:

[GET] `/repositories`

Gets information about the repositories in the Knowledge Store

Returns a `Collection<Map<String, String>>` or `Collection<RepositoryRequest>` instance, depending on the JSON serialization library being used. The keys used in the `Map<String, String>` instance match the fields in the `RepositoryRequest` class

Example 10.2. An example (formatted) response body to the get repositories call

```
[
  {
```

```
"name": "wb-assets",
"description": "generic assets",
"userName": null,
"password": null,
"requestType": null,
"gitURL": "git://bpms-assets"
},
{
"name": "loanProject",
"description": "Loan processes and rules",
"userName": null,
"password": null,
"requestType": null,
"gitURL": "git://loansProject"
}
]
```

[GET] /repositories/{repositoryName}

Gets information about a repository

Returns a `Map<String, String>` of `RepositoryRequest` instance, depending on the JSON serialization library being used. The keys used in the `Map<String, String>` instance match the fields in the `RepositoryRequest` class

Example 10.3. An example (formatted) response body to the get repository call

```
{
  "name": "wb-assets",
  "description": "generic assets",
  "userName": null,
  "password": null,
  "requestType": null,
  "gitURL": "git://bpms-assets"
}
```

[POST] /repositories

Creates a new empty repository or a new repository cloned from an existing (git) repository

Consumes a `RepositoryRequest` instance

Returns a `CreateOrCloneRepositoryRequest` instance

Example 10.4. An example (formatted) response body to the create repositories call

```
{
  "name": "new-project-repo",
  "description": "repo for my new project",
  "userName": null, "password": null,
}
```

```
"requestType": "new",  
"gitURL": null  
}
```

[DELETE] /repositories/{repositoryName}

Removes the repository from the Knowledge Store

Returns a `RemoveRepositoryRequest` instance

[POST] /repositories/{repositoryName}/projects/

Creates a project in the repository

Consumes an `Entity` instance

Returns a `CreateProjectRequest` instance

Example 10.5. An example (formatted) request body that defines the project to be created

```
{  
  "name": "myProject",  
  "description": "my project"  
}
```

[DELETE] /repositories/{repositoryName}/projects/

Deletes the project in the repository

Returns a `DeleteProjectRequest` instance

[GET] /repositories/{repositoryName}/projects/

Gets information about the projects

Returns a `Collection<Map<String, String>>` or `Collection<ProjectResponse>` instance, depending on the JSON serialization library being used. The keys used in the `Map<String, String>` instance match the fields in the `ProjectResponse` class

Example 10.6. An example (formatted) response body to the get projects call

```
[  
  {  
    "name": "wb-assets",  
    "description": "generic assets",  
    "groupId": "org.test",  
    "version": "1.0"  
  },  
  {  
    "name": "loanProject",
```

```
"description":"Loan processes and rules",
"groupId":"com.bank",
"version":"3.7"
}
]
```

10.1.3. Organizational unit calls

Organizational unit calls are calls to the Knowledge Store that allow you to manage its organizational units, so as to organize the connected Git repositories.

The following `organizationalUnits` calls are provided:

[POST] /organizationalunits

Creates an organizational unit in the Knowledge Store

Consumes an `OrganizationalUnit` instance

Returns a `CreateOrganizationalUnitRequest` instance

Example 10.7. An example (formatted) request body defining a new organizational unit to be created

```
{
  "name":"testgroup",
  "description":"",
  "owner":"tester",
  "repositories":["testGroupRepository"]
}
```

[GET] /organizationalunits/{orgUnitName}

Creates an organizational unit

Consumes an `OrganizationalUnit` instance

Returns a `CreateOrganizationalUnitRequest` instance

Example 10.8. An example (formatted) request body defining a new organizational unit to be created

```
{
  "name":"testgroup",
  "description":"",
  "owner":"tester",
  "repositories":["testGroupRepository"]
}
```

[POST] /organizationalunits/{orgUnitName}

Creates an organizational unit in the Knowledge Store

Consumes an `UpdateOrganizationalUnit` instance

Returns a `UpdateOrganizationalUnitRequest` instance

Example 10.9. An example (formatted) request body defining a new organizational unit to be created

```
{
  "name": "testgroup",
  "description": "",
  "owner": "tester",
  "repositories": ["testGroupRepository"]
}
```

[DELETE] /organizationalunits/{organizationalUnitName}

Deletes a organizational unit

Returns a `RemoveOrganizationalUnitRequest` instance

[POST] /organizationalunits/{organizationalUnitName}/repositories/{repositoryName}

Adds the repository to the organizational unit

Returns a `AddRepositoryToOrganizationalUnitRequest` instance

[DELETE] /organizationalunits/{organizationalUnitName}/repositories/{repositoryName}

Removes the repository from the organizational unit

Returns a `RemoveRepositoryFromOrganizationalUnitRequest` instance

10.1.4. Maven calls

Maven calls are calls to a Project in the Knowledge Store that allow you compile and deploy the Project resources.

The following `maven` calls are provided:

[POST] /repositories/{repositoryName}/projects/{projectName}/maven/compile

Compiles the project (equivalent to `mvn compile`)

Consumes a `BuildConfig` instance. While this must be supplied, it's not needed for the operation and may be left blank.

Returns a `CompileProjectRequest` instance

[POST] /repositories/{repositoryName}/projects/{projectName}/maven/install

Installs the project (equivalent to `mvn install`)

Consumes a `BuildConfig` instance. While this must be supplied, it's not needed for the operation and may be left blank.

Returns a `InstallProjectRequest` instance

[POST] `/repositories/{repositoryName}/projects/{projectName}/maven/test`

Compiles the project runs a test as part of compilation

Consumes a `BuildConfig` instance

Returns a `TestProjectRequest` instance

[POST] `/repositories/{repositoryName}/projects/{projectName}/maven/deploy`

Deploys the project (equivalent to `mvn deploy`)

Consumes a `BuildConfig` instance. While this must be supplied, it's not needed for the operation and may be left blank.

Returns a `DeployProjectRequest` instance

10.1.5. REST summary

The URL templates in the table below are relative the following URL:

- `http://server:port/business-central/rest`

Table 10.1. Knowledge Store REST calls

URL Template	Type	Description
<code>/jobs/{jobID}</code>	GET	return the job status
<code>/jobs/{jobID}</code>	DELETE	remove the job
<code>/organizationalunits</code>	GET	return a list of organizational units
<code>/organizationalunits</code>	POST	create an organizational unit in the Knowledge Store described by the JSON <code>OrganizationalUnit</code> entity
<code>/organizationalunits/{organizationalUnitName}/repositories/{repositoryName}</code>	POST	add a repository to an organizational unit
<code>/organizationalunits/{organizationalUnitName}/repositories/{repositoryName}</code>	DELETE	remove a repository from an organizational unit
<code>/repositories/</code>	POST	add the repository to the organizational unit described by the JSON <code>RepositoryRequest</code> entity

URL Template	Type	Description
/repositories	GET	return the repositories in the Knowledge Store
/repositories/{repositoryName}	DELETE	Remove the repository from the Knowledge Store
/repositories/	POST	create or clone the repository defined by the JSON <code>RepositoryRequest</code> entity
/repositories/{repositoryName}/projects/	POST	create the project defined by the JSON entity in the repository
/repositories/{repositoryName}/projects/{project-Name}/maven/compile/	POST	compile the project
/repositories/{repositoryName}/projects/{project-Name}/maven/install	POST	install the project
/repositories/{repositoryName}/projects/{project-Name}/maven/test/	POST	compile the project and run tests as part of compilation
/repositories/{repositoryName}/projects/{project-Name}/maven/deploy/	POST	deploy the project

Chapter 11. Workbench High Availability

11.1.1. VFS clustering

The VFS repositories (usually git repositories) stores all the assets (such as rules, decision tables, process definitions, forms, etc). If that VFS resides on each local server, then it must be kept in sync between all servers of a cluster.

Use Apache Zookeeper [<http://zookeeper.apache.org/>] and Apache Helix [<http://helix.incubator.apache.org/>] to accomplish this. Zookeeper glues all the parts together. Helix is the cluster management component that registers all cluster details (nodes, resources and the cluster itself). Uberfire (on top of which Workbench is build) uses those 2 components to provide VFS clustering.

To create a VFS cluster:

1. Download Apache Zookeeper [<http://zookeeper.apache.org/>] and Apache Helix [<http://helix.incubator.apache.org/>].
2. Install both:
 - a. Unzip Zookeeper into a directory (`$ZOOKEEPER_HOME`).
 - b. In `$ZOOKEEPER_HOME`, copy `zoo_sample.conf` to `zoo.conf`
 - c. Edit `zoo.conf`. Adjust the settings if needed. Usually only these 2 properties are relevant:

```
# the directory where the snapshot is stored.dataDir=/tmp/zookeeper# the port at which the
clients will connectclientPort=2181
is
stored.dataDir=/tmp/zookeeper# the port at which the clients
```

- d. Unzip Helix into a directory (`$HELIX_HOME`).
3. Configure the cluster in Zookeeper:
 - a. Go to its `bin` directory:

```
$ cd $ZOOKEEPER_HOME/bin
```

- b. Start the Zookeeper server:

```
$ sudo ./zkServer.sh start
```

If the server fails to start, verify that the `dataDir` (as specified in `zoo.conf`) is accessible.

- c. To review Zookeeper's activities, open `zookeeper.out`:

```
$ cat $ZOOKEEPER_HOME/bin/zookeeper.out
```

4. Configure the cluster in Helix:

- a. Go to its `bin` directory:

```
$ cd $HELIX_HOME/bin
```

- b. Create the cluster:

```
$ ./helix-admin.sh --zkSvr localhost:2181 --addCluster kie-cluster
```

The `zkSvr` value must match the used Zookeeper server. The cluster name (`kie-cluster`) can be changed as needed.

- c. Add nodes to the cluster:

```
# Node 1
$ ./helix-admin.sh --zkSvr localhost:2181 --addNode kie-cluster nodeOne:12345
# Node 2
$ ./helix-admin.sh --zkSvr localhost:2181 --addNode kie-cluster nodeTwo:12346
...
```

Usually the number of nodes `a` in cluster equal the number of application servers in the cluster. The node names (`nodeOne:12345`, ...) can be changed as needed.



Note

`nodeOne:12345` is the unique identifier of the node, which will be referenced later on when configuring application servers. It is not a host and port number, but instead it is used to uniquely identify the logical node.

- d. Add resources to the cluster:

```
$ ./helix-admin.sh --zkSvr localhost:2181 --addResource kie-cluster vfs-repo 1 LeaderS
tandby AUTO_REBALANCE
```

The resource name (`vfs-repo`) can be changed as needed.

- e. Rebalance the cluster to initialize it:

```
$ ./helix-admin.sh --zkSvr localhost:2181 --rebalance kie-cluster vfs-repo 2
```

- f. Start the Helix controller to manage the cluster:

```
$ ./run-helix-controller.sh --zkSvr localhost:2181 --cluster kie-cluster 2>&1 > /tmp/
controller.log &
```

5. Configure the security domain correctly on the application server. For example on WildFly and JBoss EAP:

- a. Edit the file `$JBOSS_HOME/domain/configuration/domain.xml`.

For simplicity sake, presume we use the default domain configuration which uses the profile `full` that defines two server nodes as part of `main-server-group`.

- b. Locate the profile `full` and add a new security domain by copying the other security domain already defined there by default:

```
<security-domain name="kie-ide" cache-type="default">  <authentication>  <login-
module code="Remoting" flag="optional">  <module-option name="password-stacking"
value="useFirstPass"/>  </login-module>  <login-module code="RealmDirect"
flag="required">  <module-option name="password-stacking" value="useFirstPass"/
>  </login-module>  </authentication></security-domain>
ide" cache-type="default">
  <authentication>  <login-module
code="Remoting" flag="optional">  <module-option name="password-
stacking" value="useFirstPass"/>
</login-module>  <login-module
code="RealmDirect" flag="required">  <module-option name="password-
stacking" value="useFirstPass"/>
</login-module>
</>
```



Important

The security-domain name is a magic value.

6. Configure the system properties for the cluster on the application server. For example on WildFly and JBoss EAP:

- a. Edit the file `$JBOSS_HOME/domain/configuration/host.xml`.
- b. Locate the XML elements `server` that belong to the `main-server-group` and add the necessary system property.

For example for nodeOne:

```
<system-properties>
  <property name="jboss.node.name" value="nodeOne" boot-time="false"/>
  <property name="org.uberfire.nio.git.dir" value="/tmp/kie/nodeone" boot-time="false"/>
    <property name="org.uberfire.metadata.index.dir" value="/tmp/kie/nodeone" boot-
time="false"/>
  <property name="org.uberfire.cluster.id" value="kie-cluster" boot-time="false"/>
  <property name="org.uberfire.cluster.zk" value="localhost:2181" boot-time="false"/>
  <property name="org.uberfire.cluster.local.id" value="nodeOne_12345" boot-time="false"/>
  <property name="org.uberfire.cluster.vfs.lock" value="vfs-repo" boot-time="false"/>
  <!-- If you're running both nodes on the same machine: -->
  <property name="org.uberfire.nio.git.daemon.port" value="9418" boot-time="false"/>
</system-properties>
```

And for nodeTwo:

```
<system-properties>
  <property name="jboss.node.name" value="nodeTwo" boot-time="false"/>
  <property name="org.uberfire.nio.git.dir" value="/tmp/kie/nodetwo" boot-time="false"/>
    <property name="org.uberfire.metadata.index.dir" value="/tmp/kie/nodetwo" boot-
time="false"/>
  <property name="org.uberfire.cluster.id" value="kie-cluster" boot-time="false"/>
  <property name="org.uberfire.cluster.zk" value="localhost:2181" boot-time="false"/>
  <property name="org.uberfire.cluster.local.id" value="nodeTwo_12346" boot-time="false"/>
  <property name="org.uberfire.cluster.vfs.lock" value="vfs-repo" boot-time="false"/>
  <!-- If you're running both nodes on the same machine: -->
  <property name="org.uberfire.nio.git.daemon.port" value="9419" boot-time="false"/>
</system-properties>
```

Make sure the cluster, node and resource names match those configured in Helix.

11.1.2. jBPM clustering

In addition to the information above, jBPM clustering requires additional configuration. See this blog post [<http://mswidorski.blogspot.com.br/2013/06/clustering-in-jbpm-v6.html>] to configure the database etc correctly.

Chapter 12. Designer

Designer is a graphical web-based BPMN2 editor. It allows users to model and simulate executable BPMN2 processes. The main goal of Designe is to provide intuitive means to both technical and non-technical users to quickly create their executable business processes. This chapter intends to describe all feature Designer offers currently.

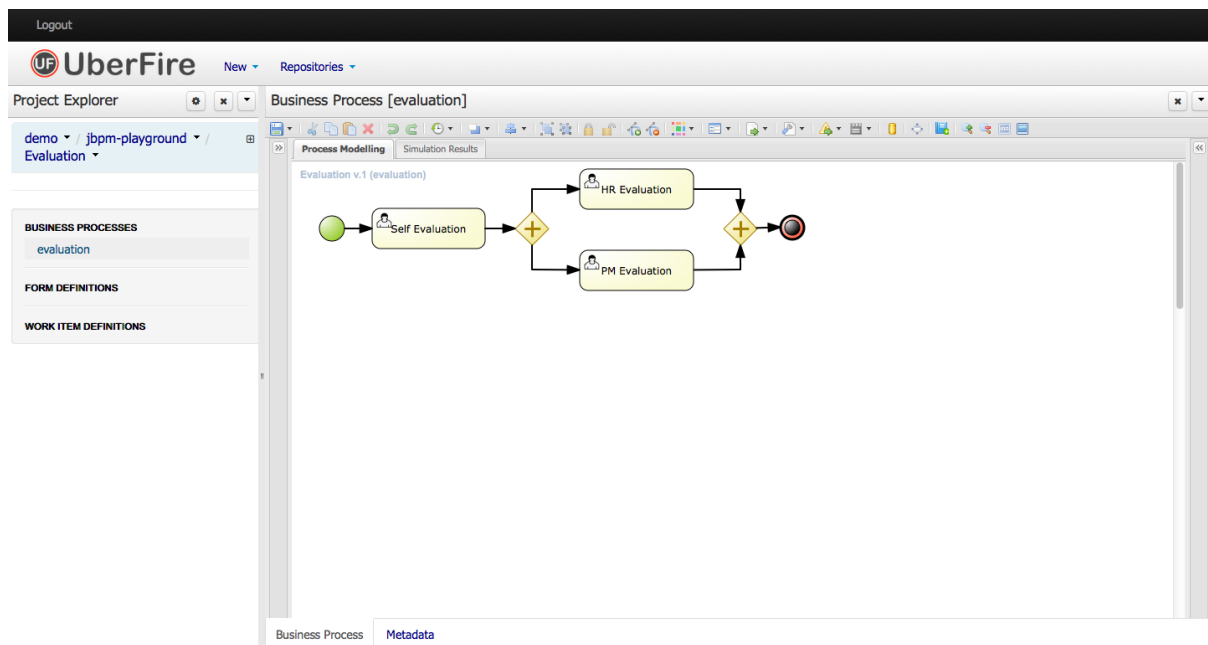


Figure 12.1. Designer

Designer targets the following business process modelling scenarios:

- View and/or edit existing BPMN2 processes: Designer allows you to open existing BPMN2 processes (for example created using the BPMN2 Eclipse editor or any other tooling that exports BPMN2 XML).
- Create fully executable BPMN2 processes: A user can create a new BPMN2 process in the Designer and use the editing capabilities (drag and drop and filling in properties in the properties panel) to fill in the details. This for example allows business users to create complete business processes all inside a browser. The integration with Drools Guvnor allows for your business processes as well as other business assets such as business rules, process forms/images, etc. to be stored and versioned inside a content repository.
- View and/or edit Human Task forms during process modelling (using the in-line form editor or the Form Modeller).
- Simulate your business process models. Business Process Simulation is based on the BPSIM 1.0 specification.

Designer supports all BPMN2 elements that are also supported by jBPM as well as all jBPM-specific BPMN2 extension elements and attributes.

12.1. Designer UI Explained

Designer UI is composed of a number of sections as shown below:

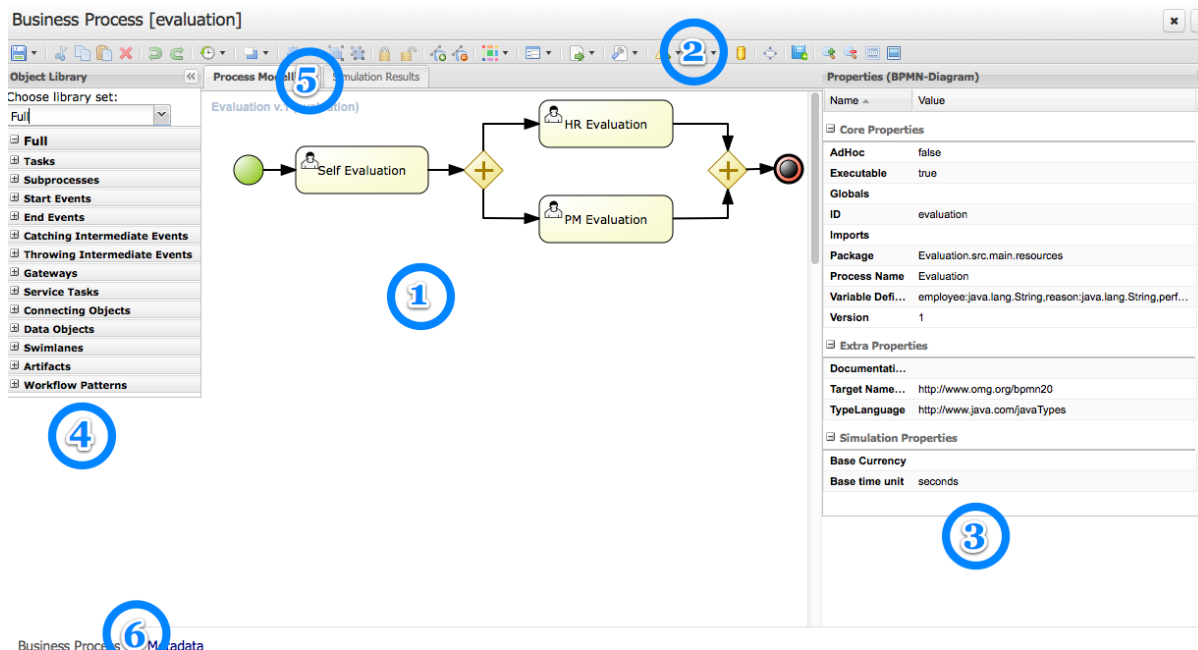


Figure 12.2. Designer sections

- (1) Modelling Canvas - this is your process drawing board. After dropping different shapes onto the canvas, you can move them around, connect them, etc. Clicking on a shape on the canvas allows you to set its properties in the expandable Properties Window (3) (as well as create connecting shapes and morph the shape into other shapes).
- (2) Toolbar - the toolbar contains a vast number of functions offered by Designer (described later). These includes operations that can be performed on shapes present on the Canvas. Individual operations are disabled or enabled depending on what is selected. For example, if no shapes are selected, the Cut/Paste/Delete operations are disabled, and become enabled once you select a shape. Hovering over the icons in the Toolbar displays the description text of the operation.
- (3) Properties Panel - this expandable section on the right side of Designer allows you to set both process and shape properties. It is divided in four sections, namely "Core properties", and "Extra Properties", "Graphical Settings", and "Simulation Properties" are is expandable. When clicking on a shape in the Canvas, this panel is reloaded to show properties specific to the shape type. If you click on the canvas itself (not on a shape) the section shows your general process properties.

- (4) Object Repository Panel - the expandable section on the left side of Designer shows the jBPM BPMN2 (default) shape repository tree. It includes all shapes of the jBPM BPMN2 stencil set which can be used to assemble your processes. If you expand each section sub-group you can see the BPMN2 elements that can be placed onto the Designer Canvas (1) by dragging and dropping the shape onto it.
- (5) View Tabs - currently Designer offers functionality tabs for Process Modelling and Simulation. Process Modelling is the default tab. When users run process simulation, its results are presented in the Simulation tab.
- (6) Info Tabs - On the bottom Designer shows two different Info tabs. The Business Process tab includes the process modeling while the Metadata tab displays the process metadata such as created by and last modified information.

12.2. Getting started with Modelling

The Object Repository panel provide means for users to select and drag/drop BPMN2 shapes onto the modelling canvas. Shapes are divided into sections as shown below:

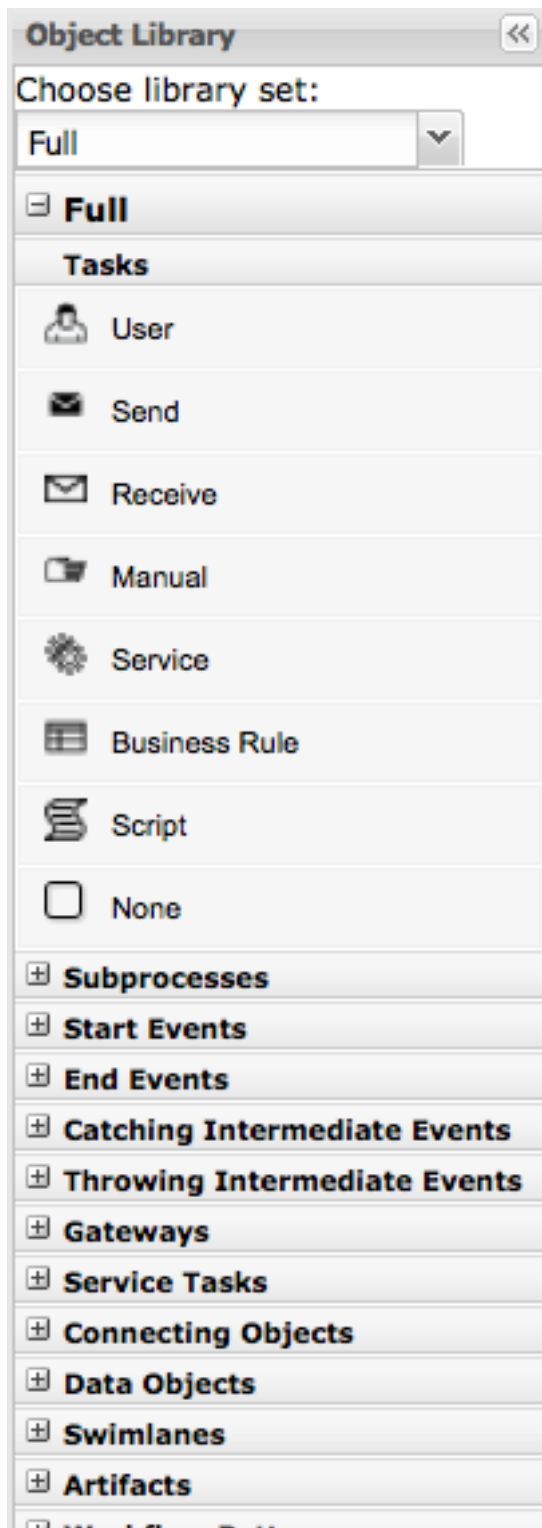


Figure 12.3. Object Repository

Once a shape is dropped onto the canvas users have a much faster way of continuing modelling without having to go back to the Object Repository panel. This is realized through the shape morphing menu which is presented when a shape on the drawing canvas is clicked on. This menu

allows users to either select a connecting shape (next shape) or morph the selected node into another node type. In addition this menu includes means to store the shape name as a dictionary item (explained later), view the specific BPMN2 code of the selected shape, as well as create/edit the task form (in the case of user tasks only).

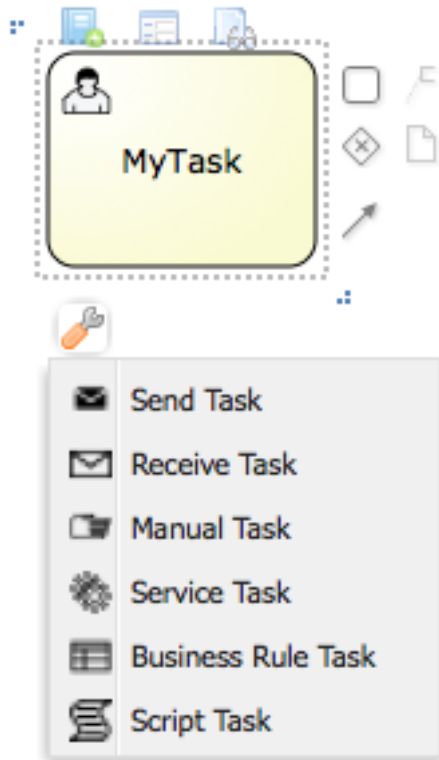


Figure 12.4. Morphing Menu for shapes

When connecting shapes Designer applies connection rules that follow the BPMN2 specification. The connection shapes presented in the morphing menu only show shapes that are allowed to be connections. Similarly same rules are applied when dropping a shape from the Object Library from the canvas and trying to connect an existing shape to it. Additional connection rules for boundary events are also available (explained later) and applied when for example moving an intermediate event node onto the edge of a task node.

Users can give names to every shape on the drawing canvas. This is done by double-clicking onto the shape as shown below.

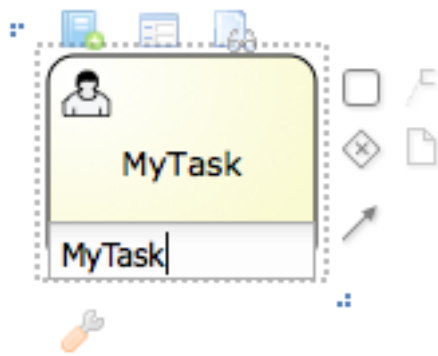


Figure 12.5. Naming a shape

The name of a shape can be pulled from the Process Dictionary. If terms are set up in the dictionary, auto-complete can be used for the node names:

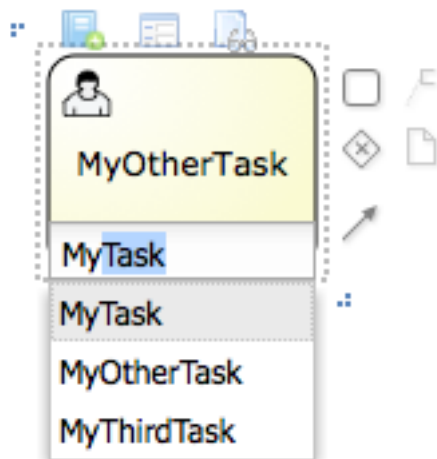


Figure 12.6. Name auto-completion from dictionary

Designer also shows three buttons on top of a clicked shape as shown below.

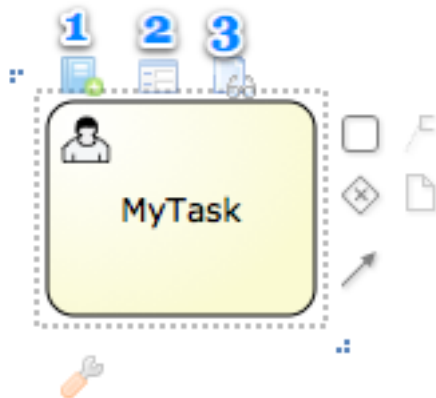


Figure 12.7. Extra in-line options

These include:

- (1) Add To Dictionary - this option allows users to add the name of the task to the Process Dictionary (explained in more details later)
- (2) Edit Task Form - allows users to create/edit the Task Form. This option is only available for User Tasks
- (3) View shape sources - shows the BPMN2 for this particular shape only.

The section should get you started with creating simple business process models by dragging/dropping BPMN2 shapes onto the drawing canvas. Next sections will dive deeper into many other aspects of Designer.

12.3. Designer Toolbar

The Designer toolbar contains many different functions which can be used during process modelling.

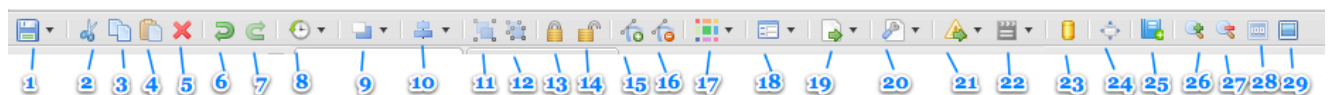


Figure 12.8. Toolbar Buttons

We will now go through each of the buttons in the Designer Toolbar and give a brief overview of what it does.

- (1) Save - allows users to save, copy, rename and delete the business process model. In addition users can turn on auto-save which will automatically save the business process within a defined time interval.

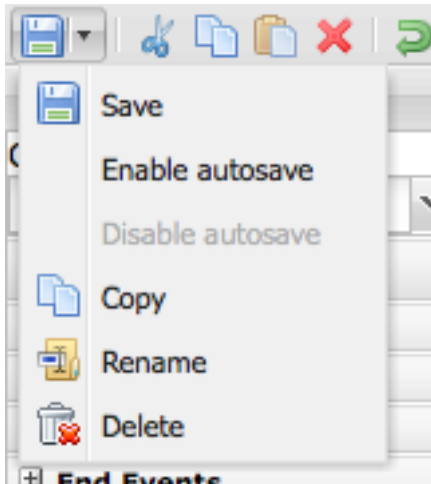


Figure 12.9. Save Button

(2) Cut - enabled when a portion of the model is selected.

(3) Copy - enabled when a portion of the model is selected.

(4) Paste - paste the copied portion of the model onto the drawing board.

(5) Delete - enabled when there is a portion of the model is selected and removes it.

(6, 7) Undo/Redo - undo the last performed operation on the drawing canvas.

(8) Local History - local history allows continuous storage of your business process onto your browsers internal storage. Stored version of the business process can persist internet outages or browser crashes so your work will not be lost. This feature is disabled by default and must be enabled by users. Once local history has been enabled users are able to view all previously stored snapshots of their business model, clear local history, configure the snapshot interval, or disable local history. Note that local history will only take a snapshot of your business process on the set storing interval if there were some changes done in the model. If at the end of the snapshot interval Designer detects that there were no changes since the last local history save, no new snapshot will be created.

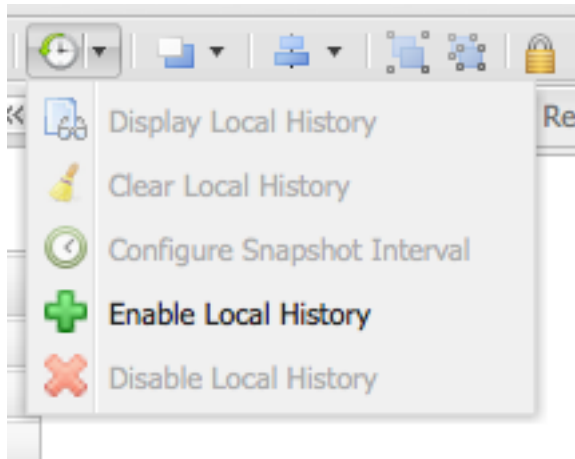


Figure 12.10. Local History

The Local History results screen allows users to select a stored snapshot of the model and view its process image, and restore it back onto their drawing board.

Local History View						Executable	true
Select Process Id and click "Restore" to restore.							
Id	Name	Package	Version	Time Stamp	Process Image		
1	evaluation	Evaluation	Evaluation.src.main.resou...	1	15.11.2013 06:37:40		

Figure 12.11. Local History Sample Results

(9) Object positioning - allows users to position one or more nodes in the business. Note that at last one shape must be selected first, otherwise these options are disable. Contains options "Bring to Front", "Bring to back", "Bring forward", and "Bring Backward"

(10) Alignment: enabled when a portion of the model is selected. Includes options "Align Bottom", "Align Middle", "Align Top", "Align Left", "Align Center", "Align Right", and "Align Same Size".

(11, 12) Group and Ungroup - allows grouping and ungrouping of selected shapes on the drawing board.

(13, 14) Locking and Unlocking - allows parts of the business model to be locked and unlocked. Locked parts of the model cannot be edited (visual display and properties are both locked). Locked nodes are displayed in a light blue color. This feature fosters collaboration of process modelling by allowing users to set parts of their model as "completed" and preventing any further changes to that portion. Other parts of the model can continue to be edited.

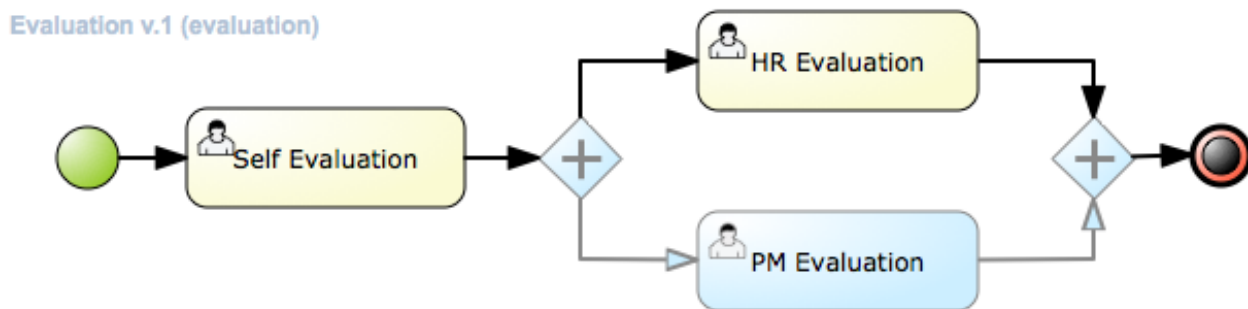


Figure 12.12. Locked Nodes

(15, 16) Add/Remove Docker - this allows users to add or remove Dockers, or edge points, to sequence flows in the model. Enables when a sequence flow (connector) is selected. It allows users to create very customized connection points from one shape to another. Users can add and remove as many dockers as they would like on a single sequence flow.

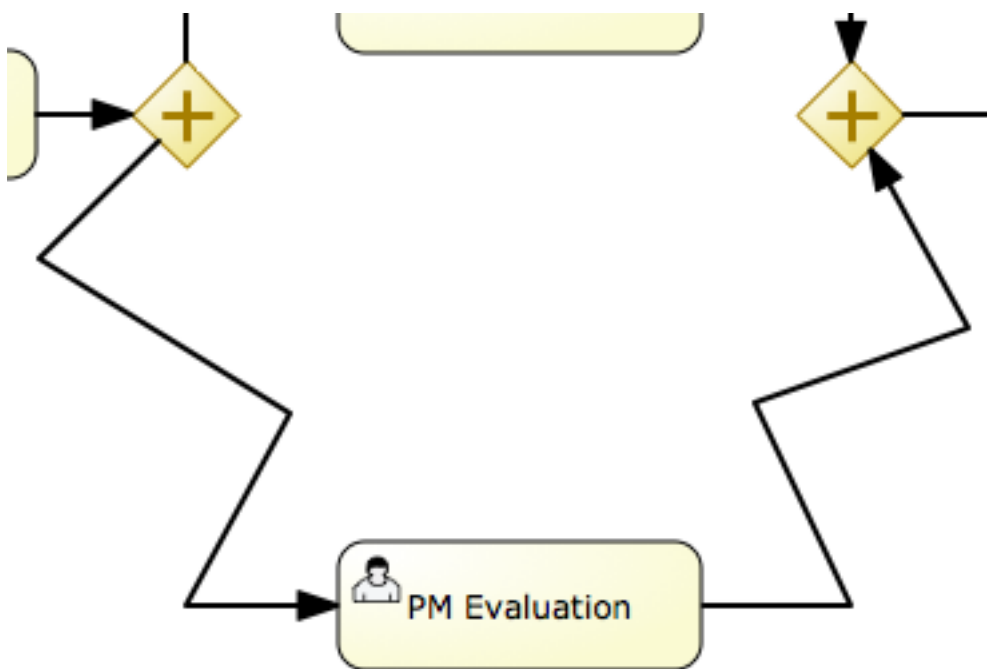


Figure 12.13. Adding dockers to a sequence flow

(17) Color Themes - Colors are a big part of process modelling as they help with expressing intent as well as help allowing visually impaired users to better view the model. Designer provides two default color themes out of the box named "jBPM" and "High Contrast". The jBPM theme is the default theme used for all new business processes created. Users can switch color themes and the changes will be applied to all nodes that are currently on the model, as well as any new shapes added. Users have the ability to add new custom color themes by adding their own definitions in the Designer themes.json file. Color theme selection is persisted over browser close or possible crash/internet loss.

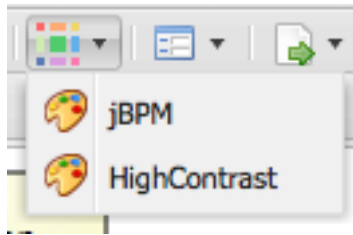


Figure 12.14. Color Themes selection

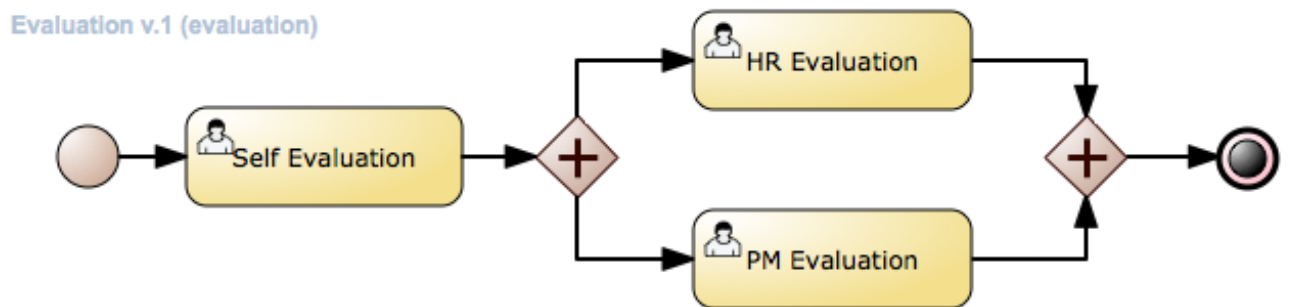


Figure 12.15. Switching to High Contrast Color Theme

(18) Process and Task forms - here users have the ability to generate/edit process and task forms. When no user task is selected the default enabled options are "Edit Process Form" and "Generate all Forms". Generate all forms will apply the current model information such as process variables, data objects, and the user tasks data input/output parameters and associations to generate default executable input forms. Upon editing a process and task form, users have the choice between two form editors, the jBPM Form Modeler, and the Designer in-line meta editor. The Designer meta editor is targeted more to technical users as it is text based with the ability for live preview. When the user selects an user task in the model, the "Edit Task Form" and "Generate Task Form" options are enabled which allow users to edit the particular task form, or choose to apply the same generation logic to create a task form for the selected task only. Users have the ability to extend the default form generation templates in designer to create fully customized templates. Note that in the case of the Designer meta editor for forms, generating forms will overwrite existing forms for the process and user tasks. In the case of Form Modeler form generation, a merging algorithm is applied when generating.

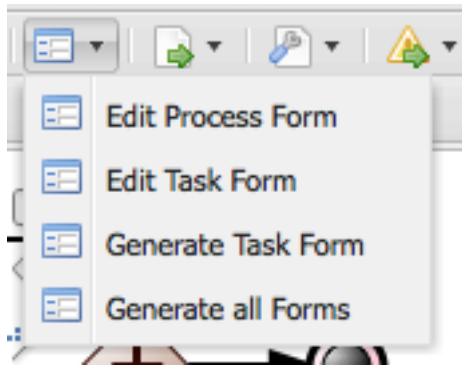


Figure 12.16. Form generation selection

When selecting a task, users have the ability to edit the selected tasks form via the form button shown above the user task node.

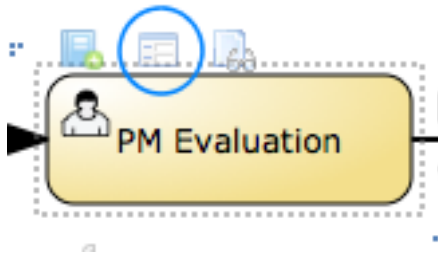


Figure 12.17. In-line task editing

When editing forms, users are asked to choose between the Form Modeler and the Designer in-line meta editor. If the user selects Form Modeler the form is shown in a new asset tab separately from Designer. Designer meta editor is in-line and part of the Designer application.

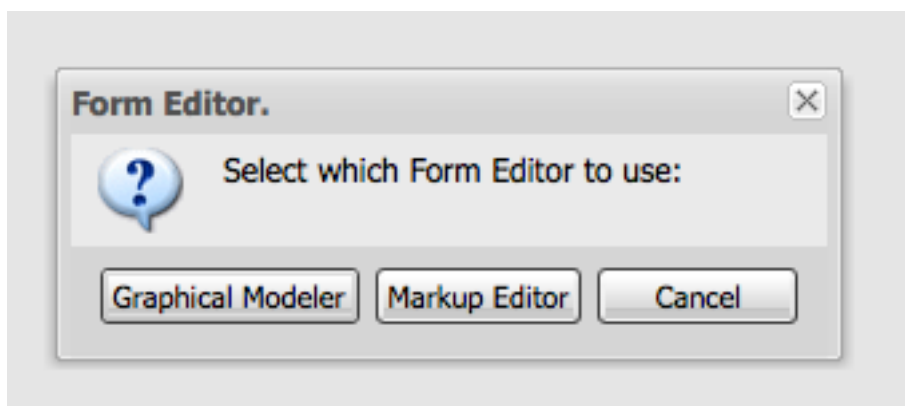


Figure 12.18. Form Editor Selection

The Designer in-line meta form editor is a powerful text-based editor with a live preview feature as well as auto-completion on process variables and user task data inputs/outputs.

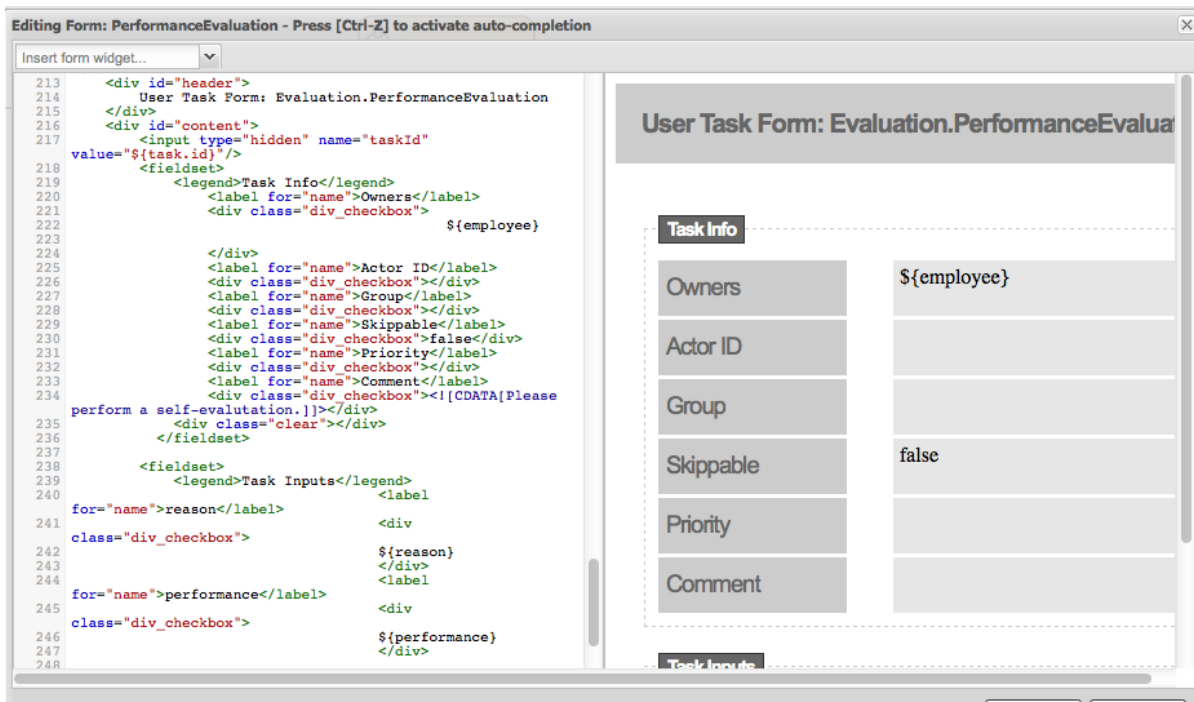


Figure 12.19. Designer in-line form meta editor with live-preview

(19) Process Information Sharing - this section includes many functions that help with sharing information of your model. These include:

- Share process image - generates a stand-alone HTML image tag which contains a Base64 encoded image source of the current model on the canvas. This link can be shared to team members or other parties and embedded in any HTML content or email that allows HTML content embedding.
- Share process PDF - generates a stand-alone HTML object tag which contains a Base64 encoded PDF source of the current model on the canvas. This can similarly be shared and embedded in any HTML content.
- Download process PNG - generates a PNG image of the current process on the drawing board which users can download and share.
- Download process PDF - generates a PDF of the current process on the drawing board which can be downloaded and shared.
- View Process Sources - displays the current process sources in various formats, namely BPMN2, JSON, SVG, and ERDF. Also has the option to download the BPMN2 sources.

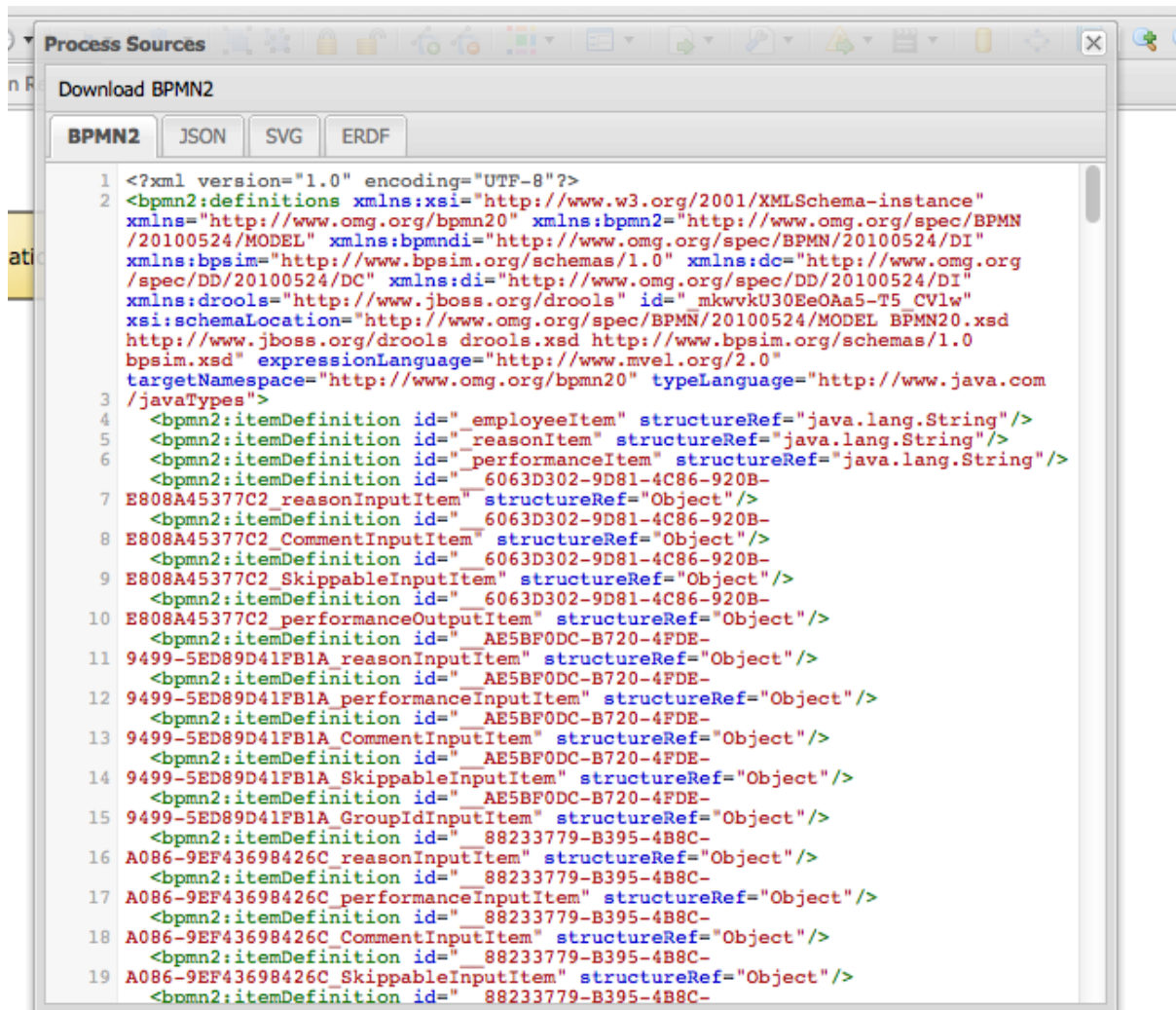


Figure 12.20. Process Sources View

(20) Extra tooling - this section allows users to import their existing BPMN2 processes into designer as well as be able to migrate their old jPDL based processes to BPMN2. For BPMN2 or JSON imports users can choose to add the import on top of the existing model on the drawing board or choose to replace the current one with the import.

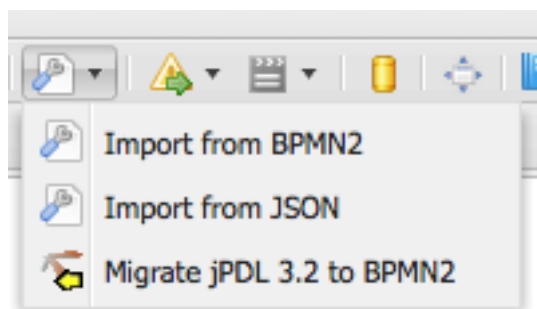


Figure 12.21. Extra tooling section

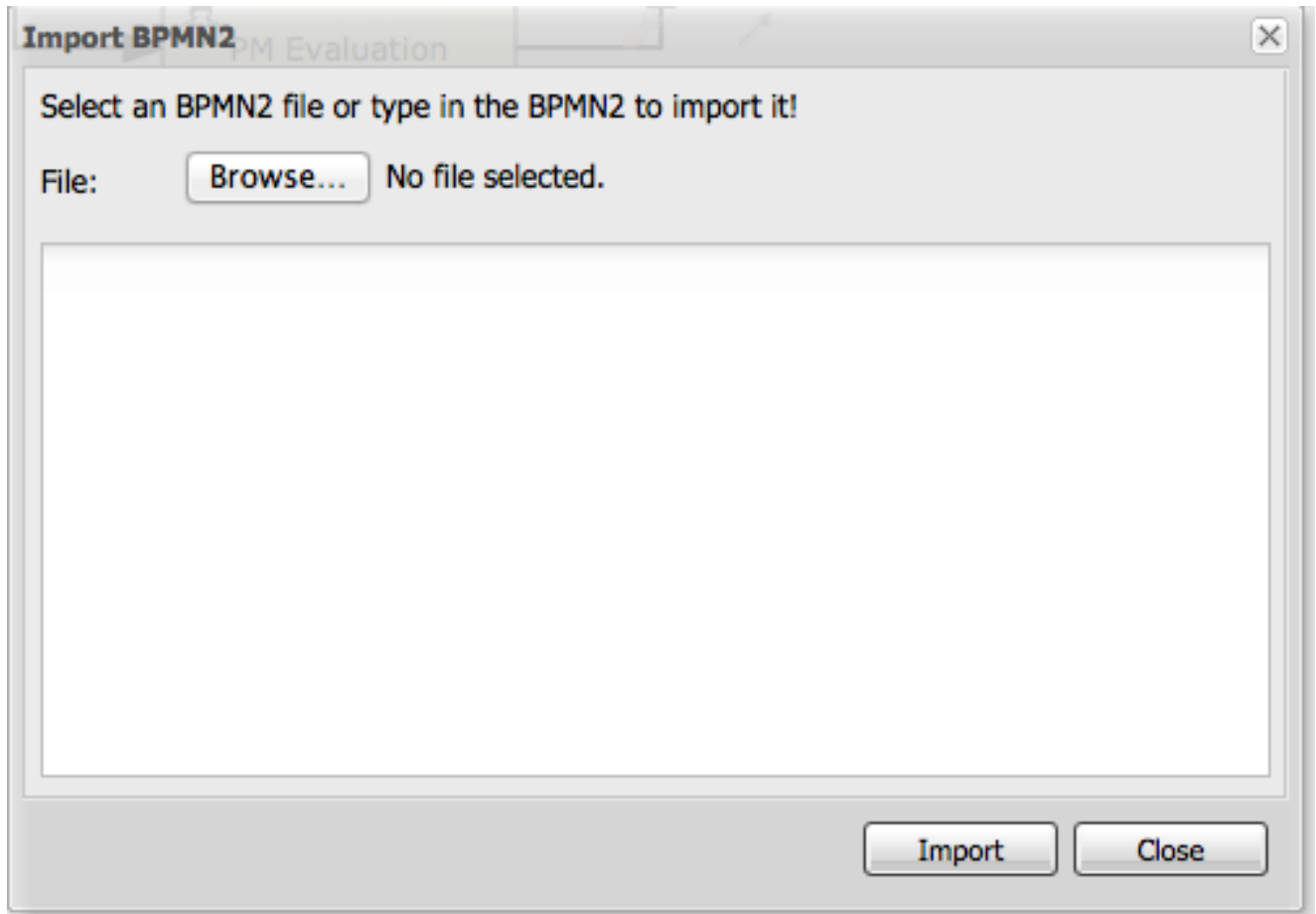


Figure 12.22. Import existing BPMN2 panel

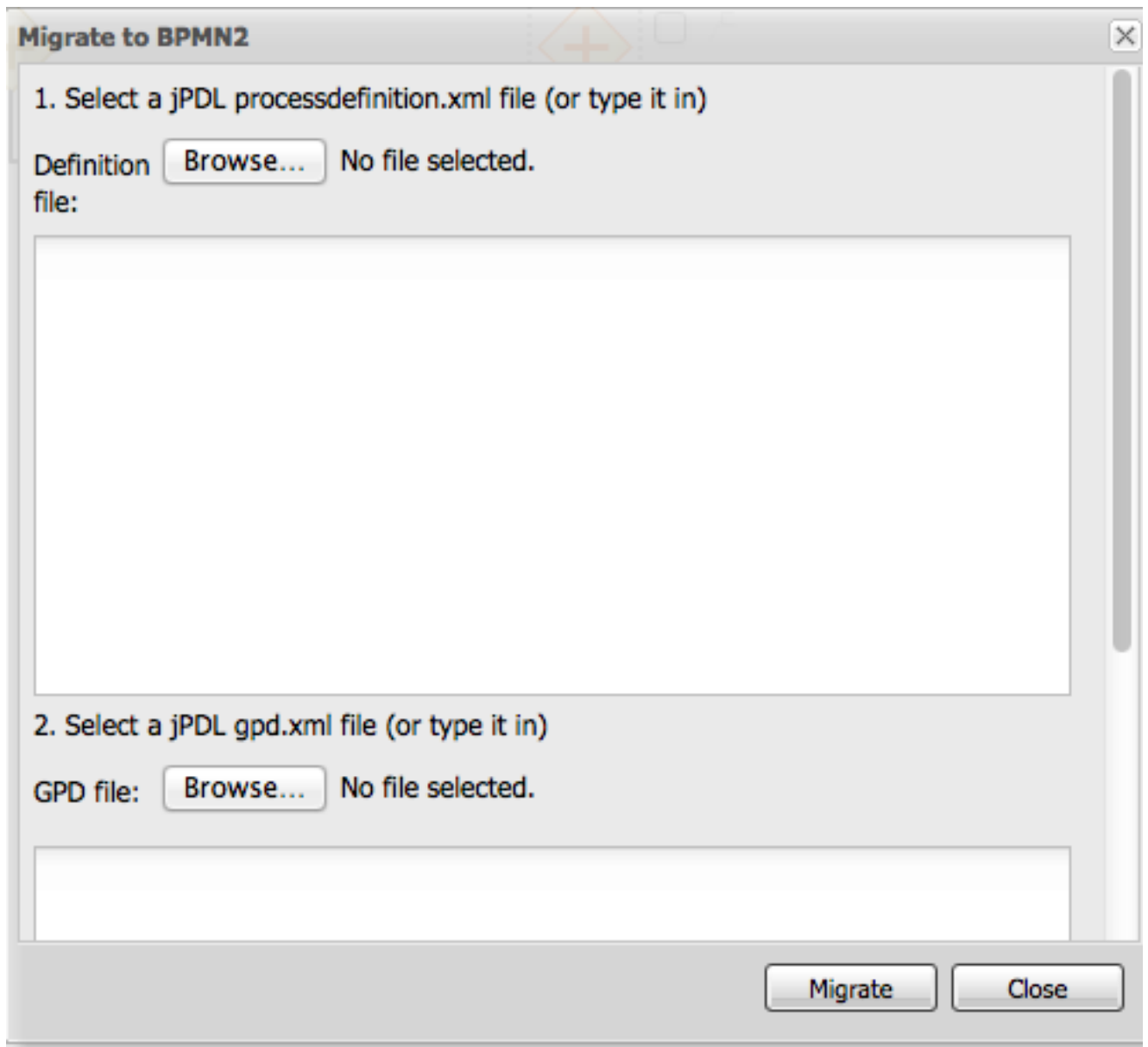


Figure 12.23. Process Migration panel

(21) Visual Validation - Designer includes over 100 validation checks and this list is growing. It allows users to view validation issues in real-time as they are modelling their business process. Users can enable visual validation, disable it, as well as view all validation issues at once. If Visual Validation is turned on, Designer will set the shape border of shapes that do not pass validation to red color. Users can then click on that particular shape to view the validation issues for that particular shape only. Alternatively "View All Issues" present a combined list of all validation errors currently found. Note that you do not have to periodically save your business process in order for validation to update. It will do so on its own short intervals during modelling. Users can extend the list of validation issues to include their own types of validation on certain elements of their business model.

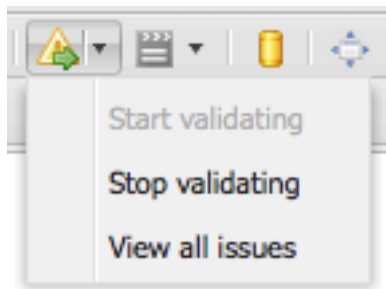


Figure 12.24. Visual Validation Toolbar

Evaluation v.1 (evaluation)

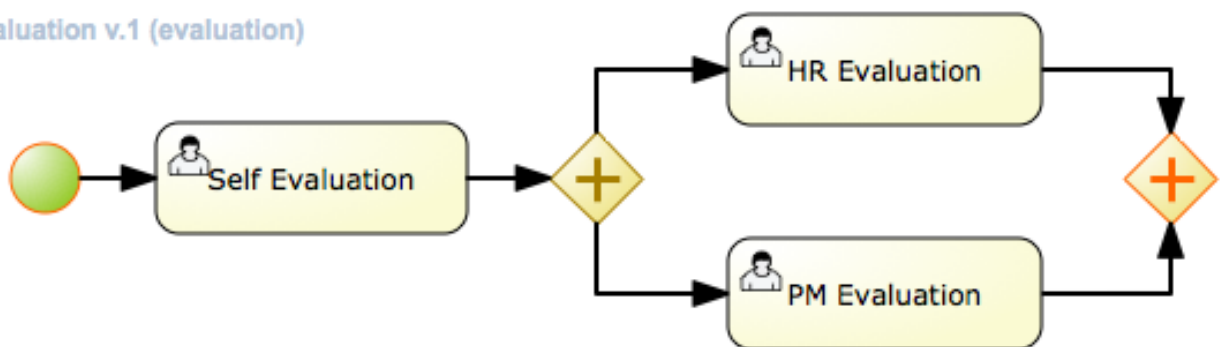


Figure 12.25. Shapes with validation errors displayed with red border

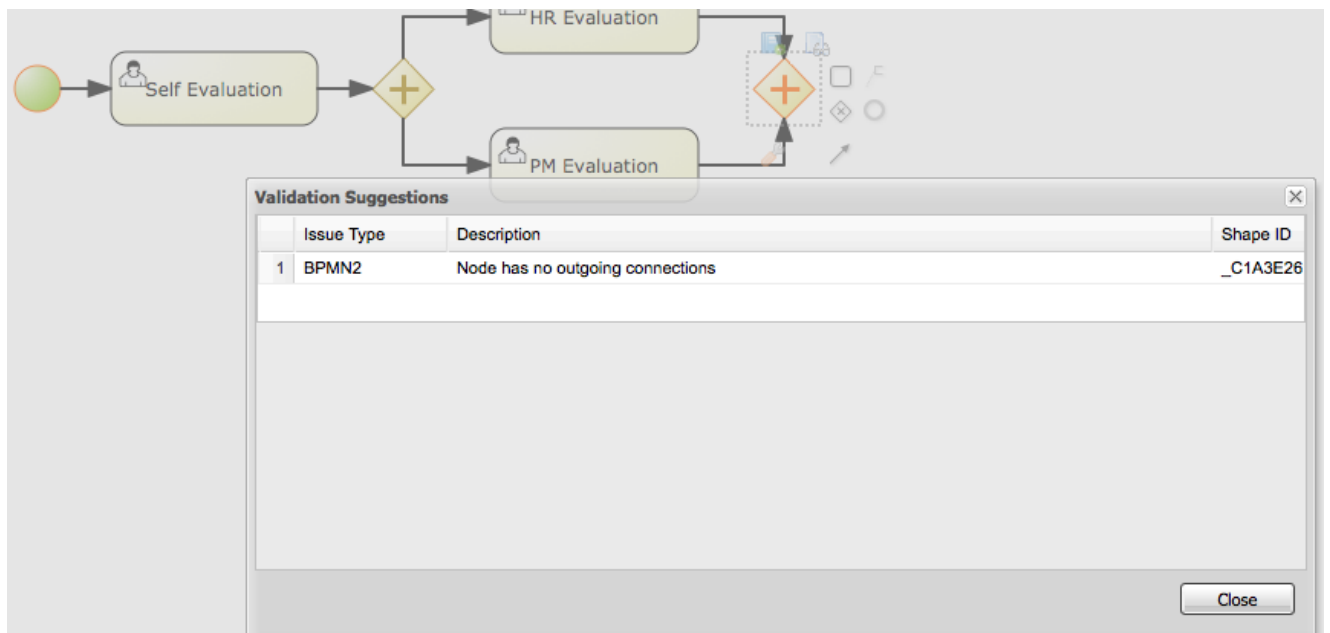
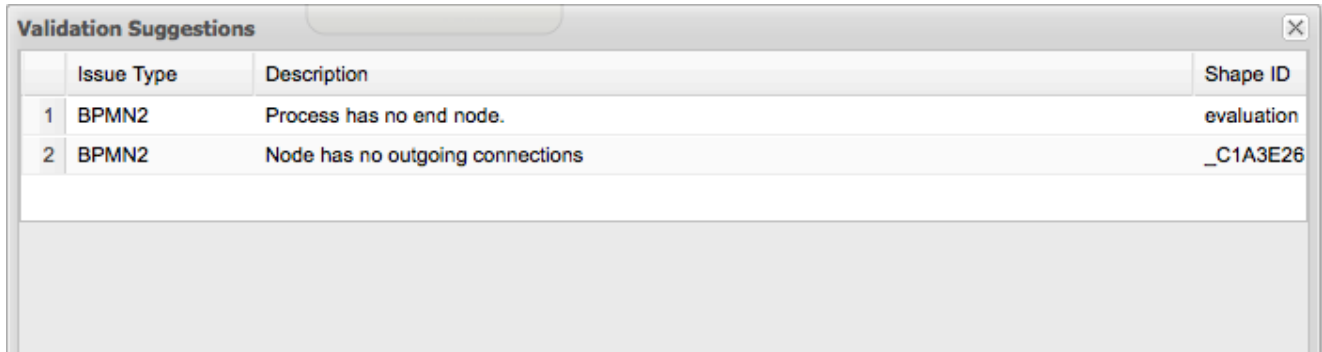


Figure 12.26. Single shape validation issues display

A screenshot of a 'Validation Suggestions' dialog box. It features a table with three columns: 'Issue Type', 'Description', and 'Shape ID'. The table contains two rows of data. Below the table is a large, empty grey rectangular area.

	Issue Type	Description	Shape ID
1	BPMN2	Process has no end node.	evaluation
2	BPMN2	Node has no outgoing connections	_C1A3E26

Figure 12.27. View all issues validation display

(22) Process Simulation - Business Process Simulation deals with statistical analysis of process models over time. It's main goals include

- Pre-execution and post-execution optimization
- Reducing the risk of change in business processes
- Predict business process performance
- Foster continuous improvements of performance, quality and resource utilization of business processes

Designer includes a powerful simulation engine which is based on jBPM and Drools and a graphical user interface to view and interpret simulation results. In addition users are able to view all process paths included in their current model on the drawing board. Designer Process Simulation is based on the BPSim 1.0 specification. Details of Process Simulation capabilities in Designer are can be found in its Simulation documentation chapter. Here we just give a brief overview of all features it contains.

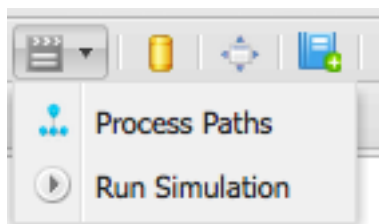


Figure 12.28. Simulation tooling section

When selecting Process Paths, the simulation engine find all possible paths in the business model. Users can choose certain found paths and choose to display them. The chosen path is marked with given colors as shown below.

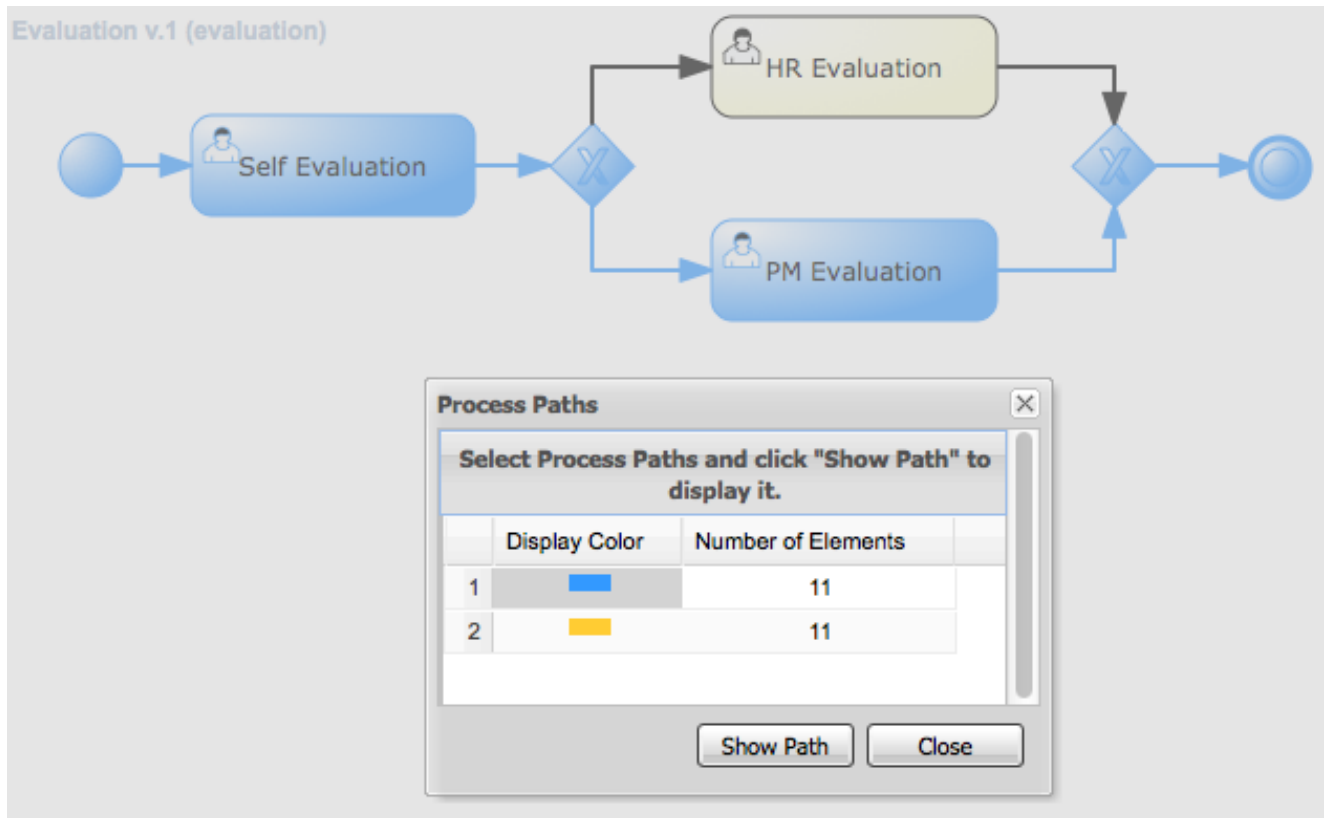


Figure 12.29. View all issues validation display

When selecting "Run Simulation", users have to enter in simulation runtime properties. These include the number of instances of this business process to simulate and the interval time and units. This interval is the time in-between consecutive simulation.

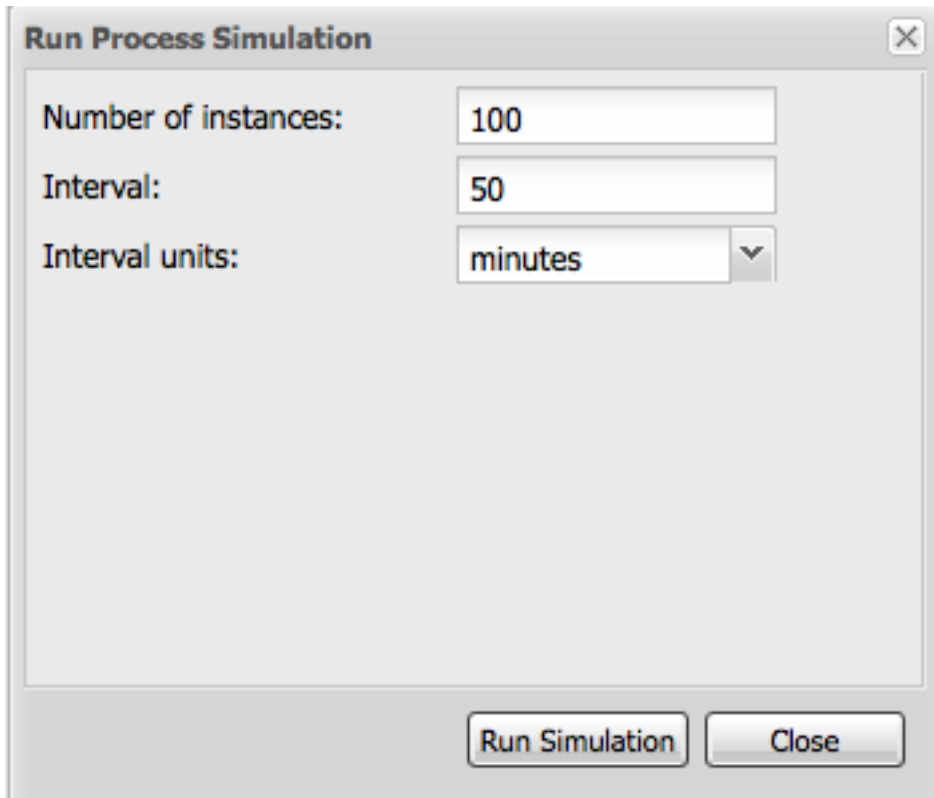


Figure 12.30. Simulation runtime properties

Each shape on the drawing board includes Simulation properties (properties panel) where users can set numerous simulation properties for that particular shape. More info on each of these properties can be found in the Simulation chapter of the documentation. Designer pre-sets some defaults for new processes, which allows business processes to be simulated by default without any modifications of these properties. Note however that the results of the default settings may not be optimal or targeted for the users particular needs.

☰ Simulation Properties

Cost per tim...	10
Distribution ...	normal
Processing t...	100
Staff availabl...	4
Standard De...	1
Working Hours	8.0

Figure 12.31. Simulation properties for shapes

Once the simulation runtime has completed, users are shown the simulation results in the "Simulation Results" tab of Designer. The results default to the process results. Users can switch to re-

sults for each particular shape in their business process to see more specific details. In addition, the results contain process paths simulation results for each path in the business process.

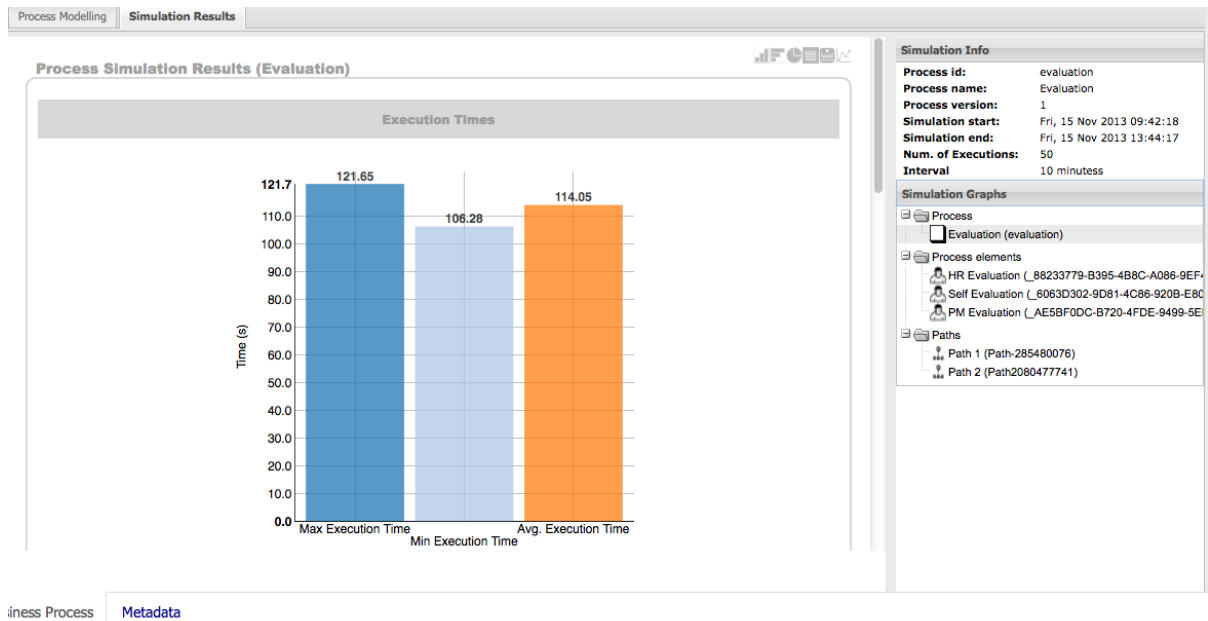


Figure 12.32. Sample simulation results

Designer simulation presents the users with many different chart types. These include:

- Process results: Execution times, Activity instances, Total cost
- Human Task results: Execution times, Resource Utilization, Resource Cost
- All other nodes: Execution times
- Process Paths: Path Execution

The below image shows a number of possible chart types users can view after process simulation has completed.



Figure 12.33. Types of simulation results charts

In addition to the chart results, Designer simulation also offers a full timeline display that includes all details of what happened during simulation. This timeline allows users to navigate through each event that happened during process simulation and select a particular node to display results at that particular point in time.

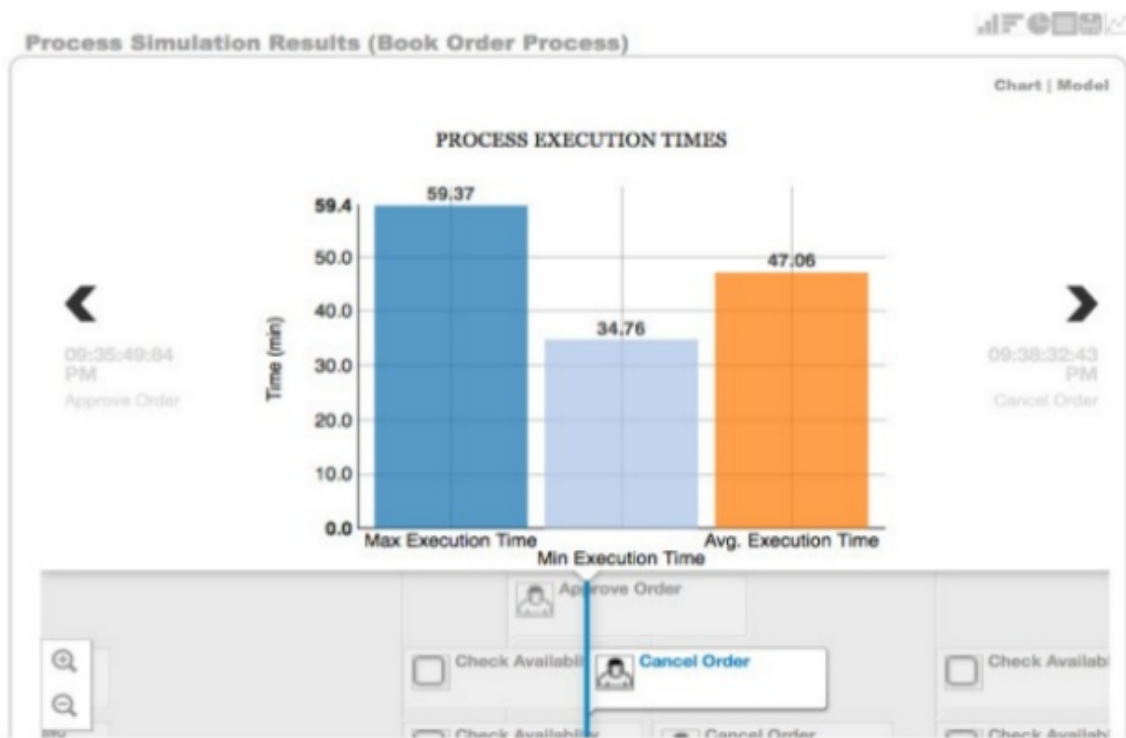


Figure 12.34. Simulation timeline

The simulation timeline can be switched to the Model view. This view displays the process model with the currently selected node in the timeline highlighted. The highlighted node displays the simulation results at that particular point in time of the simulation.

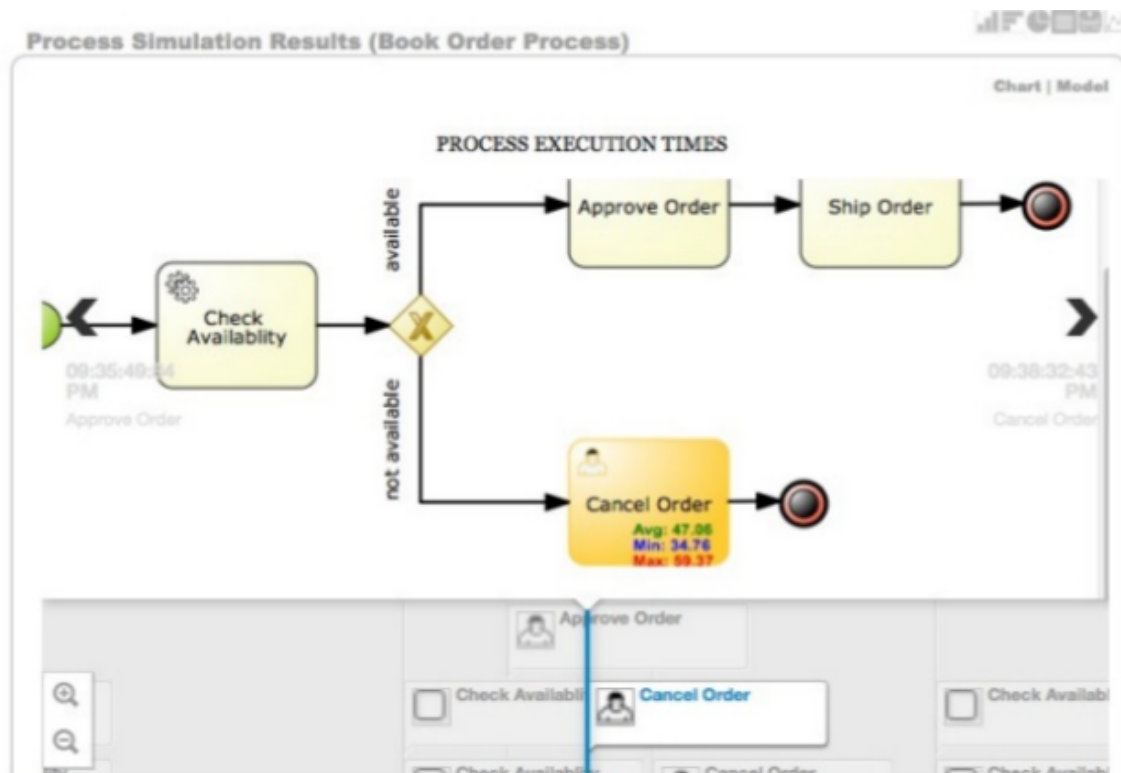


Figure 12.35. Simulation timeline model view

Path execution results shows a chart displaying the chosen path as well as path instance execution details.

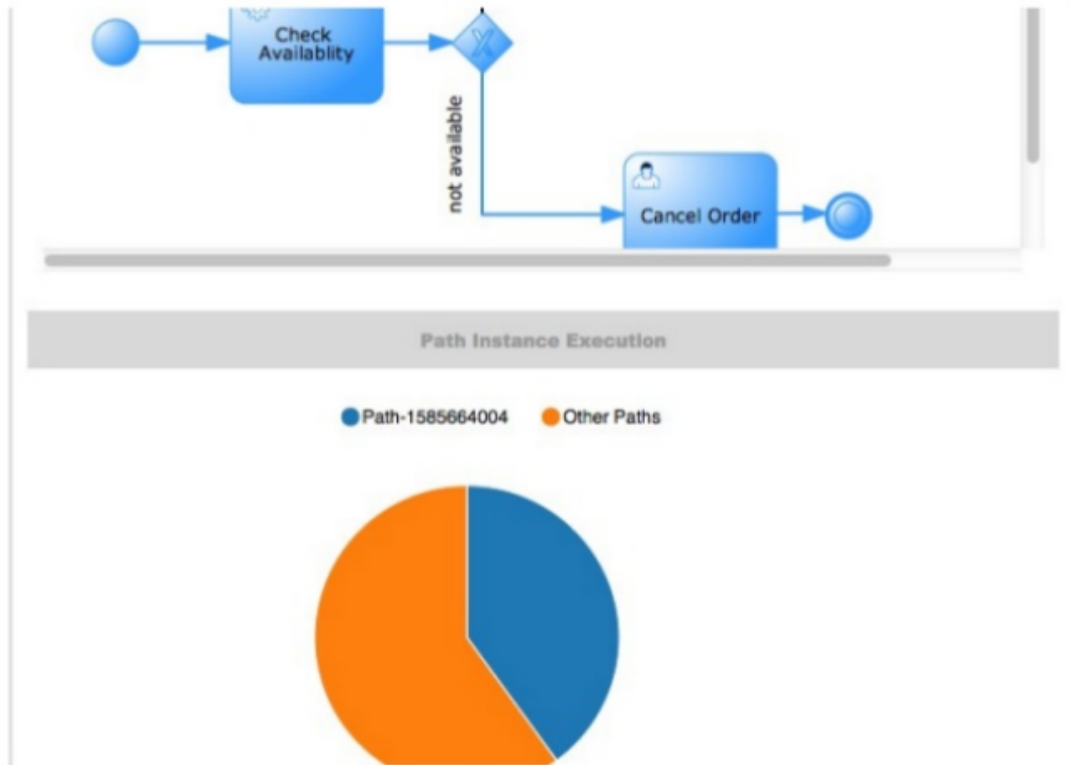


Figure 12.36. Path execution details

(23) Service Repository - this feature allows users to connect to an existing service tasks repository to install service tasks into their list of available shapes. Mode default of this can be found in the Service Repository chapter of the documentation. Users have to enter the URL to the existing service repository and then can install the available service nodes by double-clicking on a particular results row.

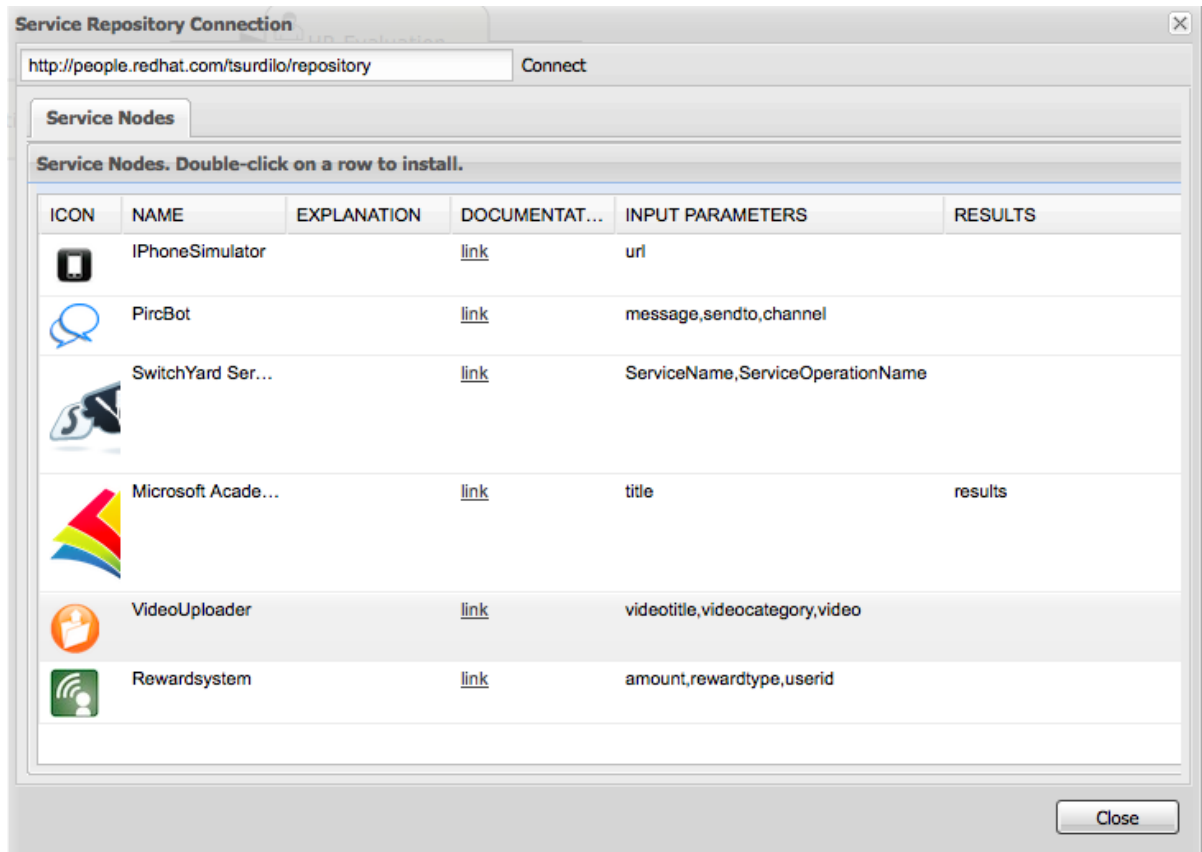


Figure 12.37. Service Repository installation view

(24) Full screen Modev - allows users to place the drawing board of Designer into full-screen mode. This can help with better visualizing larger business processes without having to scroll. Note that this feature is possible only if your browser has full screen mode capabilities. If it does not designer will show a message stating this to the user.

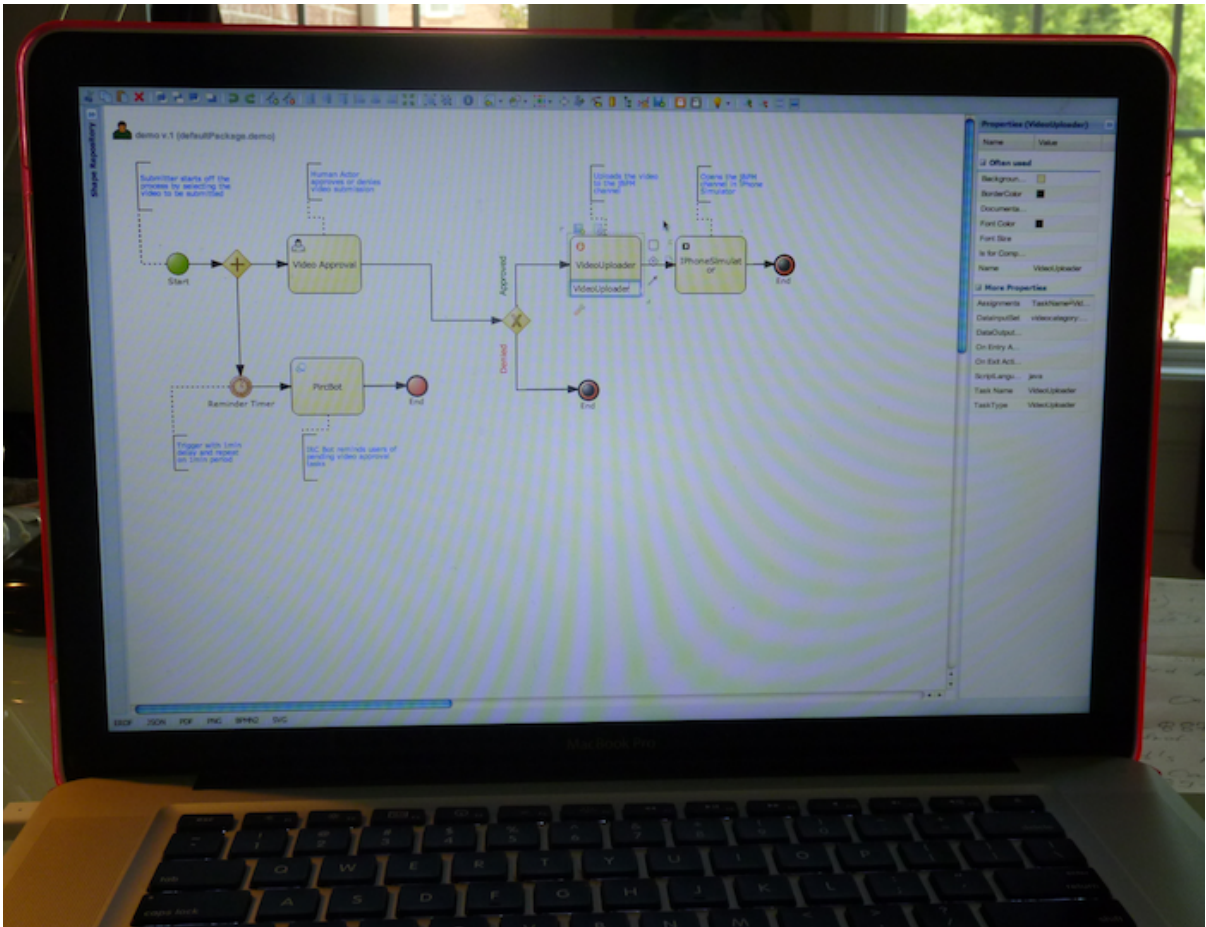


Figure 12.38. Full Screen Mode

(25) Process Dictionary - Designer Dictionary Editor allows users to create their own dictionary entries or harvest from process documentation or business requirement documents. Process Dictionary entries can be used as auto-completion for shape names. This will be expanded in the future versions to allow mapping of node patterns to specific dictionary entries as well. Users can add entries to the dictionary in the Dictionary Editor or from the selected shapes directly.

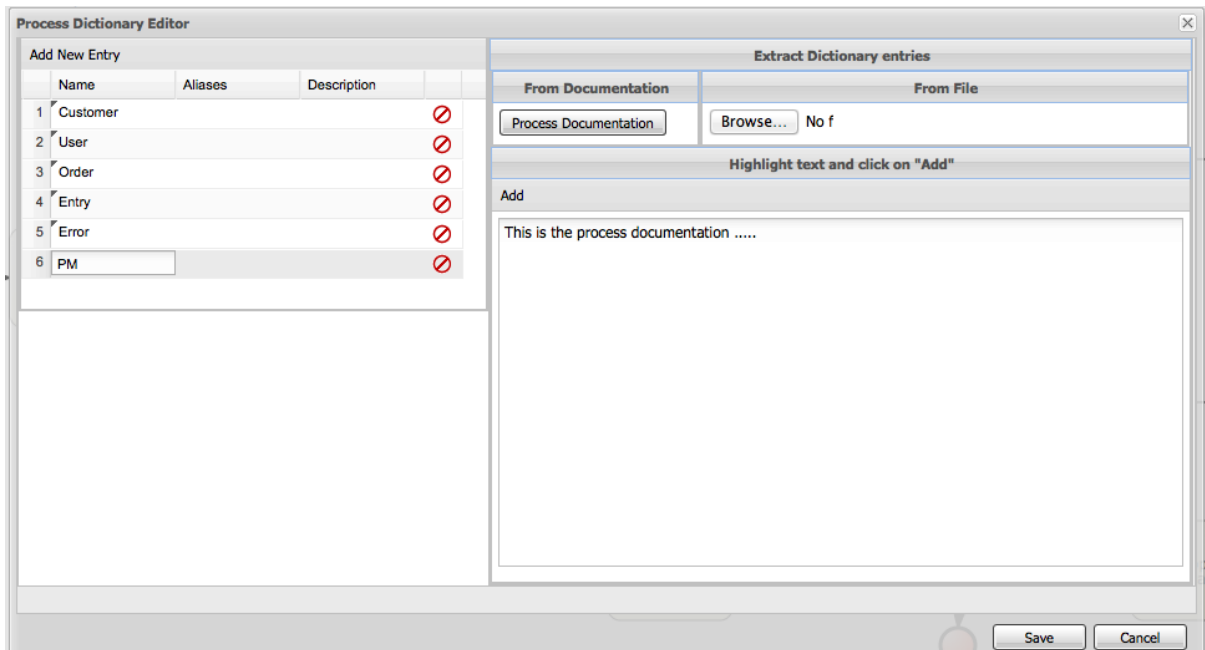


Figure 12.39. Process Dictionary entry screen

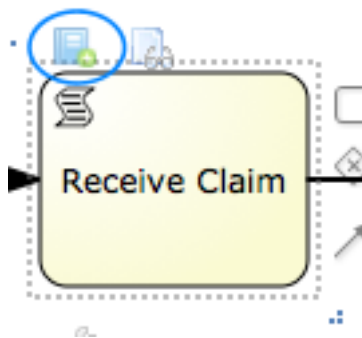


Figure 12.40. Addint to process dictionary from selected shape

(26, 27, 28, 29) Zooming - zooming allows users to zoom in/out of the model, zoom in/out back to the original setting as well as zoom the process model on the drawing board to fit the currently dimensions of the drawing board.

Chapter 13. Forms

This chapter intends to describe in a simple ways all the steps required to create a process with human tasks, generate and modify the forms for these tasks and execute them. It will provide initial guidance to perform all initial steps, but it will not provide a full description of all available features.

Given that forms are going to be used in tasks, it's possible to generate forms automatically from process variables and task definitions. These forms can be later be modified by using the form editor. In runtime, forms will receive data from process variables, display it to the user and capture his input, and then finally updating process variables again with the new values.

The following example will show all the steps to follow to create a form for the 'Create order' task in the process below.

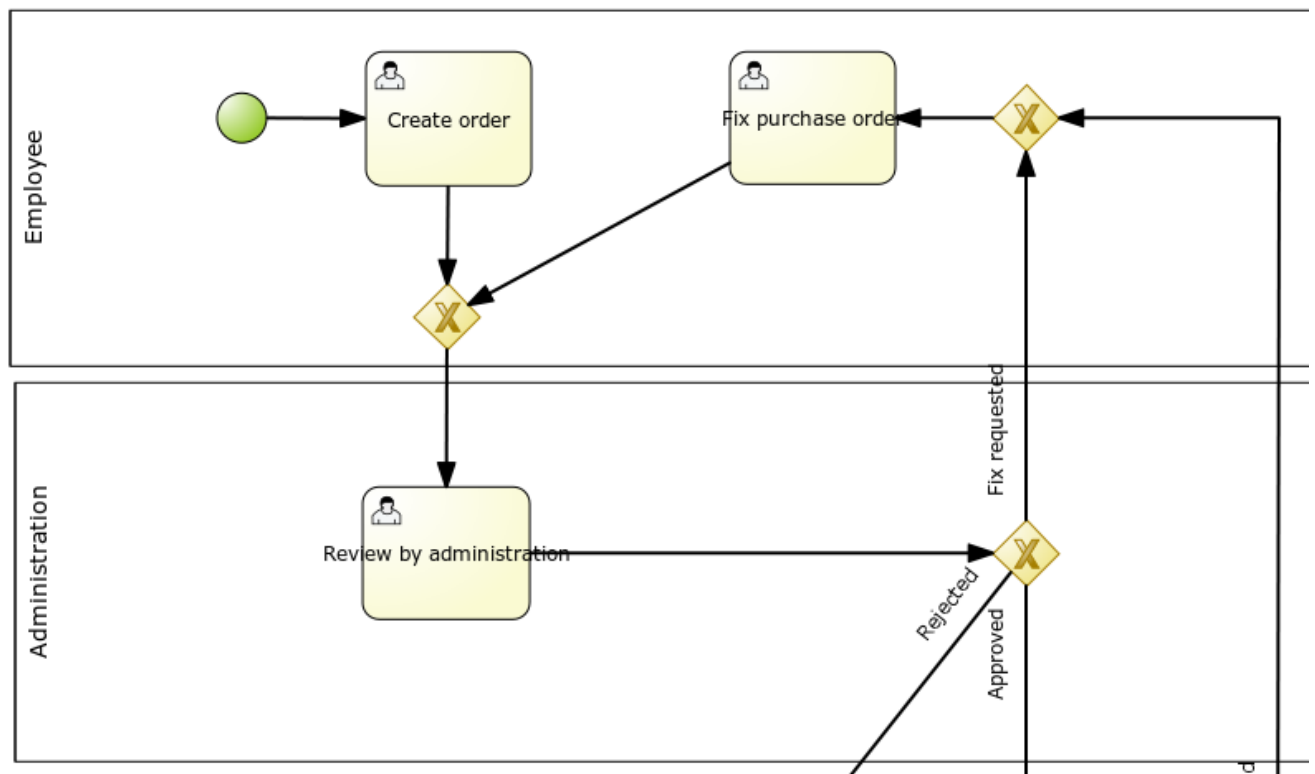


Figure 13.1. Process example

This form must look like the following in execution:

New Task Refresh ✕ ▼

Details Work Details Assignments Comments ✕ ▶

37 - Create order

Please, enter all the required information. The instructions to perform this task can be found [here](#)

Purchase Order Header

*Creation date:

*Customer:

*Project:

Lines

Actions	Description	Amount	Unit Price	Amount
<input type="button" value="Trash"/> <input type="button" value="Edit"/>	iPhone	10	500	5000
<input type="button" value="Trash"/> <input type="button" value="Edit"/>	Android phone	10	400	4000
<input type="button" value="Trash"/> <input type="button" value="Edit"/>	Laptop	3	800	2400

TOTAL:
11400.0

*Description:

1-2 of 2 ⏪ ⏩ ⏴ ⏵

Save Complete

Figure 13.2. Process example

13.1. Configure process and human tasks

To hold values capture by forms, process variables can be created. These variables can be of a simple type like 'String' or a complex type. These complex types can be defined by using the Data Modeler tool, or be just regular POJOs (Plain Java Objects) created with any Java IDE.

In this example, we define a variable 'po' of type 'org.jboss.examples.purchases.PurchaseOrder', defined with the Data Modeler tool.

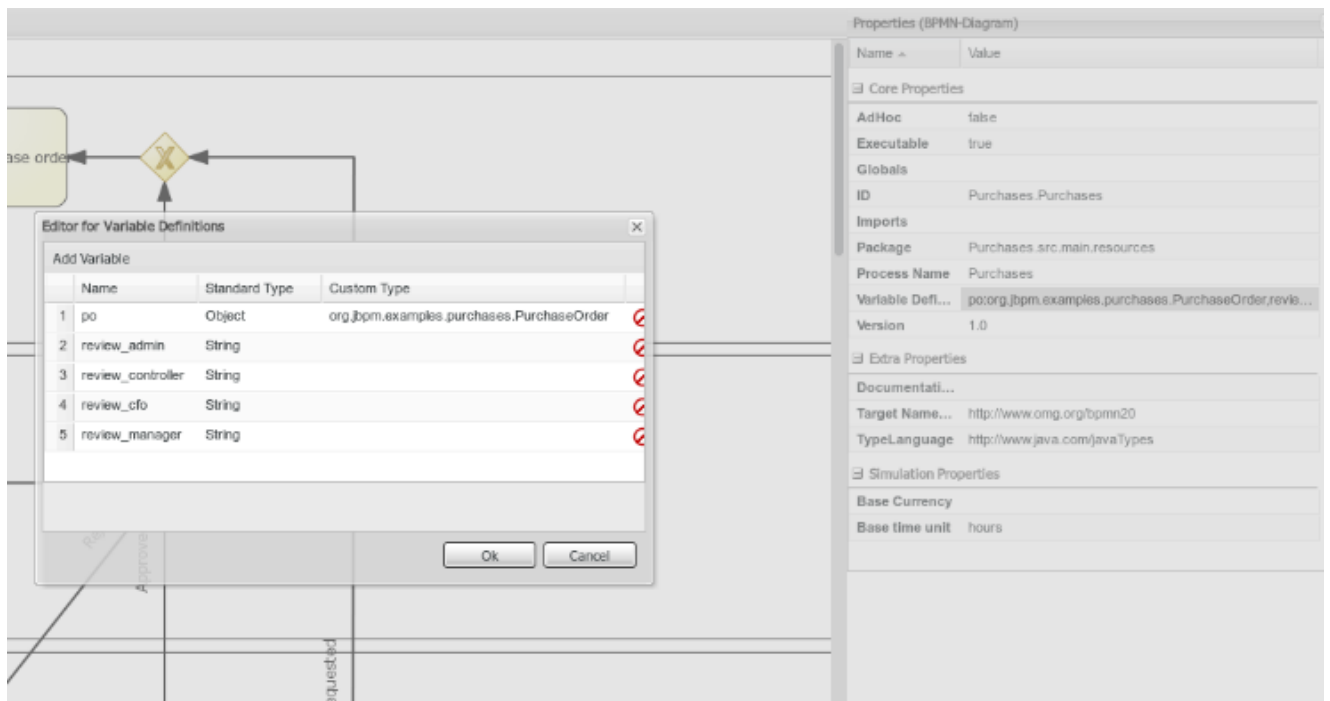


Figure 13.3. Process variable definition

This variable is declared in the 'variables definition' property for the process.

After that, we must configure which variables are set as input parameters to the task, which ones will receive the response back from the form and establish the mappings. This is done by setting the 'DataInputSet', 'DataOutputSet' and 'Assignments' properties for any human task. See screenshots below for details.

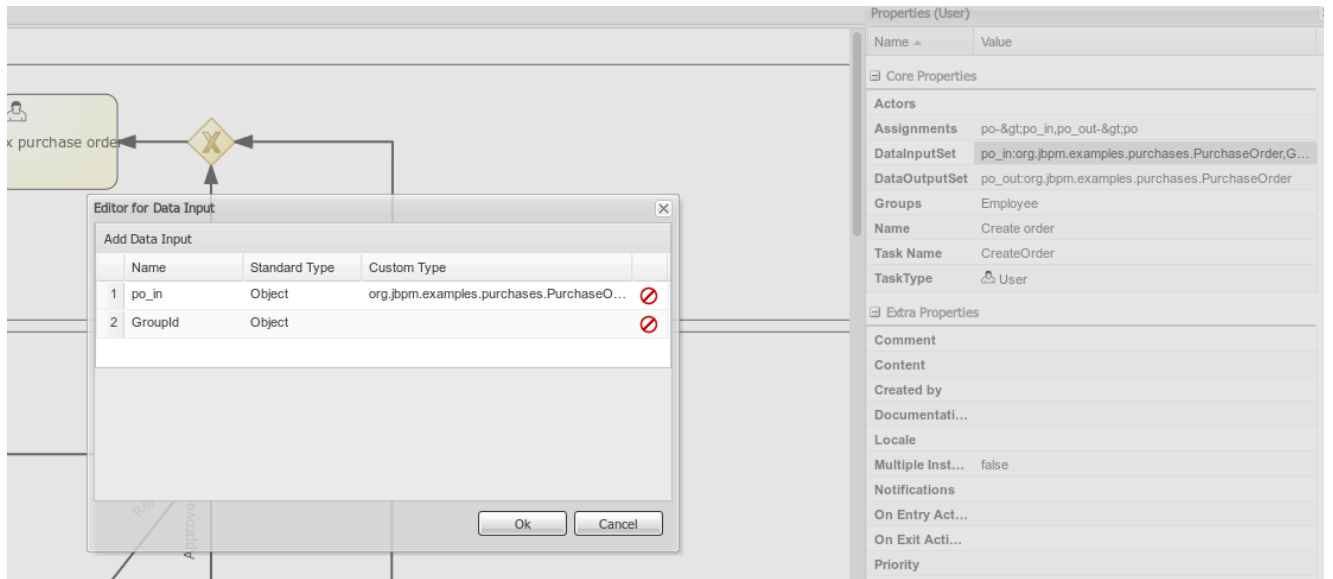


Figure 13.4. Data input variable definition

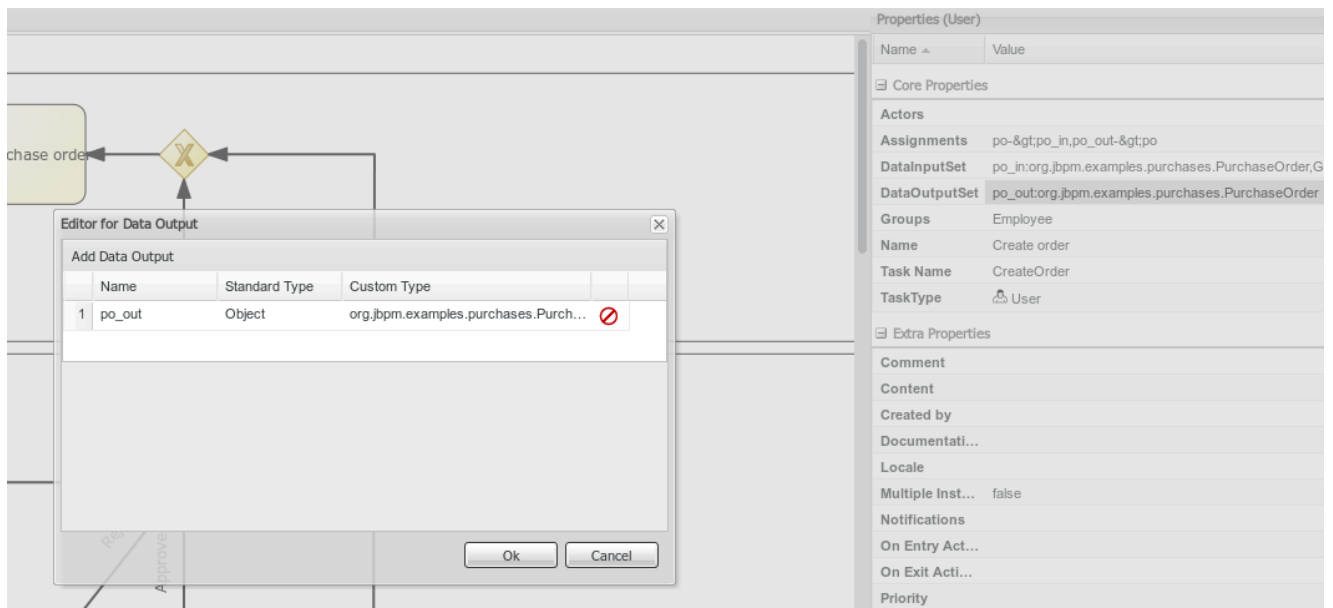


Figure 13.5. Data output variable definition

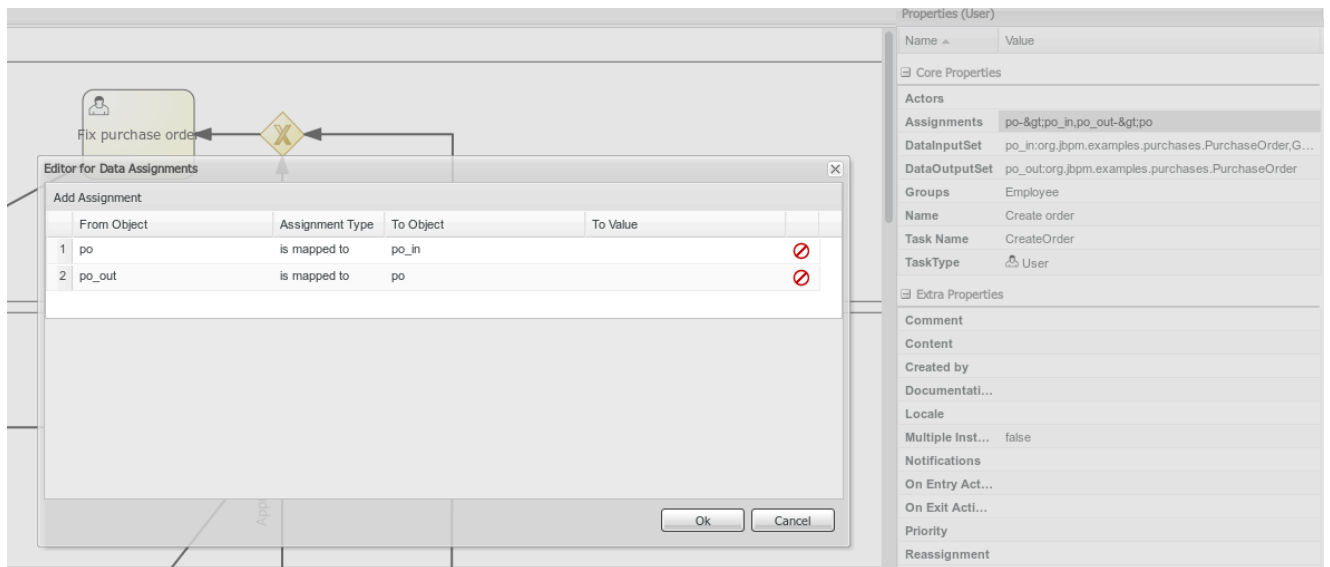


Figure 13.6. Variable mapping definition

13.2. Generate forms from task definitions

The Process Designer module provides some functionality to generate the forms automatically from task and variable definitions, as well as easily open the right form from the modeler.

This is done with the following menu option.

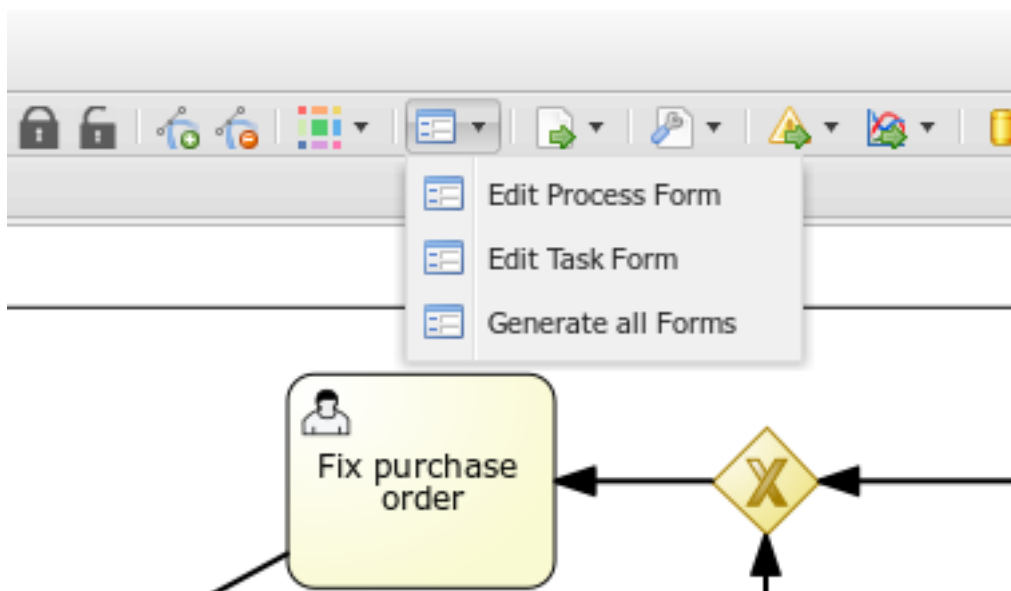


Figure 13.7. Form automatic generation

You can also click on the icon on top of task to open the form directly.

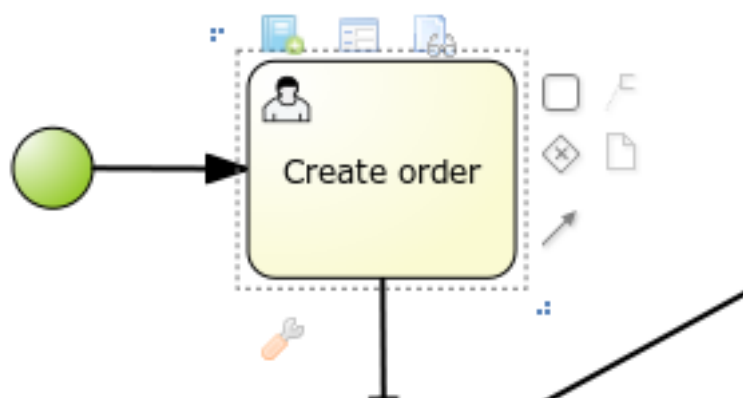


Figure 13.8. Access to form edition

Forms are related to tasks by following a naming convention. If a form with a name `formName-task-form` is defined in the same package as the process, then this form is used by the human task engine to display and capture information from user.

Also, if a form named `ProcessId-task form` is created, it will be used as the initial form when starting this process.

For example, for our process the following forms would be generated.

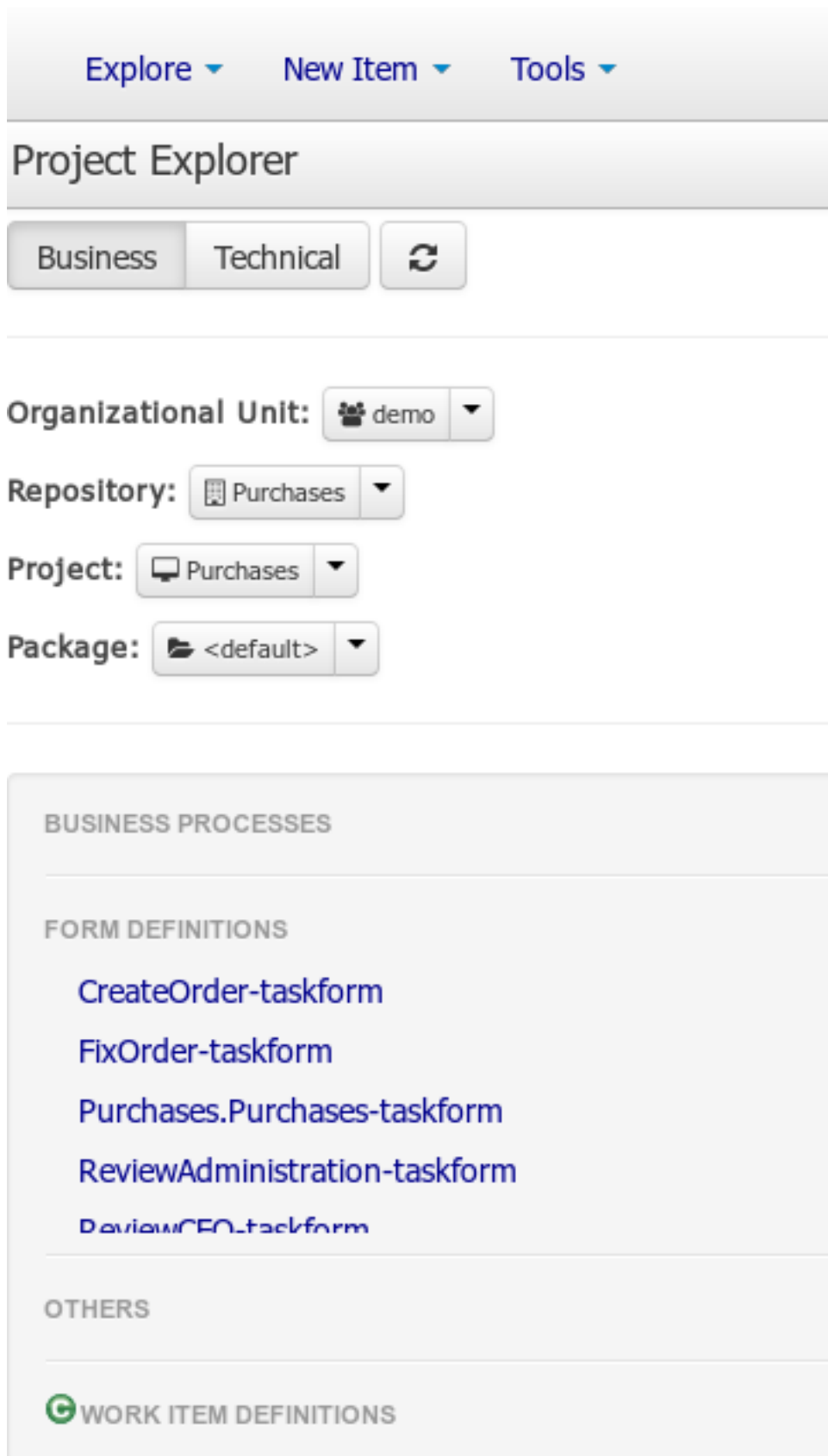


Figure 13.9. Access to form edition

13.3. Edit forms

Once the forms have been generated, you can start editing them. There are several artifacts that are generated in the previous process, but also can be created manually.

13.3.1. Form generated description

When the form has been generated automatically, this tab contain the process variables as data origins. This allow bind form fields with them, this relation it's linked creating data bindings.

A data binding define how task inputs will be mapped to form variables, and when the form is validated and submitted, how the values will update the task outputs.

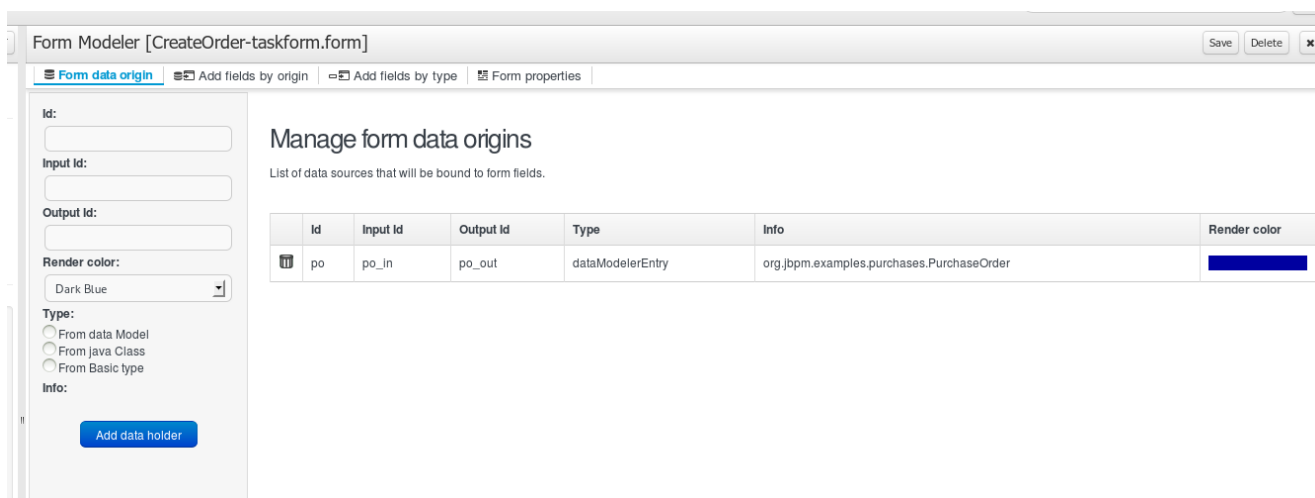


Figure 13.10. Generated form

For example, for this process, the following bindings are generated. Notice that the identifiers are automatically generated. You can have as many data origins as required, and can use a different colour to identify it.

In automatic form generation, a data origin is created for each process variable. The generated form have a field for each data origin bindable item (view FieldTypes) and this automatic fields have the binding defined too.

When these fields are displayed in editor the color of the data origin is shown over the field to make easy view if the field is correctly bound and the data origin implied.

13.3.2. Customizing form

We can change the way the form is displayed to the user in the task list. Next, we will show different levels of customization that will allow change it

13.3.2.1. Moving fields

The fields may be placed in different regions of the form. To move a field the user can access the contextual menu of the field and select 'Move field'.

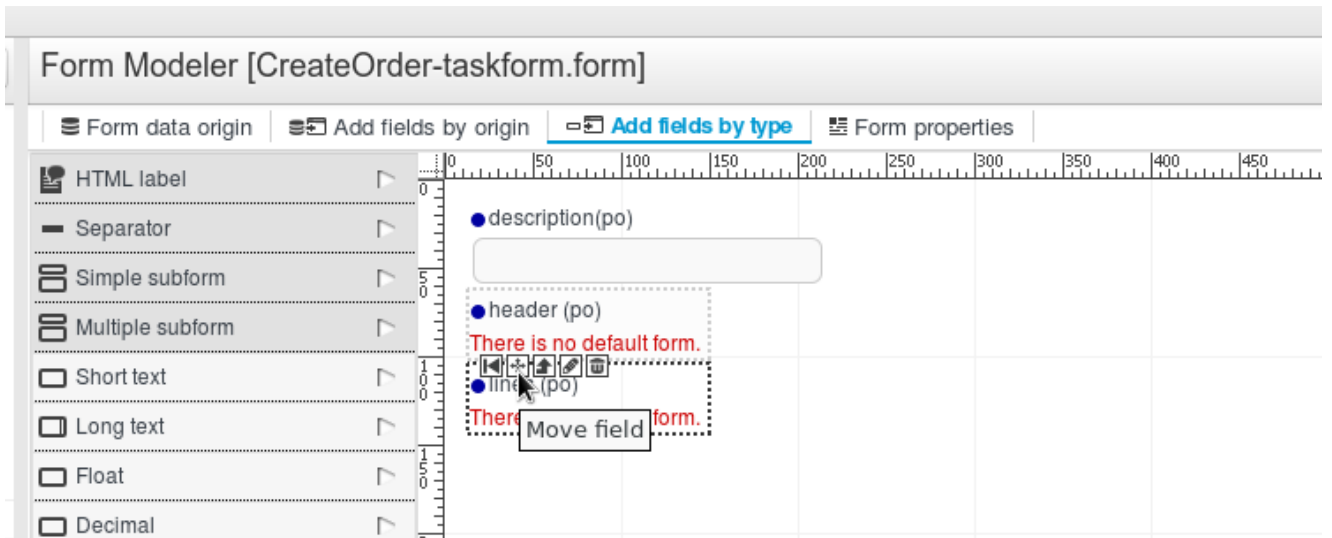


Figure 13.11. Move field option

This will display the different regions of the form where you can place it.

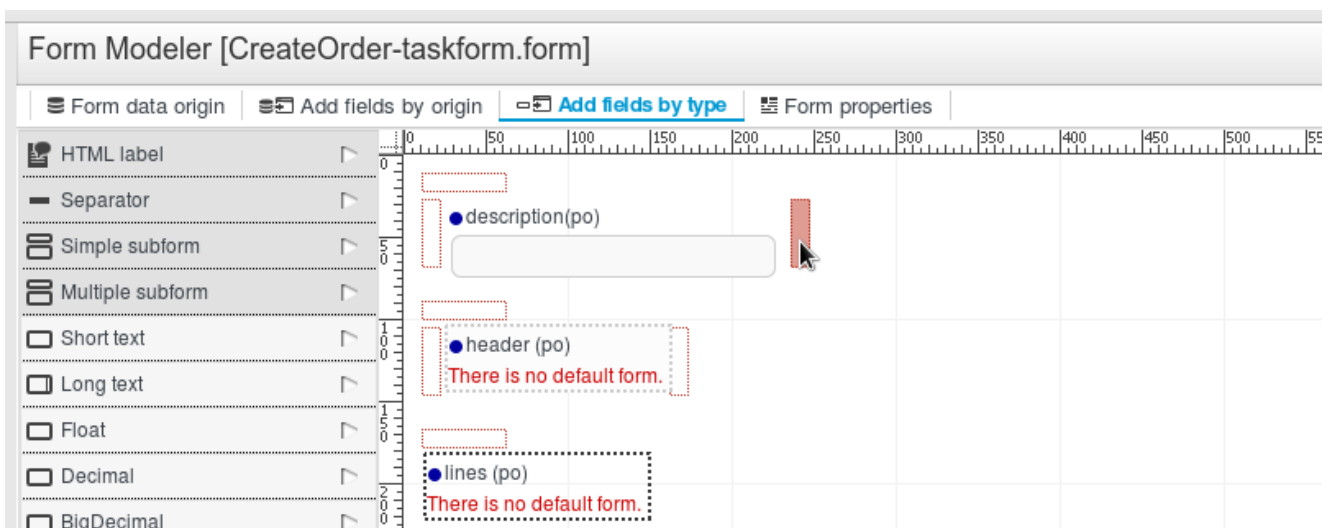


Figure 13.12. Destination areas to move the field

A field can be moved to the first or the last region with the contextual icons for that purpose.

13.3.2.2. Adding new fields

You can add fields to forms either by its origin or by selecting one type of form field.

Let's see what has been created automatically for this purchase order form.

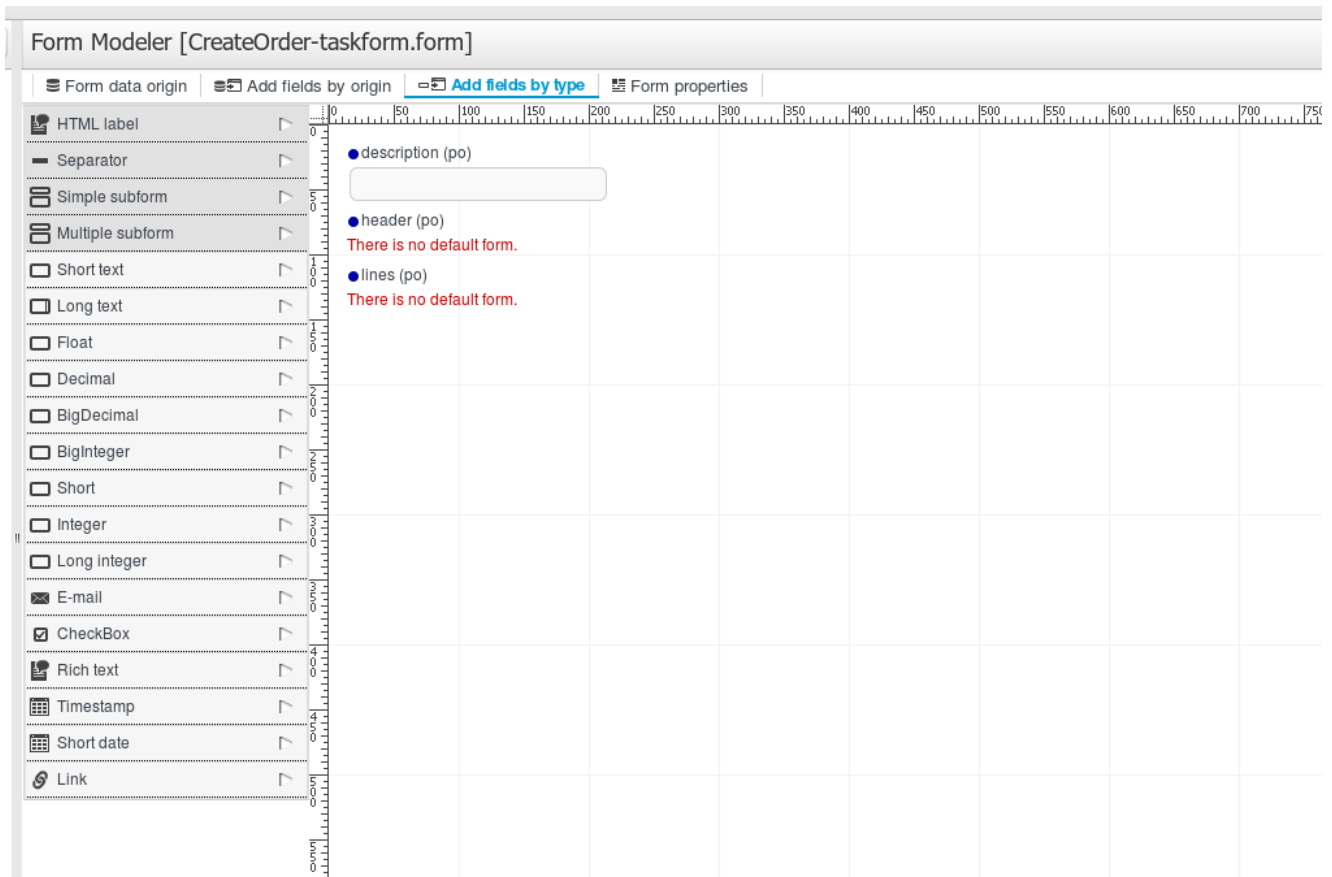


Figure 13.13. Form properties have been added by default, but are not still configured

- Add fields by origin: this tab allows you to add fields to the form based on the data origins defined. These fields will have the correct configuration on the "Input binding expression" and "Output binding expression" properties, so when the form is submitted, the fields values will be stored in the corresponding Data Origin.

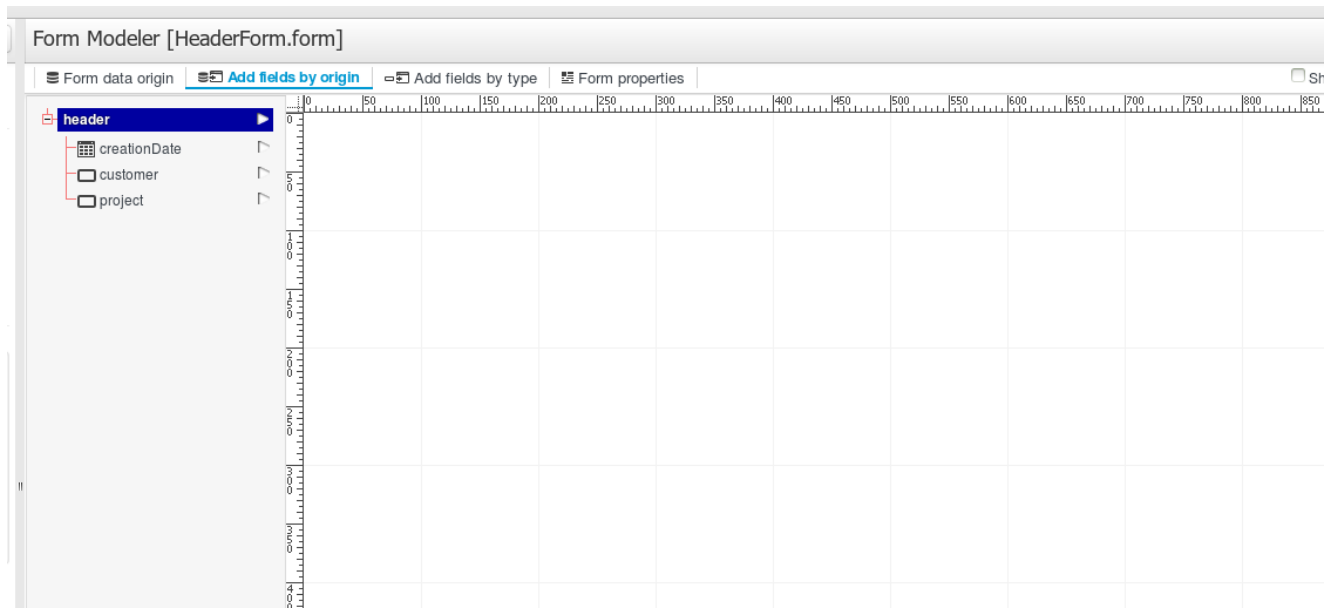


Figure 13.14. Add field by origin

- Add fields by type: this tab allows you to freely add fields to the form from the Field Types palette on the Form Modeler. These fields won't be storing their values on any Data Origin until they have a correct configuration on the "Input binding expression" and "Output binding expression" properties.

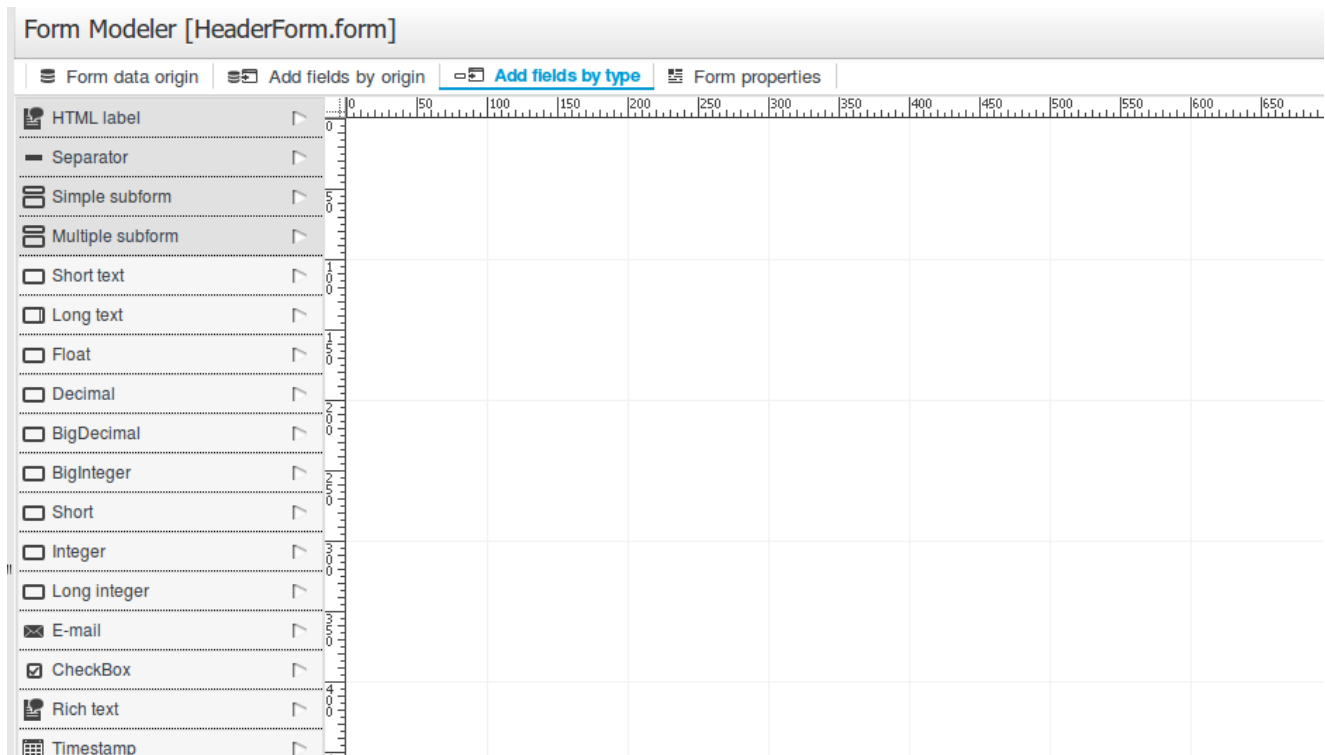


Figure 13.15. Add field by type

To see a complete list of the available field types go to Field types section.

Notice the data model 'po' of type 'org.jbpm.examples.purchases.PurchaseOrder' is composed of three properties.

- Simple: property of type text (description). We will adjust the view settings.
- Complex: property of type object (header).
- Complex: property of type array of objects (lines)

Now all these properties had to be configured.

13.3.2.3. Field configuration

Each field can be configured to enhance performance in the form. There are a group of common properties, that we call 'Generic field properties' and a group of specific properties that depends on the field type.

13.3.2.3.1. Generic field properties

There are a group of properties that are common to all field types. We will detail them below:

Table 13.1.

Field type	Can change the field type to other compatible field types
Field Name	Will be used as identifier in formulas calculation
Label	The text that will be shown as field label
Error message	When something goes wrong with the field, like validations,.. this message will be displayed
Label ccs class	Allows enter a class css to apply in label visualization
Label css style	to enter directly the style to apply to the label.
Help text	The text introduced is displayed as alt attribute to help to the user in data introduction
Style class	Allows enter a class css to apply in field visualization
Css style	to enter directly the style to apply to the label.
Read Only	When this check is on, the field will be used only for read

Input binding expression	This expression defines the link between field and process task input variable. It will be used in runtime to set the field value with that task input variable data.
Output binding expression	This expression defines the link between field and process task output variable. It will be used in runtime to set that task output variable.

13.3.2.3.2. Specific field properties

Let's explain the specific properties of each field type:

- Short Text (java.lang.String)
 - Compatible field type: Long text, E-mail, Rich text
 - Specific properties
 - Size: input text length.
 - MaxLength: Maximum number of characters allowed.
 - Required: Indicates if it's mandatory to fill this field.
 - Show HTML: indicates whether the contents of the field is interpreted as HTML in show mode.
 - Formula. to enter expressions that will be evaluated to set the field value. These expressions are described in Formula & expression section .
 - Range value. A range formula allows you to let you specify the values that the user can select from an specific field. These expressions are described in Formula & expression section
 - Pattern. Allow introduce an expression to specify the validation of the field. In case that the field value introduced hasn't match the expression, and error is thrown and the error message has to be shown.
 - Default Value formula. Expression to set the field default value.
- Long Text (java.lang.String)
 - Compatible field type: Long text, E-mail, Rich text
 - Specific properties
 - Size: input text length.
 - MaxLength: Maximum number of characters allowed.

- Required: Indicates if it's mandatory to fill this field.
 - Height: The number of rows to show at text area.
 - Formula. to enter expressions that will be evaluated to set the field value. These expressions are described in Formula & expression section .
 - Range value. A range formula allows you to let you specify the values that the user can select from an specific field. These expressions are described in Formula & expression section
 - Pattern. Allow introduce an expression to specify the validation of the field. In case that the field value introduced hasn't match the expression, and error is thrown and the error message has to be shown.
 - Default Value formula. Expression to set the field default value.
- Float (`java.lang.Float`)
 - Specific properties
 - Size: input text length.
 - MaxLength: Maximum number of characters allowed.
 - Required: Indicates if it's mandatory to fill this field.
 - Formula. to enter expressions that will be evaluated to set the field value. These expressions are described in Formula & expression section .
 - Range value. A range formula allows you to let you specify the values that the user can select from an specific field. These expressions are described in Formula & expression section
 - Pattern. Allow introduce an expression to specify how the Float value has to be displayed. The pattern allowed is show in section pattern in <http://docs.oracle.com/javase/6/docs/api/java/text/DecimalFormat.html> [<http://docs.oracle.com/javase/6/docs/api/java/text/DecimalFormat.html>]
 - Default Value formula. Expression to set the field default value.
 - Decimal (`java.lang.Double`)
 - Specific properties
 - Size: input text length.
 - MaxLength: Maximum number of characters allowed.
 - Required: Indicates if it's mandatory to fill this field.

- Formula. Used to enter expressions that will be evaluated to set the field value. These expressions are described in Formula & expression section.
 - Range value. A range formula allows you to let you specify the values that the user can select from an specific field. These expressions are described in Formula & expression section .
 - Pattern. Allow introduce an expression to specify how the Double value has to be displayed. The pattern allowed is show in section pattern in <http://docs.oracle.com/javase/6/docs/api/java/text/DecimalFormat.html> [<http://docs.oracle.com/javase/6/docs/api/java/text/DecimalFormat.html>]
 - Default Value formula. Expression to set the field default value.
- BigDecimal (java.math.BigDecimal)
 - Specific properties
 - Size: input text length.
 - MaxLength: Maximum number of characters allowed.
 - Required: Indicates if it's mandatory to fill this field.
 - Formula. Used to enter expressions that will be evaluated to set the field value. These expressions are described in Formula & expression section.
 - Range value. A range formula allows you to let you specify the values that the user can select from an specific field. These expressions are described in Formula & expression section .
 - Pattern. Allow introduce an expression to specify how the BigDecimal value has to be displayed. The pattern allowed is show in section pattern in <http://docs.oracle.com/javase/6/docs/api/java/text/DecimalFormat.html> [<http://docs.oracle.com/javase/6/docs/api/java/text/DecimalFormat.html>]
 - Default Value formula. Expression to set the field default value.
 - Big integer (java.math.BigInteger)
 - Specific properties
 - Size: input text length.
 - MaxLength: Maximum number of characters allowed.
 - Required: Indicates if it's mandatory to fill this field.
 - Formula. Used to enter expressions that will be evaluated to set the field value. These expressions are described in Formula & expression section.

- Range value. A range formula allows you to let you specify the values that the user can select from an specific field. These expressions are described in Formula & expression section .
- Default Value formula. Expression to set the field default value.
- Short (java.lang.Short)
 - Specific properties
 - Size: input text length.
 - MaxLength: Maximum number of characters allowed.
 - Required: Indicates if it's mandatory to fill this field.
 - Formula. Used to enter expressions that will be evaluated to set the field value. These expressions are described in Formula & expression section.
 - Range value. A range formula allows you to let you specify the values that the user can select from an specific field. These expressions are described in Formula & expression section .
 - Default Value formula. Expression to set the field default value.
- Integer (java.lang.Integer)
 - Specific properties
 - Size: input text length.
 - MaxLength: Maximum number of characters allowed.
 - Required: Indicates if it's mandatory to fill this field.
 - Formula. Used to enter expressions that will be evaluated to set the field value. These expressions are described in Formula & expression section.
 - Range value. A range formula allows you to let you specify the values that the user can select from an specific field. These expressions are described in Formula & expression section .
 - Default Value formula. Expression to set the field default value.
- Long Integer (java.lang.Long)
 - Specific properties
 - Size: input text length.
 - MaxLength: Maximum number of characters allowed.

- Required: Indicates if it's mandatory to fill this field.
- Formula. Used to enter expressions that will be evaluated to set the field value. These expressions are described in Formula & expression section.
- Range value. A range formula allows you to let you specify the values that the user can select from an specific field. These expressions are described in Formula & expression section .
- Default Value formula. Expression to set the field default value.
- E-mail (java.lang.String)
 - Compatible field type: Short text, Long text, Rich text
 - Specific properties
 - Size: input text length.
 - MaxLength: Maximum number of characters allowed.
 - Required: Indicates if it's mandatory to fill this field.
 - Default Value formula. Expression to set the field default value.
- Checkbox (java.lang.Boolean)
 - Specific properties
 - Required: Indicates if it's mandatory to fill this field.
 - Default Value formula. Expression to set the field default value.
- Rich text: (java.lang.String)
 - Compatible field type: Short text, Long text, E-mail
 - Specific properties
 - Size: input text length.
 - MaxLength: Maximum number of characters allowed.
 - Required: Indicates if it's mandatory to fill this field.
 - Height: The number or rows to show at text area.
 - Default Value formula. Expression to set the field default value.
- Timestamp (java.util.Date)
 - Compatible field type: Short date

- Specific properties
 - Size: input text length.
 - Required: Indicates if it's mandatory to fill this field.
 - Formula. to enter expressions that will be evaluated to set the field value. These expressions are described in Formula & expression section .
 - Default Value formula. Expression to set the field default value.
- Short date (java.util.Date)
 - Compatible field type: Timestamp
 - Specific properties
 - Size: input text length.
 - Required: Indicates if it's mandatory to fill this field.
 - Formula. to enter expressions that will be evaluated to set the field value. These expressions are described in Formula & expression section .
 - Default Value formula. Expression to set the field default value.
- Document (org.jbpm.document.Document)
 - Specific properties
 - Required: Indicates if it's mandatory to fill this field.
- Simple subform (Object)
 - For more details see sectionSimple Object (Subform field Type).
Specific properties
 - Default form. Show the list of available forms to select what one will be displayed to show the object.
- Multiple subform (Multiple Object)
 - For more details see sectionArrays of objects.(Multiple subform field Type).
Specific properties
 - Default form. Show the list of available forms to select what one will be displayed to show the object when no other form is configured with an specific purpose.
 - Preview form. If a form is specified, it will be used to show the item details

- Table form. If a form is specified, it will be used to show the table columns when the item list is showed
- New item text. Text to show at New Item button
- Add item text. Text to show at Add Item button
- Cancel text. Text to show at Cancel button
- Allow remove Items. If this check is selected, the form allow remove items in table view.
- Allow edit items. If this check is selected, the form allow edit items in table view.
- Allow preview items. If this check is selected, the form allow preview items in table view.
- Hide creation button. Check to not show the creation button
- Expanded. If is checked, when a new item is being added, the field display the table with the existing items and the creation form at same time
- Allow data enter in table mode. Allow modify data in table view directly.

13.3.2.3.3. Complex Fields Configuration

There are two types of complex fields: fields representing an object, and fields representing an object array.

Once the field is added to the form, either automatically or manually, it must be configured so that the form had to know how to display the objects that will contain in execution time.

Next we describe how can be the configuration process:

- The first thing to do is define how the contained object will be displayed. This is done creating a form that represents the object.
- In case of the object array, you can define a form to show in preview(edition), or to show when table is shown

Once the form to represent the object, the parent form has to be configured to use them in the parent Subform or Multiple subform.

Below we will describe how the setup would be:

13.3.2.3.3.1. Simple Object (Subform field Type)

One possible way of setting the value for an object property is by using an existing form, and embedding this form into the parent. This is called subform.

In this example, the Purchase Order header data is held in an object. Therefore, we must create a form to enter all the purchase order header data and link it from the parent task form.

We will follow the steps:

1. Create new form.

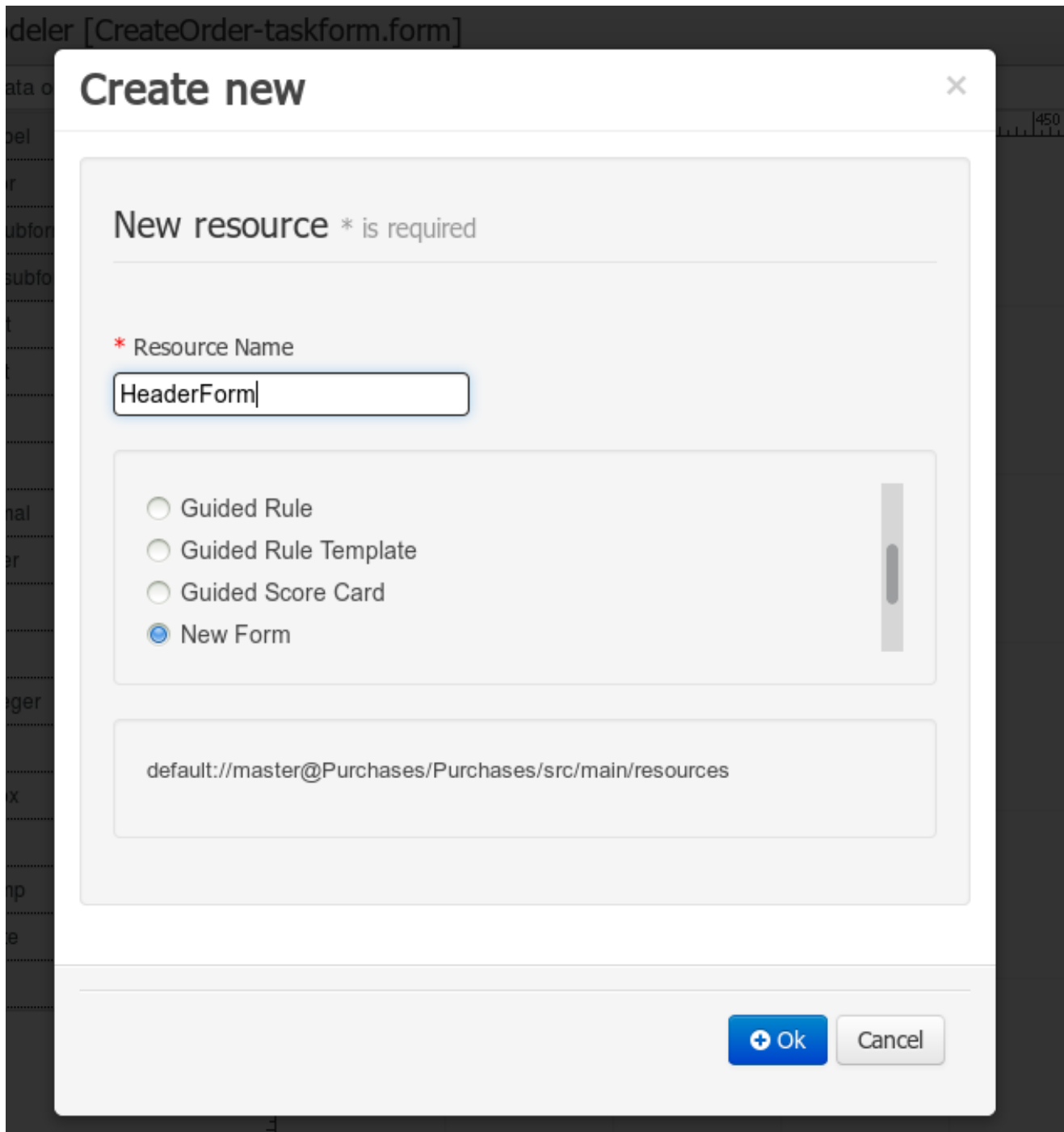


Figure 13.16. Create new form

2. Create new data origin, selecting the type of the purchase order header.

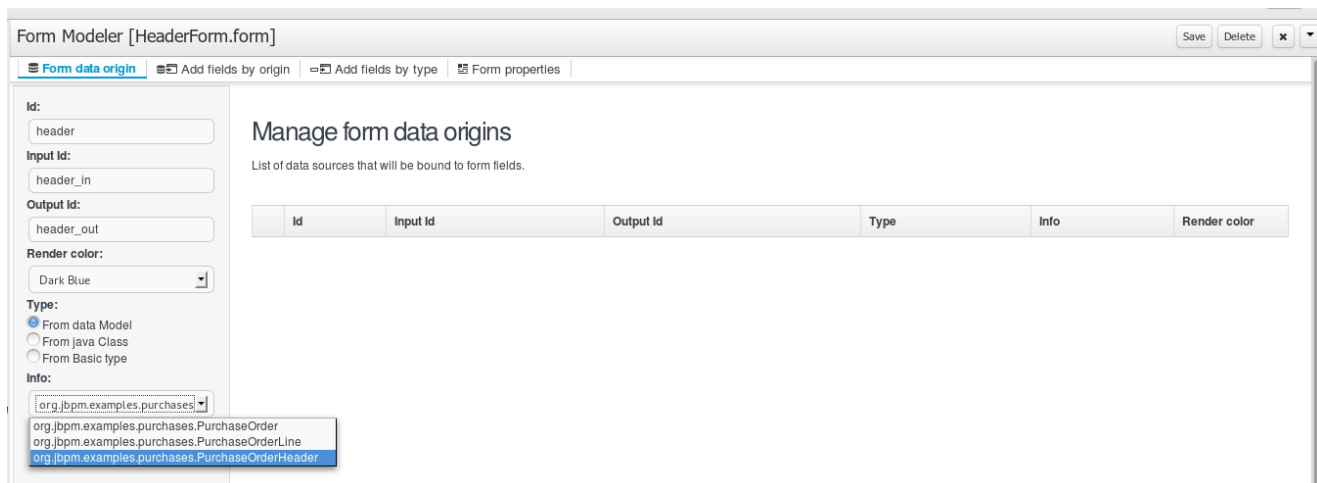


Figure 13.17. Create new data origin

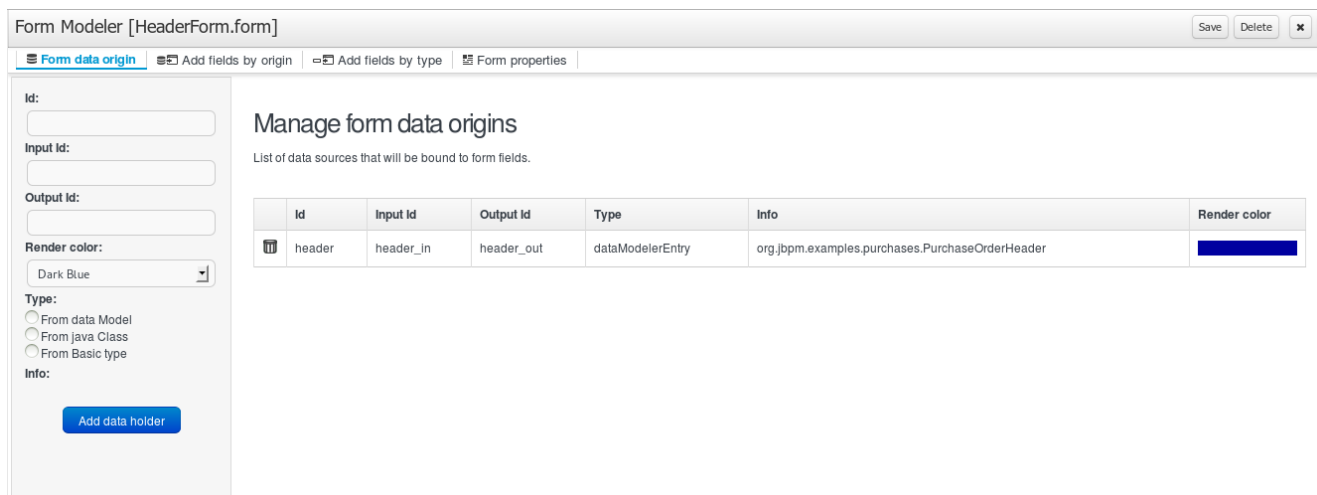


Figure 13.18. Data origin

3. Add fields by origin. All the properties are shown, and can be added to the form, either one by one or all of them at once.

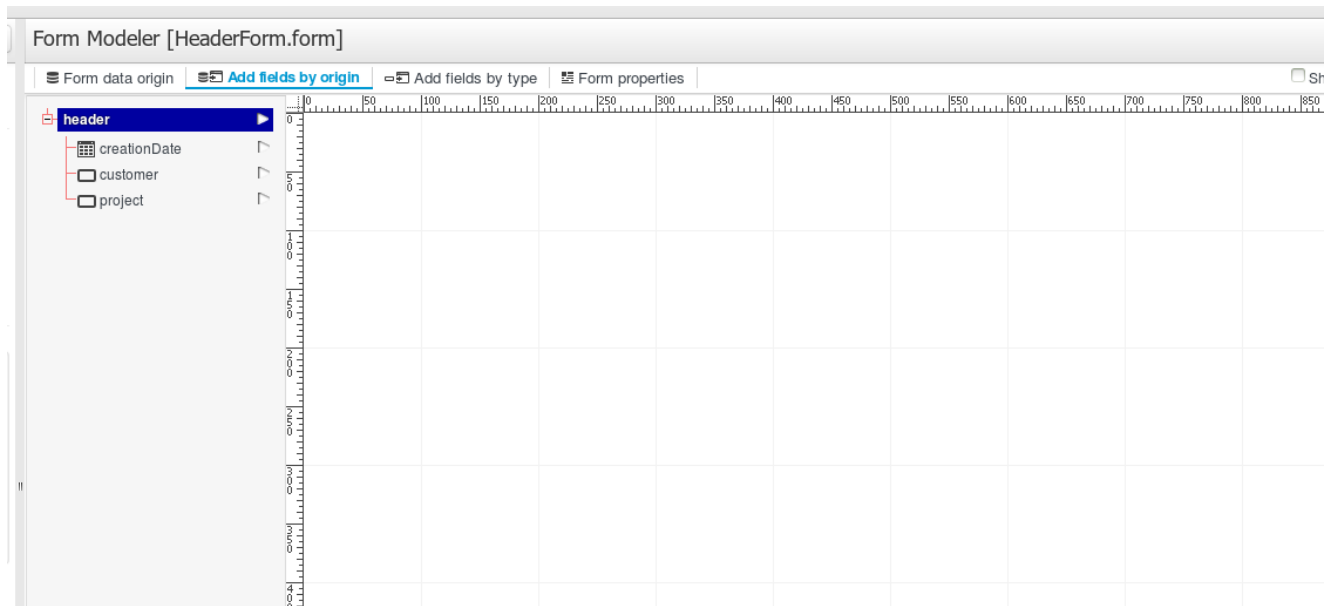


Figure 13.19. Add fields by origin

All the properties have been added to the form, and now we can edit each of them and move them around.

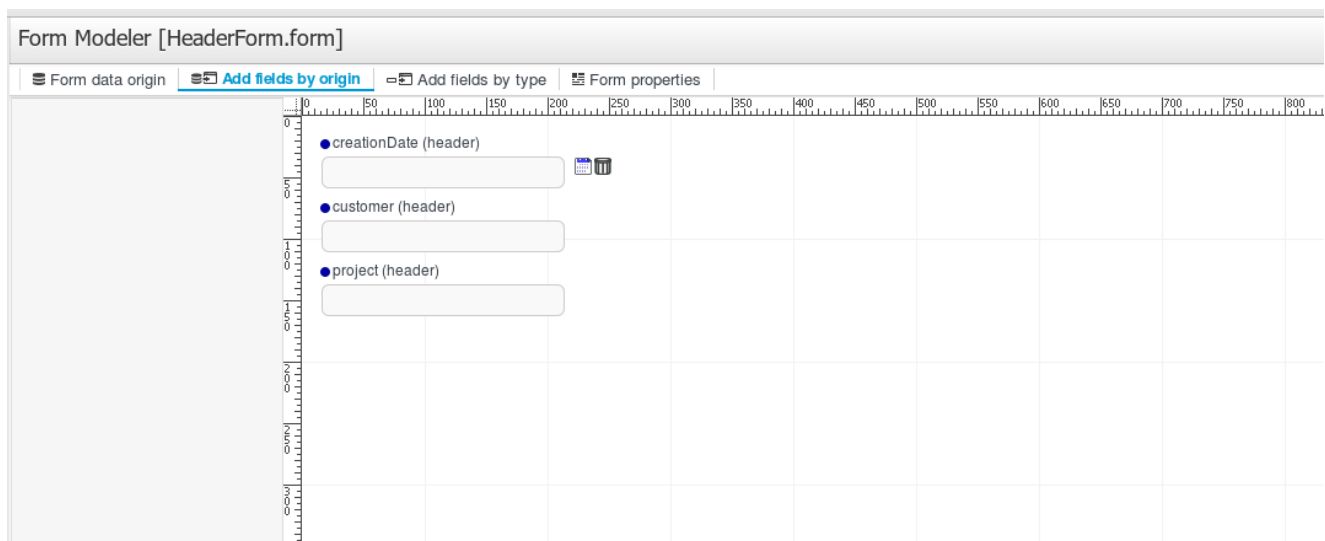


Figure 13.20. All data origin fields added

4. Configure the fields and customize form.
5. Once the form has been saved, open the initial parent form and set the field property 'Default form'.

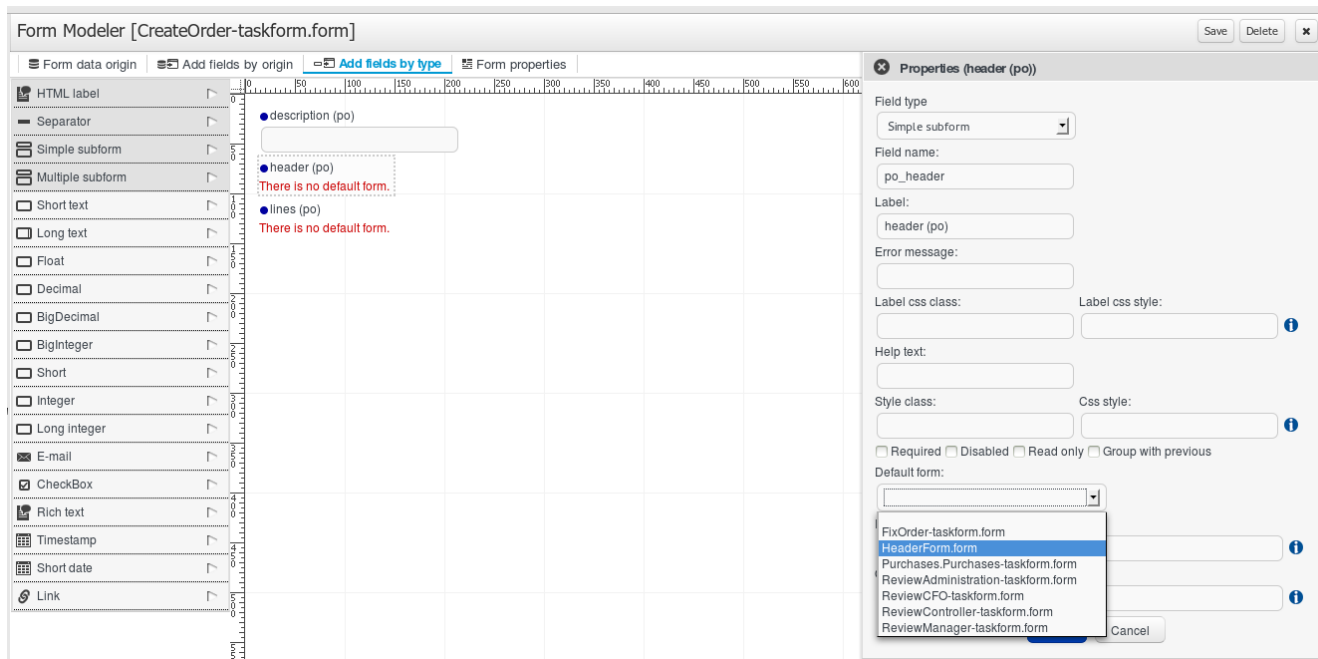


Figure 13.21. Configure the parent form

This will insert the subform inside the parent form, and will be shown as below:

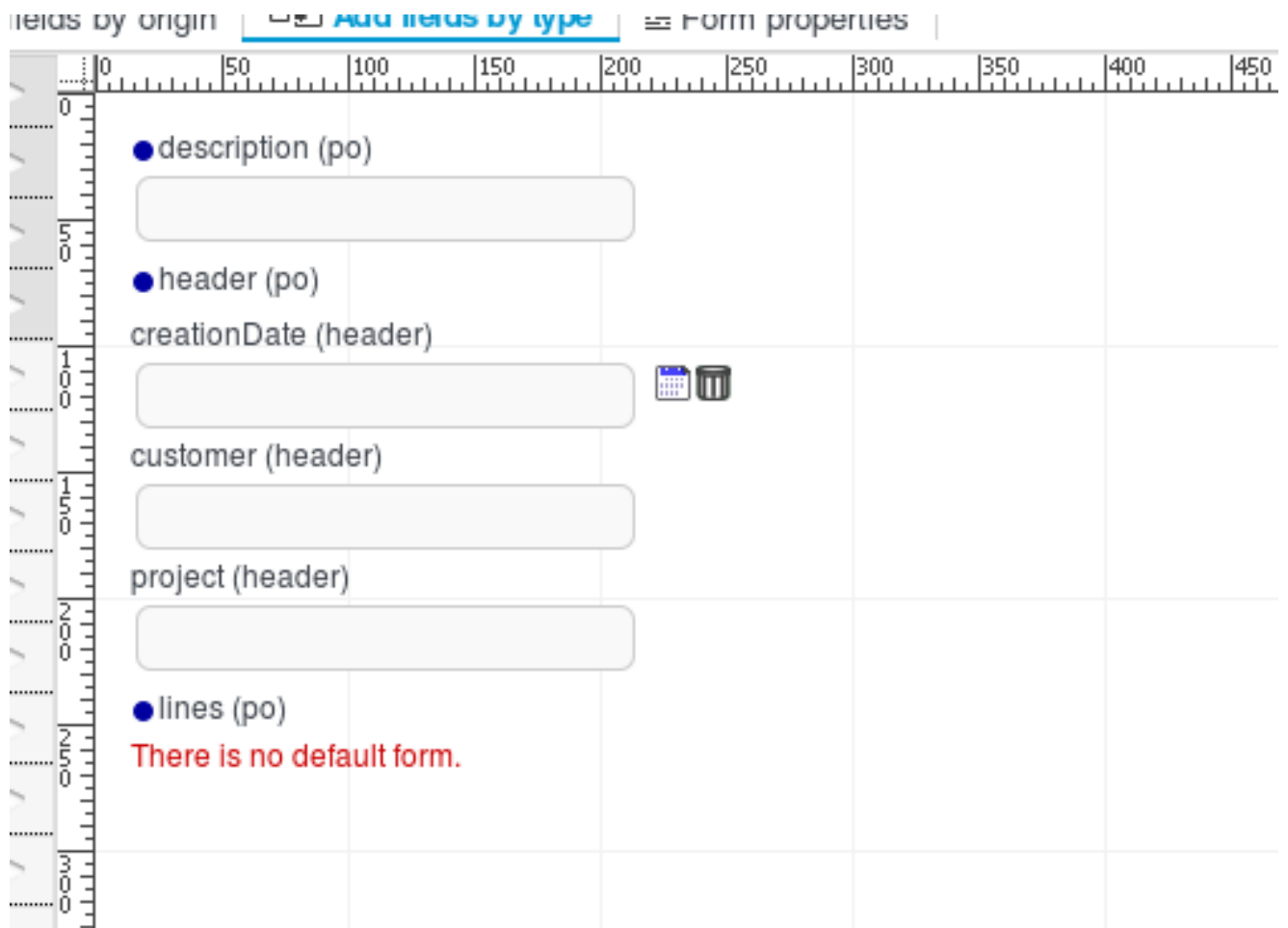


Figure 13.22. Parent form visualization after subform configuration

13.3.2.3.3.2. Arrays of objects.(Multiple subform field Type)

Now, we want to be able to create, edit and remove purchase order lines, by displaying a table with all the values and being able to capture information through a form. This will be done as follows:

Create a form that will hold and capture the information for each line's value (description, amount, unitPrice and total), following the same steps as above. This will be done as follows:

1. Create new form.

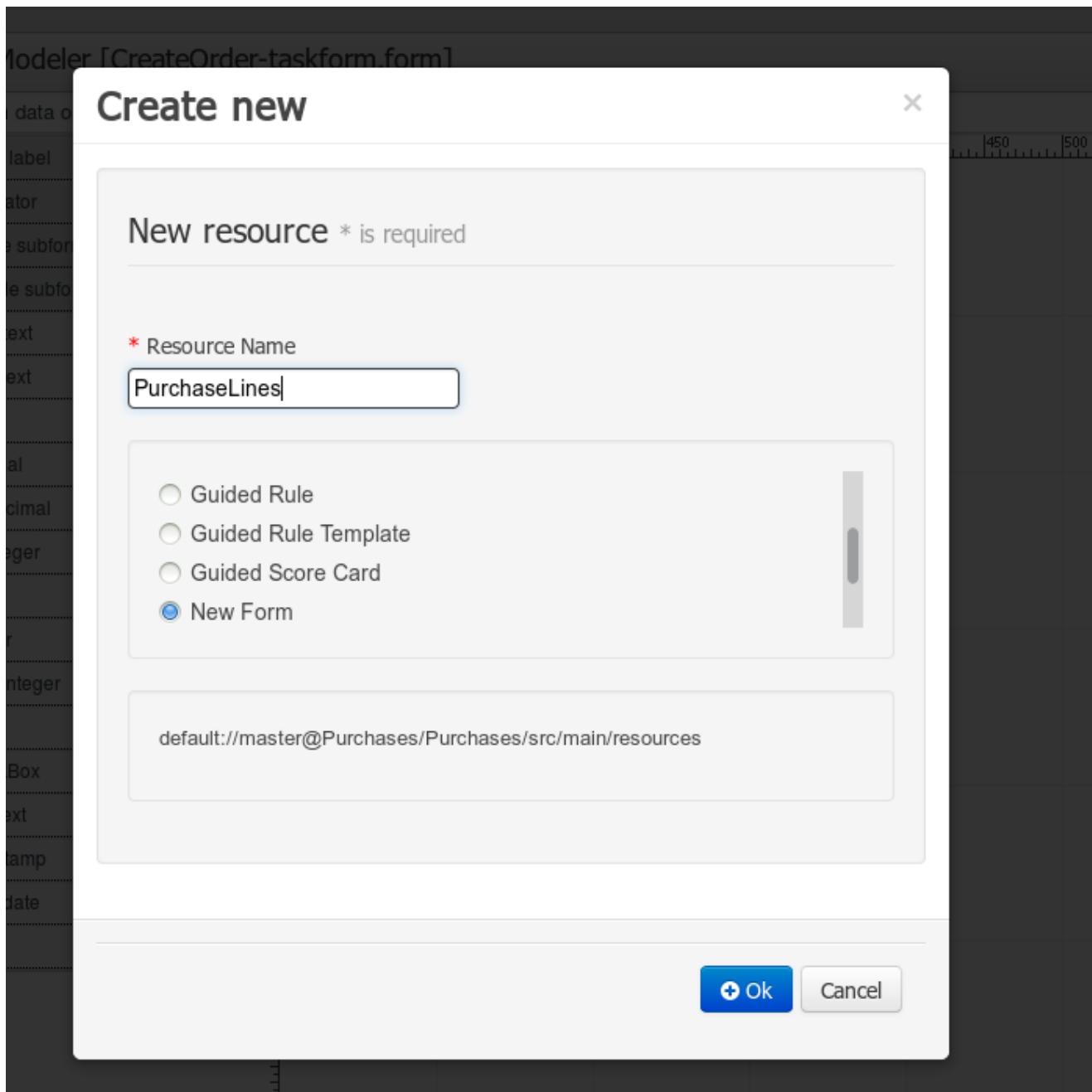


Figure 13.23. Create new form

2. Create new data origin.

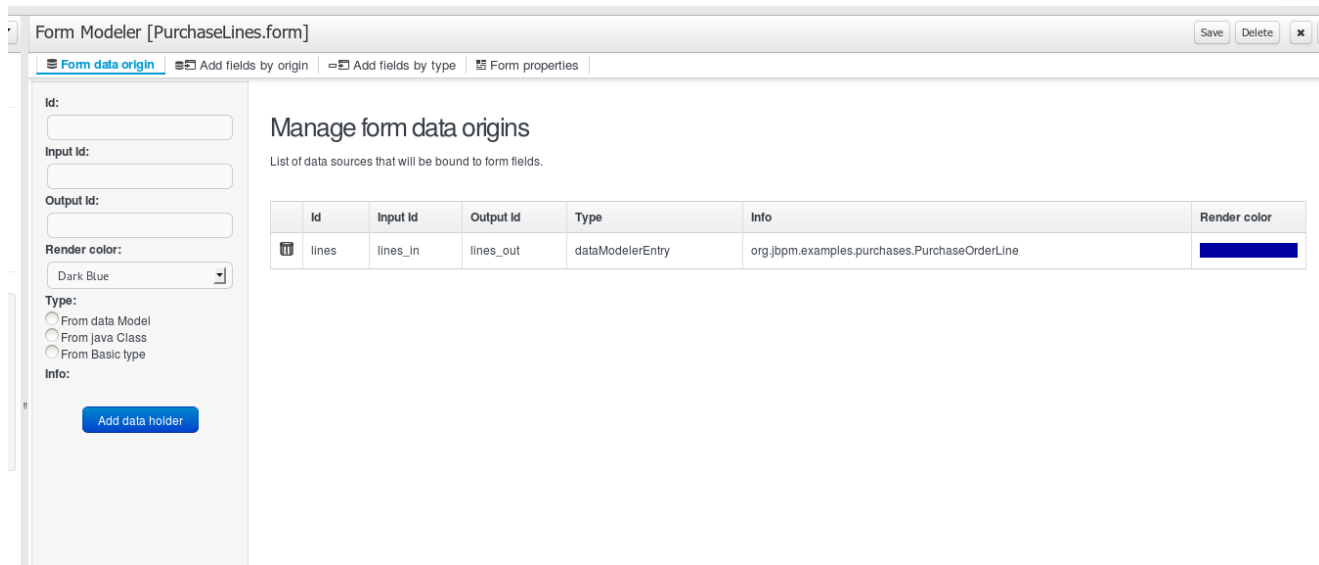


Figure 13.24. Create new data origin

3. Add fields by origin. All the properties are shown, and can be added to the form, either one by one or all of them at once.

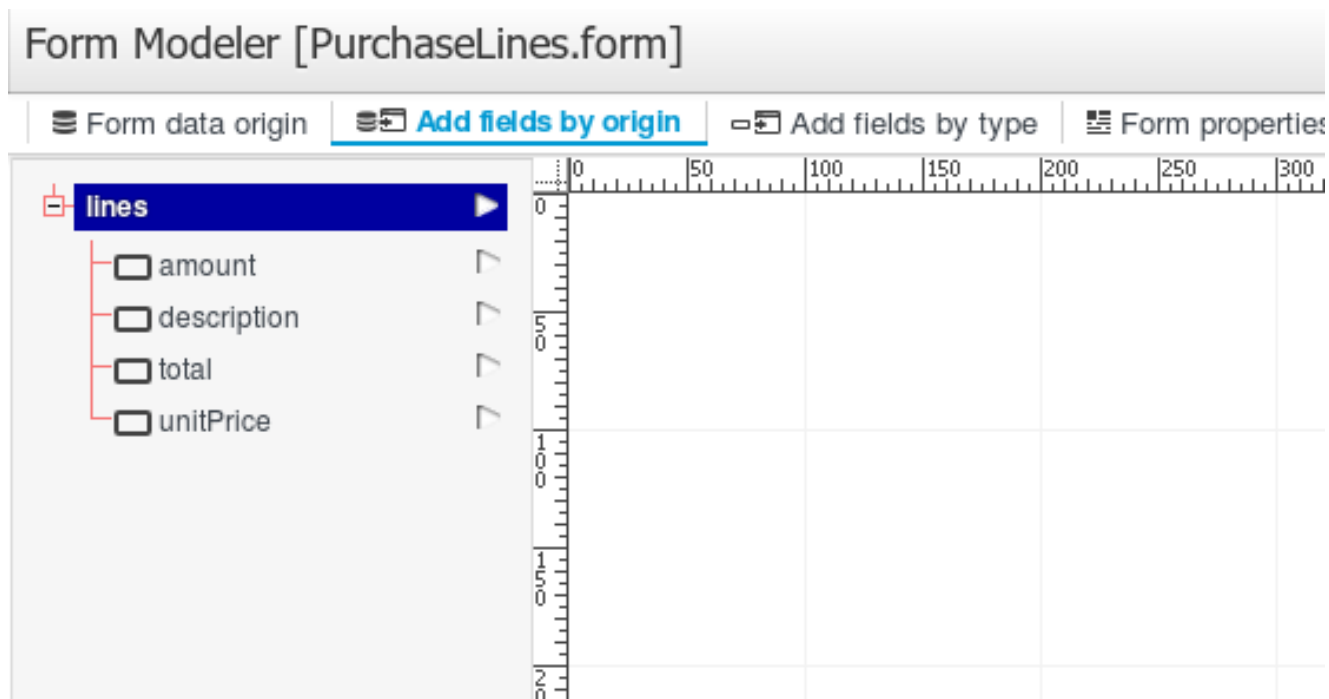


Figure 13.25. Configure the parent form

4. Customize form. Change display options to improve the form visualization

5. Configure the fields. After creating the basic form structure, we can use a formula to calculate automatically the total field. This formulas and expressions are described in Formula & expression section.

The screenshot shows a form configuration interface. On the left, a grid displays four fields: 'on (lines)', 'unitPrice (lines)', 'amount (lines)', and 'total (lines)'. The 'total (lines)' field is selected, and its properties are shown in a panel on the right. The panel is titled 'Properties (total (lines))' and contains the following fields:

- Field type: Decimal
- Field name: lines_total
- Label: total (lines)
- Error message: (empty)
- Label css class: (empty)
- Label css style: (empty)
- Help text: (empty)
- Style class: (empty)
- Css style: (empty)
- Size: 5
- Max length: (empty)
- Required:
- Disabled:
- Read only:
- Formula: `=({lines_unitPrice}*{lines_amount})`
- Range value: (empty)

Figure 13.26. Configuring formulas

6. Finally, we save the lines form and go back to the parent form and configure all the lines properties.

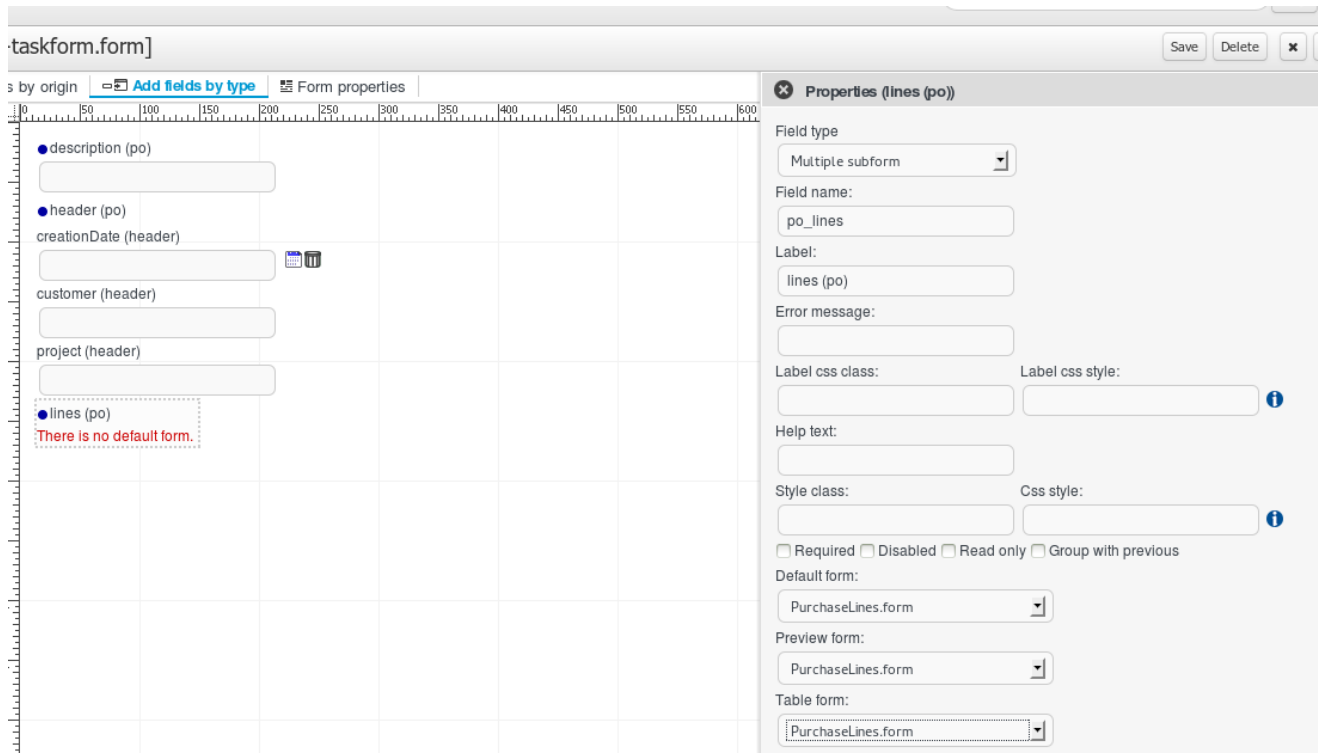


Figure 13.27. Configure the parent form

13.3.2.3.4. Formulas

Form Modeler provides a Formula Engine that you can use to automatically calculate field values. That Formula engine supports Java and XPATH expressions to access the form fields values. Let's see some examples.

- Setting a Default value formula

Imagine that you have a form that contains a date field “Creation date” that has to be set by default with the current date. To do that you should edit the field properties and set a Default value formula like:

```
=new java.util.Date();
```

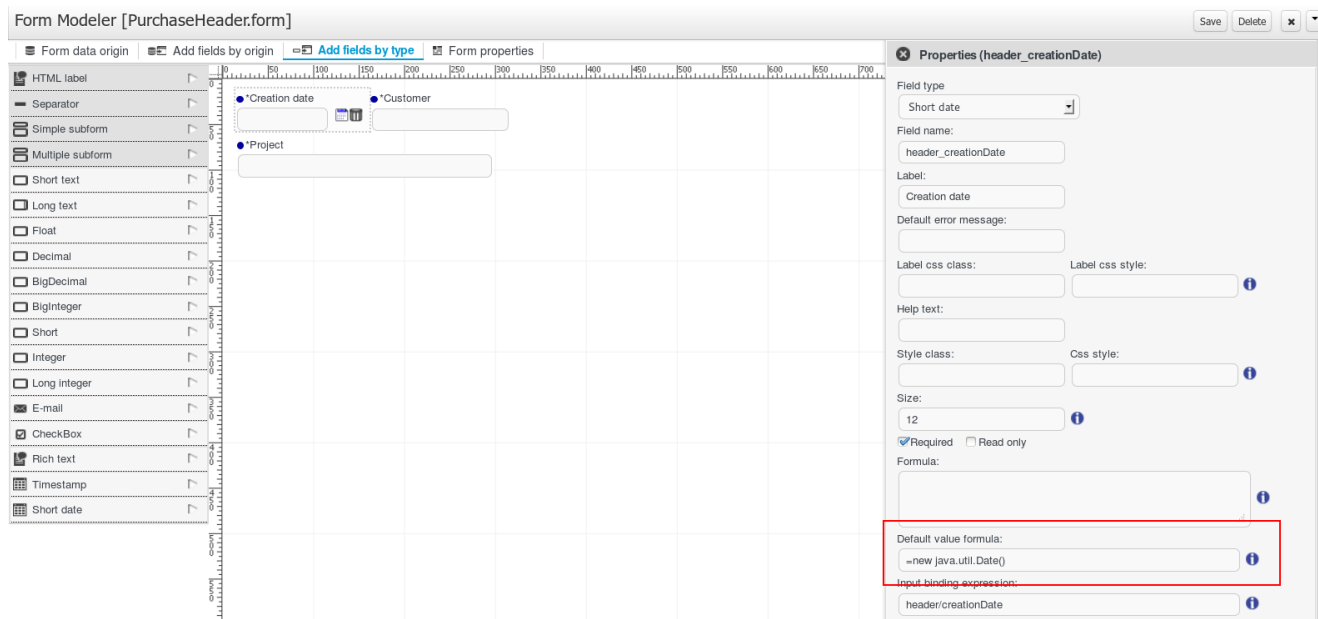


Figure 13.28. Setting default value formula

After setting a Default formula value on a field properties, when the form is rendered by the first time the field will have the specified value.

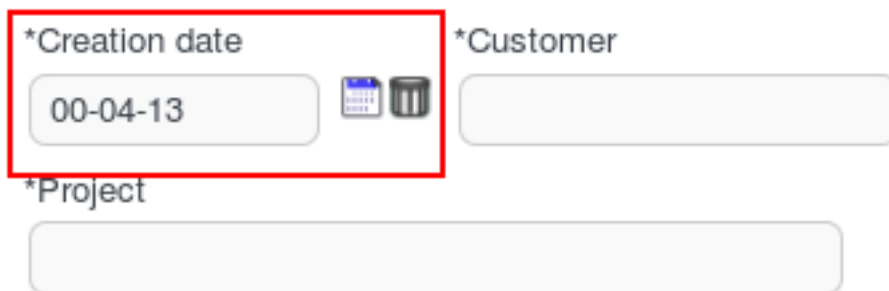


Figure 13.29. Rendering field with default formula

As you can see, you can use a default formula any expression that return a value supported for the field.

- Setting a Formula

The formula engine allows you to calculate formulas that depend on other Field values using XPATH expressions to refer to fields values like {a_field_name}, standard operators (+, -, *, /, %...) to operate with them or calls to Java Functions for more complex operations.

To start let's see how you can create a formula to calculate the line_total of a Purchase Order Line. Look at the image below and look at the formula on the line_total properties.

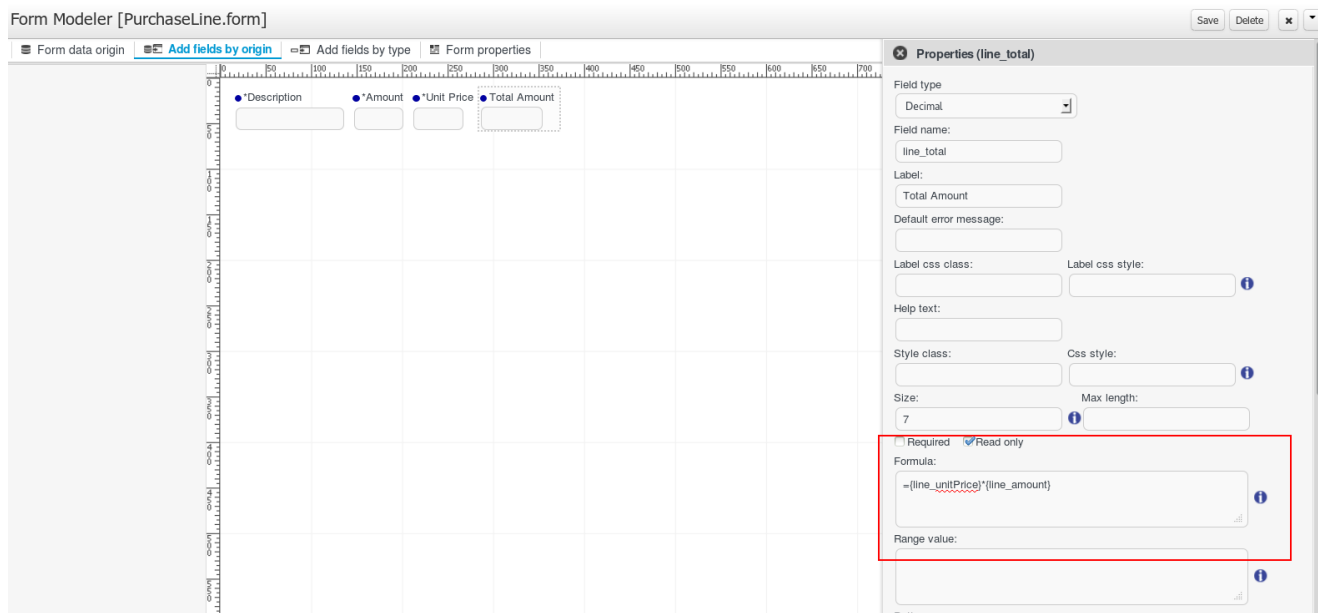


Figure 13.30. Rendering field with default formula

With this expression:

```
={line_unitPrice}*{line_amount}
```

we're forcing the Total of the line value to be the result of the the Unit price multiplied by the Amount, so when the user fills the Amount and Unit Price fields automatically the Total Amount field value is going to be calculated and filled with the operation result:

*Description	*Amount	*Unit Price	Total Amount
	3	1.45	4.35

Figure 13.31. Rendering field with default formula result

Is possible to create formulas to operate with values stored in subforms using expressions like

```
={a_field/a_subform_field}
```

Look at the next image to see how it works:

Forms

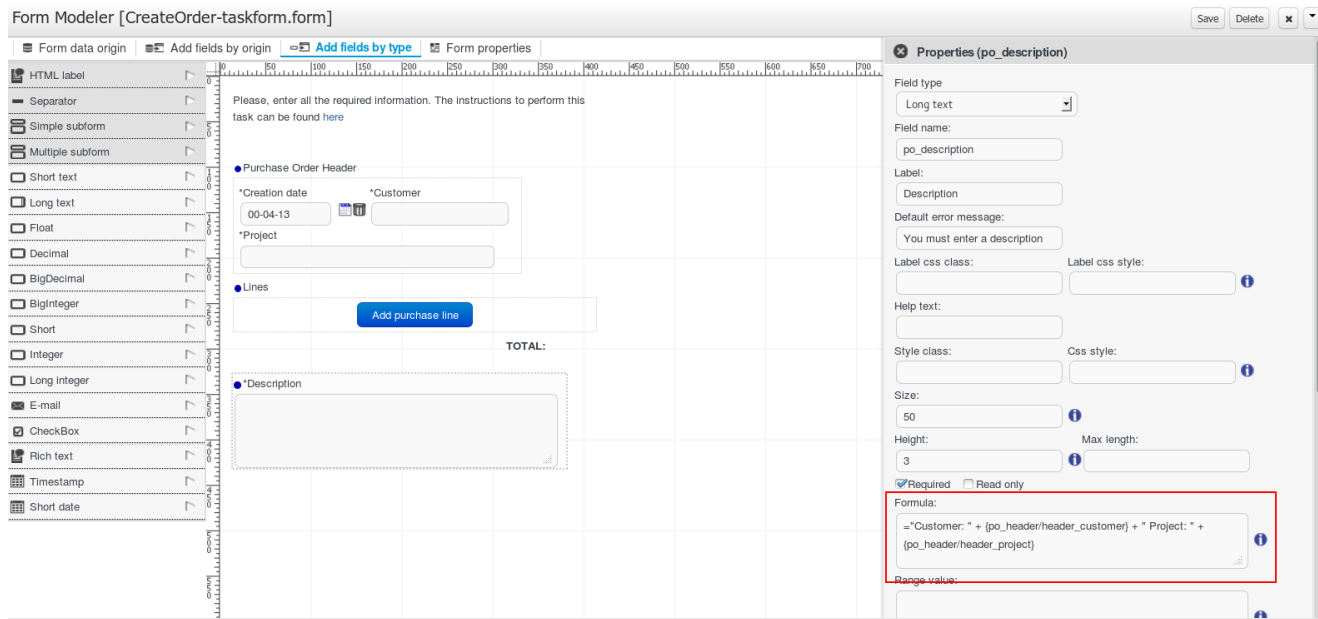


Figure 13.32.



This form has a subform field called `po_header` that is showing a form with the fields `header_creationDate`, `header_customer` and `header_project`. We want the `Description` field on our parent form to show some information from the header. Look at the `Description` field properties formula.

```
= "Customer: " + {po_header/header_customer} + " Project: " + {po_header/header_project}
```

This formula returns a text when the fields `header_customer` and `header_projects` are filled on the child form, so from now the parent form will be filled like this:

Please, enter all the required information. The instructions to perform this task can be found [here](#)

Purchase Order Header

*Creation date   *Customer
*Project

Lines

TOTAL:
0.0

*Description

Customer: John R. Project: Form Modeler Documentation

Figure 13.33.

Ok, you've seen how to create formulas that access to a subform fields values, now we are going to see how to work with values stored in Multiple Subforms. Imagine that we have a Purchase Order Line form that contains a multiple subform of Purchase Order Lines, and we want to calculate the total amount of the lines created. Look at the image below and how the TOTAL field is configured.

Forms

The screenshot displays the Form Modeler interface for 'CreateOrder-taskform.form'. On the left, there is a list of form elements including HTML_label, Separator, Simple subform, Multiple subform, Short text, Long text, Float, Decimal, BigDecimal, BigInteger, Short, Integer, Long Integer, E-mail, CheckBox, Rich text, Timestamp, and Short date. The central workspace shows a 'Purchase Order Header' section with fields for 'Creation date' (00-04-13), 'Customer', and 'Project'. Below this is a 'Lines' section with an 'Add purchase line' button and a 'TOTAL:' label. A 'Description' field is also present. The right-hand 'Properties' panel for the 'TOTAL' field shows various settings, including 'Field type' (Short text), 'Field name' (121118573), 'Label' (TOTAL:), and 'Formula' (=(sum(po_lines/line_total))). The formula field is highlighted with a red box.

Figure 13.34.





On the formula expression: `={sum(po_lines/line_total)}` we are using the XPATH function `sum()` that is going to summarize the totals of all the lines. So after creating some Lines the form will look like this:

Please, enter all the required information. The instructions to perform this task can be found [here](#)

Purchase Order Header

*Creation date	*Customer
<input type="text" value="00-04-07"/>	<input type="text"/>
*Project	
<input type="text"/>	

Lines

Actions	Lines	Lines	Lines	Lines
 	Form Modeler guide	3	35.75	107.25
 	Labtop	1	785.5	785.5

TOTAL:
892.75

*Description

Figure 13.35.

Note that the line_total child field corresponds with the field line_total field on then form selected as a Default Form selected on the Lines field configuration.

On this sample we are using the sum() XPATH function to calculate the total of the Purchase Order, but XPATH provides a lot of possibilities to select values from a set of children and also a lot functions to summarize values (sum, count, avg...). For more information about XPATH you can take a look at <http://www.w3schools.com/xpath/>

- Setting a Range Formula

A range formula allows you to let you specify the values that the user can select from an specific field, showing it like a select box. It can be used on all simple types except Dates and Checkboxes.

To see how it works look the next image and look at the Review Status field configuration.

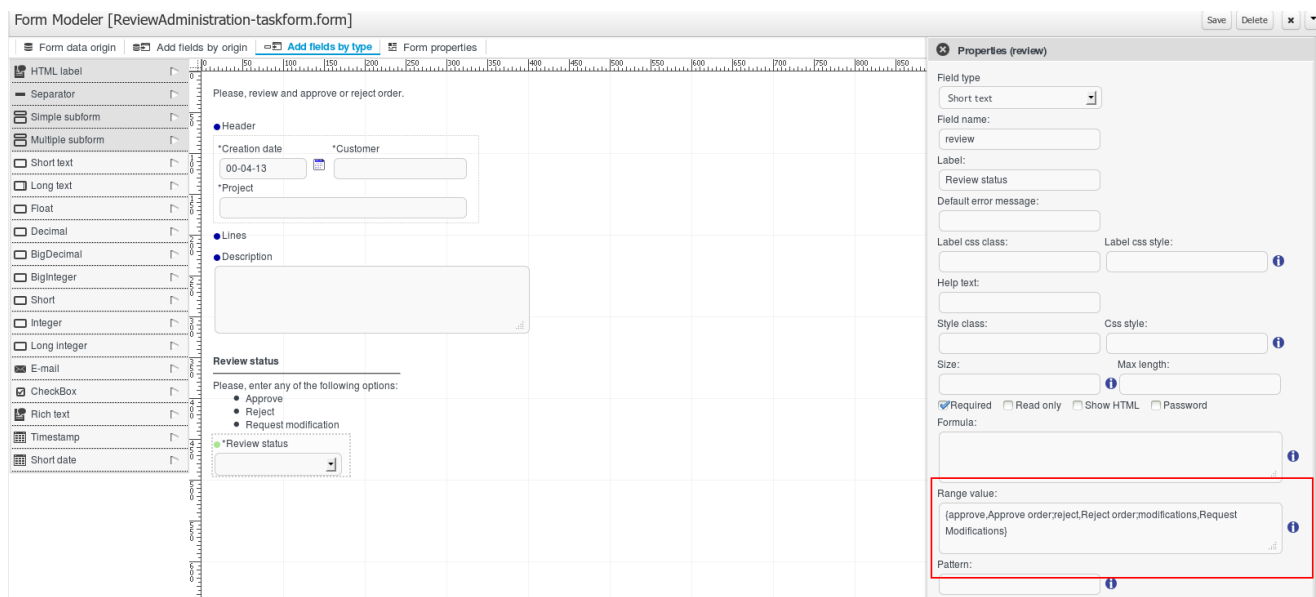


Figure 13.36. Setting default value formula

As you can see that field is being shown as a select box and it has a range formula that specifies the values like this:

```
{approve,Approve order;reject,Reject order;modifications,Request Modifications}
```

This expression is defining 3 duos of value/"text to show" separated with the character ',' and each of this duos is separated from each other other with the ';' character. So due this formula the resulting select box will show:

Table 13.2.

Value stored in input	Text shown on Select Box
approve	Approve order

Value stored in input	Text shown on Select Box
reject	Reject order
modifications	Request Modifications

13.3.2.4. Customizing form layout

When you need an extra customization level and have more control over the HTML that is displayed. The form modeler provides the ability to edit the HTML directly.

To use this functionality, the user have to specify that in the 'Form properties' tab, 'Custom form layout' option and save.

Now the form is displayed with the custom HTML. To access this HTML editing, we click on the icon 'Edit'

The HTML editor is displayed; the HTML code will define how the form has to be shown. In this editor the user can directly create the HTML i locate the fields and labels with the syntax described below:

`$field{fieldName}` for field identified fieldName

`$label{fieldName}` for field identified fieldName label

These expressions will be replaced by the field or label rendering when the form will be shown.

Form modeler also provides two ways to help in the form HTML creation.

- 'Insert form elements'

Two select: one for the fields and another for the labels. Clicking on that, the field or label text is added to HTML. These selects only show the form fields haven't been added yet.

- 'Generate template based on'

This functionality generates the HTML using all fields (default, alignment fields or Not aligned) depending on the selected value and overwrite the HTML.

13.3.3. Field types

There are three types of field types that you can use to model your form:

- Simple types

These field types are used to represent simple properties like texts, numeric, dates, etc. The supported Field types are:

Table 13.3. Field types

Name	Description	Java Type	Default on generated forms
Short Text	Simple input to enter short texts.	java.lang.String	yes
Long Text	Text area to enter long text.	java.lang.String	no
Rich Text	HTML editor to enter formatted texts .	java.lang.String	no
Email	Simple input to enter short text with email pattern.	java.lang.String	no
Float	Input to enter short decimals.	java.lang.Float	yes
Decimal	Input to enter number with decimals.	java.lang.Double	yes
BigDecimal	Input to enter big decimal numbers.	java.math.BigDecimal	yes
BigInteger	Input to enter big integers.	java.math.BigInteger	yes
Short	Input to enter short integers	java.lang.Short	yes
Integer	Input to enter integers.	java.lang.Integer	yes
Long Integer	Input to enter long integers	java.lang.Long	yes
Checkbox	Checkbox to enter true/false values	java.lang.Boolean	yes
Timestamp	Input to enter date & time values	java.util.Date	yes
Short Date	Input to enter date values.	java.util.Date	no
Document	File input to upload documents.	org.jbpm.document.Document	yes

- Complex types

These field types are made to deal with properties that are Java Objects instead of basic types. These field types need extra forms to be created in order to show and write values onto the specified Java Object/s

Table 13.4. Complex types

Name	Description	Java Type	Default on generated forms
Simple subform	Renders the a form, it is used to deal with 1:1 relationships.	java.lang.Object	yes
Multiple subform	This field type is used to deal with 1:N relationships. It allows to create, edit and delete a set child Objects.Text area to enter long text.	java.util.List	yes

- Decorators

Decorators are a type of field types that don't store data in the Object shown on the form. They can be used with aesthetic purpose

Table 13.5. Decorators

Name	Description
HTML label	Allows the user to create HTML code that will be rendered in the form
Separator	Renders an HTML separator

13.3.3.1. Custom Field Types

Is possible to extend the platform to add Custom Field Types that make a specific field (of any type) on the form to look and behave totally different than the standard platform fields. On this section we will take a look on how to create them and how to configure them.

13.3.3.1.1. How to create Custom Field Types

Basically a Custom Field Type is a Java class that implements the *org.jbpm.formModeler.core.fieldTypes.CustomFieldType* interface and is packaged inside inside a JAR file that is placed on the Application Server classpath or inside the application WAR.

Lets take a look at *org.jbpm.formModeler.core.fieldTypes.CustomFieldType*:

```
package org.jbpm.formModeler.core.fieldTypes;

import java.util.Locale;
import java.util.Map;

/**
 * Definition interface for custom fields
 */
public interface CustomFieldType {
    /**
     * This method returns a text definition for the custom type. This text will be shown
     * on the UI to identify the CustomFieldType
     * @param locale The current user locale
     * @return A String that describes the field type on the specified locale.
     */
    public String getDescription(Locale locale);

    /**
     * This method returns a string that contains the HTML code that will be used to show
     * the field value on screen
     * @param value The current field value
     * @param fieldName The field name
     * @param namespace The unique id for the rendered form, it should be used to generate
     * identifiers inside the HTML code.
     * @param required Determines if the field is required or not
     * @param readonly Determines if the field must be shown on read only mode
     * @param params A list of configuration params that can be set on the field
     * configuration screen
     * @return The HTML that will be used to show the field value
     */
    public String getShowHTML(Object value, String fieldName, String namespace,
        boolean required, boolean readonly, String... params);

    /**
     * This method returns a String that contains the HTML code that will show the input
     * view of the field. That will be used to set the field value.
     * @param value The current field value
     * @param fieldName The field name
     * @param namespace The unique id for the rendered form, it should be used to
     * generate identifiers inside the HTML code.
     * @param required Determines if the field is required or not
     * @param readonly Determines if the field must be shown on read only mode
     * @param params A list of configuration params that can be set on the field
     * configuration screen
     * @return The HTML code that will be used to show the input view of the field.
     */
    public String getInputHTML(Object value, String fieldName, String namespace,
        boolean required, boolean readonly, String... params);

    /**
     * This method is used to obtain the field value from the submitted values.
     * @param requestParameters A Map containing the request parameters for the
     * submitted form
     * @param requestFiles A Map containing the java.io.Files uploaded on the request
     * @param fieldName The field name
     * @param namespace The unique id for the rendered form, it should be used to generate
     * identifiers inside the HTML code.
     */
}
```

```

* @param previousValue The previous value of the current field
* @param required Determines if the field is required or not
* @param readonly Determines if the field must be shown on read only mode
* @param params A list of configuration params that can be set on the field
* configuration screen
* @return The value of the field based on the submitted form values.
*/
public Object getValue(Map requestParameters, Map requestFiles, String fieldName,
    String namespace, Object previousValue, boolean required, boolean readonly,
    String... params);
}

```

As you can see this Interface defines the methods that determines how the field has to be shown on the screen for when the form is shown on insert(`getInputHTML(...)`) or readonly (`getShowHTML(...)`) mode. It also provides the method (`getValue(...)`) that reads the needed parameters from the request and to obtain the correct field value. The returned value type must match with the type of the field added on the form.

13.3.3.1.2. Configuring and using Custom Field Types

Now let's see how to use and configure and use a Custom Field type. Following the example on the previous chapter, we have created a File Input type and we have it already installed on our application. So now we are going to create a new form and add a Short Text property and turn it into a File Input and edit the field properties changing the Field Type from *Short text* to *Custom field*.

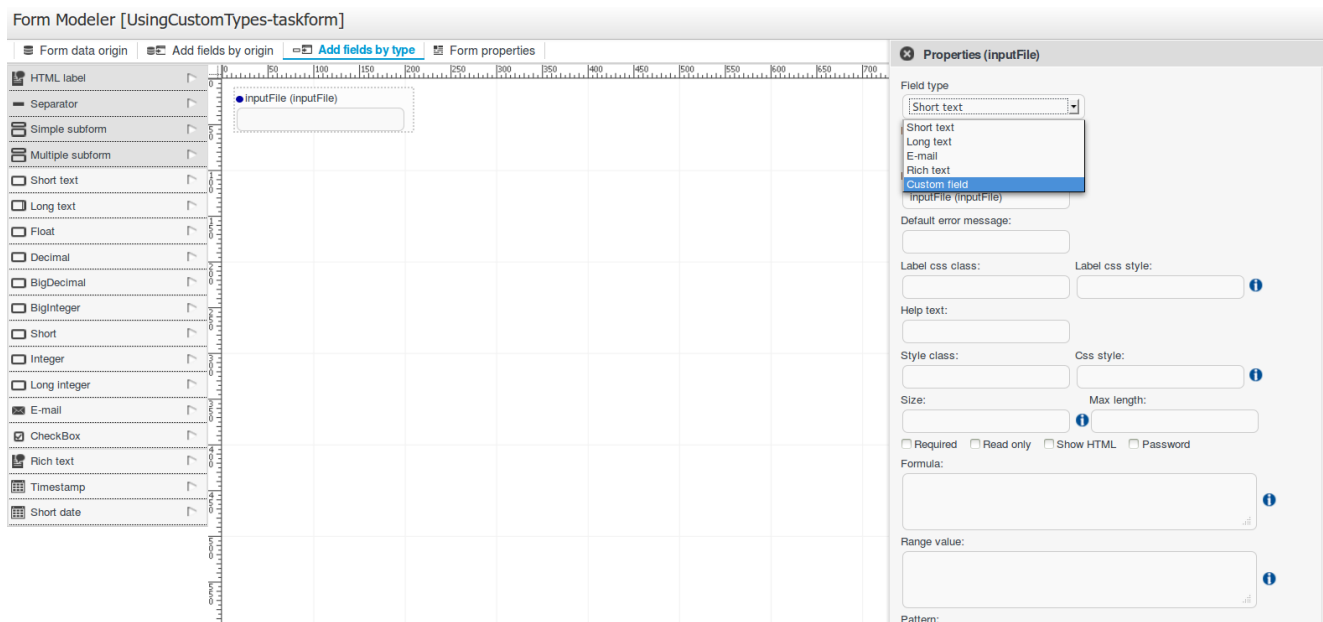


Figure 13.37. Changing a field type to *Custom field*

After changing the field type a new set of properties will appear:

✕ Properties (inputFile)

Field type
Custom field

Field name:
inputFile

Label:
inputFile (inputFile)

Custom field
[Dropdown]

First Parameter
[Text Box]

Second Parameter
[Text Box]

Third Parameter
[Text Box]

Fourth Parameter
[Text Box]

Fifth Parameter
[Text Box]

Required Read only

Input binding expression:
[Text Box] ⓘ

Output binding expression:
inputFile ⓘ

Save Cancel

Figure 13.38. Custom field properties configuration form

Table 13.6. Custom field properties

Property	Description
Field type	Can change the field type to other compatible field types
Field Name	Will be used as identifier in formulas calculation
Label	The text that will be shown as field label
Custom field	A list containing all the Custom Field Types available on the platform
First parameter	A String parameter that can be user to pass custom configuration needed by the Custom Field Type implementation
Second parameter	A String parameter that can be user to pass custom configuration needed by the Custom Field Type implementation
Third parameter	A String parameter that can be user to pass custom configuration needed by the Custom Field Type implementation
Fourth parameter	A String parameter that can be user to pass custom configuration needed by the Custom Field Type implementation
Fifth parameter	A String parameter that can be user to pass custom configuration needed by the Custom Field Type implementation
Required	Indicates if it's mandatory to fill this field.
Read Only	When this check is on, the field will be used only for read
Input binding expression	This expression defines the link between field and process task input variable. It will be used in runtime to set the field value with that task input variable data.
Output binding expression	This expression defines the link between field and process task output variable. It will be used in runtime to set that task output variable.

So opening the Custom field select box we'll be able to select the *File Input* from the available custom types:

✕ Properties (inputFile)

Field type
Custom field

Field name:
inputFile

Label:
inputFile (inputFile)

Custom field
File Input

Second Parameter

Third Parameter

Fourth Parameter

Fifth Parameter

Required Read only

Input binding expression:

Output binding expression:
inputFile

Save Cancel

Figure 13.39. Available custom types

After selecting the *File Input* type on the list and saving the field properties the form will look like:

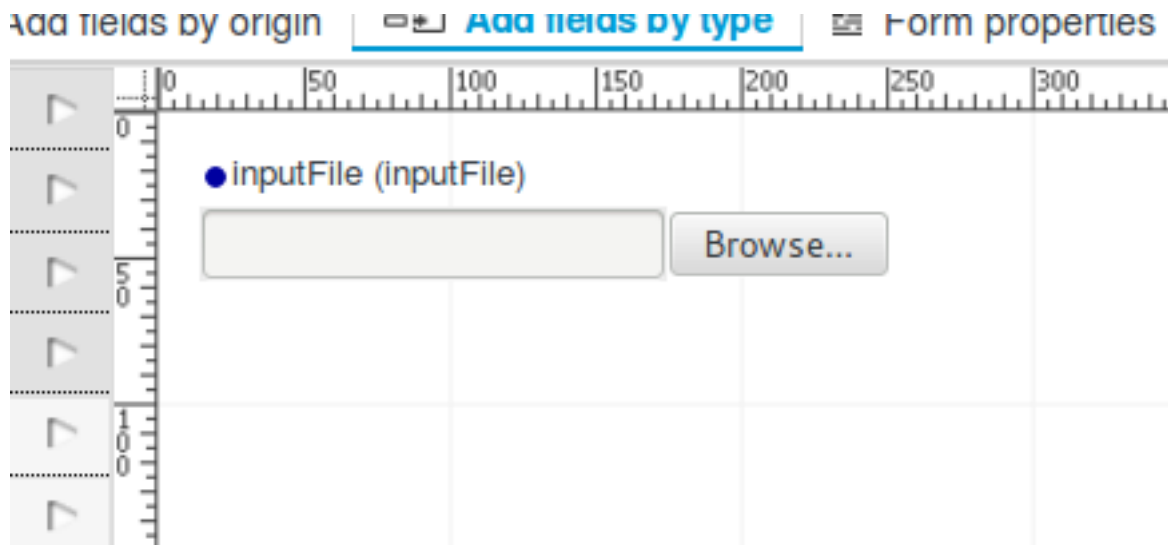


Figure 13.40. Custom type display in a form

If we build a simple process and configure a *Short text* to be shown as the sample *File Input*, if we build the project on runtime the field will behave uploading the chosen files to the server and allowing the user to download it like this:

2 - Edit File

in_inputFile (inputFile)

Figure 13.41. Choosing the file to upload

2 - Edit File

in_inputFile (inputFile)




 Planning - Jan 25.odt (209.18 Kb) 

Figure 13.42. File uploaded, showing the download link

If we take a look at what's the process variable value, we'll see that is storing a String with the file path stored in server.

Process Variables Refresh 

Instance ID 2

Definition Id UsingCustomTypes

Definition Name UsingCustomTypes


Name	Value	Type	Last Modification	Actions
inputFile	/docs/e3cab773/b14d/4e19/8cd0/e61c539a8c06/inputFile/Planning - Jan 25.odt	String	22/10/2013 15:18	

Figure 13.43. Process variable storing custom type results

13.4. Document attachments

On this section we are going to describe step by step how to attach documents to your process variables from your forms and how you can configure to store the uploaded documents anywhere (File System, Data Base, Alfresco...) using the *Pluggable Variable Persistence*.

13.4.1. Process and forms configuration

To make your process manage documents you have to define your process variables as usual using the Custom Type `org.jbpm.document.Document`. Each variable defined as *Document* will be shown on the form as a FILE input.

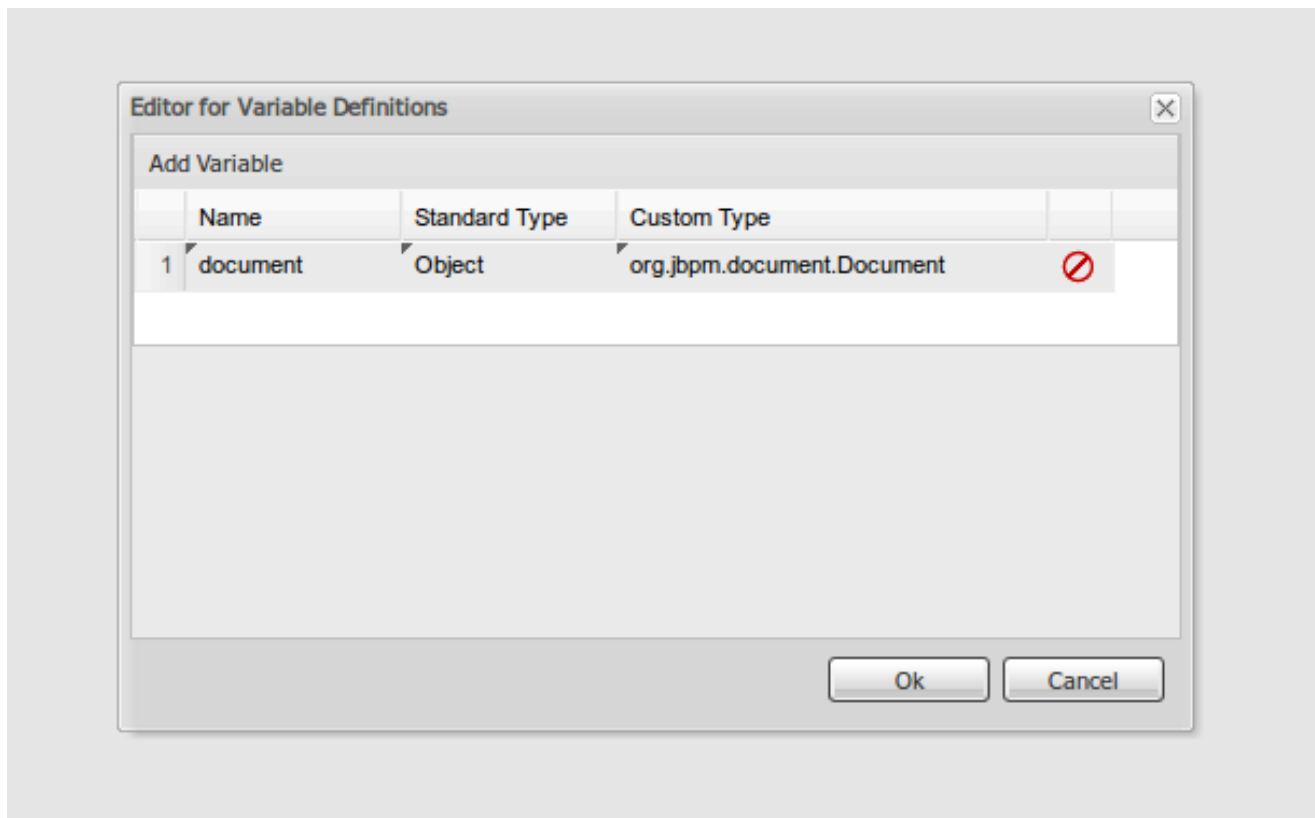


Figure 13.44. Defining a document variable

When the process forms are generated and a `org.jbpm.document.Document` variable is found a File input will be placed on the form.

The image shows a form editor interface. At the top, there are two tabs: "Add fields by origin" and "Add fields by type". Below the tabs is a grid of field configurations. The first row is selected and shows a radio button next to the text "document (document)". Below this text is a "Browse..." button and the text "No file selected.". The grid has several other rows, some of which are partially visible at the bottom, showing labels like "imal" and "cimal".

Figure 13.45. Form generated showing a `org.jbpm.document.Document` input

Each time a document is uploaded using a form the Form Engine will generate an instance of `org.jbpm.document.Document` to be stored on the process variable.

13.4.2. Marshalling strategy and deployment configuration

In order to store the document using the *Pluggable Variable Persistence* you'll have to define your *Marshalling Strategy* to manage the uploaded Documents. To start create a Maven project with your favourite IDE and add the following dependencies:

```
<dependency>
  <groupId>org.kie</groupId>
  <artifactId>kie-api</artifactId>
  <version>{version}</version>
</dependency>
<dependency>
  <groupId>org.jbpm</groupId>
  <artifactId>jbpm-document</artifactId>
  <version>{version}</version>
</dependency>
```

Once you did that is time to create your *Document Marshalling Strategy*, to do so you just have to create a class that extends:

```
package org.jbpm.document.marshalling;

public abstract class AbstractDocumentMarshallingStrategy implements ObjectMarshallingStrategy {

    public abstract Document buildDocument( String name, long size, Date lastModified, Map<String, String> params )

    public void write( ObjectOutputStream os, Object object )
        throws IOException;

    public Object read( ObjectInputStream os )
        throws IOException, ClassNotFoundException;

    public byte[] marshal( Context context, ObjectOutputStream os, Object object )
        throws IOException;

    public Object unmarshal( Context context, ObjectInputStream is, byte[] object,
        ClassLoader classloader ) throws IOException, ClassNotFoundException;

    public Context createContext();
}
```

The methods to implement are:

- **Document buildDocument(String name, long size, Date lastModified, Map<String, String> params)**: Creates a valid Document instance with the data received. This method is called when a document is uploaded to create the Document instance **before** marshalling the document content.
- **byte[] marshal(Context context, ObjectOutputStream os, Object object)**: Marshals the given object and returns the marshalled object as byte[]
- **Object unmarshal(Context context, ObjectInputStream is, byte[] object, ClassLoader classloader)**: Reads the object received as byte[] and returns the unmarshalled object
- **void write(ObjectOutputStream os, Object object)**: Implement for backwards compatibility, it should do the same functionality than **byte[] marshal(Context context, ObjectOutputStream os, Object object)**
- **Object read(ObjectInputStream os)**: Implement for backwards compatibility, it should do the same functionality than **Object unmarshal(Context context, ObjectInputStream is, byte[] object, ClassLoader classloader)**

You can see how the default *DocumentMarshallingStrategy* is implemented looking at this link [<https://github.com/droolsjbpm/jbpm/blob/master/jbpm-document/src/main/java/org/jbpm/document/marshalling/DocumentMarshallingStrategy.java>].

After creating your *Document Marshalling Strategy* and add it to your server classpath the only thing remaining is to configure your project deployment descriptor add it to the marshalling strategies list. To do it you just have to open the Kie-Workbench on your browser, open your project on the Authoring view and edit the *kie-deployment-descriptor.xml* file located on `<your-project>/src/main/resources/META-INF` and add your *Document Marshalling Strategy* to the `<marshalling-strategies>` list like this:

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<deployment-descriptor
  xsi:schemaLocation="http://www.jboss.org/jbpm deployment-descriptor.xsd"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <persistence-unit>org.jbpm.domain</persistence-unit>
  <audit-persistence-unit>org.jbpm.domain</audit-persistence-unit>
  <audit-mode>JPA</audit-mode>
  <persistence-mode>JPA</persistence-mode>
  <runtime-strategy>SINGLETON</runtime-strategy>
  <marshalling-strategies>
    <marshalling-strategy>
      <resolver>reflection</resolver>
      <identifier>
        org.jbpm.document.marshalling.DocumentMarshallingStrategy
      </identifier>
    </marshalling-strategy>
  </marshalling-strategies>
  <event-listeners/>
  <task-event-listeners/>
  <globals/>
  <work-item-handlers/>
  <environment-entries/>
  <configurations/>
  <required-roles/>
</deployment-descriptor>
```

Since this is done you're able to build your project and upload your documents on your process.

in_doc (document)

No file selected.

Figure 13.46. File input before file is uploaded

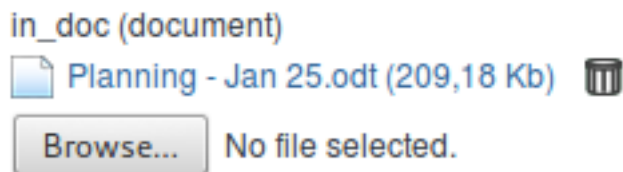


Figure 13.47. File input with an uploaded file



Note

On this example we are configuring the default `DocumentMarshallingStrategy`, please use it for test and demo purposes.

13.5. Using forms on client applications

This chapter intends to describe how you can embed process forms and interact with them on another webapp including the new Javascript API provided by the platform.

You can find the library inside the `kie-wb-*.war` on the js file located on `js/jbpm-forms-rest-integration.js`.

13.5.1. What does the API provides?

This JavaScript API tries to be a simple mechanism to use forms on remote applications allowing to load the forms from different KIE Workbench instances, submit them, launch processes/tasks and execute callback functions when the actions are done.

The basic methods are:

showStartProcessForm(hostUrl, deploymentId, processId, divId, onSuccessCallback, onErrorCallback): Makes a call to the REST endpoint to obtain the form URL and if it gets a valid response will embed the process start form on the given div. The parameteres needed are:

- *hostURL*: the URL of the KIE Workbench instance that holds the deployments.
- *deploymentId*: the deployment identifier that contains the process to run.
- *processId*: the identifier of the process to run.
- *divId*: the identifier of the div that has to contain the form.
- *onSuccessCallback* (optional): a javascript function that will be executed if the form is going to be rendered. This function will receive the server response as a parameter

- *onerrorCallback* (optional): a javascript function that will be executed if any error occurs and it is impossible to render the form. This function will receive the server response as a parameter

startProcess(divId, onSuccessCallback, onerrorCallback): Submits the form loaded on the given div and starts the process. The parameteres needed are:

- *divId*: the identifier of the div that to contains the form.
- *onSuccessCallback* (optional): a javascript function that will be executed after the process is started. This function will receive the server response as a parameter
- *onerrorCallback* (optional): a javascript function that will be executed if any error occurs and it is impossible to start the process. This function will receive the server response as a parameter

showTaskForm(hostUrl, taskId, divId, onSuccessCallback, onerrorCallback): Makes a call to the REST endpoint to obtain the form URL and if it gets a valid response will embed the task form on the given div. The parameteres needed are:

- *hostURL*: the URL of the KIE Workbench instance that holds the deployments.
- *taskId*: the identifier of the task to show the form.
- *divId*: the identifier of the div that has to contain the form.
- *onSuccessCallback* (optional): a javascript function that will be executed if the form is going to be rendered. This function will receive the server response as a parameter
- *onerrorCallback* (optional): a javascript function that will be executed if any error occurs and it is impossible to render the form. This function will receive the server response as a parameter

claimTask(divId, onSuccessCallback, onerrorCallback): Claims the task whose form is being rendered

- *divId*: the identifier of the div that contains the form.
- *onSuccessCallback* (optional): a javascript function that will be executed after the task is claimed. This function will receive the server response as a parameter
- *onerrorCallback* (optional): a javascript function that will be executed if any error occurs and it is impossible to claim the task. This function will receive the server response as a parameter

startTask(divId, onSuccessCallback, onerrorCallback): Starts the task whose form is being rendered

- *divId*: the identifier of the div that contains the form.

- *onSuccessCallback* (optional): a javascript function that will be executed after the task is started. This function will receive the server response as a parameter
- *onErrorCallback* (optional): a javascript function that will be executed if any error occurs and it is impossible to start the task. This function will receive the server response as a parameter

releaseTask(divId, onSuccessCallback, onErrorCallback): Releases the task whose form is being rendered

- *divId*: the identifier of the div that contains the form.
- *onSuccessCallback* (optional): a javascript function that will be executed after the task is released. This function will receive the server response as a parameter
- *onErrorCallback* (optional): a javascript function that will be executed if any error occurs and it is impossible to release the task. This function will receive the server response as a parameter

saveTask(divId, onSuccessCallback, onErrorCallback): Submits the form and saves the state of the task whose form is being rendered

- *divId*: the identifier of the div that contains the form.
- *onSuccessCallback* (optional): a javascript function that will be executed after the task is saved. This function will receive the server response as a parameter
- *onErrorCallback* (optional): a javascript function that will be executed if any error occurs and it is impossible to save the task. This function will receive the server response as a parameter

completeTask(divId, onSuccessCallback, onErrorCallback): Submits the form and completes task whose form is being rendered

- *divId*: the identifier of the div that contains the form.
- *onSuccessCallback* (optional): a javascript function that will be executed after the task is completed. This function will receive the server response as a parameter
- *onErrorCallback* (optional): a javascript function that will be executed if any error occurs and it is impossible to complete the task. This function will receive the server response as a parameter

clearContainer(divId): Cleans the div content and the related data stored on the component.

- *divId*: the identifier of the div that contains the form.

13.5.2. Sample usage

Now let's see an example how you can use the library to load the HR process form and start a new process instance. We are going to define a HTML page that will contain very simple components:

- "Show Process Form" BUTTON: The button that is going to make a call to a *showProcessForm()* function to embedd the process form.
- "myform" DIV: the div that will containt the form
- "Start Process" BUTTON: the button that will call the *startProcess()* function that submits the form and start a new process instance. At the begining it will be hidden and only will be displayed when the form is going to be rendered.

First we are look at the HTML code:

```
<head>
  <script src="js/jbpm-forms-rest-integration.js"></script>
  <script>
    var formsAPI = new jBPMFormsAPI();
  </script>
</head>
<body>
  <input type="button" id="showformButton"
    value="Show Process Form" onclick="showProcessForm()">
  <p/>
  <div id="myform" style="border: solid black 1px; width: 500px; height: 200px;">
  </div>
  <p/>
  <input type="button" id="startprocessButton"
    style="display: none;" value="Start Process" onclick="startProcess()">
</body>
```

Notice that in first place we have added the js library and created an instance of the *jBPMFormsAPI* object that will manage the form rendering.

Now let's see how the **showProcessForm()** function looks like:

```
function showProcessForm() {
  var onSuccessCallback = function(response) {
    document.getElementById("showformButton").style.display = "none";
    document.getElementById("startprocessButton").style.display = "block";
  }

  var onErrorCallback = function(errorMessage) {
    alert("Unable to load the form, something wrong happened: " + errorMessage);
    formsAPI.clearContainer("myform");
  }

  formsAPI.showStartProcessForm("http://localhost:8080/kie-wb/", "org.jbpm:HR:1.0", "hiring",
  "myform", onSuccessCallback, onErrorCallback);
}
```

As you can see, first we are defining the callback functions:

onsuccessCallback: This function is going to be called when the call to the REST endpoint and the form is going to be rendered. On this example we simply hide the *"Show Process Form"* button and show the *"Start Process"* button in order to allow to submit the form and start the process. This function takes as a parameter the response of the REST call to inform the user that everything gone well.

onerrorCallback: This function is going to be called if any error occurs (e.g. any communication error with the REST endpoint or unexpected js errors) On this example we simply show an alert showing the error message received and clear the *"myform"* DIV status.

Once we defined the callback function we proceed to call the **formsAPI.showStartProcessForm(...)** that is going to make the REST call and embed the form inside the specified div. Notice that we are providing a bunch of information in order to load the form, the URL where the KIE-Workbench is running (in this example `"http://localhost:8080/kie-wb/"`), the deployment where the process is located (`"org.jbpm:HR:1.0"`), the process id (`"hiring"`), the DIV id that is going to contain the form (`"myform"`) and the callback functions (`onsuccessCallback` and `onerrorCallback`).

Now let's take a look at the `startProcess()` that is the one that is going to submit the form and start the process:

```
function startProcess() {
  var onsuccessCallback = function(response) {
    document.getElementById("showformButton").style.display = "block";
    document.getElementById("startprocessButton").style.display = "none";
    formsAPI.clearContainer("myform");
    alert(response);
  }

  var onerrorCallback = function(response) {
    document.getElementById("showformButton").style.display = "block";
    document.getElementById("startprocessButton").style.display = "none";
    formsAPI.clearContainer("myform");
    alert("Unable to start the process, something wrong happened: " + response);
  }
  formsAPI.startProcess("myform", onsuccessCallback, onerrorCallback);
}
```

As **showProcessForm()**, first we are defining the callback functions. Both are doing basically the same:

- Show the *"Show Process Form"* button and hide the *"Start Process"* button to allow start another process instance.
- Clear the *"myform"* DIV status
- Show an alert with the response notifying that the process has started well or if an error occurred

Once that is done we just do the call to the **formsAPI.startProcess(...)** that will send a message to the component that renders the form inside the *"myform"* DIV and will execute the callback functions when the action is done. Notice that we don't need to provide any other information than the DIV that contains the form and optionally the callback functions.

With a simple code like this you'll be able to run process/task forms that are located on different Kie-Workbench instances from any other application.



Figure 13.48. Using forms on client applications I: Before showing the form

*Candidate Name

Start Process

Figure 13.49. Using forms on client applications II: Showing the process form

Show Process Form

Process Id: 2 started!

D'acord

Figure 13.50. Using forms on client applications III: After process started

Chapter 14. Runtime Management

14.1. Deployments

In version 5.x processes were stored in so called packages produced by Guvnor and next downloaded by jbpm console for execution using KnowledgeAgent. Alternatively one could drop their process files (bpmn2 files) into a predefined directory that was scanned on the jbpm console start. That was it. That enforces users to always use Guvnor when dynamic deployment was needed. Although there is nothing wrong with it, actually that was recommended approach but not every-time it was desired.

Version 6, on the other hand moves away from proprietary packages in favor of, well known and mature, Apache Maven based packaging - known as knowledge archives - kjar. Processes, rules etc (aka business assets) are now part of a simple jar file built and managed by Maven. Along the business assets, java classes and other file types are stored in the jar file too. Moreover, as any other maven artifact, kjar can have defined dependencies on other artifacts including other kjar. What makes the kjar special when compared with regular jars is a single descriptor file kept inside META-INF directory of the kjar - kmodule.xml. That descriptor allows to define:

- knowledge bases and their properties
- knowledge sessions and their properties
- work item handlers
- event listeners

By default, this descriptor is empty (just kmodule root element) and is considered as marker file. Whenever a runtime component (such as jbpm console) is about to process kjar it looks up kmodule.xml to build its runtime representation. In addition to kmodule.xml a deployment descriptor (that provides fine graind control over deployment) is available (since 6.1).

14.1.1. Deployment descriptors

While kmodule is mainly targeting on knowledge base and knowledge session basic configuration, deployment descriptors are considered more technical configuration. Following are the items available for configuration via deployment descriptors:

- persistence unit name for runtime data
- persistence unit for audit data
- persistence mode (JPA or NONE)

- audit mode (JPA, JMS, NONE)
- runtime strategy (SINGLETON, PER_REQUEST, PER_PROCESS_INSTANCE)
- list of event listeners to be registered
- list of task event listeners to be registered
- list of work item handlers to be registered
- list of globals to be registered
- marshalling strategies to be registered (for pluggable variable persistence)
- required roles to be granted access to resources of the kjar
- additional configuration options of knowledge session
- additional environment entries for knowledge session
- list of fully qualified class names that shall be added to the classes used for serialization by remote services
- whether or not to limit the classes from the deployment used for serialization by the remote services

Deployment descriptor is an xml file that is placed inside META-INF folder of the kjar, although it is an optional file and deployments will succeed even when such descriptor is missing.

```
<deployment-descriptor xsi:schemaLocation="http://www.jboss.org/jbpm deployment-descriptor.xsd"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <persistence-unit>org.jbpm.domain</persistence-unit>
  <audit-persistence-unit>org.jbpm.domain</audit-persistence-unit>
  <audit-mode>JPA</audit-mode>
  <persistence-mode>JPA</persistence-mode>
  <runtime-strategy>PER_PROCESS_INSTANCE</runtime-strategy>
  <marshalling-strategies/>
  <event-listeners/>
  <task-event-listeners/>
  <globals/>
  <work-item-handlers/>
  <environment-entries/>
  <configurations/>
  <required-roles/>
  <remoteable-classes/>
  <limit-serialization-classes/>
</deployment-descriptor>
```

It provides more configuration options than the standard deployment has. Deployment descriptors are used in hierarchical way meaning they can be placed on various levels of the system and merged on runtime. jBPM supports following levels of deployment descriptors:

- server level - this is the main and considered default deployment descriptors that apply to all deployments on given server
- kjar level - this is dedicated deployment descriptor to given kjar
- deploy time level - this is deployment descriptor that is given at the time of deployment

Deployment descriptors on different levels are merged on deployment time where the master is considered descriptor lower in the hierarchy and slave one that is higher in hierarchy. To give an example, when a kjar is deployed and it contains deployment descriptor kjar's deployment descriptor is considered slave and server level descriptor is considered master. With default merge mode it will override all master entries with slave ones as long as they are not empty and combine all collections.

Since kjar can have dependencies to other kjar's, and in turn that dependencies might have deployment descriptors as well, they will be placed in deployment descriptors hierarchy lower than the actual kjar that is being deployed. With that said, this is how it will look like from hierarchy point of view, starting with master (server level):

- server level
- dependency kjar level
- kjar level

That in default merging mode will result in deployment descriptor where with non empty values from kjar's deployment descriptors and merged collection from all levels.

So far all merging was done with default mode, which is `MERGE_COLLECTIONS` but that's not the only mode that is available:

- `KEEP_ALL` - meaning that the master wins - all configuration defined in master will be retained
- `OVERRIDE_ALL` - meaning that slave wins - all configuration defined in master will be retained
- `OVERRIDE_EMPTY` - meaning all non empty configuration items from slave will replace those in master, including collections
- `MERGE_COLLECTIONS` - meaning all non empty configuration items from slave will replace those in master but collections will be merged (combined)



Tip

Deployment descriptors can be given as partial xml documents, meaning they do not need to be complete set of all configuration items, e.g. if user would like to override only the audit mode in kjar, it's enough to have following deployment descriptor:

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?><deployment-  
descriptor xsi:schemaLocation="http://www.jboss.org/jbpm deployment-  
descriptor.xsd" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"> <audit-  
mode>JPA</audit-mode></deployment-descriptor>  
><deployment-descriptor xsi:schemaLocation="http://www.jboss.org/jbpm  
deployment-descriptor.xsd" xmlns:xsi="http://www.w3.org/2001/XMLSchema-  
instance"> <audit-mode>JPA</audit-  
mode></deployment-
```

Although it's worth noting that when using `OVERRIDE_ALL` merge mode all configuration items should be specified since it will always use them and do not merge with any other deployment descriptor in the hierarchy.

Default deployment descriptor

There is always default deployment descriptor available, even if it was not explicitly configured, when running in `jbpm-console` (`kie-workbench`) the default values are as follows:

- `persistence-unit` is set to `org.jbpm.domain`
- `audit-persistence-unit` is set to `org.jbpm.domain`
- `persistence-mode` is set to `JPA`
- `audit-mode` is set to `JPA`
- `runtime-strategy` is set to `SINGLETON`
- all collection based configuration items are left empty



Note

Regardless of collection elements in default deployment descriptor are empty there will be some work item handlers/listeners registered that are required to support functionality of the `jbpm console` such as `BAM` listeners or human task work item handler.

Default deployment descriptor can be altered by specifying valid URL location to an xml file that will provide fully defined deployment descriptor. By fully defined we mean that all elements should be specified as this deployment descriptor will become server level deployment descriptor.

```
-Dorg.kie.deployment.desc.location=file:/my/custom/location/deployment-descriptor.xml
```

Collection configuration items

Deployment descriptor consists of collection based items (event listeners, work item handlers, globals, etc) that usually require definition of an object that should be created on runtime. There are two types of collection based configuration items:

- object model - that is clear definition of the object to be built or looked up in available registry
- named object model - that is an extension to object model and allows to provide name of the object which will be used to register object

Object model consists of:

- identifier - defines main information about the object, such as fully qualified class name, spring bean id, mvel expression
- parameters - optional parameters that should be used while creating object instance from the model
- resolver - identifier of the resolver that will be used to create object instances from the model
- (reflection, mvel, spring)

Table 14.1. Object models

Configuration item	Type of collection items
event-listeners	ObjectModel
task-event-listeners	ObjectModel
marshalling-strategies	ObjectModel
work-item-handlers	NamedObjectModel
globals	NamedObjectModel
environment-entries	NamedObjectModel
configurations	NamedObjectModel
required-roles	String

Depending on resolver type, creation or look up of the object will be performed. The default (and easiest) is reflection that will use both parameters and identifier (in this case is FQCN) to construct the object. Parameters in this case can be String or another object model for representing other types than String. Following is an example of an object model that will create an instance of `org.jbpm.test.CustomStrategy` using reflection resolver that will use constructor of that class with two String parameters. Note that String parameters are created with different ways (using object model - first param, directly by giving String - second param).

Example 14.1.

```
...
<marshalling-strategy>
```

```

<resolver>reflection</resolver>
<identifier>org.jbpm.test.CustomStrategy</identifier>
<parameters>
  <parameter xsi:type="objectModel">
    <resolver>reflection</resolver>
    <identifier>java.lang.String</identifier>
    <parameters>
      <parameter xsi:type="xs:string" xmlns:xs="http://www.w3.org/2001/XMLSchema">param1</
parameter>
    </parameters>
  </parameter>
  <parameter xsi:type="xs:string" xmlns:xs="http://www.w3.org/2001/XMLSchema">param2</
parameter>
  </parameters>
</marshalling-strategy>
...

```

Same can be done by using DeploymentDescriptor fluent API:

```

// create instance of DeploymentDescriptor with default persistence unit
nameDeploymentDescriptor descriptor = new DeploymentDescriptorImpl("org.jbpm.domain");//
get builder and modify the descriptor descriptor.getBuilder().addMarshalingStrategy(new
  ObjectModel("org.jbpm.testCustomStrategy", new Object[]{ new
ObjectModel("java.lang.String", new Object[]{"param1"}, "param2"}));
default persistence unit

nameDeploymentDescriptor descriptor = new DeploymentDescriptorImpl("org.jbpm.domain");// get builder
and modify
the descriptor descriptor.getBuilder().addMarshalingStrategy(new
ObjectModel("org.jbpm.testCustomStrategy", new Object[]{
  new

```

Reflection based object model resolver is the most verbose in case there are parameters involved but there are few parameters that are available out of the box and do not need to be created, they are simply referenced by name:

- entityManagerFactory (type of this parameter is javax.persistence.EntityManagerFactory)
- runtimeManager (type of this parameter is org.kie.api.runtime.manager.RuntimeManager)
- kieSession (type of this parameter is org.kie.api.KieServices)
- taskService (type of this parameter is org.kie.api.task.TaskService)
- executorService (type of this parameter is org.kie.internal.executor.api.ExecutorService)

So to be able to use one of these it's enough to reference them by name and make sure that proper object type is used within your class:

```
...
```

```
<marshalling-strategy>
  <resolver>reflection</resolver>
  <identifier>org.jbpm.test.CustomStrategy</identifier>
  <parameters>
    <parameter xsi:type="xs:string" xmlns:xs="http://www.w3.org/2001/
XMLSchema">runtimeManager</parameter>
  </parameters>
</marshalling-strategy>
...
```

In case reflection based resolver is not enough, more advanced resolver can be used that utilizes power of MVEL language. It's much easier in the configuration as it expects mvel expression as identifier of the object model. It will provide the out of the box parameters (listed above: runtime manager, kie session, etc) into the mvel context while evaluating expression. To define object model with mvel resolver use following xml (that will be equivalent to reflection based above):

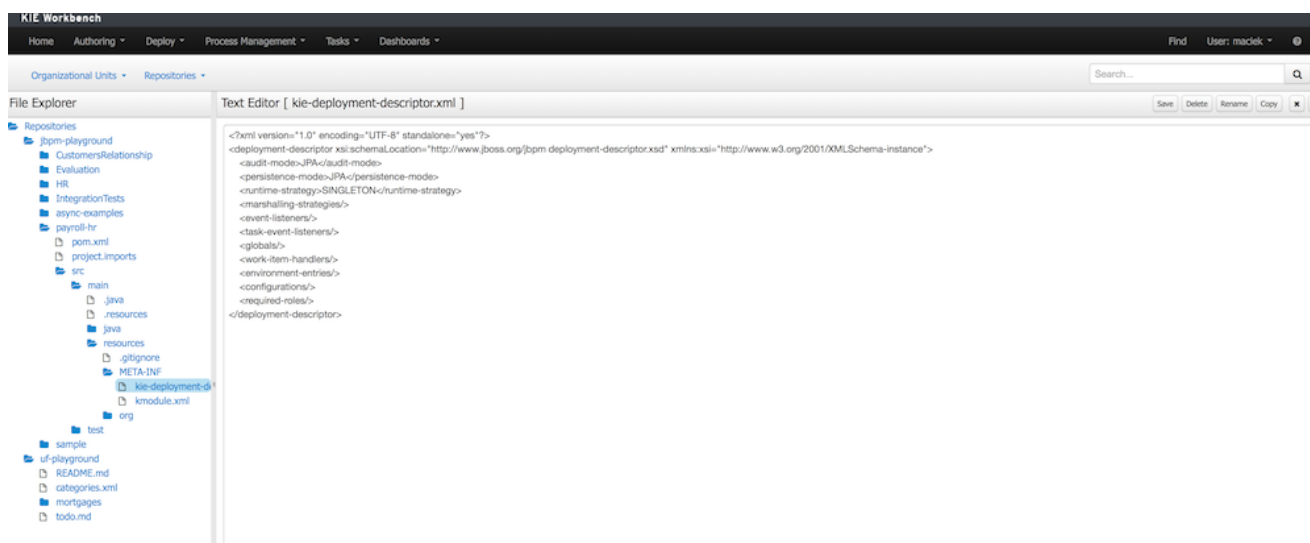
```
...
<marshalling-strategy>
  <resolver>mvel</resolver>
  <identifier>new org.jbpm.test.CustomStrategy(runtimeManager)</identifier>
</marshalling-strategy>
...
```

Last but not least, there is Spring based resolver available as well that allows to simply look up a bean by its identifier from spring application context. This resolver is not used in jbpm console (kie-workbench) as it does not use spring but whenever jBPM is used together with Spring it might become handy when deploying kjar into the runtime. It's very simple definition in xml, again equivalent to the other one assuming org.jbpm.test.CustomStrategy is registered in spring application context under customStrategy id.

```
...
<marshalling-strategy>
  <resolver>spring</resolver>
  <identifier>customStrategy</identifier>
</marshalling-strategy>
...
```

Manage deployment descriptor

Deployment descriptor is created as soon as project is created. It does contains the most basic deployment descriptor that is based on the default one. Meaning all settings present in default deployment descriptor will be copied into the one placed in the project. Further changes can be done directly in the xml content (in next versions more user friendly editor will most likely be provided). It is accessible from Administration perspective as this is considered technical administration task rather than business related activity.



Restrict access to runtime engine

jbpm console (kie-workbench) provides access restriction to repositories that can be configured with supplementary tool called kie-config-cli. This protects repositories in the authoring perspective based on roles membership. Deployment descriptors moves this capability to the runtime engine by ensuring that access to processes will be granted only to users that belong to groups defined in the deployment descriptor as required roles. By default when project is created (at the same time deployment descriptor is created as well) required roles are automatically filled in based on repository restrictions. These roles can be still altered by editing deployment descriptor via Administration perspective as presented in Manage deployment descriptor section.

Security is enforced on two levels:

- user interface - user will see only process definitions that are available for his/her roles
- runtime manager - each access to get RuntimeEngine out of RuntimeManager is protected based on the role membership, in case unauthorized access it attempted SecurityException will be thrown

Required roles are defined as simple strings that should match actual roles defined in security realm. Following is a xml snippet that shows definition of required roles in deployment descriptor:

```
<deployment-descriptor>...   <required-roles>           <required-role>experts</required-role>
  </required-roles>...</deployment-descriptor>
ment-
descriptor>...
  <required-roles>
<required-role>experts</required-role>

</required-roles>
```

In case fine grained control is required defined roles can be prefixed with one of the following to control it on further level:

- view:

to restrict access to be able to see given process definitions/instances on UI

- execute:

to restrict access to be able to execute given process definitions

- all:

applies to both view and execute restrictions and this is the default when no prefix is given.

For example to restrict access to show process from given kjar only to group 'management' but still allow them to be executed by anyone (sort of system processes) one could define it as follows:

```
<deployment-descriptor>
...
  <required-roles>
    <required-role>view:management</required-role>
  </required-roles>
...
</deployment-descriptor>
```

Classes used for serialization in the remote services

When processes make use of custom types (or in general non primitive types) and there is a use case to include remote api invocations (REST, SOAP, JMS) such types must be available to the remote services marshalling mechanism that is based on JAXB for XML type. By default all types defined in kjar will be automatically included in JAXB context and therefore will be available for remote interaction. Though there might be more classes (like from dependent model) that shall be included there too.

Upon deployment, jBPM will scan classpath of given kjar to automatically register classes that might be needed for remote interaction. This is done based on following rules:

- all classes included in kjar project itself
- all classes included as dependency of projects type kjar
- classes that are annotated with `@XmlRootElement` (JAXB annotation) and included as regular dependency of the kjar
- classes that are annotated with `@Remotable` (kie annotation) and included as regular dependency of the kjar

If that is not enough deployment descriptor allows to manually specify classes that shall be added to the JAXB context via `remoteable-classes` element:

```
<remoteable-classes>    ...    <remotable-class>org.jbpm.test.CustomClass</remotable-class>
<remotable-class>org.jbpm.test.AnotherCustomClass</remotable-class>    ...</remoteable-classes>
able-classes>
    ...    <remotable-
class>org.jbpm.test.CustomClass</remotable-class>    <remotable-
class>org.jbpm.test.AnotherCustomClass</remotable-class>
    ...
```

With this all classes can be added to the JAXB context to properly marshal and unmarshal data types when interacting with jBPM remotely.

Limiting classes used for serialization in the remote services

When there are classes in the kjar project or in the dependencies of the kjar project that would cause problems when used for serialization, the `limit-serialization-classes` property can be used to limit which classes are used for serialization

```
<limit-serialization-classes>true</limit-serialization-classes>
```

This property limits classes used for serialization to classes which fulfill both of the following "location" and "annotation" criteria:

Classes that:

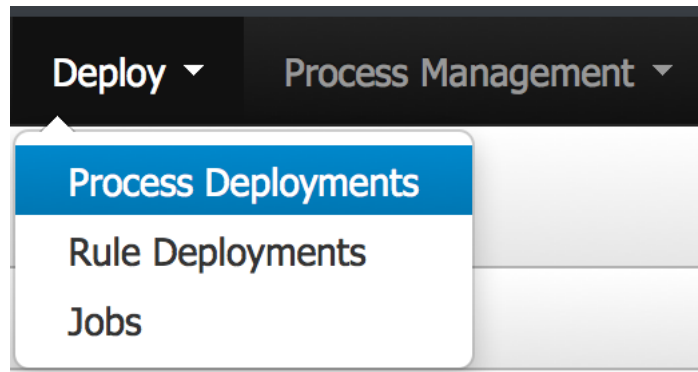
1. are located in the kjar project
 2. are in a direct dependency of the kjar project
 3. are listed in the `remoteable-classes` element and are available on the classpath of the kjar
- These classes must also be annotated with one of the following type annotations:

- `javax.xml.bind.annotation.XmlRootElement`
- `javax.xml.bind.annotation.XmlType`
- `org.kie.api.remote.Remotable`

Additionally, classes will be *excluded* if they are any of the following: interfaces, local classes, member classes or anonymous classes.

14.2. Process Deployments

You can access to the Process Deployments List under the Deploy top level menu of the KIE Workbench



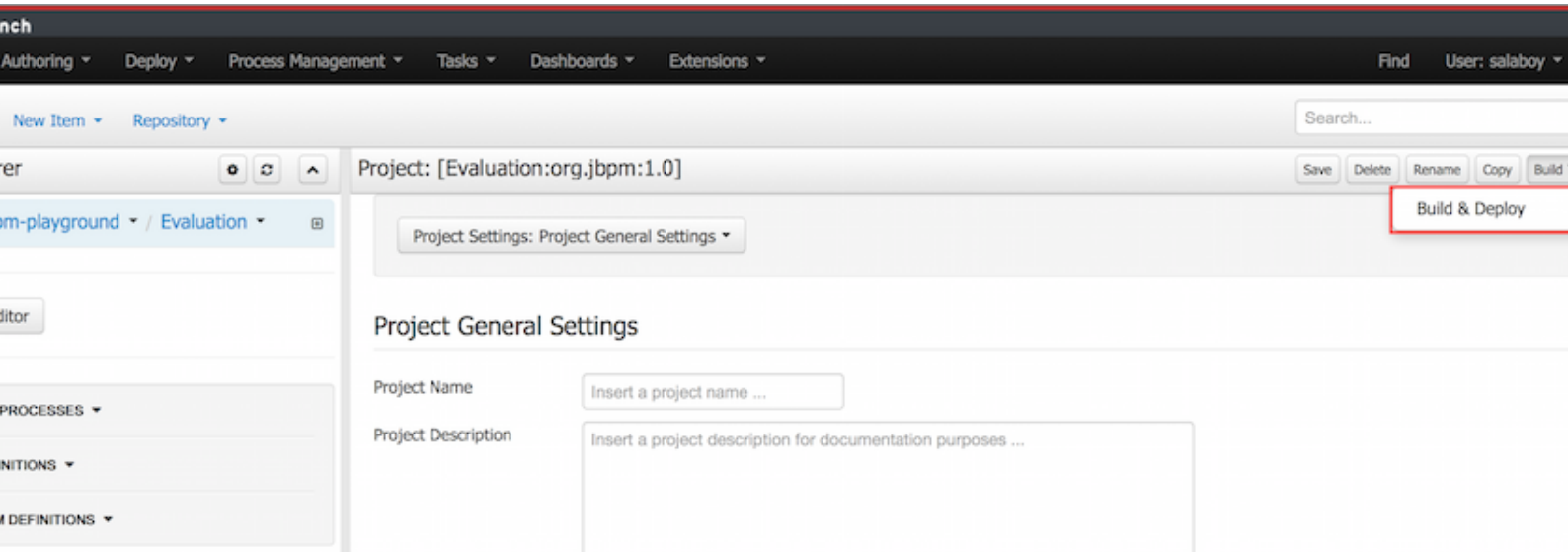
The Deployed Unit list shows all the Process Deployed Units into the platform that are already enabled to be used. Each deployment unit can contain multiple business processes and business rules. In order to have your process and rules deployed and listed in this list, you need to Build and Deploy your KIE projects from the Authoring Perspective or via the Remote Endpoints. If your processes and rules are in a KIE Project listed in this list and you have correspondent the rights you should be able to see the process definitions in the Process Definitions Perspective.

Search...

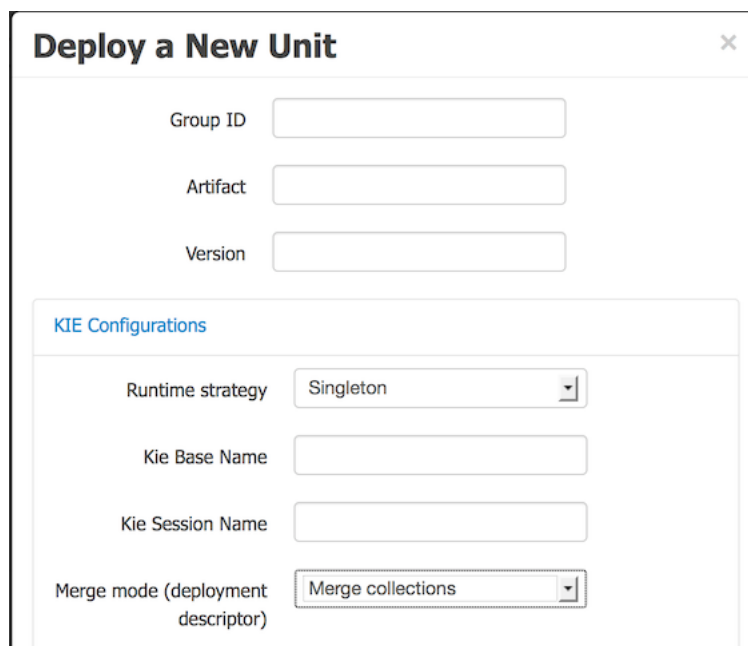
→ **New Deployment**

	Runtime strategy	Status	Actions
ion:1.0	SINGLETON	Active	⊕ ⊗

From the Authoring Perspective (Build and Deploy), a default deployment will be performed, for a more advanced deployments you can trigger a custom deployment with other options from this screen.

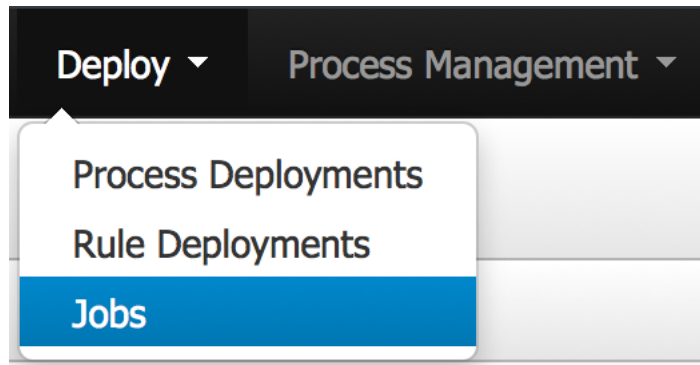


By clicking the New Deployment Unit (+) button you will be able to select a different KIE Base, KIE Session, Strategy and Merge Mode for your deployment. By default the "DEFAULT" KIE Base and KIE Sessions are used, the SINGLETON Strategy is selected and the Merge Mode is set to "Merge Collection".

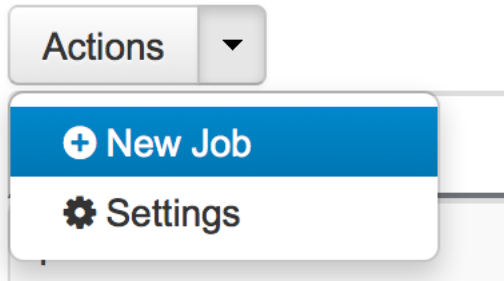


14.3. Jobs

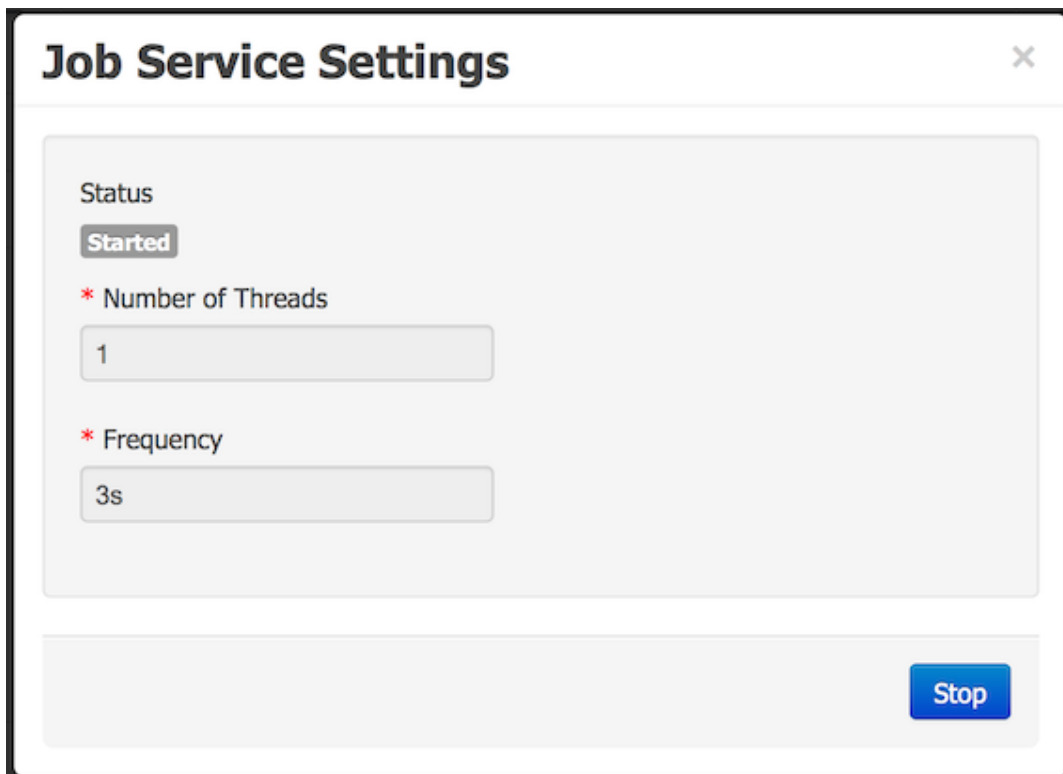
The Jobs perspective allows you to monitor and trigger Asynchronous Jobs scheduled to the jBPM Executor Service. You can access to the Jobs List from the Deploy top level menu of the KIE Workbench.



The Jobs List shows all the Jobs that were scheduled and their status. The Filter on top of the table helps the administrator to monitor the Jobs execution and take corrective actions in case of Failure. Check the jBPM Executor section of the documentation for more information.



Administrators have also the option to configure the jBPM Executor Service Settings and to start and stop the service from the User Interface via the Actions -> Settings option.



Administrators can also schedule manually new Jobs from the User Interface via the Actions - > Settings option. By specifying the command class name and the parameters needed to run the command a new Job can be created. This manually created jobs will not be associated with any process instance. Notice also that the Due Date parameter allows the execution to be deferred for the future. If the Due Date is the time of scheduling the jBPM Executor Service will execute the command as soon as there is an Executor Thread available. The number of retries will help the command to be executed more than once if it fails. This can help in situations when the business logic requires an external service to be called where the runtime cannot rely on that service to be available 100% of the time.

Quick New Job ✕

*** Name**

Due On

*** Type**

*** Retries**

Key	Value	Actions
There are no Parameters yet		

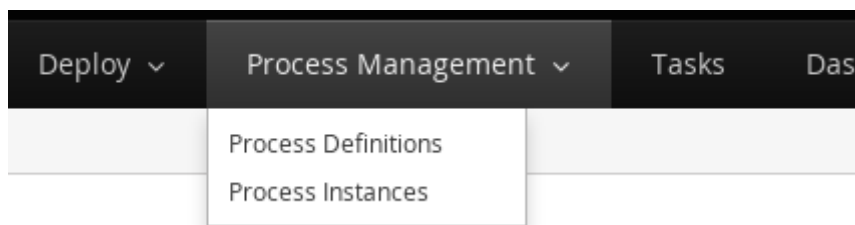
Chapter 15. Process and Task Management

15.1. Process Management

This chapter describes the screens related with the creation and management of process definitions and process instances.

Once you have modelled, configured all the technical details and build and deployed your projects containing your business processes you should be able to see all the available process definitions in the Process Definition List. For all the process definitions listed in the Process Definitions List you will be able to inspect the Process Definition details and start as many Process Instances as needed. The following sections describes the features provided by all the screens in charge of the manipulation of process definitions and process instances. You can find these screens under the **Process Management** Menu, in the jBPM Console NG or in KIE Workbench.

You can find the source code related with the process definition and instances manipulation inside this module: <http://github.com/droolsjbpm/jbpm-console-ng/tree/master/jbpm-console-ng-process-runtime> [<http://github.com/droolsjbpm/jbpm-console-ng/tree/master/jbpm-console-ng-process-runtime>] Feel free to report issues, send Pull Requests and get in contact with the team via comments in github.



15.1.1. Process Definitions

The process definition section is composed by two main screens: the Process Definition Lists and the Process Definition Details.

15.1.1.1. The Process Definition List

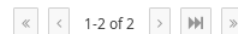
The process definition list shows all the available process definitions that were deployed into the platform. Look at the Deployments section for more information about how to check all the deployed units available in the platform runtime.

Process Definitions



Name	Version	Project	Actions
Hiring a Developer	1	org.jbpm:HR:1.0	Start
Evaluation	1	org.jbpm:Evaluation:1.0	Start

5 Items ▼



You can click in the list rows to access to the details of the process definition.

15.1.1.2. The Process Definition Details

The process definition details shows all the available information about the process definition. You can consider this screen as a brief about the process model. You can quickly see if there is a Sub Process associated with it, or how many users and groups are participating in the selected definition.

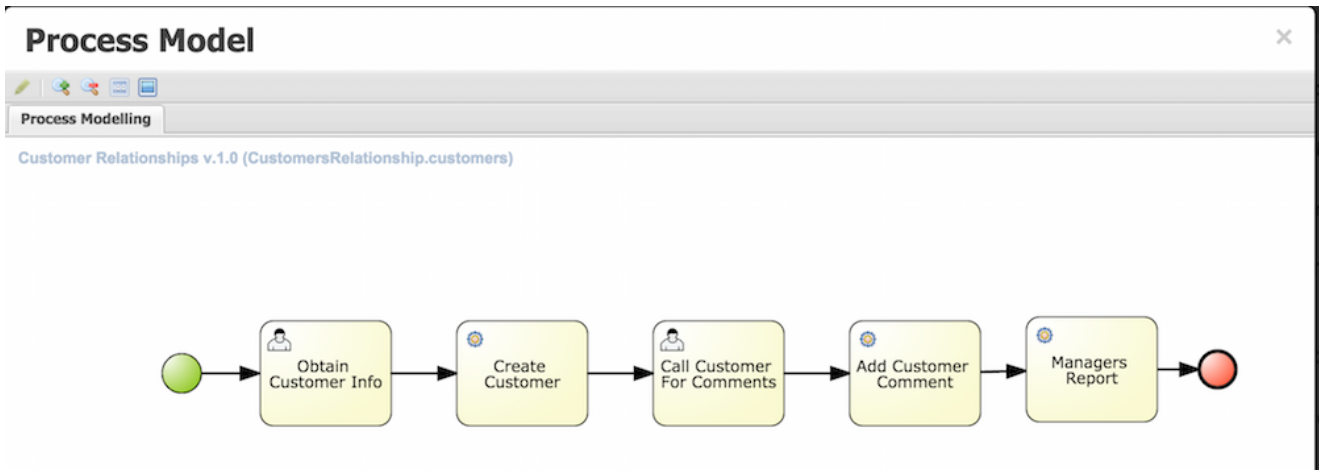
org.jbpm:HR:1.0 - hiring

▶ New Instance
Options ▾
↺
↻
✕

[Details](#)

Definition Id	hiring
Definition Name	Hiring a Developer
Deployment	org.jbpm:HR:1.0
Human Tasks	Create Proposal Sign Contract Tech Interview HR Interview
Human Task Count	4
User and Groups	'Accounting' - Create Proposal 'HR' - Sign Contract 'IT' - Tech Interview 'HR' - HR Interview
Sub Processes	No subprocesses required by this process
Process Variables	skills - String twitter - String mail - String offering - Integer name - String signed - Boolean tech_score - Integer hr_score - Integer age - Integer
Services	No services required for this process

Notice that you can View the Process Model (Read Only mode) using the Options Menu in the top bar. You can also look at all the process instances for the selected process definition by going to Options -> View Process Instances.



15.1.1.3. Creating Process Instances

You can create new Process Instances from the Process Definition List (Action Column), from the Process Definition Detail view or from the Process Instance.

The screenshot shows a form titled 'Hiring a Developer'. It has a 'Correlation key' section and a 'Form' section. The 'Form' section contains a text input field labeled '*Candidate Name' and a blue 'Submit' button at the bottom right.






When you create a Process Instance usually a Form will be presented to introduce the information required by the process to be started. Once you complete the required information and click on the Submit button, the instance will be created and the details of the Process Instance will be displayed on top of the Process Definition Details.

15.1.2. Process Instances

The process instances section is composed by two main screens: the Process Instance Lists and the Process Instance Details. In this case the Process Instance Details provides several tabs with the runtime information related with the process.

Process Instances

New Process Instance     

Active  Completed  Aborted  Evaluation  

Filter Active

Bulk Actions  

Select	Id	Name	Description	Version	Actions
<input type="checkbox"/>	1	Hiring a Developer	Hiring a Developer	1	<input type="button" value="Signal"/> <input type="button" value="Abort"/>
<input type="checkbox"/>	2	Hiring a Developer	Hiring a Developer	1	<input type="button" value="Signal"/> <input type="button" value="Abort"/>
<input type="checkbox"/>	3	Evaluation	Evaluation	1	<input type="button" value="Signal"/> <input type="button" value="Abort"/>
<input type="checkbox"/>	4	Hiring a Developer	Hiring a Developer	1	<input type="button" value="Signal"/> <input type="button" value="Abort"/>
<input type="checkbox"/>	5	Hiring a Developer	Hiring a Developer	1	<input type="button" value="Signal"/> <input type="button" value="Abort"/>

Each row inside the process instance list represent a running process instance from a particular Process Definition. Each execution is differentiated from all the others by the internal state of the information that the process is manipulating. In order to inspect this information you can click in each row to see the process instance details.

Process Instances



New Process Instance     

1 - Hiring a Developer

Options    

Active  Completed  Aborted  Evaluation  

Filter Active

Bulk Actions  

Select	Id	Name	Description	Version	Actions
<input checked="" type="checkbox"/>	1	Hiring a Develo...	Hiring a Develo...	1	<input type="button" value="Signal"/> <input type="button" value="Abort"/>
<input type="checkbox"/>	2	Hiring a Develo...	Hiring a Develo...	1	<input type="button" value="Signal"/> <input type="button" value="Abort"/>
<input type="checkbox"/>	3	Evaluation	Evaluation	1	<input type="button" value="Signal"/> <input type="button" value="Abort"/>
<input type="checkbox"/>	4	Hiring a Develo...	Hiring a Develo...	1	<input type="button" value="Signal"/> <input type="button" value="Abort"/>
<input type="checkbox"/>	5	Hiring a Develo...	Hiring a Develo...	1	<input type="button" value="Signal"/> <input type="button" value="Abort"/>

Instance Details

Process Variables

Documents

Logs

Definition Id	hiring
Instance State	Active
Deployment	org.jbpm:HR:1.0
Definition Version	1
Correlation key	
Parent Process Instance	No Parent Process Instance
Active user tasks	HR Interview (InProgress) owner: salaboy
Current Activities	11/Feb/16 10:21:22: 1 - HR Interview (HumanTaskNode)

As you can see the Process Instance Detail first tab gives you a quick overview about what is going on inside the process. This is by showing the current state of the instance and also the current activity that is being executed. The process variables tab display all the process variables that are being manipulated by the instance with the exception of the variables that contains documents.

1 - Hiring a Developer



Instance Details

Process Variables

Documents

Logs

Name	Value	Actions
name	Anne Jones	<input type="button" value="Edit"/> <input type="button" value="History"/>
initiator	salaboy	<input type="button" value="Edit"/> <input type="button" value="History"/>
skills		<input type="button" value="Edit"/> <input type="button" value="History"/>
twitter		<input type="button" value="Edit"/> <input type="button" value="History"/>
mail		<input type="button" value="Edit"/> <input type="button" value="History"/>
offering		<input type="button" value="Edit"/> <input type="button" value="History"/>
signed		<input type="button" value="Edit"/> <input type="button" value="History"/>
tech_score		<input type="button" value="Edit"/> <input type="button" value="History"/>
hr_score		<input type="button" value="Edit"/> <input type="button" value="History"/>
age		<input type="button" value="Edit"/> <input type="button" value="History"/>

10 Items ▼

A set of navigation icons including a double left arrow, a single left arrow, the text '1-10 of 10', a single right arrow, a double right arrow, and a right arrow.

If the process contains a variable of the type: org.jbpm.Document it will be listed in the Documents tab, for easy access, download and manipulation of the attached documents. Notice that at this point you cannot attach new documents to currently running instances, but this feature will be added in future versions.

1 - Hiring a Developer

Options ▾ ↻ ↗ ✕

Instance Details

Process Variables

Documents

Logs

Name	Size	Actions
No Documents Available		

Finally, the Logs tab shows two types of logs for different end users. There are two types of Logs available inside the tab: Business and Technical.

1 - Hiring a Developer

Options ▾ ↻ ↗ ✕

Instance Details

Process Variables

Documents

Logs

Business Technical Asc Desc

2 hours ago: Process 'Hiring a Developer' was created

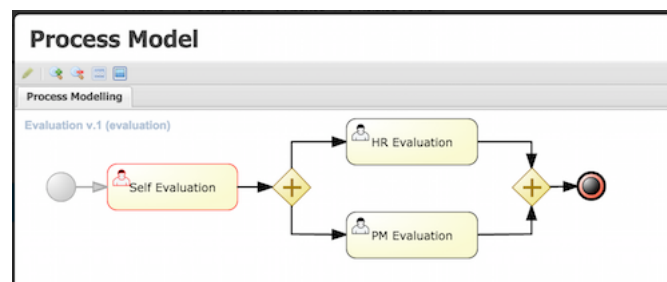
2 hours ago: Task 'HR Interview' was created

- 2 hours ago: Task 'HR Interview' was claimed by user salaboy

- moments ago: Task 'HR Interview' was released by user salaboy

- moments ago: Task 'HR Interview' was claimed by user salaboy

To complement the process logs you can open the Process Model that shows the completed activities in grey and the current activities highlighted in red.








15.1.2.2. Process Instance List

This list works with the concept of view. A view is a set of visualization parameters that modify what items has to be displayed and how the items details has to be shown.






A view embrace

- Columns to be shown
- Items by page
- Restrictions over the displayed process instances
- A Name to be shown at tab name
- A Description as title when the view is selected

We find here different areas with different purposes:Filtering, general section configuration and specific view parameter setting in the data grid presentation:



Process Instances New Process Instance     

General section configuration

Active  Completed  Aborted  Evaluation  




Specific grid interaction

Default filters Custom filter Add new filter

Filter Active Bulk Actions  

Select	Id	Name	Description	Version	Actions
<input type="checkbox"/>	1	Hiring a Developer	Hiring a Developer	1	Signal Abort
<input type="checkbox"/>	2	Hiring a Developer	Hiring a Developer	1	Signal Abort
<input type="checkbox"/>	3	Evaluation	Evaluation	1	Signal Abort
<input type="checkbox"/>	4	Hiring a Developer	Hiring a Developer	1	Signal Abort
<input type="checkbox"/>	5	Hiring a Developer	Hiring a Developer	1	Signal Abort
<input type="checkbox"/>	6	Evaluation	Evaluation	1	Signal Abort

Specific grid configuration

10 Items  « < 1-6 of 6 > »  

15.1.2.2.1. Filtering. Views on tabs

Here, there are the available views as tabs. When a tab is selected, the related parameters are applied to the data grid. Here we have include the Dataset technology for queries and its queries editor as a powerful tool to create the filters

The user can remove existing tabs clicking the cross button near the tab name

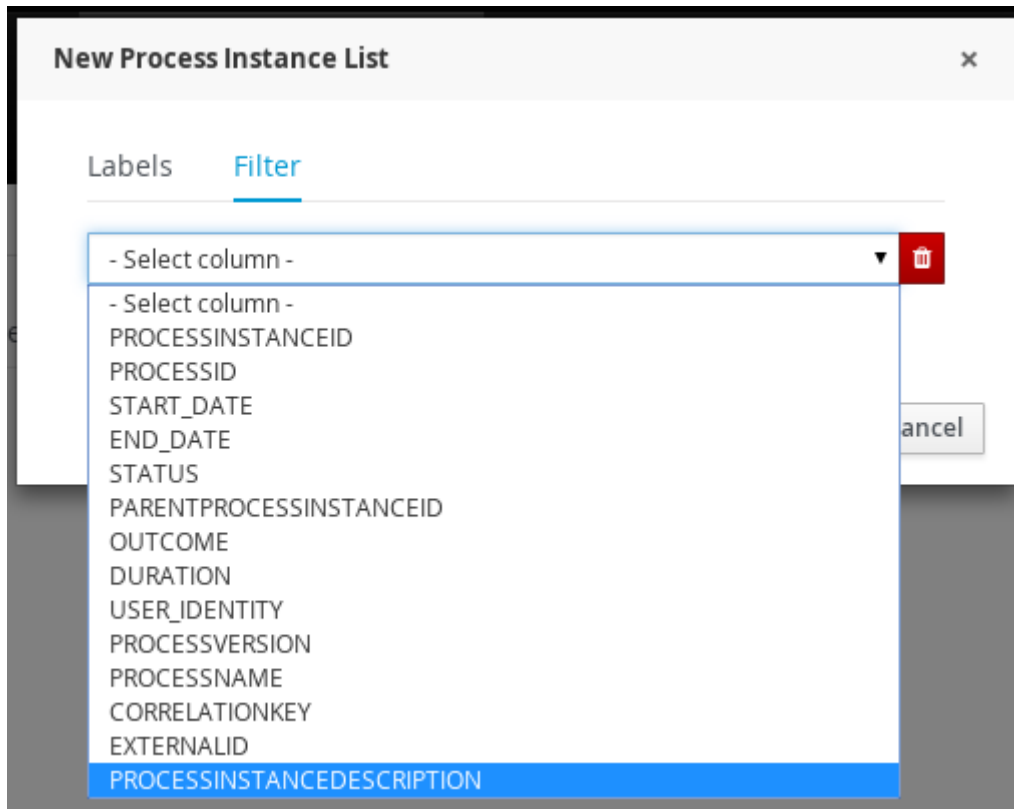
Active  Completed  Aborted  

A new view can be created clicking the last tab, over the '+' button. A New Items list popup appears and lets the user introduce parameters related with the new tab like: the name, the description and the filter.

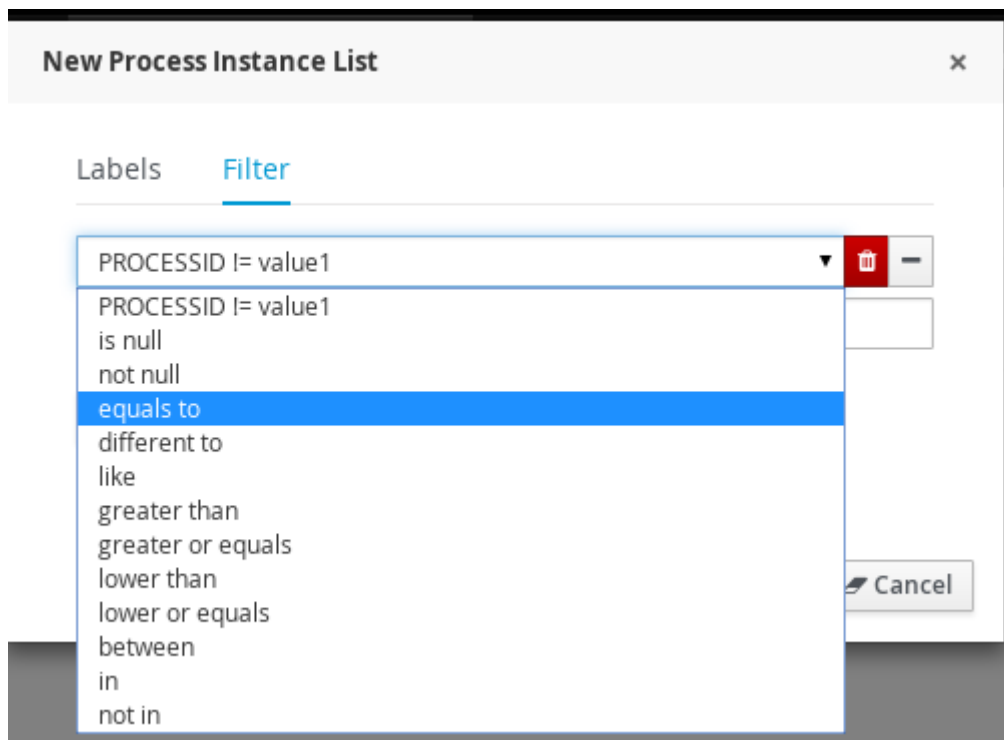
The screenshot shows a dialog box titled "New Process Instance List" with a close button (x) in the top right corner. Below the title bar, there are two tabs: "Labels" (which is selected and underlined) and "Filter". Under the "Labels" tab, there are two input fields: "Name*" with a red asterisk and a text input containing "Name", and "Description" with a text input containing "Description". At the bottom right, there are two buttons: a blue "+ Ok" button and a grey "Cancel" button with a pencil icon.

The screenshot shows the same dialog box "New Process Instance List" with the "Filter" tab selected and underlined. The "Labels" tab is now unselected. Below the tabs, there is a blue "+ Add New" button. At the bottom right, there are two buttons: a blue "+ Ok" button and a grey "Cancel" button with a pencil icon.

If the view has to include a restriction over a specific column, then the link 'Add new' has to be selected. A drop down list with all the columns to create restrictions



Once the column is selected, depending of its type, a new dropdown list is open with the kind of restrictions available for the selected column and the necessary form to add them.

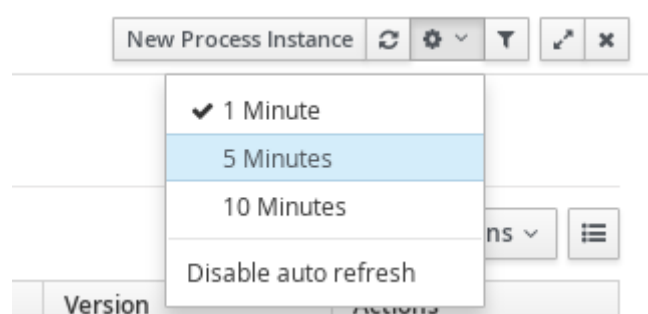


One filter can include a list of different conditions over different columns and the editor allow remove each one clicking th 'x' button near them

Once the view creation parameters are defined, the 'Ok' button makes the new view appears as a new tab.

15.1.2.2.2. General section configuration. Auto refresh and default views restore

In this area, the user can create a new item (in this case process instance), can refresh manually the view that is being displayed, can configure autorefresh option and can restore default filters.



Auto refresh is a functionality that allows define how often the data grid has to be refreshed. The user can select one of the different values (1,5 or 10 minutes),or disable this feature, clicking 'Disable'. If the auto refresh is enabled, then the last view displayed is refreshed after the amount of time defined.

The last button is the 'Restore default filters'. There is a set of predefined views that appears the first time the user access to the section, in the case of process instances list they are: Active, Complete and Aborted. The user can remove every view including the default ones, but in this area the default views can be restored clicking 'Restore default filters'.

15.1.2.2.3. Specific view configuration. Columns, Bulk actions, number of items

In this area the user can change dynamically the view editable parameters like visible columns, or set the number of items to show in a page.

Process Instances New Process Instance






Active × Completed × Aborted × Evaluation × +

Filter Active Bulk Actions ▼



Select	Id	Name	Description	Version	Actions
<input checked="" type="checkbox"/>	1	Hiring a Developer	Hiring a Developer	1	Signal Abort
<input checked="" type="checkbox"/>	2	Hiring a Developer	Hiring a Developer	1	Signal Abort
<input type="checkbox"/>	3	Evaluation	Evaluation	1	Signal Abort
<input type="checkbox"/>	4	Hiring a Developer	Hiring a Developer	1	Signal Abort
<input type="checkbox"/>	5	Hiring a Developer	Hiring a Developer	1	Signal Abort
<input type="checkbox"/>	6	Evaluation	Evaluation	1	Signal Abort

Initiator
 Version
 State
 Start Date

Here we have the possibility or execute bulk actions over the items marked as selected. In this case the available actions are 'Abort' or 'Signal'

Process Instances New Process Instance     

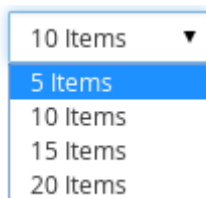
Active × Completed × Aborted × Evaluation × +

Filter Active Bulk Actions  

Select	Id	Name	Description	Version	Actions
<input checked="" type="checkbox"/>	1	Hiring a Developer	Hiring a Developer	1	Signal Abort
<input checked="" type="checkbox"/>	2	Hiring a Developer	Hiring a Developer	1	Signal Abort
<input type="checkbox"/>	3	Evaluation	Evaluation	1	Signal Abort
<input type="checkbox"/>	4	Hiring a Developer	Hiring a Developer	1	Signal Abort
<input type="checkbox"/>	5	Hiring a Developer	Hiring a Developer	1	Signal Abort
<input type="checkbox"/>	6	Evaluation	Evaluation	1	Signal Abort

🗑 Bulk Abort
🔔 Bulk Signal






The number of items to show in a page can be configurable too, from the page size dropdown list





15.1.2.2.4. Special filter in process instance list

There is an specific restriction than makes the process instance list view, have a different behaviour. This happend when a filter over the column 'PROCESSID' is defined.





In this case, the columns available to show have been incremented with the specified process variables which have value. The user can then, view process instance variables from a specific process id, in the same grid of the process instances.

Process Instances New Process Instance     

Active × Completed × Aborted × Evaluation × +

Filter Active Bulk Actions  

Select	Id	Name	Description	Version	Actions
<input type="checkbox"/>	3	Evaluation	Evaluation	1	Signal Abort

3 - Evaluation Options    

Instance Details Process Variables Documents Logs

Name	Value	Actions
reason	Evaluation requested	Edit History
employee	salaboy	Edit History
initiator	salaboy	Edit History
performance		Edit History

15.2. Tasks

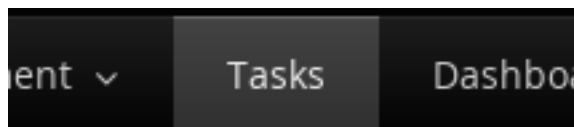
This chapter introduces the Task Management screens and the its integration with the Form Modeller component to allow users to work on their assigned tasks. You can find the source code of these screens here: <https://github.com/droolsjbpm/jbpm-console-ng/tree/master/jbpm-console-ng-human-tasks> [<https://github.com/droolsjbpm/jbpm-console-ng/tree/master/jbpm-console-ng-human-tasks>]. Feel free to report issues, send Pull Requests and get in contact with the

team via comments in github. At the end of this section you will find a technical description about how to customize these views.

15.2.1. Task List

Every user with access to the platform will have access to its personal task list where tasks assigned to him/her will be displayed. Each user will be able to create its own personal tasks or work on tasks that were create as a result of a business process execution.

You can access to the Task List accessing **Tasks** main menu:



15.2.1.1. Task List (Personal and Group Tasks)

Pending tasks for each user will be displayed in their task list screen. Notice that you will not be able to see assigned tasks from another user different from the one that is currently logged in.

15.2.1.1.1. Task List

The list will show all the tasks that match with the defined restrictions ordered by the columns presented. You can change the default ordering clicking on the column header. This view offer a more traditional BPM Task List view where you can sort the data based on different columns.

The screenshot shows the KIE Workbench interface. At the top, there is a navigation bar with 'Tasks' selected. Below it, the 'Tasks List' page is displayed. There are filter tabs for 'Active', 'Personal', 'Group', 'All', and 'Admin'. The main content is a table titled 'Filter Active' with the following data:

Task	Description	Actions
HR Interview	Candidate: Anne Jones	Release Open
HR Interview	Candidate: David Smith	Claim
Self Evaluation	Please perform a self-evaluation.	Release
HR Interview	Candidate: Carl Lane	Claim
HR Interview	Candidate: Coral Teller	Claim

At the bottom left, there is a dropdown menu showing '10 Items'. At the bottom right, there are pagination controls showing '1-5 of 5' and navigation arrows.

Here appears again the concept of view versus just filtering as we explained in the process instance list. The default views here have the following restrictions over the tasks to show:

- **Active:** all the Active tasks that user can work on. That means Personal and Group Tasks.
- **Personal:** all the personal tasks that already belong to the user.
- **Group:** all the group tasks that needs to be claimed by the user in order to start working on them.
- **All:** show all the tasks no matter the status. It will show completed tasks as well with the exception of completed tasks that belongs to a process that is already finished. In such cases the tasks are cleaned up after the process is completed and for that reason they will not be displayed.
- **Admin:** show all the tasks where the currently logged user was set as business administrator for such task.

Note

The user can always restore the default filters selecting the option 'Restore default filters'

15.2.1.1.2. Task List custom filters. Ability to show bussiness data at task list.

As was explained in the process instance list, the user can define custom filters adding new tab and defining restrictions over task data in this case.

The user can now create a specific filter that provides domain specific columns to be added to a task list. When the user creates a custom filter for a specific task name the task variables are enabled as columns.

Tasks List

New Task
↺
⚙
▼
⌵
↻
✕

Active ✕
Personal ✕
Group ✕
All ✕
Admin ✕
HR ✕
+

Filter Active
☰

Task	Description	Actions
HR Interview	Candidate: Anne Jones	Claim
HR Interview	Candidate: David Smith	Claim
HR Interview	Candidate: Carl Lane	Claim
HR Interview	Candidate: Coral Teller	Claim

Id

Description

Process Name

Process Id

Priority

Status

CreatedOn

DueOn

Reset

Figure 15.1. Basic available columns that every task list allows select to be displayed.

The custom filter that activates the capability to display task variables as columns is set a filter with the restriction Name="taskName".

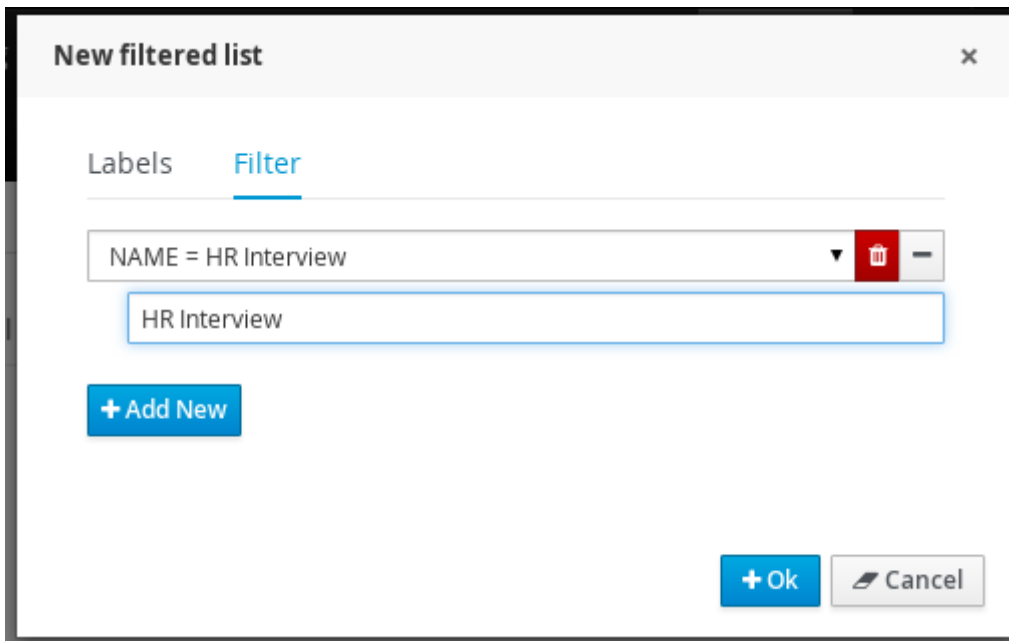


Figure 15.2. Filter by task name creation

When the filter with the restriction over a specific task name is applied, the task associated variables appear as a selectable columns, to the task list.

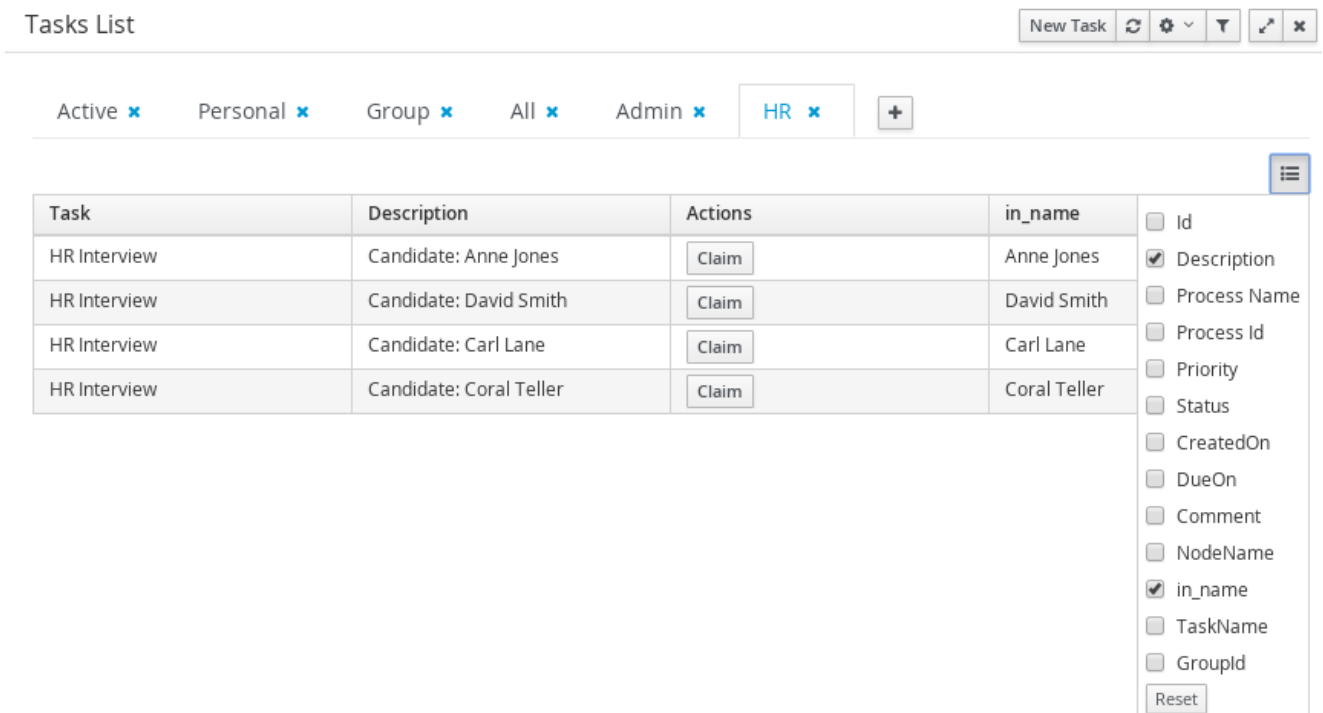
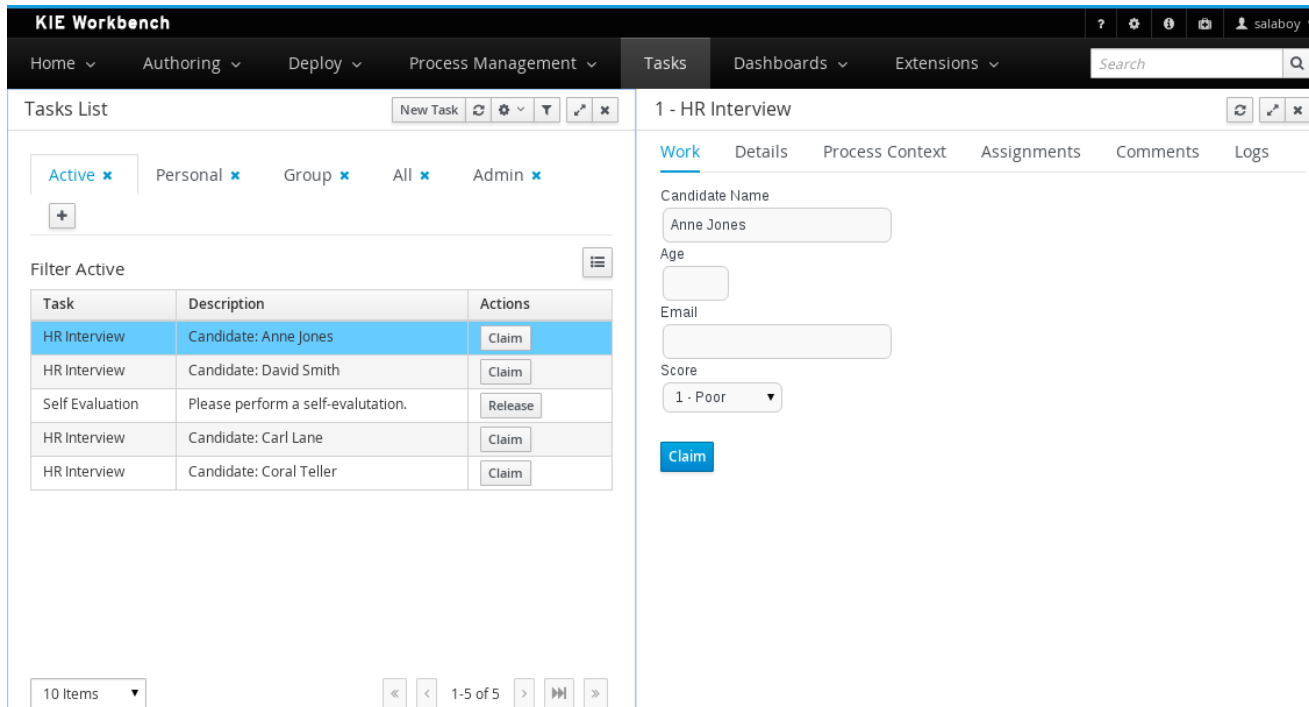


Figure 15.3. task list with task name restriction applied

15.2.1.2. Task Details

You can access to the Task Details by clicking in a task row. The details associated with a task can be changed, like for example the Due Date, the Priority or the task description.



The task details appear in a new region with different sections that allow view the task associated information:

Work In this tab the associated form is displayed if the task has one. In this section is where the user can interact with the process, executing the available actions in each moment.

Details Here the basic task data is accessible: priority, status, description

1 - HR Interview



Work Details Process Context Assignments Comments Logs

Description	Candidate: Anne Jones	
Status		
Due On		00:00 ▾
Priority	0 - High ▾	
User		
	<input type="button" value="Update"/>	

Process Context Data related with the process instance associated. If the task was created by a Business Process, you will have access to see the Process Instance status that has created it.

1 - HR Interview



Work Details Process Context Assignments Comments Logs

Process Instance Id	1
Process Definition Id	hiring
	<input type="button" value="Process Instance Details"/>

Assignments The Task Assignments tab allows you to delegate the task to another person or group if you are not able to continue working on it.

1 - HR Interview



- Work
- Details
- Process Context
- Assignments
- Comments
- Logs

Potential Owners [Group:HR]

User

Please enter a user or a group to delegate the task

Delegate

Comments You can also add while you are working on a task comments about the progress.

1 - HR Interview



- Work
- Details
- Process Context
- Assignments
- Comments
- Logs

Comment

Add Comment



Added By	At	Comment	
salaboy	10/02/2016 19:55	Waiting for confirmation	Delete
salaboy	10/02/2016 19:57	Ask questions about technology	Delete

15.2.1.3. Work on a Task

Tasks can have associated a Form to store data. If tasks are part of a Business Process, usually some data needs to be collected and propagated to the business process for further usage. For that reason, tasks has to provide a way to gather and store data. Forms can be created for specific tasks using the Form Modeller. If no form is provided a dynamic form will be created based on the information that the task needs to handle. If a task is created as an ad-hoc task (not related with any process) there will be no such information to generate a form and only basic actions will be provided.

1 - HR Interview



Work Details Process Context Assignments Comments Logs

Candidate Name

Anne Jones

Age

Email

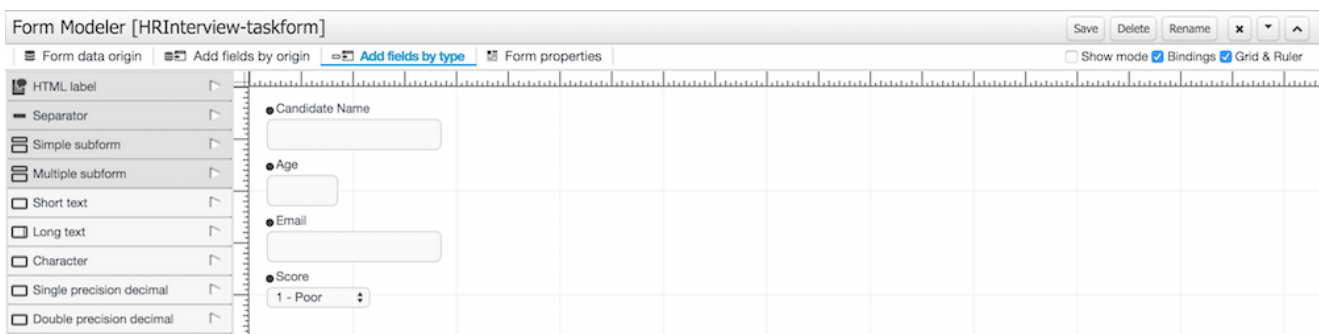
Score

1 - Poor

Save Release **Complete**

15.2.1.4. Task Forms generated by the Form Modeller

As part of your projects you can model your forms for your human tasks, providing a rich interface for collecting data. This shows the Form Modeller canvas while designing the previously Task Form.



15.2.2. New Task (Ad-Hoc Task)

As mentioned in the introduction a User can create their own tasks, which will not be associated with any Business Process. These tasks can be used to keep track of your personal list of TO DOs. You can also create tasks and assign them to different people in your team or group.

The screenshot shows a 'New Task' dialog box with a close button (X) in the top right corner. Below the title bar, there are three tabs: 'Basic' (selected and underlined), 'Advanced', and 'Form'. In the 'Basic' tab, there is a single text input field labeled 'Task Name *'. At the bottom right of the dialog, there is a blue button with a white plus sign and the text '+ Create'.

At the advanced tab the user can define information like priority or the task due on date.

The screenshot shows the 'New Task' dialog box with the 'Advanced' tab selected. The 'Basic' tab is now greyed out. The 'Advanced' tab contains several fields: 'Due On' with a date input field containing '12/02/2016' and a time dropdown menu showing '12:00'; 'Priority' with a dropdown menu showing '0 - High'; two buttons labeled 'Add User' and 'Add Group'; and 'User' with a text input field containing 'salaboy' and a red trash icon. A blue '+ Create' button is located at the bottom right.

When a user creates a new task, can associate an existing form. At the 'Form' tab, the deployment id has to be selected from the list of available deployments id

The screenshot shows a 'New Task' dialog box with three tabs: 'Basic', 'Advanced', and 'Form'. The 'Form' tab is active. There are two dropdown menus: 'Task form deploymentId' and 'Task form name'. The 'Task form deploymentId' dropdown is open, showing two options: 'org.jbpm:Evaluation:1.0' and 'org.jbpm:HR:1.0'. A blue '+ Create' button is located at the bottom right of the dialog.

In that moment, the next list of form names is filled with the available forms at that deployment.

The screenshot shows the 'New Task' dialog box with the 'Form' tab active. The 'Task form deploymentId' dropdown is now set to 'org.jbpm:HR:1.0'. The 'Task form name' dropdown is open, displaying a list of form names: 'CreateProposal-taskform.form', 'CreateProposal-taskform.ftl', 'HRInterview-taskform.form', 'HRInterview-taskform.ftl', 'SignContract-taskform.form', 'SignContract-taskform.ftl', 'TechInterview-taskform.form', 'TechInterview-taskform.ftl', 'hiring-taskform.form', and 'hiring-taskform.ftl'. A blue 'create' button is partially visible on the right side of the dialog.

Once the 'Create' button has been selected, a task is created with the associated form and the status 'In Progress'. The complete action on task shows the selected form.

Chapter 16. Business Activity Monitoring

16.1. Overview

Imagine you are developing a BPM solution which mixes process with business data. Imagine also you need some forms to be used within processes in order to let the users enter data. Moreover, you'll likely want to have some kind of dashboards to display metrics and key performance indicators in order to quickly assess how your processes are doing. So far so good.

jBPM brings you all the ingredients you need to develop end-to-end business process solutions. The jBPM's BAM module (also known as Dashbuilder) allows for composing custom business dashboards by mixing data coming from heterogeneous sources of information. The module is now fully integrated into KIE workbench. A new specific section for dealing with dashboards has been added and it can be accessed either from the home page or from the menu bar, as shown in the next figure.

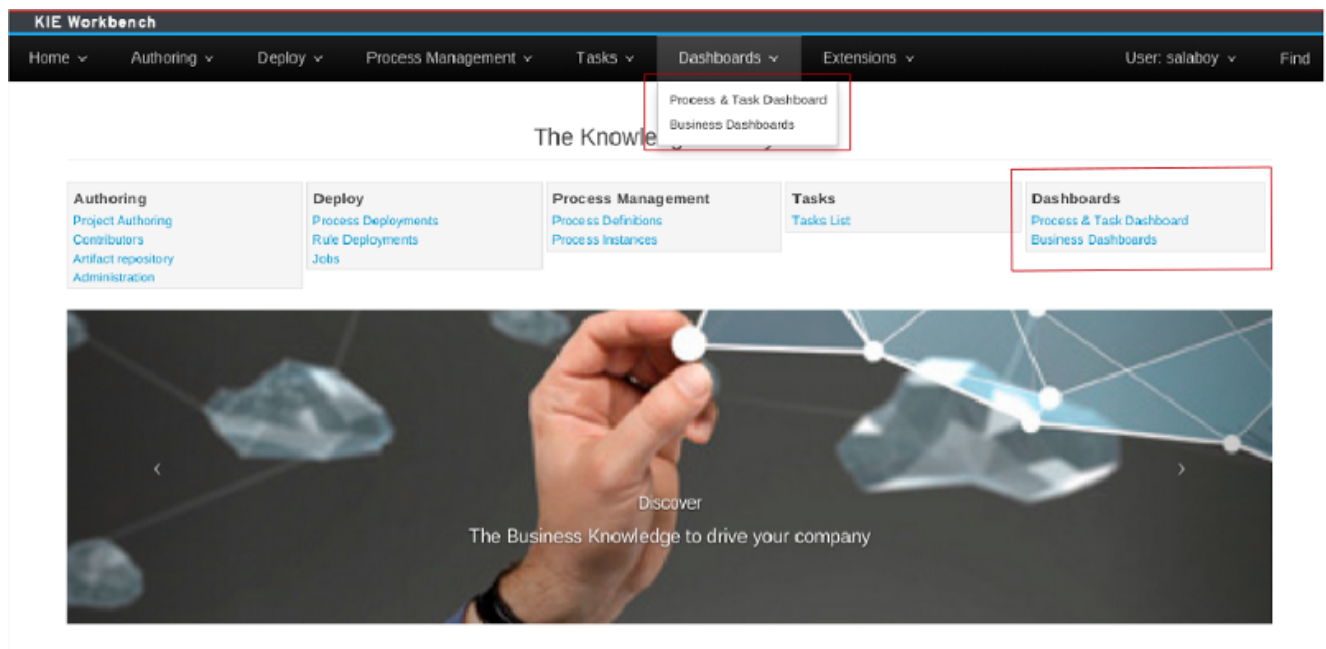


Figure 16.1. BAM menu options in the KIE Workbench home page

In the figure, within the highlighted sections, there exists two options:

- **Business Dashboards:** This option is intended to give users access to the generic dashboard tooling either to compose new dashboards or just to consume existing ones.

- **Process & Task Dashboard:** It opens up the Process Dashboard perspective which contains several performance indicators related to the jBPM execution engine.

16.2. Business Dashboards

BPM solutions are not only made up with processes, rules or forms but also with data belonging to the customer business domain. Such data is handled in the forms, the rules and, of course, the dashboards that are part of the solution. Usually, dashboards feed with data coming from several sources of information, from business domain entities persisted into relational databases to data hold in legacy systems. In order to cope with this kind of scenarios a generic highly customizable dashboard tooling is needed.

It's obviously expected that a customer building a BPM solution want to track how its processes are performing. To do so the customer need a monitoring and reporting tool. This is the main reason why the Dashbuilder project has been included as a core module of the jBPM ecosystem. Notice also that Dashbuilder, as an independent project, is not only used by jBPM but also by many other projects like, for example, JBoss Teiid a data virtualization system that allows applications to use data from multiple, heterogeneous data stores.



Note

Please, read the Dashbuilder book in order to get detailed information about how to build custom dashboards.

An example of dashboard is the Sales Dashboard which comes built-in any installation of Dashbuilder. Two screenshots below:

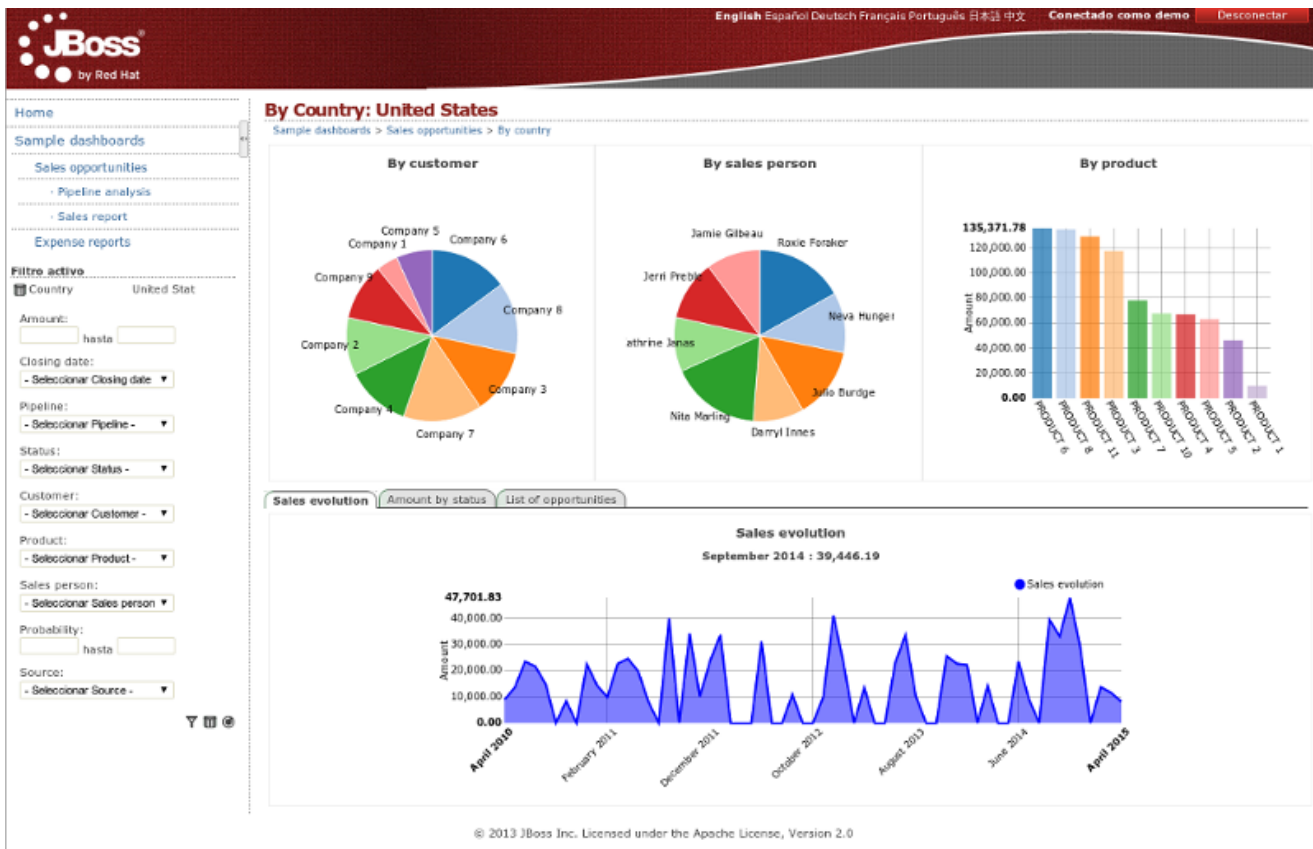


Figure 16.2. Sales opportunities by country

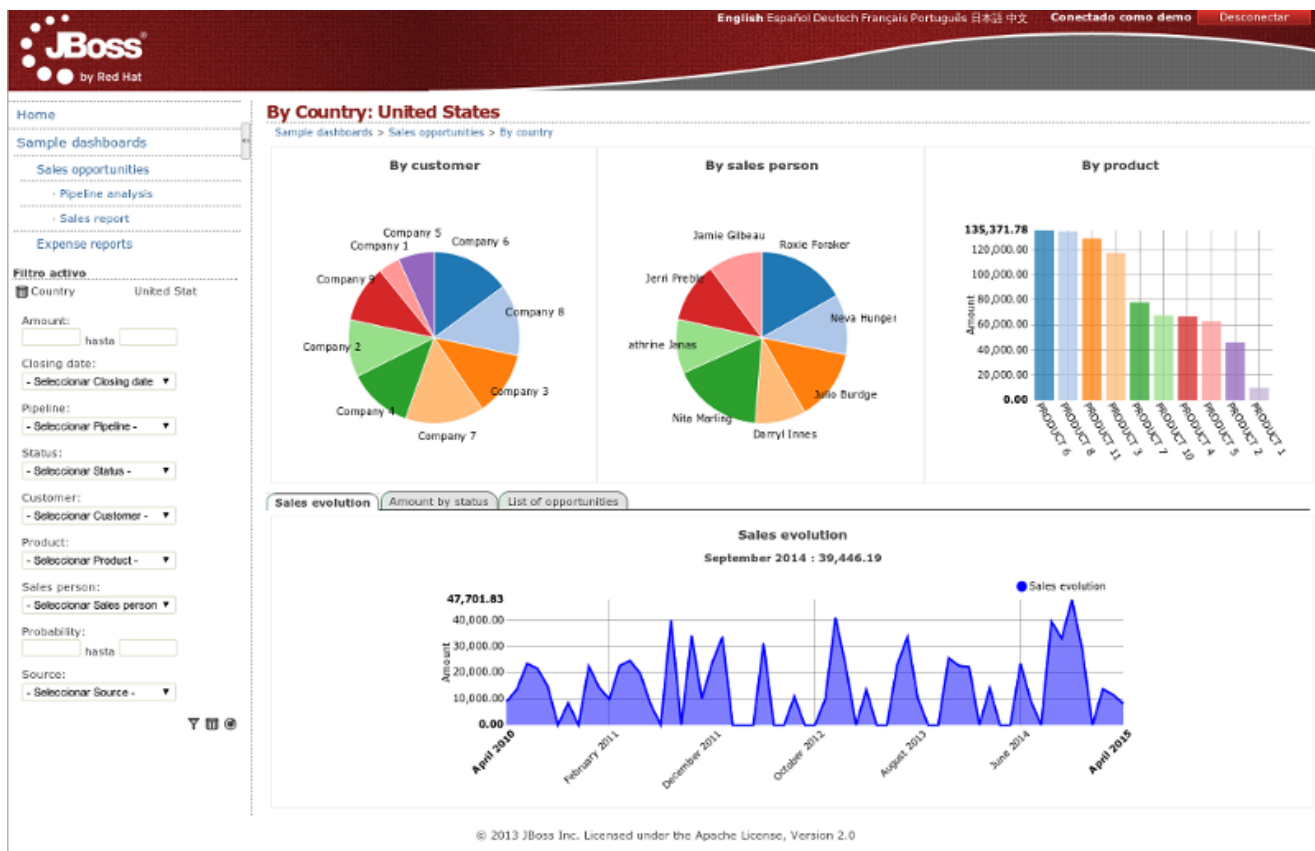


Figure 16.3. Sales opportunities report table

16.3. Process Dashboard

The jBPM Process Dashboard is an specific use case of a dashboard feed from data coming from a relational database via SQL queries. In this case, the database tables consumed are: *processinstancelog* and *bamtasksummary* both belonging to the jBPM engine.

Every time the jBPM runtime updates the information stored into such tables the data becomes automatically available to the dashboard indicators. The following picture shows the main screen that users get when navigating to the Process & Task Dashboard.

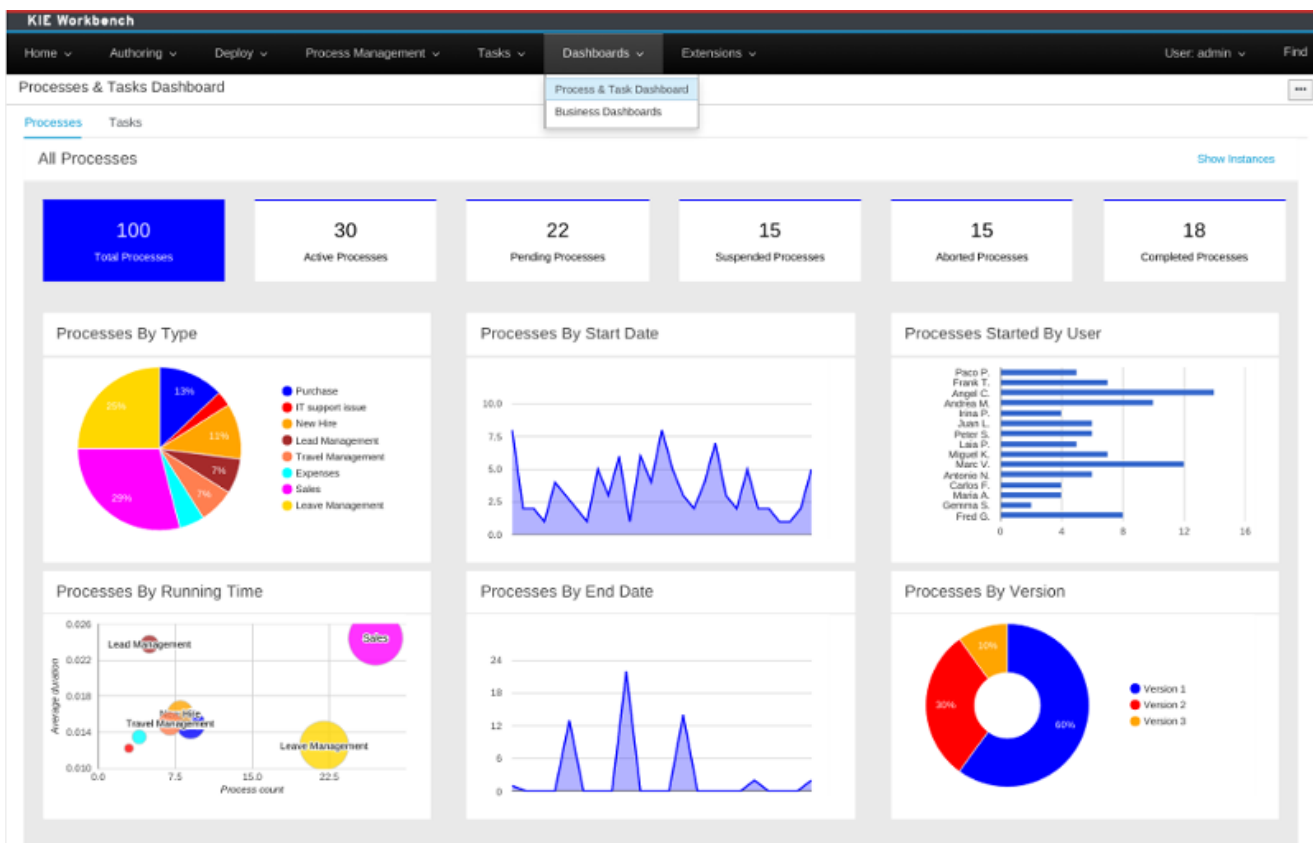


Figure 16.4. Processes dashboard



Note

Notice, those are generic metrics not tied to any specific business process. Nonetheless, it's worth to mention that it would be very easy for customers to modify, extend or adapt this generic dashboard for custom needs. A customer could take the jBPM Process Dashboard as the base template for building a custom dashboard which mixes data coming from the jBPM engine plus data coming from its own business domain.

As you can see there exists two tabs in the top of the screen: Processes and Tasks. As their name indicates, every tab contains only indicators related to either processes or tasks.

To filter through the data users can click on the charts in order to select, for instance, a given process, a given status, etc... Every time a filter is applied, all the indicators are automatically updated and synced according to the criteria set. The next picture shows, for instance, what happens when both the process *Sales* and the status *Active* are selected.

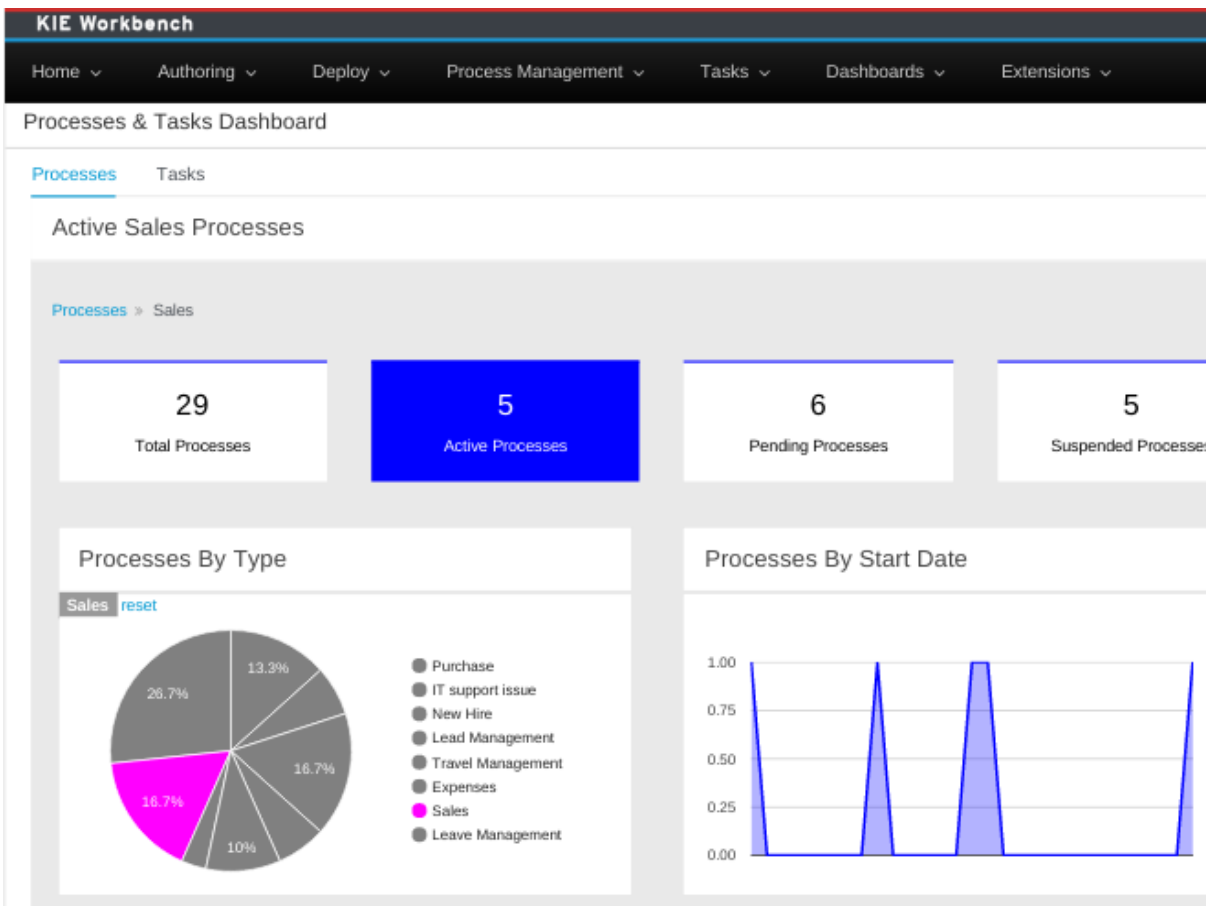


Figure 16.5. Active Process Filter

Using the built-in filter features is a good way to select the process instances the users want to look into. Additionally, at any time, no matter whether there is any active filter or not, users can also navigate to the actual list of instances the dashboard indicators are showing. The *Show Instances* link at the top right side on the screen can be used to display those instances. Once clicked, the view is switched to the screen shown in the next picture:

The screenshot shows the 'Processes & Tasks Dashboard' in KIE Workbench. The 'All Processes' section contains a table with 10 rows of process instances. The columns are: Id, Deployment Id, Process Id, Process name, Initiator, Status, Version, Start, End, and Duration. Row 8 is highlighted in blue.

Id	Deployment Id	Process Id	Process name	Initiator	Status	Version	Start	End	Duration
1	org.jbpm.Evaluato...	evaluation	Evaluation	salaboy	Aborted	1	Oct 15, 2015 11:44	Oct 15, 2015 11:59	15m 31s
2	org.jbpm.Customer...	CustomersRelatio...	Customer Relation...	salaboy	Active	1.0	Oct 15, 2015 11:56	---	17m 48s
3	org.jbpm.Customer...	CustomersRelatio...	Customer Relation...	salaboy	Active	1.0	Oct 15, 2015 11:56	---	17m 36s
4	org.jbpm.Customer...	CustomersRelatio...	Customer Relation...	salaboy	Active	1.0	Oct 15, 2015 11:56	---	17m 28s
5	org.jbpm.Evaluato...	evaluation	Evaluation	salaboy	Active	1	Oct 15, 2015 11:56	---	17m 15s
6	org.jbpm.Evaluato...	evaluation	Evaluation	salaboy	Active	1	Oct 15, 2015 11:56	---	17m 4s
7	org.jbpm.Evaluato...	evaluation	Evaluation	salaboy	Active	1	Oct 15, 2015 11:56	---	16m 49s
8	org.jbpm.Evaluato...	evaluation	Evaluation	salaboy	Active	1	Oct 15, 2015 11:56	---	16m 33s
9	org.jbpm.HR.1.0	hiring	Hiring a Developer	salaboy	Active	1	Oct 15, 2015 11:56	---	16m 25s
10	org.jbpm.HR.1.0	hiring	Hiring a Developer	salaboy	Active	1	Oct 15, 2015 11:56	---	16m 14s

Figure 16.6. Process Instance List

From this view, users can sort the instances just by clicking on any column. They can get a detailed view of a particular instance just by clicking on the desired row as well.

The screenshot shows the '4 - Customer Relationships' instance details panel. The left pane shows a smaller table of active processes. The right pane displays the following details:

- Definition Id:** CustomersRelationship.customers
- Instance State:** Active
- Deployment:** org.jbpm:CustomersRelationship:1.0
- Definition Version:** 1.0
- Correlation key:**
- Parent Process Instance:** No Parent Process Instance
- Active user tasks:** Obtain Customer Info (Ready) owner: ---
- Current Activities:** 15/Oct/15 11:56:38: 1 - Obtain Customer Info (HumanTaskNode)

Figure 16.7. Process Instance Details

The process instance details panel is shown on the right of the screen just after clicking on a row. Notice this is a read only view, just for monitoring purposes. After identifying a target process instance the next step is to use the *JBPM Process Instance Console* in case the user needs to manage such process instance.

16.3.1. Task Dashboard

To switch from the process view to the task view just click on the *Tasks* tab at the top of the screen.

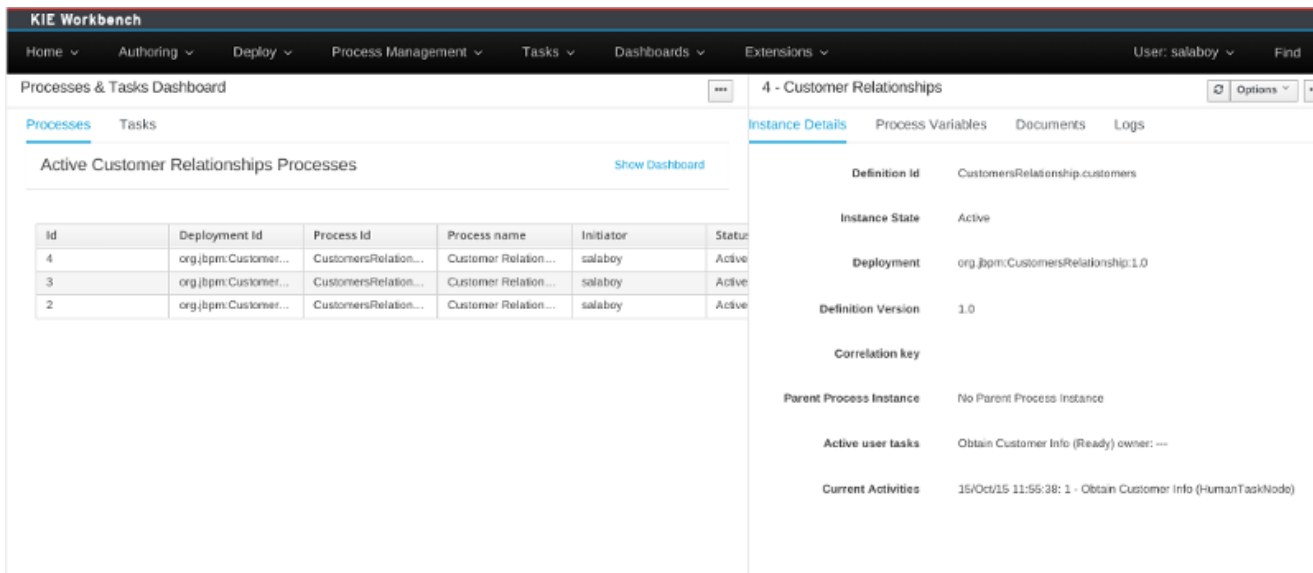


Figure 16.8. Task Dashboard

The task view only contains indicators related to tasks. It basically provides the same features introduced above for process instances (filters, show instances, get details), this time related to tasks instead of processes though.

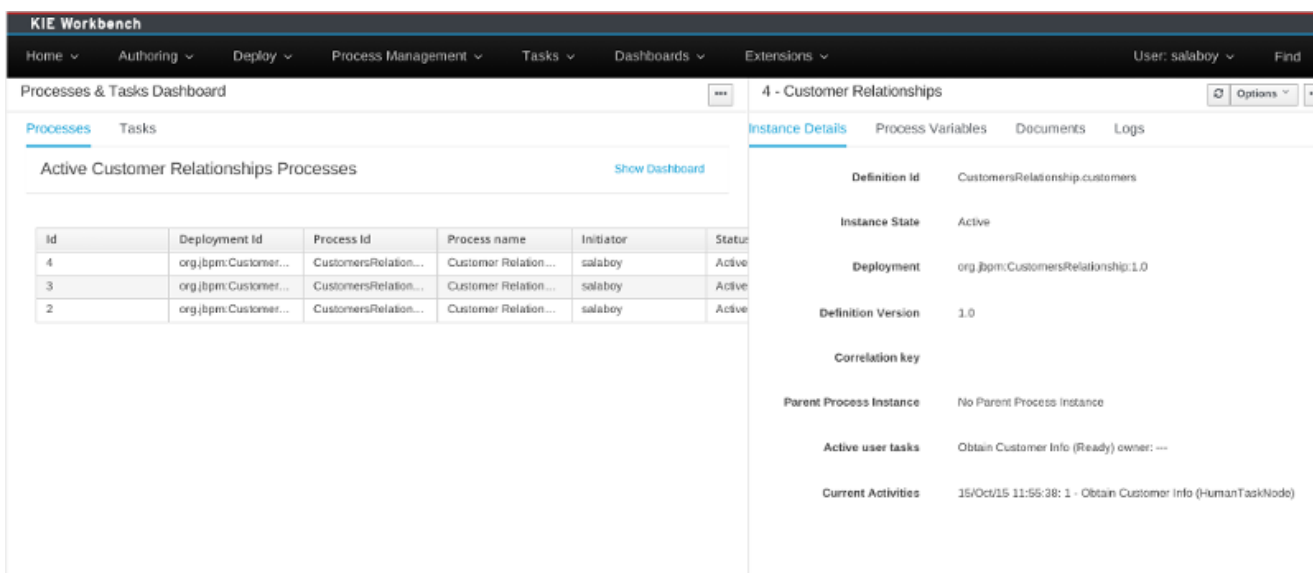


Figure 16.9. Task Instance List

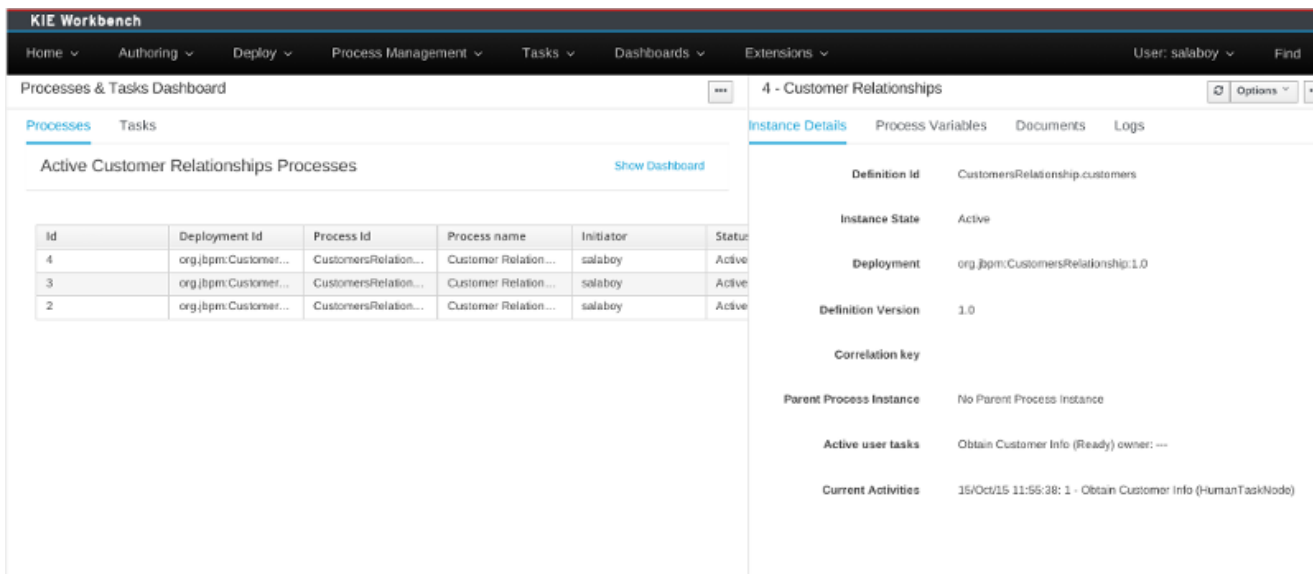


Figure 16.10. Task Instance Details

To sum up, the jBPM Process & Task Dashboard let users:

- To monitor their processes and tasks
- To apply the proper filters in order quickly identify problematic instances
- To get the required information about a given instance in order to be able to fix any unexpected issue

Chapter 17. Remote API

The workbench contains an execution server (for executing processes and tasks), which also allows you to invoke various process and task related operations through a remote API. As a result, you can setup your process engine "as a service" and integrate this into your applications easily by doing remote requests and/or sending the necessary triggers to the execution server whenever necessary (without the need to embed or manage this as part of your application).

Both a REST and JMS based service are available (which you can use directly), and a Java remote client allows you to invoke these operations using the existing `KieSession` and `TaskService` interfaces (you also use for local interaction), making remote integration as easy as if you were interacting with a local process engine.

17.1. Remote Java API

The Remote Java API provides `KieSession`, `TaskService` and `AuditService` interfaces to the JMS and REST APIs.

The interface implementations provided by the Remote Java API take care of the underlying logic needed to communicate with the JMS or REST APIs. In other words, these implementations will allow you to interact with a remote workbench instance (i.e. KIE workbench or the jBPM Console) via known interfaces such as the `KieSession` or `TaskService` interface, without having to deal with the underlying transport and serialization details.

The first step in interacting with the remote runtime is to use a `RemoteRuntimeEngineFactory` static `newRestBuilder()`, `newJmsBuilder()` or `newCommandWebServiceClientBuilder()` to create a builder instance. Use the new builder instance to configure and to create a `RuntimeEngine` instance to interact with the server.

Each of the REST, JMS or `WebServiceRemoteClientBuilder` instances exposes different methods that allow the configuration of properties like the base URL of the REST API, JMS queue locations or timeout while waiting for responses.



The Remote Java API provides clients, not "instances"

While the `KieSession`, `TaskService` and `AuditService` instances provided by the Remote Java API may "look" and "feel" like local instances of the same interfaces, please make sure to remember that these instances are only wrappers around a REST or jMS client that interacts with a remote REST or JMS API.

This means that if a requested operation fails on the *server*, the Remote Java API client instance on the *client* side will throw a `RuntimeException` indicating that the REST call failed. This is different from the behaviour of a "real" (or local) instance of

a `KieSession`, `TaskService` and `AuditService` instance because the exception the local instances will throw will relate to how the operation failed. Operations on a Remote Java API client instance that would normally throw other exceptions (such as the `TaskService.claim(taskId, userId)` operation when called by a user who is not a potential owner), will now throw a `RuntimeException` instead when the requested operation fails on the server.

Also, while local instances require different handling (such as having to dispose of a `KieSession`), client instances provided by the Remote Java API hold no state and thus do not require any special handling.

Finally, the instances returned by the client `KieSession` and `TaskService` instances (for example, process instances or task summaries) are not the same (internal) objects as used by the core engines. Instead, these returned instances are simple data transfer objects (DTOs) that implement the same interfaces but are designed to only return the associated data. Modifying or casting these returned instances to an internal implementation class will not succeed.

Creating a Remote Java Client Instance

The following is a simple example of creating a REST-based client. The `appName` variable in the code below will be either "business-central" or "kie-wb" depending on whether you're using product or community.

```
String deploymentId = "com.burns.reactor:homer:1.0";
String serverInstanceUrl = "http://localhost:8080/" + appName;

RuntimeEngine engine = RemoteRuntimeEngineFactory.newRestBuilder()
    .addDeploymentId(deploymentId)
    .addUrl(new URL(serverInstanceUrl))
    .addUserName("homer")
    .addPassword("d0nut5R!!!")
    .build();

KieSession kieSessionClient = engine.getKieSession();
```

Create the appropriate builder instance. The method `.newJmsBuilder()` is available to create JMS based builder instances

Call the appropriate methods and pass the appropriate parameters to configure the client

"Build" or instantiate the actual client `RuntimeEngine` instance which you can then use to interact with the server

17.1.1. Remote REST Java API Client Configuration

Each builder has a number of different (required or optional) methods to configure a client `RuntimeEngine` instance.

- Methods with `always` next to them are **always** required.
- Methods with `when` next to them are *required depending on the factors described* ("required when...") and otherwise optional.
- All other methods are optional.

Remote Rest Runtime Engine Builder methods

`addDeploymentId(String deploymentId)` ^{when}

Set the deployment id of the deployment

Required when:

doing an operation on a client instance that affects a process instance

`addExtraJaxbClasses(Class... extraJaxbClasses)` ^{when}

Add extra classes to the classpath available to the serialization mechanisms

When passing instances of user-defined classes in a Remote Java API call, it's important to use this method first to add the classes so that the class instances can be serialized correctly.

Required when:

passing custom class instances as arguments to an operation on a client instance

`addPassword(String password)` ^{always}

Set the password of the user connecting to the server

`addProcessInstanceId(long process)` ^{when}

Set the process instance id of the deployment

Required when:

interacting with a `PER_PROCESS_INSTANCE` deployment

`addTimeout(int timeoutInSeconds)`

Set the timeout for the REST call

The default is 5 seconds.

`addUrl(URL serverInstanceUrl)` ^{always}

Set the URL for the application instance

This should be a URL that roughly corresponds to `http://server:port/business-central/` or `http://server:port/kie-wb/`.

`addUserName(String userName)` ^{always}

Set the name of the user connecting to the server

clearJaxbClasses()

Clears the list of (user-defined) Classes that the client instance should know about

17.1.1.1. Example REST Remote Java Client Configuration

The following example illustrates how the Remote Java API can be used with the REST API.

```
public void startProcessAndHandleTaskViaRestRemoteJavaAPI(URL serverRestUrl, String deploymentId, String user, String password) {
    // the serverRestUrl should contain a URL similar to "http://localhost:8080/jbpm-console/"

    // Setup the factory class with the necessary information to communicate with the REST services
    RuntimeEngine engine = RemoteRuntimeEngineFactory.newRestBuilder()
        .addUrl(serverRestUrl)
        .addTimeout(5)
        .addDeploymentId(deploymentId)
        .addUserName(user)
        .addPassword(password)
        // if you're sending custom class parameters, make sure that
        // the remote client instance knows about them!
        .addExtraJaxbClasses(MyType.class)
        .build();

    // Create KieSession and TaskService instances and use them
    KieSession ksession = engine.getKieSession();
    TaskService taskService = engine.getTaskService();

    // Each operation on a KieSession, TaskService or AuditLogService (client) instance
    // sends a request for the operation to the server side and waits for the response
    // If something goes wrong on the server side, the client will throw an exception.
    Map<String, Object> params = new HashMap<String, Object>();
    params.put("paramName", new MyType("name", 23));
    ProcessInstance processInstance
    = ksession.startProcess("com.burns.reactor.maintenance.cycle", params);
    long procId = processInstance.getId();

    String taskUserId = user;
    taskService = engine.getTaskService();
    List<TaskSummary> tasks = taskService.getTasksAssignedAsPotentialOwner(user, "en-UK");

    long taskId = -1;
    for (TaskSummary task : tasks) {
        if (task.getProcessInstanceId() == procId) {
            taskId = task.getId();
        }
    }

    if (taskId == -1) {
        throw new IllegalStateException("Unable to find task for " + user +
            " in process instance " + procId);
    }

    taskService.start(taskId, taskUserId);

    // resultData can also just be null
    Map<String, Object> resultData = new HashMap<String, Object>();
}
```



```
taskService.complete(taskId, taskUserId, resultData);
}
```

17.1.2. Remote JMS Java API Client Configuration

When configuring the remote JMS client, you must choose one of the following ways to configure the JMS connection:

1. Pass the `ConnectionFactory` instance and the `KieSession`, `TaskService` and `ResponseQueue` instances when configuring the remote java client. To do that, please use the following methods:

- `addConnectionFactory(ConnectionFactory)`
- `addKieSessionQueue(Queue)`
- `addTaskServiceQueue(Queue)`
- `addResponseQueue(Queue)`
- `addHostName(String)`
- `addJmsConnectorPort(String)`

2. or pass a remote `InitialContext` instance that contains references to the necessary `ConnectionFactory` and `Queue` instances (see previous bullet).

- please then use the method `addRemoteInitialContext(InitialContext)`

3. or pass a `String` with the hostname of the JBoss EAP server that KIE Workbench is running on

- please then use the method `addJbossServerHostName(String)`

In addition, if you are doing an operation on a task via the remote JMS client (and are not using the `disableTaskSecurity()` method), then you must also configure SSL. The following methods (described in more detail below) are available for this:

- `addHostName(String)`
- `addJmsConnectorPort(int)`
- `addKeystoreLocation(String)`
- `addKeystorePassword(String)`
- `addTruststoreLocation(String)`
- `addTruststorePassword(String)`
- `useKeystoreAsTruststore()`

17.1.2.1. Example JMS Remote Java Client Configuration

Example JMS Remote Java Client Configuration with a remote `javax.jms` classes

The following example illustrates how to configure a Remote Java API JMS client using instances of the `ConnectionFactory` and `Queue` classes.

```
private static final String CONNECTION_FACTORY_NAME = "jms/RemoteConnectionFactory";
private static final String KSESSION_QUEUE_NAME = "jms/queue/KIE.SESSION";
private static final String TASK_QUEUE_NAME = "jms/queue/KIE.TASK";
private static final String RESPONSE_QUEUE_NAME = "jms/queue/KIE.RESPONSE";

public void startProcessViaJmsRemoteJavaAPI(String hostname, int jmsConnPort,
String deploymentId, String user, String password,
String processId) throws NamingException {

    InitialContext remoteInitialContext = getRemoteInitialContext();

    String queueName = KSESSION_QUEUE_NAME;
    Queue sessionQueue = (Queue) remoteInitialContext.lookup(queueName);
    queueName = TASK_QUEUE_NAME;
    Queue taskQueue = (Queue) remoteInitialContext.lookup(queueName);
    queueName = RESPONSE_QUEUE_NAME;
    Queue responseQueue = (Queue) remoteInitialContext.lookup(queueName);

    String connFactoryName = CONNECTION_FACTORY_NAME;
    ConnectionFactory connFact = (ConnectionFactory) remoteInitialContext.lookup(connFactoryName);

    RuntimeEngine engine = RemoteRuntimeEngineFactory.newJmsBuilder()
        .addDeploymentId(deploymentId)
        .addConnectionFactory(connFact)
        .addKieSessionQueue(sessionQueue)
        .addTaskServiceQueue(taskQueue)
        .addResponseQueue(responseQueue)
        .addUserName(user)
        .addPassword(password)
        .addHostName(hostname)
        .addJmsConnectorPort(jmsConnPort)
        .disableTaskSecurity()
        .build();

    // Create KieSession instances and use them
    KieSession ksession = engine.getKieSession();

    // Each operation on a KieSession, TaskService or AuditLogService (client) instance
    // sends a request for the operation to the server side and waits for the response
    // If something goes wrong on the server side, the client will throw an exception.
    ProcessInstance processInstance = ksession.startProcess(processId);
    long procId = processInstance.getId();
}
```

The names of the `ConnectionFactory` and `Queue` instances may differ depending on your application server

Here we add the connection factory and queue instances.

If we are not using SSL, but are doing operations on tasks, then we have to explicitly call the `disableTaskSecurity()` method. SSL is necessary for security reasons (plain-text password in message) when doing task operations via the remote Java API.

Example JMS Remote Java Client Configuration with a remote `InitialContext` instance

The following example illustrates how to configure a Remote Java API JMS client using a remote `InitialContext` instance. See your application server documentation for how to instantiate a remote instance of your application server's `InitialContext`.

```
public void startProcessViaJmsRemoteJavaAPIInitialContext(String hostname, int jmsCon
nPort,
    String deploymentId, String user, String password,
    String processId) {

    // See your application server documentation for how to initialize
    // a remote InitialContext instance for your server instance
    InitialContext remoteInitialContext = getRemoteInitialContext();

    RuntimeEngine engine = RemoteRuntimeEngineFactory.newJmsBuilder()
        .addDeploymentId(deploymentId)
        .addRemoteInitialContext(remoteInitialContext)
        .addUserName(user)
        .addPassword(password)
        .build();

    // Create KieSession instances and use them
    KieSession ksession = engine.getKieSession();

    // Each operation on a KieSession, TaskService or AuditLogService (client) instance
    // sends a request for the operation to the server side and waits for the response
    // If something goes wrong on the server side, the client will throw an exception.
    ProcessInstance processInstance = ksession.startProcess(processId);
    long procId = processInstance.getId();
}
```

Example JMS Remote Java Client Configuration with JBoss EAP hostname

The following example illustrates how to configure a Remote Java API JMS client using the hostname of the JBoss EAP server on which kie-wb or business-central is running.

```
public void startProcessViaJmsRemoteJavaAPI(String hostNameOrIpAddress,
    String deploymentId, String user, String password,
    String processId) {

    // this requires that you also have the following dependencies
    // - org.jboss.as:jboss-naming artifact appropriate to the EAP version you're using
    RuntimeEngine engine = RemoteRuntimeEngineFactory.newJmsBuilder()
        .addJbossServerHostName(hostNameOrIpAddress)
```

```
.addDeploymentId(deploymentId)
.addUserName(user)
.addPassword(password)
.build();
}
```

17.1.2.2. Remote JMS Runtime Engine Builder methods

Each builder has a number of different (required or optional) methods to configure a client `RuntimeEngine` instance.

- Methods with **always** next to them are **always** required.
- Methods with **when** next to them are *required depending on the factors described* ("required when...") and otherwise optional.
- All other methods are optional.

Remote JMS Runtime Engine Builder methods

`addConnectionFactory(ConnectionFactory connectionFactory)` ^{when}
Add a `ConnectionFactory` used to create JMS session to send and receive messages

Required when:

configuring the JMS java client by passing `ConnectionFactory` and `Queue` instances

`addDeploymentId(String deploymentId)` ^{when}
Set the deployment id of the deployment

Required when:

doing an operation on a client instance that affects a process instance — this also includes completing or failing tasks created by process instances

`addExtraJaxbClasses(Class... extraJaxbClasses)` ^{when}
Add extra classes to the client for when user-defined class instances are passed as parameters to client methods

When passing instances of user-defined classes in a Remote Java API call, it's important to use this method first to add the classes so that the class instances can be serialized correctly.

Required when:

passing custom class instances as arguments to an operation on a client instance

`addHostName(String hostname)` ^{when}
Set the host name for the server that the client is making a JMS connection with

Required when:

configuring the JMS java client by setting `ConnectionFactory` and `Queue` instances

configuring the JMS java client to use SSL

addJbossServerHostName(String hostname)

Set the host name of the JBoss EAP server that the client is making a JMS connection with

After using this method, no other configuration is needed with regards to the server. However, additional server parameters (host name, port) may be needed when also configuring SSL.

Make sure that the EAP version-appropriate `org.jboss.naming:jboss-naming` dependency is available on the classpath when doing this

addJmsConnectorPort(int port) when

Set the port used for the JMS connection connection with the server

Required when:

configuring the JMS java client by passing `ConnectionFactory` and `Queue` instances

configuring the JMS java client to use SSL

addKeystoreLocation(String keystorePath) when

Set the location (path) of the keystore

Required when:

configuring the JMS java client to use SSL

addKeystorePassword(String keystorePassword) when

Set the password for the keystore

Required when:

configuring the JMS java client to use SSL

addKieSessionQueue(Queue ksessionQueue) when

Pass the `javax.jms.Queue` instance representing the `KIE.SESSION` queue used to receive process instance requests from the client

Required when:

configuring the JMS java client by setting `ConnectionFactory` and `Queue` instances

addPassword(String password) always

Set the password of the user connecting to the server

addProcessInstanceId(long process) when

Set the process instance id of the deployment

Required when:

interacting with a `'PER_PROCESS_INSTANCE'` deployment

addRemoteInitialContext(InitialContext remoteInitialContext)

Set the remote `InitialContext` instance from the remote application server, which is then used to retrieve the `ConnectionFactory` and `Queue` instances

After using this method, no other configuration is needed with regards to the server. However, additional server parameters (host name, port) may be needed when also configuring SSL.

`addResponseQueue(Queue responseQueue)` ^{when}

Pass the `javax.jms.Queue` instance representing the `KIE.RESPONSE` queue used to send responses to the client

Required when:

configuring the JMS java client by setting `ConnectionFactory` and `Queue` instances

`addTaskServiceQueue(Queue taskServiceQueue)` ^{when}

Pass the `javax.jms.Queue` instance representing the `KIE.TASK` queue used to receive task operation requests to the client

Required when:

configuring the JMS java client by setting `ConnectionFactory` and `Queue` instances

`addTimeout(int timeoutInSeconds)`

Set the timeout for the JMS message. The default is 5 seconds.

`addTruststoreLocation(String truststorePath)` ^{when}

Set the location (path) of the keystore

Required when:

configuring the JMS java client to use SSL

`addTruststoreLocation(String truststorePassword)` ^{when}

Set the password for the keystore

Required when:

configuring the JMS java client to use SSL

`addUserName(String userName)` ^{always}

Set the name of the user connecting to the server

This is also the user whose permissions will be used when doing any task operations

`clearJaxbClasses()`

Clears the list of (user-defined) Classes that the client instance should know about

`disableTaskSecurity()`

Enables configuration of a client that can send task-related operation requests without having to use SSL. If this option is **not** used and a task operation is called, the client will throw an exception.

`useKeystoreAsTruststore()`

Uses the same file (location) and password for the truststore configuration when configuring SSL.



Important

In order to instantiate a remote `InitialContext` via JNDI, the application-server-specific dependencies need to be included on the classpath.

For JBoss EAP 6, the artifact (jar) containing this class is the `org.jboss:jboss-remote-naming` artifact (jar), version `1.0.5.Final` or higher. Depending on the version of AS 7 or EAP 6 that you use, this version may vary.

If you are using a *different* application server, please see your specific application server documentation for the parameters and artifacts necessary to create an `InitialContextFactory` instance or otherwise get a remote `InitialContext` instance (via JNDI) from the application server instance.

17.1.2.3. Example JMS client configuration and usage with SSL

The following example illustrates how to configure a Remote Java API JMS client using a remote `InitialContext` instance along with SSL. In this case, the same file is being used as both the client's keystore (the client's identifying keys and certificates) and as the client's truststore (the client's list of trusted certificates from other parties, in this case, the server).

```
public void startProcessAndHandleTaskViaJmsRemoteJavaAPISSL(String hostNameOrIpAdress, int jmsSslConnectorPort,
    String deploymentId, String user, String password,
    String keyTrustStoreLocation, String keyTrustStorePassword,
    String processId) {

    InitialContext remoteInitialContext = getRemoteInitialContext();

    RuntimeEngine engine = RemoteRuntimeEngineFactory.newJmsBuilder()
        .addDeploymentId(deploymentId)
        .addRemoteInitialContext(remoteInitialContext)
        .addUserName(user)
        .addPassword(password)
        .addHostName(hostNameOrIpAdress)
        .addJmsConnectorPort(jmsSslConnectorPort)
        .useKeystoreAsTruststore()
        .addKeystoreLocation(keyTrustStoreLocation)
        .addKeystorePassword(keyTrustStorePassword)
        .build();

    // create JMS request
    KieSession ksession = engine.getKieSession();
    ProcessInstance processInstance = ksession.startProcess(processId);
    long procInstId = processInstance.getId();
    logger.debug("Started process instance: " + procInstId );

    TaskService taskService = engine.getTaskService();
    List<TaskSummary> taskSumList
    = taskService.getTasksAssignedAsPotentialOwner(user, "en-UK");
    TaskSummary taskSum = null;
```

```

for( TaskSummary taskSumElem : taskSumList ) {
    if( taskSumElem.getProcessInstanceId().equals(procInstId) ) {
        taskSum = taskSumElem;
    }
}
long taskId = taskSum.getId();
logger.debug("Found task " + taskId);

// get other info from task if you want to
Task task = taskService.getTaskById(taskId);
logger.debug("Retrieved task " + taskId);

taskService.start(taskId, user);

Map<String, Object> resultData = new HashMap<String, Object>();
// insert results for task in resultData
taskService.complete(taskId, user, resultData);
logger.debug("Completed task " + taskId);
}

```

17.1.3. Remote CommandWebService Java API Client Configuration

Starting with this release, a simple webservice has been added to the remote API.

Example WebService Remote Java Client Configuration

The following example illustrates how to configure a Remote Java API WebService client using the hostname of the JBoss EAP server on which kie-wb or business-central is running.

```

import java.net.URL;
import java.util.List;
import java.util.Map;

import org.kie.api.command.Command;
import org.kie.api.task.model.Task;
import org.kie.remote.client.documentation.objects.MyType;
import org.kie.remote.client.jaxb.JaxbCommandsRequest;
import org.kie.remote.client.jaxb.JaxbCommandsResponse;
import org.kie.remote.jaxb.gen.GetTaskCommand;
import org.kie.remote.jaxb.gen.GetTaskContentCommand;
import org.kie.remote.jaxb.gen.GetTasksByProcessInstanceIdCommand;
import org.kie.remote.jaxb.gen.JaxbStringObjectPairArray;
import org.kie.remote.jaxb.gen.StartProcessCommand;
import org.kie.remote.jaxb.gen.util.JaxbStringObjectPair;
import org.kie.remote.services.ws.command.generated.CommandWebService;
import org.kie.remote.services.ws.command.generated.CommandWebServiceException;
import org.kie.services.client.api.RemoteRuntimeEngineFactory;
import org.kie.services.client.serialization.jaxb.impl.JaxbCommandResponse;
import org.kie.services.client.serialization.jaxb.impl.JaxbLongListResponse;
import org.kie.services.client.serialization.jaxb.impl.process.JaxbProcessInstanceResponse;
import org.slf4j.Logger;
import org.slf4j.LoggerFactory;

```



```
public class WebserviceJavaApiExamples {

    private Logger logger = LoggerFactory.getLogger(WebserviceJavaApiExamples.class);

    /**
     * Create the webservice client
     * @param applicationUrl Something like "http://localhost:8080/kie-wb/"
     *                        or "http://localhost:8080/business-central/"
     * @param user The user doing the webservice requests
     * @param password The user's password
     * @param deploymentId The deployment id that the request will interact with
     * @return A {@link CommandWebService} client instance
     */
    private static CommandWebService createWebserviceClient(URL applicationUrl,
        String user, String password, String deploymentId) {
        CommandWebService client =
            RemoteRuntimeEngineFactory.newCommandWebServiceClientBuilder()
                .addServerUrl(applicationUrl)
                .addUserName(user)
                .addPassword(password)
                .addDeploymentId(deploymentId)
                .addExtraJaxbClasses(MyType.class)
                .buildBasicAuthClient();

        return client;
    }

    /**
     * Send a webservice request with a single command
     * @param service The webserivce client instance
     * @param cmd The command that we're sending (see the
     *            'org.kie.remote.jaxb.gen package' in kie-remote-client)
     * @param respClass The class that we expect as a response
     * @param deploymentId The id of the deployment that we will interact with
     * @return the response object
     * @throws CommandWebServiceException if the webservice operation fails
     */
    private static <T> T doWebserviceSingleCommandRequest(CommandWebService service,
        Command<?> cmd, Class<T> respClass, String deploymentId)
        throws CommandWebServiceException {
        // Get a response from the WebService
        JaxbCommandsRequest req = new JaxbCommandsRequest(deploymentId, cmd);
        JaxbCommandsResponse response = service.execute(req);

        // check response
        JaxbCommandResponse<?> cmdResp = response.getResponses().get(0);

        return (T) cmdResp;
    }

    /**
     * Start a simple process, and retrieve the task information and content
     * via the webservice
     *
     * @param applicationUrl Something like "http://localhost:8080/kie-wb/"
     *                        or "http://localhost:8080/business-central/"
     * @param user The user doing the webservice requests
     * @param password The user's password
     * @param deploymentId The deployment id that the request will interact with
     */
}
```

```
* @param processId The id of the process we want to start
* @throws Exception if something goes wrong
*/
public static void startSimpleProcess(URL applicationUrl,
String user, String password, String deploymentId, String processId)
throws Exception {

    CommandWebService commandWebService
= createWebServiceImpl(applicationUrl, user, password, deploymentId);

    // Create start process command
    StartProcessCommand spc = new StartProcessCommand();
    spc.setProcessId(processId);
    JAXBStringObjectPairArray map = new JAXBStringObjectPairArray();
    JAXBStringObjectPair keyValue = new JAXBStringObjectPair();
    keyValue.setKey("myobject");
    keyValue.setValue(new MyType("variable", 29));
    map.getItems().add(keyValue);
    spc.setParameter(map);

    // Do webservice request
    JAXBProcessInstanceResponse jpir
= doWebServiceSingleCommandRequest(commandWebService, spc,
    JAXBProcessInstanceResponse.class, deploymentId);
    long procInstId = ((JAXBProcessInstanceResponse) jpir).getId();

    // Create command
    GetTasksByProcessInstanceIdCommand gtbic = new GetTasksByProcessInstanceIdCommand();
    gtbic.setProcessInstanceId(procInstId);

    // Do webservice request
    JAXBLongListResponse jllr
= doWebServiceSingleCommandRequest(commandWebService, gtbic,
    JAXBLongListResponse.class, deploymentId );
    List<Long> taskIds = jllr.getResult();
    long taskId = taskIds.get(0);

    // Commands for task and task content
    GetTaskCommand gtc = new GetTaskCommand();
    gtc.setTaskId(taskId);
    GetTaskContentCommand gtcc = new GetTaskContentCommand();
    gtcc.setTaskId(taskId);

    // Do webservice request (with both commands)
    JAXBCommandsRequest req = new JAXBCommandsRequest(deploymentId, gtc);
    req.getCommands().add(gtcc);
    JAXBCommandsResponse response = commandWebService.execute(req);

    // Get task and content response
    Task task = (Task) response.getResponses().get(0).getResult();
    Map<String, Object> contentMap
= (Map<String, Object>) response.getResponses().get(1).getResult();
}

}
```

All commands that can be used with the webservice can be found in the `org.kie.remote.jaxb.gen` package in the `kie-remote-client` module. These commands contain the same data as the commands that they are based on (that have the same name) in the core `jbpm` and `drools` modules.

The `addExtraJaxbClasses(Class...)` method must be used when using instances of user-defined classes in a command sent in a webservice request.

Similar to the REST `/execute` method, multiple commands can be sent in one webservice request

Remote Webservice Client Builder methods

`addDeploymentId(String deploymentId)` ^{when}

Set the deployment id of the deployment

Required when:

doing an operation on a client instance that affects a process instance — this also includes completing or failing tasks created by process instances

`addExtraJaxbClasses(Class... extraJaxbClasses)` ^{when}

Add extra classes to the client for when user-defined class instances are passed as parameters to client methods

When passing instances of user-defined classes in a Remote Java API call, it's important to use this method first to add the classes so that the class instances can be serialized correctly.

Required when:

passing custom class instances as arguments to an operation on a client instance

`addServerUrl(URL applicationUrl)` ^{always}

Set the URL for the application (`kie-wb` or `business-central`) that the webservice request will be sent to

`addPassword(String password)` ^{always}

Set the password of the user connecting to the server

`addTimeout(int timeoutInSeconds)`

Set the timeout for the Webservice response. The default is 5 seconds.

`addUserName(String userName)` ^{always}

Set the name of the user connecting to the server

This is also the user whose permissions will be used when doing any task operations

`setWsdLocationRelativePath()`

OCRAM

`useHttpRequestRedirect()`

OCRAM

17.1.4. Supported methods

As mentioned above, the Remote Java API provides client-like instances of the `RuntimeEngine`, `KieSession`, `TaskService` and `AuditService` interfaces.

This means that while many of the methods in those interfaces are available, some are not. The following tables lists the methods which are available. Methods not listed in the below, will throw an `UnsupportedOperationException` explaining that the called method is not available.

Table 17.1. Available process-related `KieSession` methods

Method signature
<code>getProcessInstance(processInstanceId)</code>
<code>getProcessInstance(processInstanceId)</code>
<code>getProcessInstance(processInstanceId, boolean readOnly)</code>
<code>getProcessInstances()</code>
<code>getProcessInstances(active)</code>

Method

signature
type
ture

in-
stances

Signal
nal Event(
all ring
(ac-
tive),
process
ject
stances

Signal
nal Event(
the ring
process
in 1,
stance
ject
event,
long
processIn-
stanceId)

Start
ProcessIn-
stances(
new ring
process Id,
and-
re-
turn
the on-
process
in-
stance
(if-
the on-
process
map<String,
stance
has>
not

Method

signature
type
ture

im-
me-
di-
ate-
ly
com-
plet-
ed)

StartSession(String
sessionId,
newString,

process
and >

re-
turn
the

process
in-
stance
(if
the
process
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ed)

Table 17.2. Available rules-related `KieSession` methods

Method
<code>getFactCount()</code>
<code>getGlobal(String)</code>
<code>getGlobalFact(String)</code>
<code>getId()</code>
<code>getKieSession()</code>
<code>setGlobal(String, Object)</code>
<code>setGlobalFact(String, Object)</code>
<code>fireAllRules()</code>

Table 17.3. Available `WorkItemManager` methods

Method signature
<code>AbortWorkItem(long workItemId)</code>
<code>CompleteWorkItem(long workItemId, Map<String, Object> results)</code>
<code>RevertWorkItem(long workItemId)</code>

Table 17.4. Available task operation `TaskService` methods

Method signature
<code>AddTask(Task object, Map<String, Object> params)</code>
<code>Activate(long taskId, long userId)</code>
<code>Claim(long taskId, Task object)</code>

Method**signature**String
userId)**Claim**(long

taskId,

task

userId,

List<String>

groupIds)

ClaimNextAvailable(String

userId,

next

available

page)

task

for

a

user

ClaimNextAvailable(String

userId,

next<String>

available

page)

task

for

a

user

Complete(long

taskId,

string

taskId,

Map<String,

Ob-

ject>

data-

ta)

Delegate(long

taskId,

task

userId,

Method

signature
type
ture

atring

task

ge-

tUserId)

Exid(long

itaskId,

atring

taskId)

Faild(long

aaskId,

tasking

userId,

Map<String,

Ob-

ject>

fault-

Da-

ta)

Forward(long

wardId,

atring

taskId,

String

tar-

ge-

tEn-

ti-

tyId)

Nominate(long

iaskId,

rateing

aserId,

task<OrganizationalEntity>

po-

ten-

tialOwn-

ers)

Release(long

leaseId,

Method	Signature
Retrieve	Retrieve(long taskId)
Resume	Resume(long taskId, string taskId)
Resume	Resume(long taskId, string taskId)
Skip	Skip(long taskId, string taskId, string taskId, string taskId, string taskId)
Start	Start(long taskId, string taskId, string taskId, string taskId)
Stop	Stop(long taskId, string taskId, string taskId, string taskId)
Suspend	Suspend(long taskId, string taskId, string taskId, string taskId)

Table 17.5. Available task retrieval and query `TaskService` methods

Method	Signature
<code>GetTaskByWorkItemId</code>	<code>GetTaskByWorkItemId(long workItemId)</code>
<code>GetTaskById</code>	<code>GetTaskById(long taskId)</code>

Method**Signature****Type****Return**

```
getTasksSummaryAsBusinessAdministrator(String  
userId,  
String  
language)
```

```
getTasksSummaryAsPotentialOwner(String  
userId,  
String  
language)
```

```
getTasksSummaryAsPotentialOwnerByStatus(String  
userId,  
List<Status>  
statuses,  
String  
language)
```

```
getTasksSummaryBy  
userId,  
String  
language)
```

```
getTasksSummaryByStatus(String  
userId,  
List<Status>  
statuses,  
String  
language)
```

```
getTasksSummaryByProcessInstanceId(long  
processIn-  
stanceId,  
List<Status>  
statuses,  
String
```

Method**signature****type****return**

language)

guage)

~~getTaskSummary~~ InstanceId(long

processIn-

stanceId)

~~ListTaskSummary~~ fields(List<Long>

workItemIds,

List<Long>

taskIds,

List<Long>

procIn-

stIds,

List<String>

bu-

sAd-

mins,

List<String>

po-

tOwn-

ers,

List<String>

taskOwn-

ers,

List<Status>

sta-

tus,

boolean

union)

~~getTaskSummary~~ Fields(Map

<String,

List<?

>>

pa-

ra-

me-

ters,

boolean

union)

Method	Signature	Type	Return
<code>getContentById</code>	<code>(long contentId)</code>		
<code>getAttachmentById</code>	<code>(long attachmentId)</code>		

Table 17.6. Available `AuditService` methods

Method	Signature	Type	Return
<code>find</code>	<code><ProcessInstanceLog> find(ProcessInstances)</code>		
<code>find</code>	<code><ProcessInstanceLog> find(String processId)</code>		
<code>find</code>	<code><ProcessInstanceLog> find(String processId)</code>		
<code>find</code>	<code>ProcessInstance find(long processInstanceId)</code>		
<code>find</code>	<code>ProcessInstance find(long processInstanceId)</code>		
<code>find</code>	<code>ProcessInstance find(long processInstanceId, String nodeId)</code>		
<code>find</code>	<code>ProcessInstance find(long processInstanceId)</code>		

Method**Signature****Type****Return**

```

FindVariablesInstancesLogg
processIn-
stanceId,
String
vari-
ableId)

FindVariablesByInstanceName(String
vari-
ableId,
boolean
only-
Ac-
tive-
Process-
es)

FindVariablesByInstanceNameAndValue(String
vari-
ableId,
String
val-
ue,
boolean
only-
Ac-
tive-
Process-
es)

void()

```

17.2. REST

REST API calls to the execution server allow you to remotely manage processes and tasks and retrieve various dynamic information from the execution server. The majority of the calls are synchronous, which means that the call will only finish once the requested operation has completed on the server. The exceptions to this are the deployment `POST` calls, which will return the status of the request while the actual operation requested will asynchronously execute.

When using Java code to interface with the REST API, the classes used in `POST` operations or otherwise returned by various operations can be found in the `(org.kie.remote:kie-services-client)` JAR.

17.2.1. REST permissions

As of the community 6.2.0.Final release, users now need to be assigned one of the following roles in order to be able to access REST URLs:

Table 17.7. REST permission roles

Role	Description
rest-all	May use all REST URLs
rest-project-management	May use REST URLs relating to project management, including repository and organizational unit management
rest-deployment	May use REST URLs relating to deployment management
rest-process	May use REST URLs relating to process management
rest-process-read-only	May use REST URLs that return info about processes
rest-task	May use REST URLs relating to task management
rest-task-read-only	May use REST URLs that return info about tasks
rest-query	May use the query REST URLs
rest-client	May use the REST URL relating to the java remote client

Specifically, the roles give the user access to the following URLs:

Table 17.8. REST permission roles

Role	Description
rest-all	All REST URLs
rest-project	Only the following URLs are available with this role:

Role	Description
	<ul style="list-style-type: none"> • [GET] .../rest/jobs/{jobsId} • [DELETE] .../rest/jobs/{jobsId} • [GET] .../rest/repositories • [GET] .../rest/repositories/{repoName} • [POST] .../rest/repositories • [DELETE] .../rest/repositories/{repoName} • [POST] .../rest/repositories/{repoName}/projects • [GET] .../rest/repositories/{repoName}/projects • [DELETE] .../rest/repositories/{repoName}/projects/{projectName} • [POST] .../rest/repositories/{repoName}/projects/{projectName}/maven/compile • [POST] .../rest/repositories/{repoName}/projects/{projectName}/maven/test • [POST] .../rest/repositories/{repoName}/projects/{projectName}/maven/install • [POST] .../rest/repositories/{repoName}/projects/{projectName}/maven/deploy • [POST] .../rest/organizationalunits • [GET] .../rest/organizationalunits/{orgUnitName} • [POST] .../rest/organizationalunits/{orgUnitName} • [DELETE] .../rest/organizationalunits/{orgUnitName} • [POST] .../rest/organizationalunits/{orgUnitName}/repositories/{repoName} • [DELETE] .../rest/organizationalunits/{orgUnitName}/repositories/{repoName}
rest-deployment	<p>Only the following URLs are available with this role:</p> <ul style="list-style-type: none"> • [GET] .../rest/deployment/

Role	Description
	<ul style="list-style-type: none"> • [GET] .../rest/deployment/processes • [GET] .../rest/deployment/{deploymentId} • [POST] .../rest/deployment/{deploymentId}/deploy • [POST] .../rest/deployment/{deploymentId}/undeploy • [POST] .../rest/deployment/{deploymentId}/activate • [POST] .../rest/deployment/{deploymentId}/deactivate • [GET] .../rest/deployment/{deploymentId}/processes
rest-process	<p>In short, only URLs that start with one of the following are available with this role:</p> <div style="background-color: #f0f0f0; padding: 5px; margin: 10px 0;"> <pre>.../rest/runtime/deployment/{deploymentId}/* .../rest/history/*</pre> </div> <p>Only the following URLs are available with this role:</p> <ul style="list-style-type: none"> • [GET] .../rest/runtime/deployment/{deploymentId}/process/{procDefId} • [POST] .../rest/runtime/deployment/{deploymentId}/process/{procDefId}/start • [GET] .../rest/runtime/deployment/{deploymentId}/process/{procDefId}/startform • [GET] .../rest/runtime/deployment/{deploymentId}/process/instance/{procInstId} • [POST] .../rest/runtime/deployment/{deploymentId}/process/instance/{procInstId}/abort • [POST] .../rest/runtime/deployment/{deploymentId}/process/instance/{procInstId}/signal • [GET] .../rest/runtime/deployment/{deploymentId}/process/instance/{procInstId}/variable/{varName}

Role	Description
	<ul style="list-style-type: none"> • [POST] .../rest/runtime/deployment/{deploymentId}/signal • [GET] .../rest/runtime/deployment/{deploymentId}/workitem/{workItemId} • [POST] .../rest/runtime/deployment/{deploymentId}/workitem/{workItemId}/complete • [POST] .../rest/runtime/deployment/{deploymentId}/workitem/{workItemId}/abort • [POST] .../rest/runtime/deployment/{deploymentId}/withvars/process/{procDefId}/start • [GET] .../rest/runtime/deployment/{deploymentId}/withvars/process/instance/{procInstId} • [POST] .../rest/runtime/deployment/{deploymentId}/withvars/process/instance/{procInstId}/signal • [GET] .../rest/history/instances • [GET] .../rest/history/instance/{procInstId} • [GET] .../rest/history/instance/{procInstId}/child • [GET] .../rest/history/instance/{procInstId}/node • [GET] .../rest/history/instance/{procInstId}/variable • [GET] .../rest/history/instance/{procInstId}/node/{nodeId} • [GET] .../rest/history/instance/{procInstId}/variable/{varId} • [GET] .../rest/history/process/{procDefId} • [GET] .../rest/history/variable/{varId} • [GET] .../rest/history/variable/{varId}/value/{value} • [GET] .../rest/history/variable/{varId}/instances

Role	Description
	<ul style="list-style-type: none"> • [GET] .../rest/history/variable/{varId}/value/{value}/instances • [POST] .../rest/history/clear
rest-process-read-only	<p>In short, all GET URLs that start with one of the following are available with this role:</p> <pre>.../rest/runtime/deployment/{deploymentId}/* .../rest/history/*</pre> <p>Only the following URLs are available with this role:</p> <ul style="list-style-type: none"> • [GET] .../rest/runtime/deployment/{deploymentId}/process/{procDefId} • [GET] .../rest/runtime/deployment/{deploymentId}/process/{procDefId}/startform • [GET] .../rest/runtime/deployment/{deploymentId}/process/instance/{procInstId} • [GET] .../rest/runtime/deployment/{deploymentId}/process/instance/{procInstId}/variable/{varName} • [GET] .../rest/runtime/deployment/{deploymentId}/workitem/{workItemId} • [GET] .../rest/runtime/deployment/{deploymentId}/withvars/process/instance/{procInstId} • [GET] .../rest/history/instances • [GET] .../rest/history/instance/{procInstId} • [GET] .../rest/history/instance/{procInstId}/child • [GET] .../rest/history/instance/{procInstId}/node • [GET] .../rest/history/instance/{procInstId}/variable • [GET] .../rest/history/instance/{procInstId}/node/{nodeId}

Role	Description
	<ul style="list-style-type: none"> • [GET] .../rest/history/instance/{procInstId}/variable/{varId} • [GET] .../rest/history/process/{procDefId} • [GET] .../rest/history/variable/{varId} • [GET] .../rest/history/variable/{varId}/value/{value} • [GET] .../rest/history/variable/{varId}/instances • [GET] .../rest/history/variable/{varId}/value/{value}/instances • [POST] .../rest/history/clear
rest-task	<p>In short, all URLs that start with the following are available with this role:</p> <div style="background-color: #f0f0f0; padding: 5px; margin: 10px 0;"> <pre>.../rest/task/*</pre> </div> <p>Only the following URLs are available with this role:</p> <ul style="list-style-type: none"> • [GET] .../rest/task/{taskId} • [POST] .../rest/task/{taskId}/activate • [POST] .../rest/task/{taskId}/claim • [POST] .../rest/task/{taskId}/claimnextavailable • [POST] .../rest/task/{taskId}/complete • [POST] .../rest/task/{taskId}/delegate • [POST] .../rest/task/{taskId}/exit • [POST] .../rest/task/{taskId}/fail • [POST] .../rest/task/{taskId}/forward • [POST] .../rest/task/{taskId}/release • [POST] .../rest/task/{taskId}/resume • [POST] .../rest/task/{taskId}/skip

Role	Description
	<ul style="list-style-type: none"> • [POST] .../rest/task/{taskId}/start • [POST] .../rest/task/{taskId}/stop • [POST] .../rest/task/{taskId}/suspend • [POST] .../rest/task/{taskId}/nominate • [GET] .../rest/task/{taskId}/showTaskForm • [GET] .../rest/task/{taskId}/content • [GET] .../rest/task/content/{contentId} • [POST] .../rest/task/history/bam/clear
rest-task-read-only	<p>In short, all GET URLs that start with one of the following are available with this role:</p> <div style="background-color: #f0f0f0; padding: 5px; margin: 10px 0;"> <p>.../rest/task/*</p> </div> <p>Only the following URLs are available with this role:</p> <ul style="list-style-type: none"> • [GET] .../rest/task/{taskId} • [GET] .../rest/task/{taskId}/showTaskForm • [GET] .../rest/task/{taskId}/content • [GET] .../rest/task/content/{contentId}
rest-query	<p>Only the following URLs are available with this role:</p> <ul style="list-style-type: none"> • [GET] .../rest/task/query (deprecated) • [GET] .../rest/query/runtime/process • [GET] .../rest/query/runtime/task • [GET] .../rest/query/task
rest-client	<p>Only the following URLs are available with this role:</p> <ul style="list-style-type: none"> • [POST] .../rest/execute

Role	Description
	This URL is used by the Java remote API to communicate with the server. Use of this URL without the Java remote API code is not recommended!

17.2.2. Runtime calls

This section lists REST calls that interface process instances.

The *deploymentId* component of the REST calls below must conform to the following regular expression:

```
[\\w\\.\\.-]+(:[\\w\\.\\.-]+){2,2}(:[\\w\\.\\.-]*){0,2}
```

For more information about the composition of the deployment id, see the Deployment Calls section.

17.2.2.1. Process calls

[POST] `/runtime/{deploymentId}/process/{processDefId}/start`

- Starts a process.
- Returns a `JaxbProcessInstanceResponse` instance, that contains basic information about the process instance.
- Notes:
 - The *processDefId* component of the URL must conform to the following regex: `[_a-zA-Z0-9-:\\.]+`
- Parameters:
 - This operation takes *map query parameters* (see below), which will be used as parameters for the process instance.
 - You can only pass basic types (as map query parameters) using this URL. If you want to pass complex and/or custom classes, you should use the Java Remote API instead.

[GET] `rest/runtime/{deploymentId}/process/{processDefId}/startform`

- Checks that exists the process identified by *processDefId* on the given deployment and generates an URL to show the start form on a remote application.
- Returns a `JaxbProcessInstanceFormResponse` instance, that contains the URL to the start process form.
- Notes:

- The *processDefId* component of the URL must conform to the following regex: `[_a-zA-Z0-9-:\.]+`

[GET] `/runtime/{deploymentId}/process/instance/{procInstId}`

- Does a (read only) retrieval of the process instance. This operation will fail (code 400) if the process instance has been completed.
- Returns a `JaxbProcessInstanceResponse` instance.
- Notes:
 - The *procInstId* component of the URL must conform to the following regex: `[0-9]+`

[POST] `/runtime/{deploymentId}/process/instance/{procInstId+}/abort`

- Aborts the process instance.
- Returns a `JaxbGenericResponse` indicating whether or not the operation has succeeded.
- Notes:
 - The *procInstId* component of the URL must conform to the following regex: `[0-9]+`

[POST] `/runtime/{deploymentId}/process/instance/{procInstId}/signal`

- Signals the process instance.
- Returns a `JaxbGenericResponse` indicating whether or not the operation has succeeded.
- Notes:
 - The *procInstId* component of the URL must conform to the following regex: `[0-9]+`
- Parameters: This operation takes a `signal` and a `event` query parameter.
 - The `signal` parameter value is used as the name of the signal. This parameter is required.
 - The `event` parameter value is used as the value of the event. This value may use the *number query parameter* syntax described above.

[GET] `/runtime/{deploymentId}/process/instance/{procInstId}/variable/{varName}`

- Returns the value of a process variable in a process instance.
- Either the variable object instance itself is returned or, if the variable is a primitive, the variable value wrapped in simple class which is returned.
- Notes:

- The *proclnstd* component of the URL must conform to the following regex: `[0-9]+`

[POST] `/runtime/{deploymentId}/signal`

- Signals the `KieSession`
- Returns a `JaxbGenericResponse` indicating whether or not the operation has succeeded.
- Notes:
 - The *proclnstd* component of the URL must conform to the following regex: `[0-9]+`
- Parameters: This operation takes a `signal` and a `event` query parameter.
 - The `signal` parameter value is used as the name of the signal. This parameter is required.
 - The `event` parameter value is used as the value of the event. This value may use the *number query parameter* syntax described above.

[GET] `/runtime/{deploymentId}/workitem/{workItemId}`

- Gets a `WorkItem` instance
- Returns a `JaxbWorkItem` instance
- Notes:
 - The *workItemId* component of the URL must conform to the following regex: `[0-9]+`

[POST] `/runtime/{deploymentId}/workitem/{workItemId}/complete`

- Completes a `WorkItem`
- Returns a `JaxbGenericResponse` indicating whether or not the operation has succeeded
- Notes:
 - The *workItemId* component of the URL must conform to the following regex: `[0-9]+`
- Parameters:
 - This operation takes *map query parameters*, which are used as input to signify the results for completion of the work item.
 - You can only pass basic types (as map query parameters) using this URL. If you want to pass complex and/or custom classes, you should use the Java Remote API instead.

[POST] `/runtime/{deploymentId}/workitem/{workItemId: [0-9-]+}/abort`

- Aborts a `WorkItem`

- Returns a `JaxbGenericResponse` indicating whether or not the operation has succeeded
- Notes:
 - The `workItemId` component of the URL must conform to the following regex: `[0-9]+`

17.2.2.2. Process calls "with variables"

[POST] `/runtime/{deploymentId}/withvars/process/{processDefId}/start`

- Starts a process and retrieves the list of variables associated with the process instance
- Returns a `JaxbProcessInstanceWithVariablesResponse` that contains:
 - Information about the process instance (with the same fields and behaviour as the `JaxbProcessInstanceResponse`)
 - A key-value list of the variables available in the process instance.
- Notes:
 - The `processDefId` component of the URL must conform to the following regex: `[_a-zA-Z0-9-:\.]+`

[GET] `/runtime/{deploymentId}/withvars/process/instance/{procInstId}`

- Retrieves a process instances and the list of variables associated with the process instance
- Returns a `JaxbProcessInstanceWithVariablesResponse` (see the above REST call)
- Notes:
 - The `processInstId` component of the URL must conform to the following regex: `[0-9]+`

[POST] `/runtime/{deploymentId}/withvars/process/instance/{procInstId}/signal`

- Signals a process instance and retrieves the list of variables associated it
- Returns a `JaxbProcessInstanceWithVariablesResponse` (see above)
- Notes:
 - The `processInstId` component of the URL must conform to the following regex: `[0-9]+`
- Parameters:: This operation takes a `signal` and a `event` query parameter.
 - The `signal` parameter value is used as the name of the signal. This parameter is required.
 - The `event` parameter value is used as the value of the event. This value may use the *number query parameter* syntax described above.

17.2.2.3. History calls

[POST] `/history/clear`

- Cleans (deletes) all history logs

[GET] `/history/instances`

- Gets a list of `ProcessInstanceLog` instances
- Returns a `JaxbHistoryLogList` instance that contains a list of `JaxbProcessInstanceLog` instances
- Notes:
 - This operation responds to pagination parameters

[GET] `/history/instance/{procInstId}`

- Gets the `ProcessInstanceLog` instance associated with the specified process instance
- Returns a `JaxbHistoryLogList` instance that contains a `JaxbProcessInstanceLog` instance
- Notes:
 - The `processInstId` component of the URL must conform to the following regex: `[0-9]+`
- Parameters: This operation responds to pagination parameters

[GET] `/history/instance/{procInstId}/child`

- Gets a list of `ProcessInstanceLog` instances associated with any child/sub-processes associated with the specified process instance
- Returns a `JaxbHistoryLogList` instance that contains a list of `JaxbProcessInstanceLog` instances
- Notes:
 - The `processInstId` component of the URL must conform to the following regex: `[0-9]+`
- Parameters: This operation responds to pagination parameters

[GET] `/history/instance/{procInstId}/node`

- Gets a list of `NodeInstanceLog` instances associated with the specified process instance
- Returns a `JaxbHistoryLogList` instance that contains a list of `JaxbNodeInstanceLog` instances

- Notes:
 - The *processInstId* component of the URL must conform to the following regex: `[0-9]+`
- Parameters: This operation responds to pagination parameters

[GET] `/history/instance/{procInstId}/variable`

- Gets a list of `VariableInstanceLog` instances associated with the specified process instance
- Returns a `JaxbHistoryLogList` instance that contains a list of `JaxbVariableInstanceLog` instances
- Notes:
 - The *processInstId* component of the URL must conform to the following regex: `[0-9]+`
- Parameters: This operation responds to pagination parameters

[GET] `/history/instance/{procInstId}/node/{nodeId}`

- Gets a list of `NodeInstanceLog` instances associated with the specified process instance that have the given (node) id
- Returns a `JaxbHistoryLogList` instance that contains a list of `JaxbNodeInstanceLog` instances
- Notes:
 - The *processInstId* component of the URL must conform to the following regex: `[0-9]+`
 - The *nodeId* component of the URL must conform to the following regex: `[a-zA-Z0-9-:\.]+`
- Parameters: This operation responds to pagination parameters

[GET] `/history/instance/{procInstId}/variable/{varId}`

- Gets a list of `VariableInstanceLog` instances associated with the specified process instance that have the given (variable) id
- Returns a `JaxbHistoryLogList` instance that contains a list of `JaxbVariableInstanceLog` instances
- Notes:
 - The *processInstId* component of the URL must conform to the following regex: `[0-9]+`
 - The *varId* component of the URL must conform to the following regex: `[a-zA-Z0-9-:\.]+`
- Parameters: This operation responds to pagination parameters

[GET] /history/process/{processDefId}

- Gets a list of `ProcessInstanceLog` instances associated with the specified process definition
- Returns a `JaxbHistoryLogList` instance that contains a list of `JaxbProcessInstanceLog` instances
- Notes:
 - The *processDefId* component of the URL must conform to the following regex: `[_a-zA-Z0-9-:\.]+`
- Parameters: This operation responds to pagination parameters

17.2.2.4. History calls that search by variable

[GET] /history/variable/{varId}

- Gets a list of `VariableInstanceLog` instances associated with the specified variable id
- Returns a `JaxbHistoryLogList` instance that contains a list of `JaxbVariableInstanceLog` instances
- Notes:
 - The *varId* component of the URL must conform to the following regex: `[a-zA-Z0-9-:\.]+`
- Parameters: This operation responds to pagination parameters

[GET] /history/variable/{varId}/value/{value}

- Gets a list of `VariableInstanceLog` instances associated with the specified variable id that contain the value specified
- Returns a `JaxbHistoryLogList` instance that contains a list of `JaxbVariableInstanceLog` instances
- Notes:
 - Both the *varId* and *value* components of the URL must conform to the following regex: `[a-zA-Z0-9-:\.]+`
- Parameters: This operation responds to pagination parameters

[GET] /history/variable/{varId}/instances

- Gets a list of `ProcessInstance` instances that contain the variable specified by the given variable id.

- Returns a `JaxbProcessInstanceListResponse` instance that contains a list of `JaxbProcessInstanceResponse` instances
- Notes:
 - The *varId* component of the URL must conform to the following regex: `[a-zA-Z0-9-:\.]+`
- Parameters: This operation responds to pagination parameters

[GET] /history/variable/{varId}/value/{value}/instances

- Gets a list of `ProcessInstance` instances that contain the variable specified by the given variable id which contains the (variable) value specified
- Returns a `JaxbProcessInstanceListResponse` instance that contains a list of `JaxbProcessInstanceResponse` instances
- Notes:
 - Both the *varId* and *value* components of the URL must conform to the following regex: `[a-zA-Z0-9-:\.]+`
- Parameters: This operation responds to pagination parameters

17.2.2.5. History calls that search by variable

[GET] /runtime/{deploymentId}/history/variable/{varId}

- Gets a list of `VariableInstanceLog` instances associated with the specified variable id
- Returns a `JaxbHistoryLogList` instance that contains a list of `JaxbVariableInstanceLog` instances
- Notes:
 - The *varId* component of the URL must conform to the following regex: `[a-zA-Z0-9-:\.]+`
- Parameters: This operation responds to pagination parameters

[GET] /runtime/{deploymentId}/history/variable/{varId}/value/{value}

- Gets a list of `VariableInstanceLog` instances associated with the specified variable id that contain the value specified
- Returns a `JaxbHistoryLogList` instance that contains a list of `JaxbVariableInstanceLog` instances
- Notes:

- Both the *varId* and *value* components of the URL must conform to the following regex: `[a-zA-Z0-9-:\.]+`
- Parameters: This operation responds to pagination parameters

[GET] `/runtime/{deploymentId}/history/variable/{varId}/instances`

- Gets a list of `ProcessInstance` instances that contain the variable specified by the given variable id.
- Returns a `JaxbProcessInstanceListResponse` instance that contains a list of `JaxbProcessInstanceResponse` instances
- Notes:
 - The *varId* component of the URL must conform to the following regex: `[a-zA-Z0-9-:\.]+`
- Parameters: This operation responds to pagination parameters

[GET] `/runtime/{deploymentId}/history/variable/{varId}/value/{value}/instances`

- Gets a list of `ProcessInstance` instances that contain the variable specified by the given variable id which contains the (variable) value specified
- Returns a `JaxbProcessInstanceListResponse` instance that contains a list of `JaxbProcessInstanceResponse` instances
- Notes:
 - Both the *varId* and *value* components of the URL must conform to the following regex: `[a-zA-Z0-9-:\.]+`
- Parameters: This operation responds to pagination parameters

17.2.3. Task calls

The following section describes the three different types of task calls: * Task REST operations that mirror the `TaskService` interface, allowing the user to interact with the remote `TaskService` instance * The Task query REST operation, that allows users to query for `Task` instances * Other Task REST operations that retrieve information

Task operation authorizations. Task REST operations use the user information (used to authorize and authenticate the HTTP call) to check whether or not the requested operations can happen. This also applies to REST calls that retrieve information, such as the task query operation. REST calls that request information will only return information about tasks that the user is allowed to see.

With regards to retrieving information, only users associated with a task may retrieve information about the task. However, the authorizations of progress and other modifications of task information

are more complex. See the Task Permissions section in the Task Service documentation for more information.



Note

Given that many users have expressed the wish for a "super-task-user" that can execute task REST operations on all tasks, regardless of the users associated with the task, there are now plans to implement that feature. However, so far for the 6.x releases, this feature is not available.

17.2.3.1. Task operation calls

All of the task operation calls described in this section use the user (id) used in the REST basic authorization as input for the user parameter in the specific call.

Some of the operations take an optional `language` query parameter. If this parameter is not given as a element of the URL itself, the default value of "en-UK" is used.

The `taskId` component of the REST calls below must conform to the following regex:

```
[0-9]+
```

[POST] `/task/{taskId}/activate`

- Activates a task
- Returns a `JaxbGenericResponse` with the status of the operation

[POST] `/task/{taskId}/claim`

- Claims a task
- Returns a `JaxbGenericResponse` with the status of the operation

[POST] `/task/{taskId}/claimnextavailable`

- Claims the next available task
- Returns a `JaxbGenericResponse` with the status of the operation
- Parameters: Takes an optional `language` query parameter.

[POST] `/task/{taskId}/complete` - Completes a task - Returns a `JaxbGenericResponse` with the status of the operation - Parameters: Takes map query parameters, which are the "results" input for the complete operation

[POST] `/task/{taskId}/delegate`

- Delegates a task
- Returns a `JaxbGenericResponse` with the status of the operation
- Parameters: Requires a `targetId` query parameter, which identifies the user or group to which the task is delegated

[POST] `/task/{taskId}/exit`

- Exits a task
- Returns a `JaxbGenericResponse` with the status of the operation

[POST] `/task/{taskId}/fail`

- Fails a task
- Returns a `JaxbGenericResponse` with the status of the operation

[POST] `/task/{taskId}/forward`

- Delegates a task
- Returns a `JaxbGenericResponse` with the status of the operation
- Parameters: Requires a `targetId` query parameter, which identifies the user or group to which the task is forwarded

[POST] `/task/{taskId}/nominate`

- Nominates a task
- Returns a `JaxbGenericResponse` with the status of the operation
- Parameters: Requires at least one of either the `user` or `group` query parameter, which identify the user(s) or group(s) that are nominated for the task

[POST] `/task/{taskId}/release`

- Releases a task
- Returns a `JaxbGenericResponse` with the status of the operation

[POST] `/task/{taskId}/resume`

- Resumes a task
- Returns a `JaxbGenericResponse` with the status of the operation

[POST] `/task/{taskId}/skip`

- Skips a task
- Returns a `JaxbGenericResponse` with the status of the operation

[POST] `/task/{taskId}/start`

- Starts a task
- Returns a `JaxbGenericResponse` with the status of the operation

[POST] `/task/{taskId}/stop` - Stops a task - Returns a `JaxbGenericResponse` with the status of the operation

[POST] `/task/{taskId}/suspend`

- Suspends a task
- Returns a `JaxbGenericResponse` with the status of the operation

17.2.3.2. Task query call

[GET] `/task/query`

- The `/task/query` operation queries all non-archived tasks based on the parameters given.
- This URL has been deprecated. Please see the `/query/task` operation.

==== Other Task calls

[GET] `/task/{taskId}`

- Gets the task info from a task identified by the given task id
- Returns: a `JaxbTask` with the content of the task
- Notes:
 - The `taskId` component of the URL must conform to the following regex: `[0-9]+`
 - Will return HTTP Status 404 (not found) if the task does not exist

[GET] `/task/{taskId}/content`

- Gets the task content from a task identified by the given task id
- Returns: a `JaxbContent` with the content of the task
- Notes:
 - The `taskId` component of the URL must conform to the following regex: `[0-9]+`

[GET] `/task/content/{contentId}`

- Gets the task content from a task identified by the given content id
- Returns a `JaxbContent` with the content of the task
- Notes:
 - The `contentId` component of the URL must conform to the following regex: `[0-9]+`

[GET] `/task/{taskId}/showTaskForm`

- Checks that the task identified by `taskId` exists and generates an URL to show the task form on a remote application.
- Returns a `JaxbTaskFormResponse` instance, that contains the URL to the task form.

[POST] `/task/history/bam/clear`

- Clears (deletes) all `BAMTaskSummary` instances in the database.

17.2.4. Deployment Calls

The calls described in this section allow users to manage deployments. Deployments are in fact `KieModule` JARs which can be deployed or undeployed, either via the UI or via the REST calls described below. Configuration options, such as the runtime strategy, should be specified when deploying the deployment: the configuration of a deployment can not be changed after it has already been deployed.

The above `deploymentId` regular expression describes an expression that contains the following elements, separated from each other by a `:` character:

- The group id
- The artifact id
- The version
- The (optional) kbase id
- The (optional) ksession id

In a more formal sense, the `deploymentId` component of the REST calls below must conform to the following regex:

```
^[\\w\\.-]+(:[\\w\\.-]+){2,2}(:[\\w\\.-]*){0,2}`
```

This regular expression is explained as follows:

- The `[\w\.-]` element, which occurs 3 times in the above regex, refers to a character set that can contain the following character sets:

Table 17.9. `[\w\.-]` character sets

```
[0-9]
[Z]
[a-
z]
```

This `[\w\.-]` element occurs at least 3 times and at most 5 times, separated by a `:` character each time.

Example 17.1. Accepted deploymentId's

- `com.wonka:choco-maker:67.190`
- These example `deploymentId`'s contain the optional `kbase` and `ksession` id groups.
 - `com.wonka:choco-maker:67.190:oompaBase`
 - `com.wonka:choco-maker:67.190:oompaLoompaBase:gloopSession`

17.2.4.1. Asynchronous deployment calls

There are 2 operations that can be used to modify the status of a deployment:

- `/deployments/{deploymentId}/deploy`
- `/deployments/{deploymentId}/undeploy`

These `POST` deployment calls are both *asynchronous*, which means that the information returned by the `POST` request does not reflect the eventual final status of the operation itself.



Important

As noted above, both the `/deploy` and `/undeploy` operations are *asynchronous* REST operations. Successful requests to these URLs will return the status `202` upon the request completion. RFC 2616 defines the `202` status as meaning the following:

RFC 2616 [<https://www.ietf.org/rfc/rfc2616.txt>]: "the request has been accepted for processing, but the processing has not been completed."

This means the following:

1. While the request may have been accepted "successfully", the operation itself (deploying or undeploying the deployment unit) may actually fail.
2. Furthermore, information about deployments, such as that retrieved by calling the `GET` operations described below, are *snapshots* and the information (including the status of the deployment unit) may have changed by the time the user client receives the answer to the `GET` request.

17.2.5. Deployment call details

[GET] `/deployment/`

- Returns a list of all the available deployed instances in a `JaxbDeploymentUnitList` instance

[GET] `/deployment/processes`

- Returns a list of all the available deployed process definitions in a `JaxbProcessDefinitionList` instance

[GET] `/deployment/ {deploymentId}`

- Returns a `JaxbDeploymentUnit` instance containing the information (including the configuration) of the deployment unit.
- Notes:
 - This operation will fail when the URL uses a *deploymentId* that refers to a deployment unit that does not exist or for which the deployment has not yet been completed.
 - This operation may succeed for deployment units for which an undeploy operation request has not yet completed.

[POST] `/deployment/{deploymentId}/deploy`

- Deploys the deployment unit referenced by the *deploymentId*
- Returns a `JaxbDeploymentJobResult` instance with the status of the *request*
- Parameters: Takes a *strategy* query parameter, which
 - describes the runtime strategy used for the deployment.
 - must have one of the following (case-_in_sensitive) values:
 - `SINGLETON`

- `PER_REQUEST`
- `PER_PROCESS_INSTANCE`
- The default runtime strategy used for a deployment is `SINGLETON`.
- Notes:
 - The deploy operation is an *asynchronous* operation: the request can fail after being submitted. The status of the deployment can be retrieved using the `GET` calls described above.
 - It is possible to post a deployment descriptor (or a fragment of it) while submitting deploy request. That allows to override other deployment descriptors in the hierarchy. To do so the content type of the request must be set to `application/xml` and the request body should be a valid deployment descriptor content.

Example 17.2. Changing the audit logging mode from default JPA to JMS submit

```
<deployment-descriptor      xsi:schemaLocation="http://www.jboss.org/jbpm      deploy
ment-descriptor.xsd"
                             xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <audit-mode>JMS</audit-mode>
</deployment-descriptor>
```

- Since deployment descriptors can be merged differently, it's possible to provide the merge mode as part of deploy request by adding query parameter:
 - `mergemode` where values should be one of the following
 - `KEEP_ALL`
 - `OVERRIDE_ALL`
 - `OVERRIDE_EMPTY`
 - `MERGE_COLLECTIONS`

[POST] `/deployment/{deploymentId}/undeploy`

- Undeploys the deployment unit referenced by the `deploymentId`
- Returns a `JaxbDeploymentJobResult` instance with the status of the *request*
- Notes:
 - The undeploy operation is an *asynchronous* operation. The status of the deployment can be retrieved using the `GET` calls described above.

[POST] `/deployment/{deploymentId}/activate`

- Activates the deployment unit referenced by the `deploymentId`
- Returns a `JaxbDeploymentJobResult` instance with the status of the *request*
- Notes:
 - The undeploy operation is an *asynchronous* operation. The status of the deployment can be retrieved using the `GET` calls described above.

[POST] `/deployment/{deploymentId}/deactivate`

- Deactivates the deployment unit referenced by the `deploymentId`
- Returns a `JaxbDeploymentJobResult` instance with the status of the *request*
- Notes:
 - The undeploy operation is an *asynchronous* operation. The status of the deployment can be retrieved using the `GET` calls described above.

[GET] `/deployment/{deploymentId}/processes`

- Undeploys the deployment unit referenced by the `deploymentId`
- Returns a `JaxbDeploymentJobResult` instance with the status of the *request*
- Notes:
 - The undeploy operation is an *asynchronous* operation. The status of the deployment can be retrieved using the `GET` calls described above.

17.2.6. Execute calls

While there is a `/runtime/{id}/execute` and a `task/execute` method, both will take all types of commands. This is possible because `execute` takes a `JaxbCommandsRequest` object, which contains a list of `(org.kie.api.command.)Command` objects. The `JaxbCommandsRequest` has fields to store the proper `deploymentId` and `processInstanceId` information.

Of course, if you send a request with a command that needs this information (`deploymentId`, for example) and don't fill the `deploymentId` in, the request will fail.

17.2.6.1. Execution call details

[POST] `/execute`

- Executes a `Command`
- Returns a `JaxbCommandResponse` implementation with the result of the operation

17.2.6.2. Commands accepted

Table 17.10. Runtime commands

~~Get-~~
~~ProcessIn-~~
~~StateCom-~~
 mand
~~Set-~~
~~ProcessIn-~~
~~StateCom-~~
~~mand~~
~~Get-~~
~~ProcessId-~~
~~StateCom-~~
~~mand~~
~~Set-~~
~~ProcessIn-~~
~~StateCom-~~
~~mand~~
~~Get-~~
~~ProcessId-~~
~~StateCom-~~
~~mand~~
~~Get-~~
~~ProcessIn-~~
~~StateCom-~~
~~mand~~

re-
la-
tion-
K-
ey-
Command

Table 17.11. Task commands

~~Exit-~~
~~TaskOwned-~~
~~Command~~
~~TaskCom-~~
~~mand~~
~~Admin-~~
~~TaskCom-~~
~~TaskCom-~~
~~TaskCom-~~
~~mand~~
~~ContextSub-~~
~~TaskCom-~~
~~TimeCom-~~
~~Command~~
~~mand~~
~~Claim-~~
~~Base-~~
~~TaskCom-~~
~~Command~~
~~TaskCom-~~
~~mand~~
~~Claim-~~
~~TaskTaskCom-~~
~~mandAs-~~
Busi-
nes-
sAd-
min-
Com-
mand
~~Claim-~~
~~TaskCom-~~
~~TaskAsPo-~~
teand

tialOwn-
 er-
 Com-
 mand
Start-
TaskBy-
ItemId-
Com-
mand
Step-
TaskCom-
mand
Set-
Tasks-
ByAccessIn-
trude-
Com-
mand

Table 17.12. History/Audit commands

Clear His-
torinessCom-
mand
Find-
AccessIn-
trudeCom-
mand
Find-
ProcessIn-
stancesCom-
mand
Find-
ProcessIn-
stancesCom-
mand

17.2.6.3. Basic example

The following `/rest/execute` call can be used to start a process (with process id 'evaluation' in the project with deployment id 'org.jbpm:Evaluation:1.0') and two parameters (parameter `employee` equal to 'krisv' and `reason` equal to 'Yearly performance evaluation').

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<command-request>
  <deployment-id>org.jbpm:Evaluation:1.0</deployment-id>
  <ver>6.2.0.1</ver>
  <user>krisv</user>
  <start-process processId="evaluation">
    <parameter>
      <item key="reason">
        <value xsi:type="xs:string" xmlns:xs="http://www.w3.org/2001/XMLSchema"
          xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">Yearly performance evaluation</
value>
      </item>
      <item key="employee">
        <value xsi:type="xs:string" xmlns:xs="http://www.w3.org/2001/XMLSchema"
          xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">krisv</value>
      </item>
    </parameter>
  </start-process>
</command-request>
```

Note that the request should also contain the following HTTP headers:

- A Content-Type [<http://www.w3.org/Protocols/rfc2616/rfc2616-sec14.html#sec14.17>] header with the value of `application/xml`
- A Authorization [<http://www.w3.org/Protocols/rfc2616/rfc2616-sec14.html#sec14.8>] header with basic authentication information, as specified by RFC2616 (see link).

The response will contain information about the process instance that was just started:

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<command-response>
  <deployment-id>org.jbpm:Evaluation:1.0</deployment-id>
  <ver>6.2.0.1</ver>
  <process-instance index="0">
    <process-id>evaluation</process-id>
    <id>15</id>
    <state>1</state>
    <parentProcessInstanceId>0</parentProcessInstanceId>
    <command-name>StartProcessCommand</command-name>
  </process-instance>
</command-response>
```

17.2.6.4. More Complex Example with a Custom Data Type

The `/execute` operation also supports sending user-defined class instances as parameters in the command. This relies on JAXB for serialization and deserialization. To be able to deserialize the custom class on the server side, a "Kie-Deployment-Id" header must also be set to the deployment id of the project.

For example, when starting a process or completing a task, a user typically passes additional parameters (process variable values or the result data for the completed task). These values are then either primitives (Strings, ints, etc.) or user-defined classes that were created using the data modeler in the workbench, added directly to the deployed project or part of a dependency to the deployment (project).

The following request starts a process which contains a custom `TestObject` class (with two fields) as a parameter.

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<command-request>
  <deployment-id>demo:testproject:1.0</deployment-id>
  <ver>6.2.0.1</ver>
  <user>krisv</user>
  <start-process processId="testproject.testprocess">
    <parameter>
      <item key="testobject">
        <value xsi:type="testObject" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
          <field1>1</field1>
          <field2>2</field2>
        </value>
      </item>
    </parameter>
  </start-process>
</command-request>
```

Just as in the basic example above, both a `Content-Type` and `Authorization` header should be set in the request.

The 3 headers that therefore need to be set in the request are the following:

- A `Content-Type` [<http://www.w3.org/Protocols/rfc2616/rfc2616-sec14.html#sec14.17>] header with the value of `application/xml`
- A `Authorization` [<http://www.w3.org/Protocols/rfc2616/rfc2616-sec14.html#sec14.8>] header with basic authentication information, as specified by RFC2616 (see link).
- A `Kie-Deployment-Id` [<https://github.com/droolsjbpm/droolsjbpm-integration/blob/6.2.x/kie-remote/kie-remote-jaxb/src/main/java/org/kie/services/client/serialization/JaxbSerializationProvider.java#L73>] header with the value of the deployment id containing the class definitions of any parameters sent with the command .

17.2.7. REST summary

The URL templates in the table below are relative to the one of the following URLs:

- `http://server:port/business-central/rest`
- `http://server:port/kie-wb/rest`

17.2.7.1. Runtime REST calls

[GET] `/runtime/{deploymentId}/process/{procDefID}`

- returns basic information about the process definition, including process variable information

[POST] `/runtime/{deploymentId}/process/{procDefID}/start`

- start a process instance based on the Process definition (accepts query map parameters)

[GET] `/runtime/{deploymentId}/process/{procDefID}/startform`

- returns a valid URL to the start process form to be shown on a client application.

[GET] `/runtime/{deploymentId}/process/instance/{procInstanceID}`

- return a process instance details

[POST] `/runtime/{deploymentId}/process/instance/{procInstanceID}/abort`

- abort the process instance

[POST] `/runtime/{deploymentId}/process/instance/{procInstanceID}/signal`

- send a signal event to process instance (accepts query map parameters)

[GET] `/runtime/{deploymentId}/process/instance/{procInstanceID}/variable/{varId}`

- return a variable from a process instance

[POST] `/runtime/{deploymentId}/signal/`

- send a signal event to deployment

[GET] `/runtime/{deploymentId}/workitem/{workItemID}`

- complete a work item (accepts query map parameters)

[POST] `/runtime/{deploymentId}/workitem/{workItemID}/complete`

- complete a work item (accepts query map parameters)

[POST] `/runtime/{deploymentId}/workitem/{workItemID}/abort`

- abort a work item

[POST] `/runtime/{deploymentId}/withvars/process/{procDefinitionID}/start`

- start a process instance and return the process instance with its variables

[GET] `/runtime/{deploymentId}/withvars/process/instance/{procInstanceID}/`

- return a process instance with its variables

[POST] `/runtime/{deploymentId}/withvars/process/instance/{procInstanceID}/signal`

- send a signal event to the process instance (accepts query map parameters)

The following query parameters are accepted:

- The `signal` parameter specifies the name of the signal to be sent — The `event` parameter specifies the (optional) value of the signal to be sent

17.2.7.2. Task REST calls

[GET] `/task/query`

- return a TaskSummary list

[GET] /task/content/{contentID}

- returns the content of a task

[GET] /task/{taskID}

- return the task

[POST] /task/{taskID}/activate

- activate the task

[POST] /task/{taskID}/claim

- claim the task

[POST] /task/{taskID}/claimnextavailable

- claim the next available task

[POST] /task/{taskID}/complete

- complete the task (accepts query map paramaters)

[POST] /task/{taskID}/delegate

- delegate the task

[POST] /task/{taskID}/exit

- exit the task

[POST] /task/{taskID}/fail

- fail the task

[POST] /task/{taskID}/forward

- forward the task

[POST] /task/{taskID}/nominate

- nominate the task

[POST] /task/{taskID}/release

- release the task

[POST] /task/{taskID}/resume

- resume the task (after suspending)

[POST] /task/{taskID}/skip

- skip the task

[POST] /task/{taskID}/start

- start the task

[POST] /task/{taskID}/stop

- stop the task

[POST] /task/{taskID}/suspend

- suspend the task

[GET] /task/{taskID}/content

- returns the content of a task

[GET] /task/{taskID}/showTaskForm

- returns a valid URL to the task form to be shown on a client application.

17.2.7.3. History REST calls

[POST] `/history/clear/`

- delete all process, node and history records

[GET] `/history/instances`

- return the list of all process instance history records

[GET] `/history/instance/{procInstId}`

- return a list of process instance history records for a process instance

[GET] `/history/instance/{procInstId}/child`

- return a list of process instance history records for the subprocesses of the process instance

[GET] `/history/instance/{procInstId}/node`

- return a list of node history records for a process instance

[GET] `/history/instance/{procInstId}/node/{nodeId}`

- return a list of node history records for a node in a process instance

[GET] `/history/instance/{procInstId}/variable`

- return a list of variable history records for a process instance

[GET] `/history/instance/{procInstId}/variable/{variableId}`

- return a list of variable history records for a variable in a process instance

[GET] `/history/process/{procDefId}`

- return a list of process instance history records for process instances using a given process definition

[GET] `/history/variable/{varId}`

- return a list of variable history records for a variable

[GET] `/history/variable/{varId}/instances`

- return a list of process instance history records for process instances that contain a variable with the given variable id

[GET] `/history/variable/{varId}/value/{value}`

- return a list of variable history records for variable(s) with the given variable id and given value

[GET] `/history/variable/{varId}/value/{value}/instances`

- return a list of process instance history records for process instances with the specified variable that contains the specified variable value

17.2.7.4. Deployment REST calls

[GET] `/deployments`

- return a list of (deployed) deployments

[GET] `/deployment/{deploymentId}`

- return the status and information about the deployment

[POST] `/deployment/{deploymentId}/deploy`

- submit a request to deploy a deployment

[POST] `/deployment/{deploymentId}/undeploy`

- submit a request to undeploy a deployment

17.3. REST Query API

The REST Query API allows users of the jBPM console and the KIE workbench (as well as products based on these applications) to "richly" query tasks, variables and process instances.

17.3.1. Query URL layout

The rich query operations can be reached via the following URLs:

```
http://server.address:port/{application-id}/rest/query/
  task                * [GET] rich query operation for task summaries
runtime
  process             * [GET] rich query operation for process
instances and process variables
  task                * [GET] rich query operation for task summaries
and process variables
```

Both url's take a number of different query parameters. See the next section for a description of these.

The following is a summary of the query operations:

17.3.1.1. [POST] /query/runtime/process

- Queries the process instances and process variables
- Returns a `JaxbQueryProcessInstanceResult` containing the results of the query
- Takes the URL query parameters described in the Query parameters table below

17.3.1.2. [POST] /query/runtime/task

- Queries the tasks and process variables
- Returns a `JaxbQueryTaskResult` containing the results of the query
- Takes the URL query parameters described in the Query parameters table below

17.3.1.3. [POST] /query/task

- Queries all non-archived tasks based on the parameters given.
- Returns a `JaxbTaskSummaryListResponse` with a list of `TaskSummary` instances
- Parameters:
 - Takes the following (case-'in' sensitive) query parameters listed below.

- All parameters except for the `union` parameter may be repeated.

`businessAdministrator`

Returned tasks should have a business administrator identified by this parameter

`potentialOwner`

Returned tasks should have a potential owner identified by this parameter

`processInstanceId`

Returned tasks should be associated with the process instance identified by this parameter

`status`

Returned tasks should have a status identified by this parameter

`taskId`

Returned tasks should have the (task) id identified by this parameter

`taskOwner`

Returned tasks should have a task owner (initiator) identified by this parameter

`workItemId`

Returned tasks should be associated with the work item identified by this parameter

`language`

Specifies the language that the returned tasks should be associated with

`union`

This specifies whether the query should query the union or intersection of the parameters. See below for an example and more info. This parameter may only be passed *once*

Example 17.3. `/query/task` usage

The following `/query/task` operation retrieves the task summaries of all tasks that have a work item id of 3, 4, or 5. If you specify the *same* parameter multiple times, the query will select tasks that match *any* of that parameter.

```
http://server:port/rest/task/query?workItemId=3&workItemId=4&workItemId=5
```

The next call will retrieve any task summaries for which the task id is 27 *and* for which the work item id is 11. Specifying *different* parameters will result in a set of tasks that match *both* (*all*) parameters.

```
`http://server:port/rest/task/query?workItemId=11&taskId=27`
```

The next call will retrieve any task summaries for which the task id is 27 *or* the work item id is 11. While these are different parameters, the `union` parameter is being used here so that the union of the two queries (the work item id query and the task id query) is returned.

```
http://server:port/rest/task/query?workItemId=11&taskId=27&union=true`
```

The next call will retrieve any task summaries for which the status is `Created` *and* the potential owner of the task is `Bob`. Note that the letter case for the status parameter value is case-insensitive.

```
http://server:port/rest/task/query?status=creAted&potentialOwner=Bob`
```

The next call will return any task summaries for which the status is `Created` *and* the potential owner of the task is `bob`. Note that the potential owner parameter is case-sensitive. `bob` is not the same user id as `Bob`!

```
http://server:port/rest/task/query?status=created&potentialOwner=bob`
```

The next call will return the *intersection* of the set of task summaries for which the process instance is 201, the potential owner is `bob` and for which the status is `Created` *or* `Ready`.

```
http://server:port/rest/task/query?
status=created&status=ready&potentialOwner=bob&processInstanceId=201
```

That means that the task summaries that have the following characteristics would be included:

- process instance id 201, potential owner `bob`, status `Ready`
- process instance id 201, potential owner `bob`, status `Created`

And that following task summaries will *not* be included:

- process instance id 183, potential owner `bob`, status `Created`
- process instance id 201, potential owner `"mary"`, status `Ready`
- process instance id 201, potential owner `bob`, status `"Complete"`

17.3.2. Query Parameters

In the documentation below,

- "query parameters" are strings like `processInstanceId`, `taskId` and `tid`. The case (lowercase or uppercase) of these parameters does not matter, except when the query parameter also specifies the name of a user-defined variable.
- "parameters" are the values that are passed with some query parameters. These are values like `org.process.frombulator, 29` and `harry`.

When you submit a REST call to the query operation, your URL will look something like this:

```
http://localhost:8080/business-central/rest/query/runtime/process/  
processId=org.process.frombulator&piid=29
```

A query containing multiple different query parameters will search for the intersection of the given parameters.

However, many of the query parameters described below can be entered multiple times: when multiple values are given for the same query parameter, the query will then search for any results that match one or more of the values entered.

Example 17.4. Repeated query parameters

The following process instance query:

```
processId=org.example.process&processInstanceId=27&processInstanceId=29
```

will return a result that

- only contains information about process instances with the "org.example.process" process definition
- only contains information about process instances that have an id of 27 *or* 29

17.3.2.1. Range and Regular Expression parameters

Some query criteria can be given in ranges while for others, a simple regular expression language can be used to describe the value.

Query parameters that

- can be given in ranges have an "X" in the **min/max** column in the table below.
- use regular expressions have an "X" in the **regex** column below.

17.3.2.2. Range query parameters

In order to pass the lower end or start of a range, add `_min` to end of the parameter name. In order to pass the upper end or end of a range, add `_max` to end of the parameter name.

Range ends are inclusive.

Only passing one end of the range (the lower **or** upper end), results in querying on an open ended range.

Example 17.5. Range parameters

A task query with the following parameters:

```
processId=org.example.process&taskId_min=50&taskId_max=53
```

will return a result that

- only contains information about tasks associated with the "org.example.process" process definition
- only contains information about tasks that have a task id between 50 and 53, inclusive.

While a task query with the following parameters:

```
processId=org.example.process&taskId_min=52
```

will return a result that

- only contains information about tasks associated with the "org.example.process" process definition
- only contains information about tasks that have a task id that is *larger than or equal* to 52

17.3.2.3. Regular expression query parameters

In order to apply regular expressions to a query parameter, add “_re” to the end of the parameter name.

The regular expression language contains 2 special characters:

- * means 0 or more characters
- . means 1 character

The slash character (\) is not interpreted.

Example 17.6. Regular expression parameters

The following process instance query

```
processId_re=org.example.*&processVersion=2.0
```

will return a result that

- only contains information about process instances associated with a process definition whose name matches the regular expression "org.example.*". This includes:
 - org.example.process
 - org.example.process.definition.example.long.name

- orgXexampleX
- only contains information about process instances that have a process (definition) version of 2.0

17.3.3. Parameter Table

The "task or process" column describes whether or not a query parameter can be used with the task and/or the process instance query operations.

Table 17.13. Query parameters

Parameter	Task or Process
processinstanceid	Process instance
processinstancesid	Process instance
deploymentid	Deployment
taskid	Task
taskinitiator/creator	Task
taskstakeholder	Task
taskpotentialowner	Task

~~High~~
~~comp-~~
~~process~~
~~ter~~

~~Task~~own-
~~own-~~
~~er~~

~~Task-~~
~~busi-~~
~~ness~~
~~adm~~
~~in~~

~~Task~~sta-
~~sta-~~
~~tus~~

~~Process~~
~~in-~~essin-
~~stance~~es-
~~sta-~~
~~tus~~

~~Process~~ver-
~~ver-~~
~~sion~~

~~Process~~
~~in-~~te
~~stance~~
~~start~~
~~date~~¹

~~Process~~
~~in-~~te
~~stance~~
~~end~~
~~date~~¹

~~Valid~~
~~able~~
~~id~~

~~Var-~~
~~able~~
~~val-~~
~~ue~~

**Single
process
parameter**

Variable
id
and
value
2

Variable
id
and
value
3

Which
variable
history
logs
4

[1] The date operations take strings with a specific date format as their values: `YY-MM-dd_HH:mm:ss.SSS`. However, users can also submit only part of the date:

- Submitting only the date (`YY-MM-dd`) means that a time of 00:00:00 is used (the beginning of the day).
- Submitting only the time (`HH:mm:ss`) means that the current date is used.

Table 17.14. Example date strings

Date string	Actual meaning
15-05-29_13:40:12.288	May 29th, 2015, 13:40:12.288 (1:40:12.288 PM)
14-11-20	November 20th, 2014, 00:00:00.000
9:30:00	Today, 9:30:00 (AM)

For the format used, see the SimpleDateFormat documentation [<http://docs.oracle.com/javase/6/docs/api/java/text/SimpleDateFormat.html>].

[2] The `var` query parameter is used differently than other parameters. If you want to specify **both** the variable id and value of a variable (as opposed to just the variable id), then you can do it by using the `var` query parameter. The syntax is `var_<variable-id>=<variable-value>`

Example 17.7. `var_X=Y` example

The query parameter and parameter pair `var_myVar=value3` queries for process instances with variables⁴ that are called `myVar` and that have the value `value3`

[3] The `varregex` (or shortened version `vr`) parameter works similarly to the `var` query parameter. However, the value part of the query parameter can be a regular expression.

[4] By default, only the information from most recent (last) variable instance logs is retrieved. However, users can also retrieve all variable instance logs (that match the given criteria) by using this parameter.

17.3.4. Parameter examples

Table 17.15. Query parameters examples

```

short
form
pie-
ter

pie-
ids&in-
stan-
ceid

processid=com.acme.example
ces-
sid

ded_re=com.willy.loompa.*
ploy-
men-
tid

task-
id=4

init_re=Davi*
tia-
tor

stheBoss&stho=theBossesAssistant
hold-
er

potentialowner=sara
ten-

```

```

short
form
ple-
ter
tialown-
er
taskowner_re=*anderson
er
basadmin
nes-
sad-
min
taskReserved
tus
pist=3&pist=4
cessin-
stances-
ta-
tus
processVersion_re=4.2*
sion
start_min=00:00:00
date
edd_max=15-01-01
date
valid=numCars
varabracadabra
val-
ue
var_numCars=10
var_nameCar=chitty*
regex
all

```

17.3.5. Query Output Format

The process instance query returns a `JaxbQueryProcessInstanceResult` [<https://github.com/droolsjbpm/droolsjbpm-integration/blob/6.2.x/kie-remote/kie-remote-jaxb/src/main/java/org/kie/services/client/serialization/jaxb/impl/query/JaxbQueryProcessInstanceResult.java>] instance.

The task query returns a `JaxbQueryTaskResult` [<https://github.com/droolsjbpm/droolsjbpm-integration/blob/6.2.x/kie-remote/kie-remote-jaxb/src/main/java/org/kie/services/client/serialization/jaxb/impl/query/JaxbQueryTaskResult.java>] instance.

Results are structured as follows:

- a list of process instance info (`JaxbQueryProcessInstanceInfo` [<https://github.com/droolsjbpm/droolsjbpm-integration/blob/6.2.x/kie-remote/kie-remote-jaxb/src/main/java/org/kie/services/client/serialization/jaxb/impl/query/JaxbQueryProcessInstanceInfo.java>]) objects
- or a list of task instance info (`JaxbQueryTaskInfo` [<https://github.com/droolsjbpm/droolsjbpm-integration/blob/6.2.x/kie-remote/kie-remote-jaxb/src/main/java/org/kie/services/client/serialization/jaxb/impl/query/JaxbQueryTaskInfo.java>]) objects

A `JaxbQueryProcessInstanceInfo` [<https://github.com/droolsjbpm/droolsjbpm-integration/blob/6.2.x/kie-remote/kie-remote-jaxb/src/main/java/org/kie/services/client/serialization/jaxb/impl/query/JaxbQueryProcessInstanceInfo.java>] object contains:

- a process instance object
- a list of 0 or more variable objects

A `JaxbQueryTaskInfo` [<https://github.com/droolsjbpm/droolsjbpm-integration/blob/6.2.x/kie-remote/kie-remote-jaxb/src/main/java/org/kie/services/client/serialization/jaxb/impl/query/JaxbQueryTaskInfo.java>] info object contains:

- the process instance id
- a list of 0 or more task summary objects
- a list of 0 or more variable objects

17.4. JMS

The Java Message Service (JMS) is an API that allows Java Enterprise components to communicate with each other asynchronously and reliably.

Operations on the runtime engine and tasks can be done via the JMS API exposed by the jBPM console and KIE workbench. However, it's not possible to manage deployments or the knowledge base via this JMS API.

Unlike the REST API, it is possible to send a batch of commands to the JMS API that will all be processed in one request after which the responses to the commands will be collected and return in one response message.

17.4.1. JMS Queue setup

When the Workbench is deployed on the JBoss AS or EAP server, it automatically creates 3 queues:

- `jms/queue/KIE.SESSION`
- `jms/queue/KIE.TASK`
- `jms/queue/KIE.RESPONSE`

The `KIE.SESSION` and `KIE.TASK` queues should be used to send request messages to the JMS API. Command response messages will be then placed on the `KIE.RESPONSE` queues. Command request messages that involve starting and managing business processes should be sent to the `KIE.SESSION` and command request messages that involve managing human tasks, should be sent to the `KIE.TASK` queue.

Although there are 2 different input queues, `KIE.SESSION` and `KIE.TASK`, this is only in order to provide multiple input queues so as to optimize processing: command request messages will be processed in the same manner regardless of which queue they're sent to. However, in some cases, users may send many more requests involving human tasks than requests involving business processes, but then not want the processing of business process-related request messages to be delayed by the human task messages. By sending the appropriate command request messages to the appropriate queues, this problem can be avoided.

The term "*command request message*" used above refers to a JMS text message that contains a serialized `JaxbCommandsRequest` object. At the moment, only XML serialization (as opposed to, JSON or protobuf, for example) is supported.

17.4.2. Using the remote Java API

While it is possible to interact with a BPMS or KIE workbench server instance by sending and processing JMS messages that you create yourself, *it will always be easier to use the remote Java API* that's supplied by the `kie-services-client` jar.

For more information about how to use the remote Java API to interact with the JMS API of a server instance, see the [Remote Java API](#) section.

17.4.2.1. Serialization issues

The JMS API accepts `TextMessage` instances that contain serialized `JaxbCommandsRequest` objects. These `JaxbCommandsRequest` instances can be filled with multiple command objects. In this way, it's possible to send a batch of commands for processing to the JMS API.

When users wish to include their own classes with requests, there a number of requirements that must be met for the user-defined classes. For more information about these requirements, see the [Sending and receiving user class instances](#) section in the remote API additional documentation section.

17.4.3. Example JMS usage

The following is a rather long example that shows how to use the JMS API. The numbers ("call-outs") along the side of the example refer to notes below that explain particular parts of the example. It's supplied for those advanced users that do not wish to use the jBPM Remote Java API.

The jBPM Remote Java API, described here, will otherwise take care of all of the logic shown below.

```
package org.kie.remote.client.documentation.jms;

import static org.kie.services.client.serialization.SerializationConstants.DEPLOYMENT_ID_PROPERTY_NAME;
import static org.kie.services.client.serialization.SerializationConstants.SERIALIZATION_TYPE_PROPERTY_NAME;
import static org.kie.services.shared.ServicesVersion.VERSION;

import java.util.Collections;
import java.util.List;
import java.util.Set;
import java.util.UUID;

import javax.jms.Connection;
import javax.jms.ConnectionFactory;
import javax.jms.JMSEException;
import javax.jms.Message;
import javax.jms.MessageConsumer;
import javax.jms.MessageProducer;
import javax.jms.Queue;
import javax.jms.Session;
import javax.jms.TextMessage;
import javax.naming.InitialContext;
import javax.naming.NamingException;

import org.kie.api.command.Command;
import org.kie.api.runtime.process.ProcessInstance;
import org.kie.api.task.model.TaskSummary;
import org.kie.remote.client.api.RemoteRuntimeEngineFactory;
import org.kie.remote.client.api.exception.MissingRequiredInfoException;
import org.kie.remote.client.api.exception.RemoteApiException;
import org.kie.remote.client.api.exception.RemoteCommunicationException;
import org.kie.remote.client.jaxb.ClientJaxbSerializationProvider;
import org.kie.remote.client.jaxb.JaxbCommandsRequest;
import org.kie.remote.client.jaxb.JaxbCommandsResponse;
import org.kie.remote.jaxb.gen.AuditCommand;
import org.kie.remote.jaxb.gen.GetTaskAssignedAsPotentialOwnerCommand;
import org.kie.remote.jaxb.gen.StartProcessCommand;
import org.kie.remote.jaxb.gen.TaskCommand;
import org.kie.services.client.serialization.JaxbSerializationProvider;
import org.kie.services.client.serialization.SerializationException;
import org.kie.services.client.serialization.SerializationProvider;
import org.kie.services.client.serialization.jaxb.impl.JaxbCommandResponse;
import org.kie.services.client.serialization.jaxb.rest.JaxbExceptionResponse;
import org.slf4j.Logger;
import org.slf4j.LoggerFactory;

public class SendJmsExample {
```

```

protected static final Logger logger = LoggerFactory.getLogger(SendJmsExample.class);

public void sendCommandsViaJms( String user, String password, String connectionUser, String connectionPassword,
String deploymentId, String processId, String hostName ) {

    /**
     * JMS setup
     */
    // Get JNDI context from server
    InitialContext context = RemoteRuntimeEngineFactory.getRemoteJbossInitialContext(hostName, connectionUser, connectionPassword);

    // Create JMS connection
    ConnectionFactory connectionFactory;
    try {
        connectionFactory = (ConnectionFactory) context.lookup("jms/RemoteConnectionFactory");
    } catch( NamingException ne ) {
        throw new RuntimeException("Unable to lookup JMS connection factory.", ne);
    }

    // Setup queues
    Queue sessionQueue, taskQueue, sendQueue, responseQueue;
    try {
        sendQueue = sessionQueue = (Queue) context.lookup("jms/queue/KIE.SESSION");
        taskQueue = (Queue) context.lookup("jms/queue/KIE.TASK");
        responseQueue = (Queue) context.lookup("jms/queue/KIE.RESPONSE");
    } catch( NamingException ne ) {
        throw new RuntimeException("Unable to lookup send or response queue", ne);
    }

    /**
     * Command preparation
     */
    StartProcessCommand startProcCmd = new StartProcessCommand();
    startProcCmd.setProcessId(processId);

    /**
     * Send command via JMS and receive response
     */
    SerializationProvider serializationProvider = ClientJaxbSerializationProvider.newInstance();
    ProcessInstance procInst = (ProcessInstance) sendJmsCommand(startProcCmd,
        connectionUser, connectionPassword,
        user, password, deploymentId, null,
        connectionFactory, sendQueue, responseQueue,
        serializationProvider, Collections.EMPTY_SET, JaxbSerializationProvider.JMS_SERIALIZATION_TYPE,
        5 * 1000);

    /**
     * Command preparation
     */
    GetTaskAssignedAsPotentialOwnerCommand gtaapoCmd = new GetTaskAssignedAsPotentialOwnerCommand();
    gtaapoCmd.setUserId(user);

    // Send command request
    Long processInstanceId = null; // needed if you're doing an operation on a
    PER_PROCESS_INSTANCE deployment

    /**
     * Send command via JMS and receive response
     */
}

```



```

@SuppressWarnings("unchecked")
List<TaskSummary> taskSumList = (List<TaskSummary>) sendJmsCommand(gtaapoCmd,
connectionUser, connectionPassword,
user, password, deploymentId, processInstanceId,
connectionFactory, sendQueue, responseQueue,
serializationProvider, Collections.EMPTY_SET, JaxbSerializationProvider.JMS_SERIALIZATION_TYPE,
5 * 1000);

long taskId = taskSumList.get(0).getId();
}

// @formatter:off
public static Object sendJmsCommand( Command command,
String connUser, String connPassword,
String userName, String password, String deploymentId, Long processInstanceId,
ConnectionFactory factory, Queue sendQueue, Queue responseQueue,
SerializationProvider serializationProvider, Set<Class<?>> extraJaxbClasses, int serializationType,
long timeoutInMilliseconds ) {
// @formatter:on

if( deploymentId == null && !(command instanceof TaskCommand || command instanceof AuditCommand) ) {
throw new MissingRequiredInfoException("A deployment id is required when sending commands
involving the KieSession.");
}
JaxbCommandsRequest req;
if( command instanceof AuditCommand ) {
req = new JaxbCommandsRequest(command);
} else {
req = new JaxbCommandsRequest(deploymentId, command);
}

req.setProcessInstanceId(processInstanceId);
req.setUser(userName);
req.setVersion(VERSION);

Connection connection = null;
Session session = null;
JaxbCommandsResponse cmdResponse = null;
String corrId = UUID.randomUUID().toString();
String selector = "JMSCorrelationID = '" + corrId + "'";
try {

// setup
MessageProducer producer;
MessageConsumer consumer;
try {
if( password != null ) {
connection = factory.createConnection(connUser, connPassword);
} else {
connection = factory.createConnection();
}
session = connection.createSession(false, Session.AUTO_ACKNOWLEDGE);

producer = session.createProducer(sendQueue);
consumer = session.createConsumer(responseQueue, selector);

connection.start();
} catch( JMSEException jmse ) {
throw new RemoteCommunicationException("Unable to setup a JMS connection.", jmse);
}

```

```
}

// Create msg
TextMessage textMsg;
try {

// serialize request
String xmlStr = serializationProvider.serialize(req);
textMsg = session.createTextMessage(xmlStr);

// set properties
// 1. corr id
textMsg.setJMSCorrelationID(corrId);
// 2. serialization info
textMsg.setIntProperty(SERIALIZATION_TYPE_PROPERTY_NAME, serializationType);
if( extraJaxbClasses != null && !extraJaxbClasses.isEmpty() ) {
if( deploymentId == null ) {
throw new MissingRequiredInfoException(
    "Deserialization of parameter classes requires a deployment id, which has not been
configured.");
}
textMsg.setStringProperty(DEPLOYMENT_ID_PROPERTY_NAME, deploymentId);
}
// 3. user/pass for task operations
boolean isTaskCommand = (command instanceof TaskCommand);
if( isTaskCommand ) {
if( userName == null ) {
throw new RemoteCommunicationException(
    "A user name is required when sending task operation requests via JMS");
}
if( password == null ) {
throw new RemoteCommunicationException(
    "A password is required when sending task operation requests via JMS");
}
textMsg.setStringProperty("username", userName);
textMsg.setStringProperty("password", password);
}
// 4. process instance id
} catch( JMSEException jmse ) {
throw new RemoteCommunicationException("Unable to create and fill a JMS message.", jmse);
} catch( SerializationException se ) {
throw new RemoteCommunicationException("Unable to deserialize JMS message.", se.getCause());
}
}

// send
try {
producer.send(textMsg);
} catch( JMSEException jmse ) {
throw new RemoteCommunicationException("Unable to send a JMS message.", jmse);
}

// receive
Message response;
try {
response = consumer.receive(timeoutInMillisecs);
} catch( JMSEException jmse ) {
throw new RemoteCommunicationException("Unable to receive or retrieve the JMS
response.", jmse);
}
}
```

```

    if( response == null ) {
        logger.warn("Response is empty");
        return null;
    }
    // extract response
    assert response != null: "Response is empty.";
    try {
        String xmlStr = ((TextMessage) response).getText();
        cmdResponse = (JaxbCommandsResponse) serializationProvider.deserialize(xmlStr);
    } catch( JMSEException jmse ) {
        throw new RemoteCommunicationException("Unable to extract
" + JaxbCommandsResponse.class.getSimpleName()
+ " instance from JMS response.", jmse);
    } catch( SerializationException se ) {
        throw new RemoteCommunicationException("Unable to extract
" + JaxbCommandsResponse.class.getSimpleName()
+ " instance from JMS response.", se.getCause());
    }
    assert cmdResponse != null: "Jaxb Cmd Response was null!";
    } finally {
        if( connection != null ) {
            try {
                connection.close();
            } if( session != null ) {
                session.close();
            }
        } catch( JMSEException jmse ) {
            logger.warn("Unable to close connection or session!", jmse);
        }
    }

    String version = cmdResponse.getVersion();
    if( version == null ) {
        version = "pre-6.0.3";
    }
    if( !version.equals(VERSION) ) {
        logger.info("Response received from server version [{}] while client is version [{}].
This may cause problems.",
        version, VERSION);
    }

    List<JaxbCommandResponse<?>> responses = cmdResponse.getResponses();
    if( responses.size() > 0 ) {
        JaxbCommandResponse<?> response = responses.get(0);
        if( response instanceof JaxbExceptionResponse ) {
            JaxbExceptionResponse exceptionResponse = (JaxbExceptionResponse) response;
            throw new RemoteApiException(exceptionResponse.getMessage());
        } else {
            return response.getResult();
        }
    } else {
        assert responses.size() == 0: "There should only be 1 response, not " + responses.size() + ",
returned by a command!";
        return null;
    }
}

```

```
}
```

These classes can all be found in the `kie-api`, `kie-services-client` and `kie-services-jaxb` JARs. For this example, the only dependency needed is `org.kie.remote:kie-remote-client`, which transitively depends on both the `org.kie:kie-api` and `org.kie.remote:kie-remote-jaxb` artifacts.

The `JaxbCommandsRequest` instance is the "holder" object in which you can place all of the commands you want to execute in a particular request. By using the `JaxbCommandsRequest.getCommands()` method, you can retrieve the list of commands in order to add more commands to the request. A deployment id is required for command request messages that deal with business processes. Command request messages that only contain human task-related commands do not require a deployment id.

Note that the JMS message sent to the remote JMS API *must* be constructed as follows:

- It must be a JMS text message (`javax.jms.TextMessage`).
- It must contain a serialized instance of a `JaxbCommandsRequest`, added to the message as a UTF string
- It must have a filled JMS Correlation ID property.
- It must have an int property with the name of "serialization" set to an acceptable value (only 0 at the moment).

The same serialization mechanism used to serialize the request message will be used to serialize the response message.

17.5. Additional Information

17.5.1. REST Serialization: JAXB or JSON

Except for the Execute calls, all other REST calls described below can use either JAXB or JSON.

All REST calls, unless otherwise specified, use JAXB serialization.

When using JSON, make sure to add the JSON media type (`"application/json"`) to the `ACCEPT` header of your REST call.

17.5.2. Sending and receiving user class instances

Sometimes, users may wish to pass instances of their own classes as parameters to commands sent in a REST or Webservice request or JMS message. In order to do this, there are a number of requirements.

- The user-defined class satisfy the following in order to be property serialized and deserialized:
 - It should be possible to serialize and deserialize the user-defined class using JAXB. For simple custom classes, this might be available out-of-the-box, but for more complex types,

this might mean the classes need to be correctly annotated with JAXB annotations, including the following:

- The user-defined class must be annotated with a `javax.xml.bind.annotation.XmlRootElement` annotation with a non-empty `name` value
- All fields or getter/setter methods must be annotated with a `javax.xml.bind.annotation.XmlElement` or `javax.xml.bind.annotation.XmlAttribute` annotations.
- Furthermore, the following usage of JAXB annotations is recommended:
 - Annotate the user-defined class with a `javax.xml.bind.annotation.XmlAccessorType` annotation specifying that fields should be used, (`javax.xml.bind.annotation.XmlAccessType.FIELD`). This also means that you should annotate the fields (instead of the getter or setter methods) with `@XmlElement` or `@XmlAttribute` annotations.
 - Fields annotated with `@XmlElement` or `@XmlAttribute` annotations should also be annotated with `javax.xml.bind.annotation.XmlSchemaType` annotations specifying the type of the field, even if the fields contain primitive values.
- Use objects to store primitive values. For example, use the `java.lang.Integer` class for storing an integer value, and not the `int` class. This way it will always be obvious if the field is storing a value.
- The user-defined class definition must implement a no-arg constructor.
- Any fields in the user-defined class must either be object primitives (such as a `Long` or `String`) or otherwise be objects that satisfy the same requirements in this list (correct usage of JAXB annotations and a no-arg constructor).
- The class definition must be included in the deployment jar (kjar) of the deployment that the command (request) is sent to.
- The sender must pass the deployment id in the header of the request. This property is necessary to be able to load the proper classes from the deployment itself before deserializing the message on the server side.
 - For REST requests, this means that the "Kie-Deployment-Id" header property must be set.
 - For JMS messages, the `deploymentId` string property on the JMS text message must be set.



Retrieving process variables

While *submitting* an instance of a user-defined class is possible via both the JMS and REST API, *retrieving* an instance of the process variable is only possible via the REST API.

17.5.3. Including the deployment id

When interacting with the Remote API, users may want to pass instances of their own classes as parameters to certain operations. As mThis will only be possible if the KJar for a deployment includes these classes.

REST calls that involve the `TaskService` (e.g. that start with `/task..`), often do not contain any information about the associated deployment. In that case, an extra query parameter will have to be added to the REST call so that the server can find the appropriate deployment with the class (definition) and correctly deserialize the information passed with the call.

For these REST calls which do not contain the deployment id, you'll need to add the following parameter:

Table 17.16. Deployment id query parameter

Description
parameter name
Value
must match the regex
<code>[a-zA-Z0-9-:\.]+</code>
specifies the deployment

**De-
scrip-
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17.5.4. REST Pagination

Some of the REST calls below return lists of information. The results of these operations can be *paginated*, which means that the lists can be split up and returned according to the parameters sent by the user.

For example, if the REST call parameters indicate that *page 2* with *page size 10* should be returned for the results, then results 10 to (and including) 19 will be returned.

The first page is always page 1 (as opposed to page "0").

Table 17.17. Pagination query parameter syntax

De- scrip- tion	Page number re- quest- ed. The de- fault val- ue is 1.
Synonym	for the above page pa- ra- me- ter.
PageSize	num- ber of el- e- ments per page to re- turn. The de-

**De-
scrip-
tion
parameter
name**

fault
val-
ue
is
10.

Synonym

for
the
above

pageSize

pa-
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ter.

If both a "long" pagination parameter and its synonym are used, then only the value from the "long" variant is used. For example, if the `page` is given with a value of 11 and the `p` parameter is given with a value of 37, then the value of the `page` parameter, `11`, will be used and the `p` parameter will be ignored.

For the following operations, pagination is *always* used. See above for the default values used.

Table 17.18. REST operations using pagination

REST

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SET**Del****Subscription****Re-****tuns****ao-****list/in-****stance/{procIn-****ward}/vari-****ableIn-****stanceL-****og****in-****stances****Re-****tuns****ao-****list/in-****stance/{procIn-****ward}/vari-****ableIn{varId}****stanceL-****og****in-****stances****Re-****tuns****ao-****list/vari-****able/{vari-****ableId}****ableIn-****stanceL-****og****in-****stances****Re-****tuns****ao-****list/vari-****able/{vari-****ProcessIn-**

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**Re-
turns**

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stances

**Re-
turns/**

query
list
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ma-
ryIm-

```

REST
Description
Instances
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turns/
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Query-
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sult
in-
stance
Re-
turns/
aun-
damb/process
QueryProcessIn-
stanceRe-
sult
in-
stance

```

17.5.5. REST Map query parameters

If you're triggering an operation with a REST API call that would normally (e.g. when interacting the same operation on a local `KieSession` or `TaskService` instance) take an instance of a `java.util.Map` as one of its parameters, you can submit key-value pairs to the operation to simulate this behaviour by passing a query parameter whose name starts with `map_`.

Example 17.8. Query parameter examples

If you pass the query parameter `map_key=vAlue` in a REST call, then the `Map` that's passed to the actual underlying `KieSession` or `TaskService` operation will contain this `(String, String)` key value pair: `"key" # "vAlue"`. You could pass this parameter like so:

```

http://localhost:8080/kie-wb/rest/runtime/myproject/process/
wonka.factory.loompa.hire/start?map_key=vAlue

```

Map query parameters also use the object query parameter syntax described below, so the following query parameter, `map_total=5000` will be translated into a key-value pair in a map where the key is the `String` "total" and the value is a `Long` with the value of 5000. For example:

```
http://localhost:8080/kie-wb/rest/runtime/myproject/process/
wonka.factory.oompa.chocolate/start?map_total=5000`
```

The following operations take query map parameters:

- /runtime/{deploymentId}/process/{processDefId}/start
- /runtime/{deploymentId}/workitem/{processItemId}/complete
- /runtime/{deploymentId}/withvars/process/{processDefId}/start
- /task/{taskId}/complete
- /task/{taskId}/fail

17.5.6. REST Number query parameters

While REST calls obviously only take strings as query parameters, using the following notation for query parameters will mean that the string is translated into a different type of object when the value of the string is used in the actual operation:

Table 17.19. Number query parameter syntax

Regex
syn-
tax
<code>\d</code>
<code>+</code>
<code>\d-</code>
<code>\d-</code>
<code>ger</code>
<code>\d</code>
<code>+</code>

17.5.7. Runtime strategies

The remote API calls allow access to the underlying deployments, regardless of whether these deployments use the `Singleton`, `Per-Process-Instance` or `Per-Request` strategies.

While there's enough information in the URL in order to access deployments that use the `Singleton`, or `Per-Request` strategies, that's not always the case with the `Per-Process-Instance` runtimes because the remote API operation will need the process instance id in order to identify the deployment.

Therefore, for REST calls for which the URL does not contain the process instance id, you'll need to add the following parameter:

Table 17.20. Per-Process-Instance runtime query parameter

Description	Parameter name	Value
The regex [0-9]+) specifies the process instance id that identifies the underlying Per-Process-Instance deployment. Will have no effect if	(must match)	

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Part IV. Eclipse

How to use the Eclipse-based tooling

Chapter 18. jBPM Eclipse Plugin

18.1. jBPM Eclipse Plugin

The jBPM Eclipse plugin provides developers (and very technical users) with an environment to edit and test processes, and integrate it deeply with their applications. It provides the following features (on top of the Eclipse IDE):

- Wizards for creation of
 - a jBPM project
 - a BPMN2 process
- jBPM Perspective (showing the most commonly used views in a predefined layout)

18.1.1. Installation

The jBPM installer is capable of downloading and installing an Eclipse installation, including the Drools and jBPM Eclipse plugin (with a full jBPM runtime preconfigured) and the Eclipse BPMN2 Modeler.



Tip

Using the jBPM installer is definitely the recommended starting point for most users.

You can however also download and install the jBPM Eclipse Plugin manually. To do so, you need to:

- Download Eclipse (Kepler recommended, but older versions like Indigo or Juno should also still work)
- Start Eclipse
- Select "Install New Software ..." from the Help menu. Add the Drools and jBPM update site <http://downloads.jboss.org/jbpm/release/6.0.1.Final/updatesite/> [<http://downloads.jboss.org/jbpm/release/6.0.1.Final/updatesite/>]. You should see the plugins as shown below. Note that you can also download and unzip the Drools and jBPM update site to your local file system and use that as local update site instead.

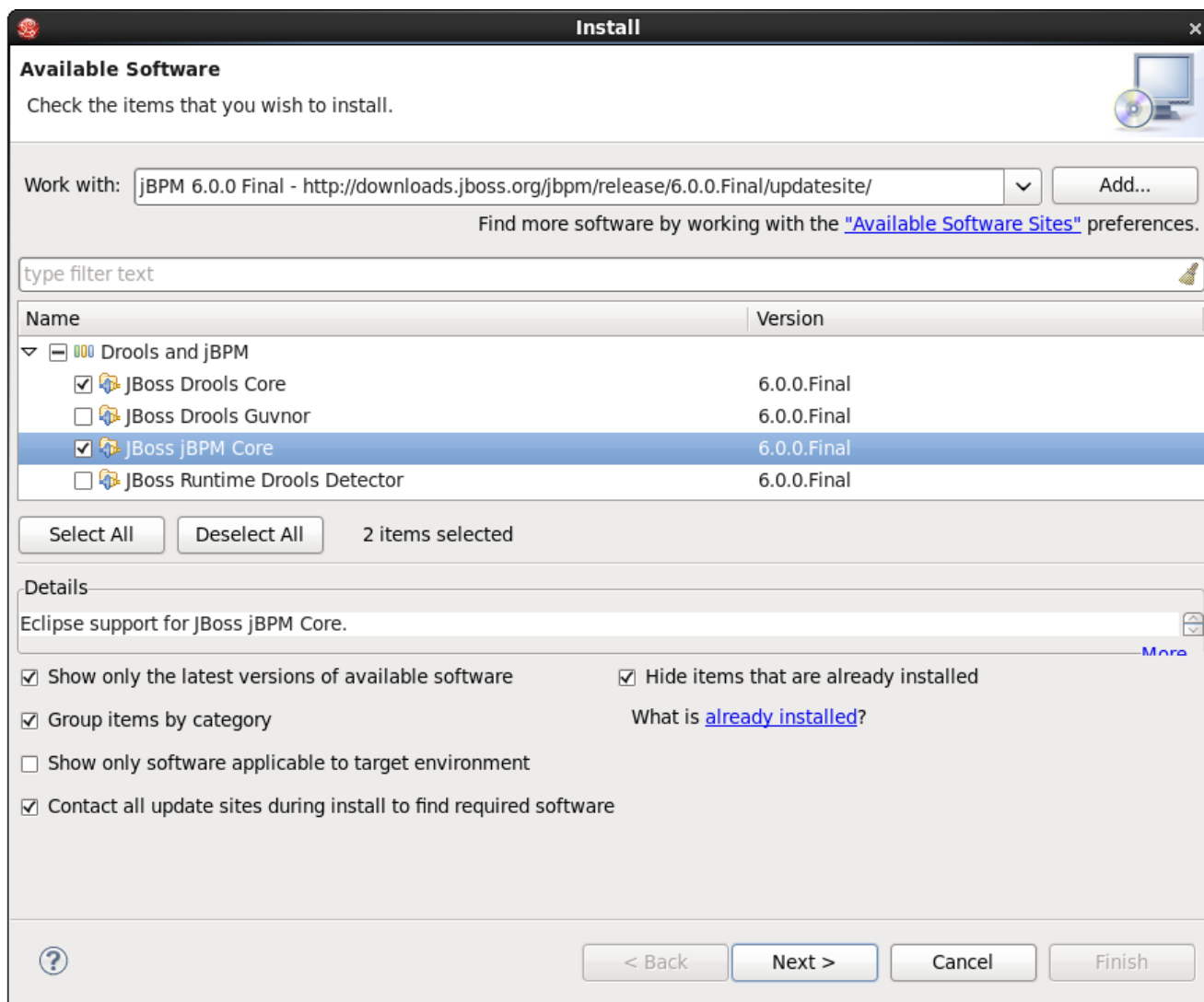


Figure 18.1.

Select the JBoss jBPM Core and JBoss Drools Core plugins and click "Next >". Click "Next >" again after reviewing your selecting, accept the terms of the license agreement and click "Finish" to download and install the plugins. If you get a warning about installing software that contains unsigned content, click OK. After successful installation, Eclipse should ask you to restart, click Yes.

- The plugin should now be installed. To check, check if you can for example see the new jBPM Project wizard: under the "File" menu, select "New Project ..." and there you should be able to see "New jBPM Project" under the jBPM category.
- Register a jBPM runtime to get started, see the section on jBPM runtimes in this chapter for more information.

Note that, when doing a manual install, you still need to manually install the Eclipse BPMN 2.0 Modeler plugin as well. Check out the chapter on the Eclipse BPMN 2.0 Modeler on how to do that.

18.1.2. jBPM Project Wizard

The aim of the new project wizard is to set up an executable sample project to start using processes immediately. This will set up a basic structure, the classpath, sample process and a test case to get you started. To create a new jBPM project, in the "File" menu select "New" and then "Project ..." and under the jBPM category, select "jBPM Project". A dialog as shown below should pop up.

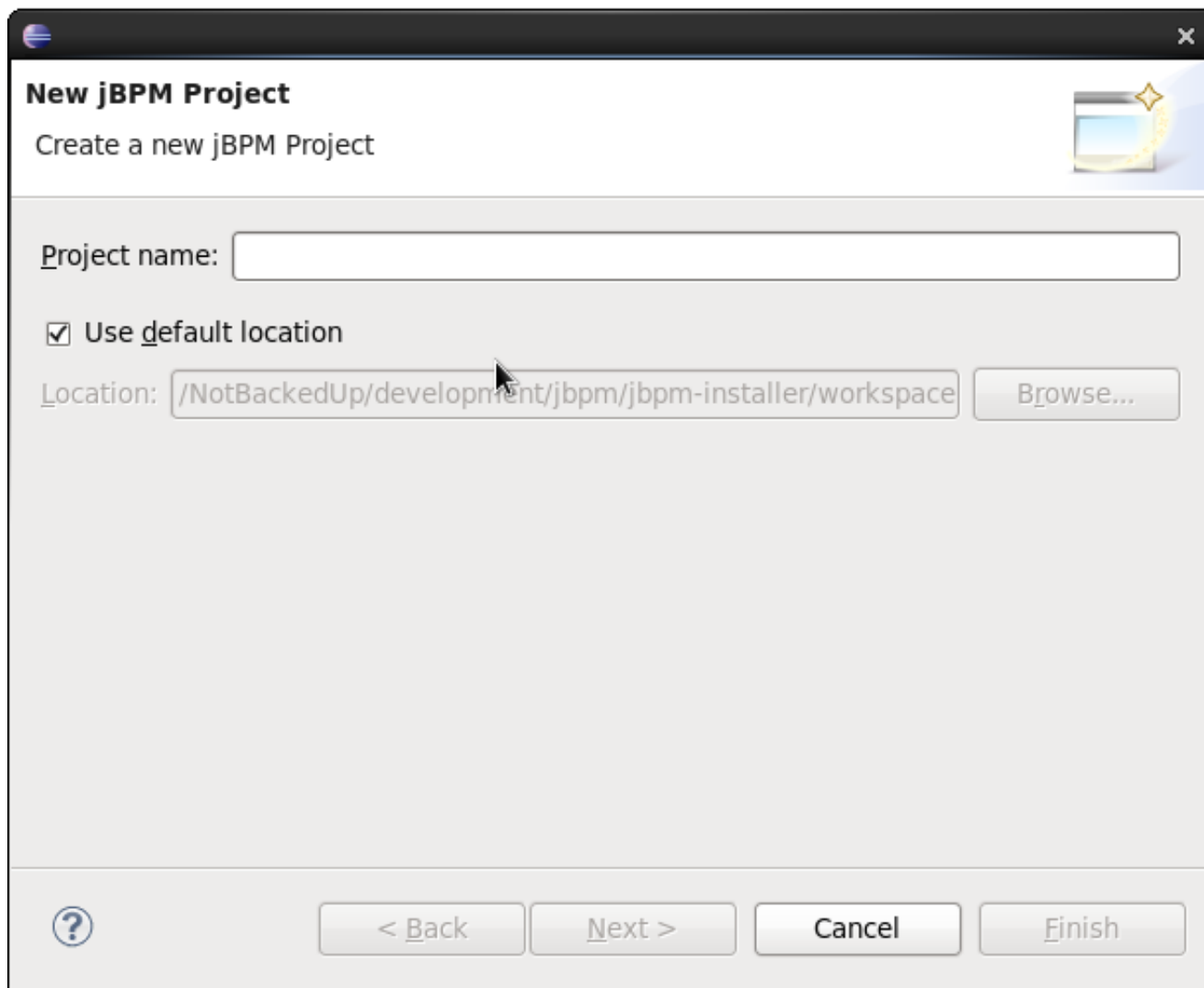


Figure 18.2.

Fill in a name for your project and if necessary change the location where this project should be located (by default Eclipse will generate it inside your Eclipse workspace folder) and click "Next >".

Now you can optionally include a sample process in your project to get started. You can select to either use a simple "Hello World" process, a slightly more advanced process including human tasks and persistence or simply an empty project. You can also select to include a JUnit test class that you can use to test your process. These can serve as a starting point, and will give you something executable almost immediately, which you can then modify to your needs.

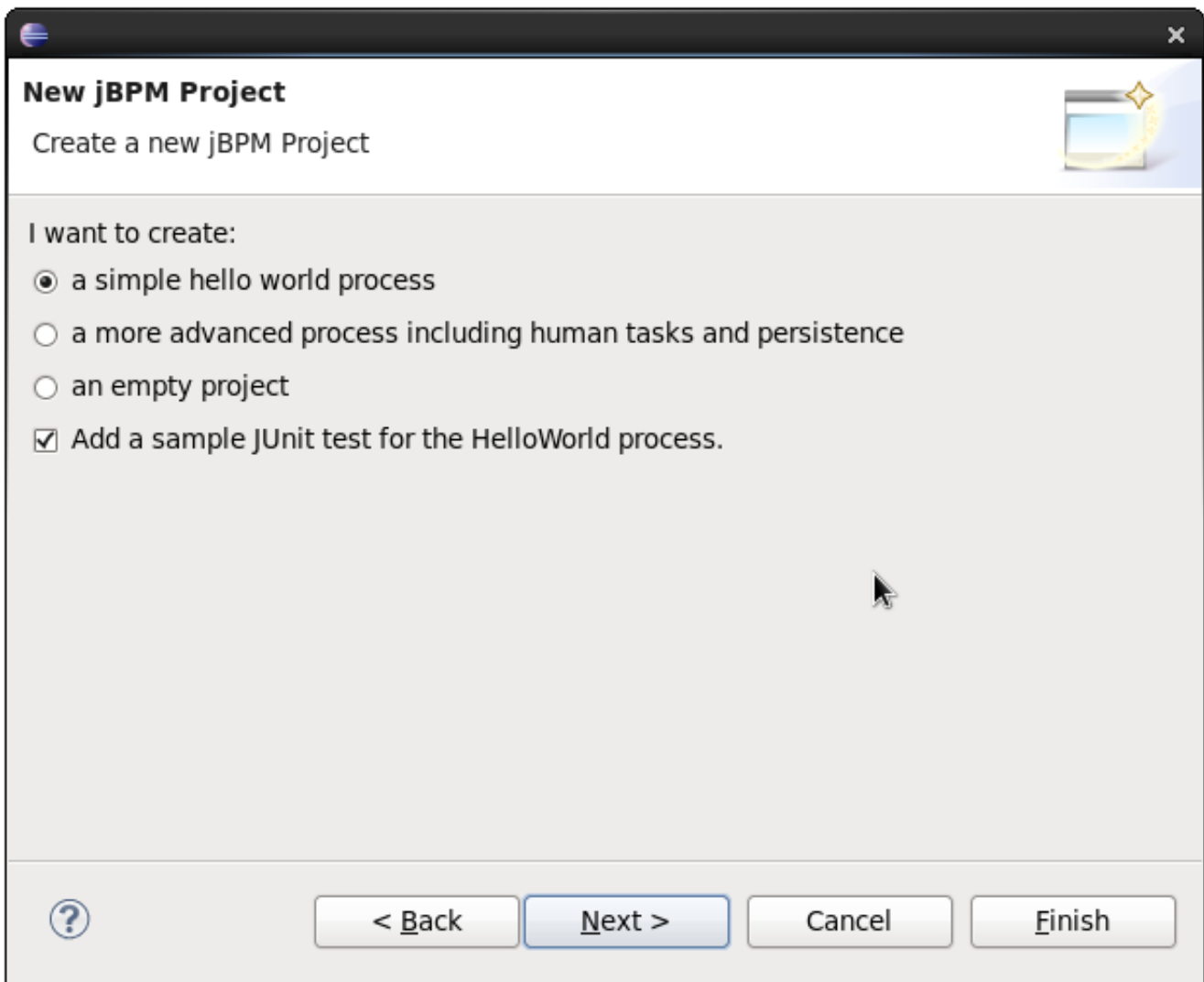


Figure 18.3.

Finally, the last page in the wizard allows you select a jBPM runtime, as shown below. You can either use the default runtime (as configured for you workspace, in your workspace preferences), or you can select a specific runtime for this project. For more information about runtimes and how to create them, see the section on jBPM runtimes in this chapter.

You can also select which version of jBPM you want to generate sample code for. By default it will generate an example using the latest jBPM 6.x API, but you could also generate examples using the old jBPM 5.x API. Note that you yourself are responsible for making sure that the code you generate can be understood by the runtime (for example, if you create an example using jBPM6 API but select a jBPM5 runtime, your sample will not compile). Also note that, if you want to execute a jBPM5 example on jBPM6, you will need to have the knowledge-api JAR inside your jBPM6 runtime, as this is responsible for the backwards compatibility of the jBPM5 API in jBPM6.

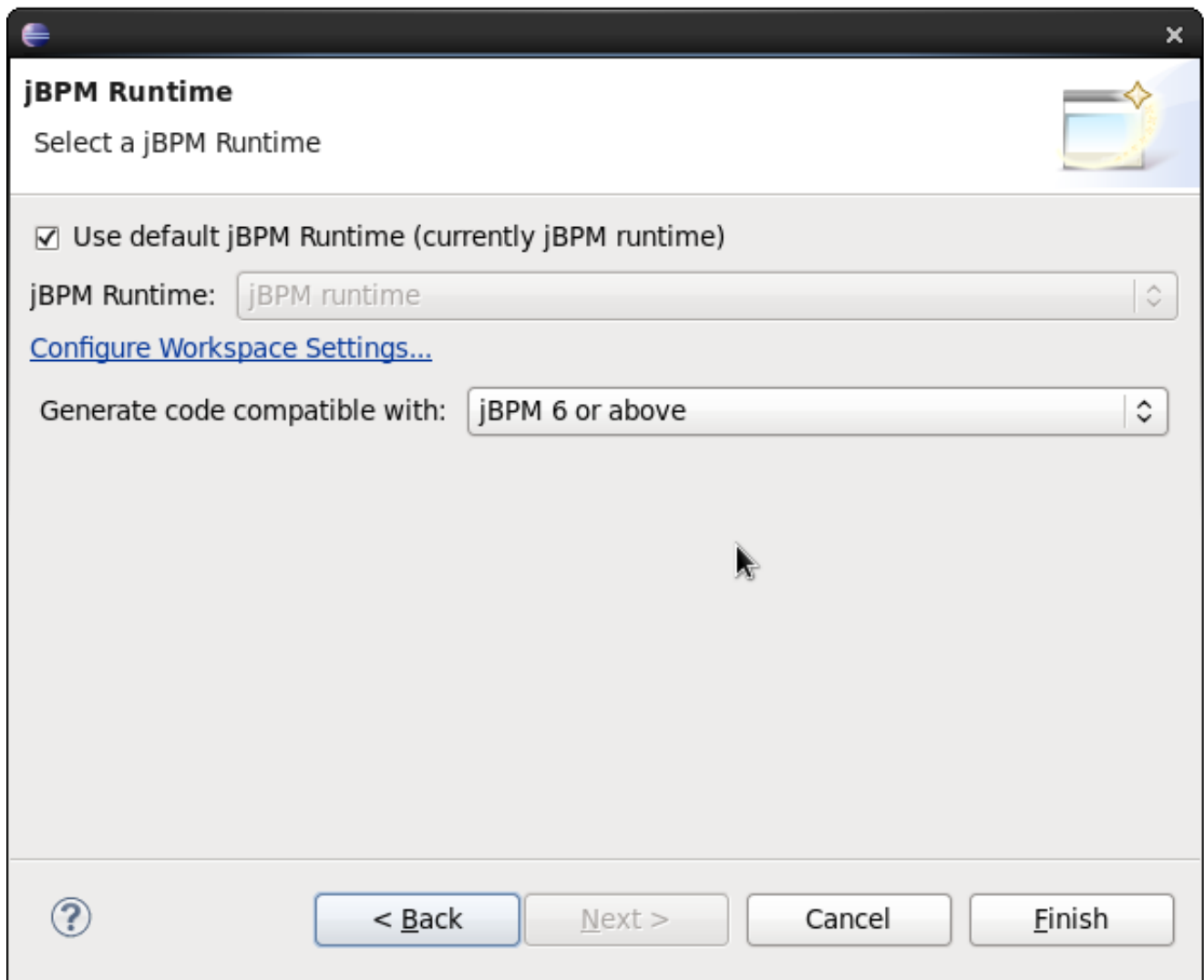


Figure 18.4.

When you selected the simple 'hello world' example, the result is shown below. Feel free to experiment with the plug-in at this point.

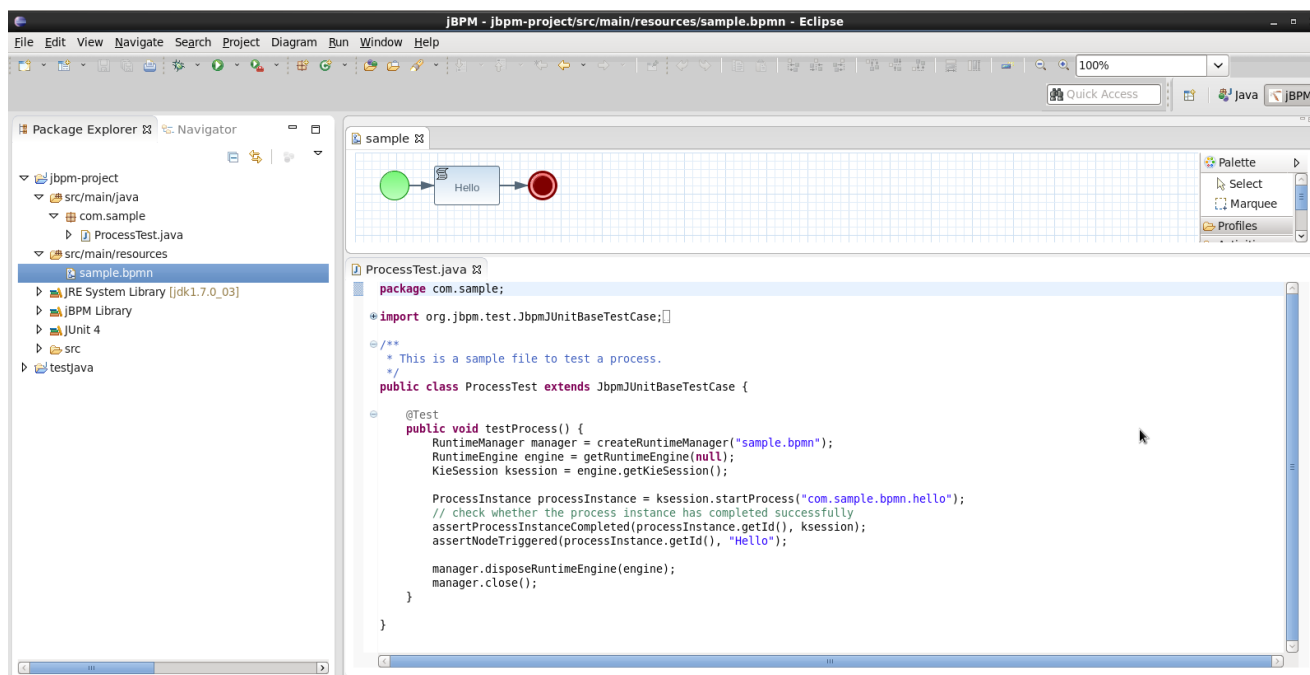


Figure 18.5. New jBPM project artifacts

The newly created project contains an example process file (sample.bpmn) in the src/main/resources directory and an example Java file (ProcessTest.java) that can be used to test the process in a jBPM engine. You'll find this in the folder src/main/java, in the com.sample package. All the other JARs that are necessary during execution are also added to the classpath in a custom classpath container called jBPM Library.

You can also convert an existing Java project to a jBPM project by selecting the "Convert to jBPM Project" action. Right-click the project you want to convert and under the "Configure" category (at the bottom) select "Convert to jBPM Project". This will add the jBPM Library to your project's classpath.

18.1.3. New BPMN2 Process Wizard

You can create a new process simply as an empty text file with extension ".bpmn", or use the "New BPMN2 Process" wizard to do so. To create a new process, in the "File" menu select "New" and then "Other ..." and under the jBPM category, select "BPMN2 Process" and click "Next >". In the next dialog, you should select the folder where the process should be created (for example the src/main/resources folder of your project) and a name for the process. Clicking "Finish" should create your new process (by default it should only contain one start node) and open it so you can start editing it.

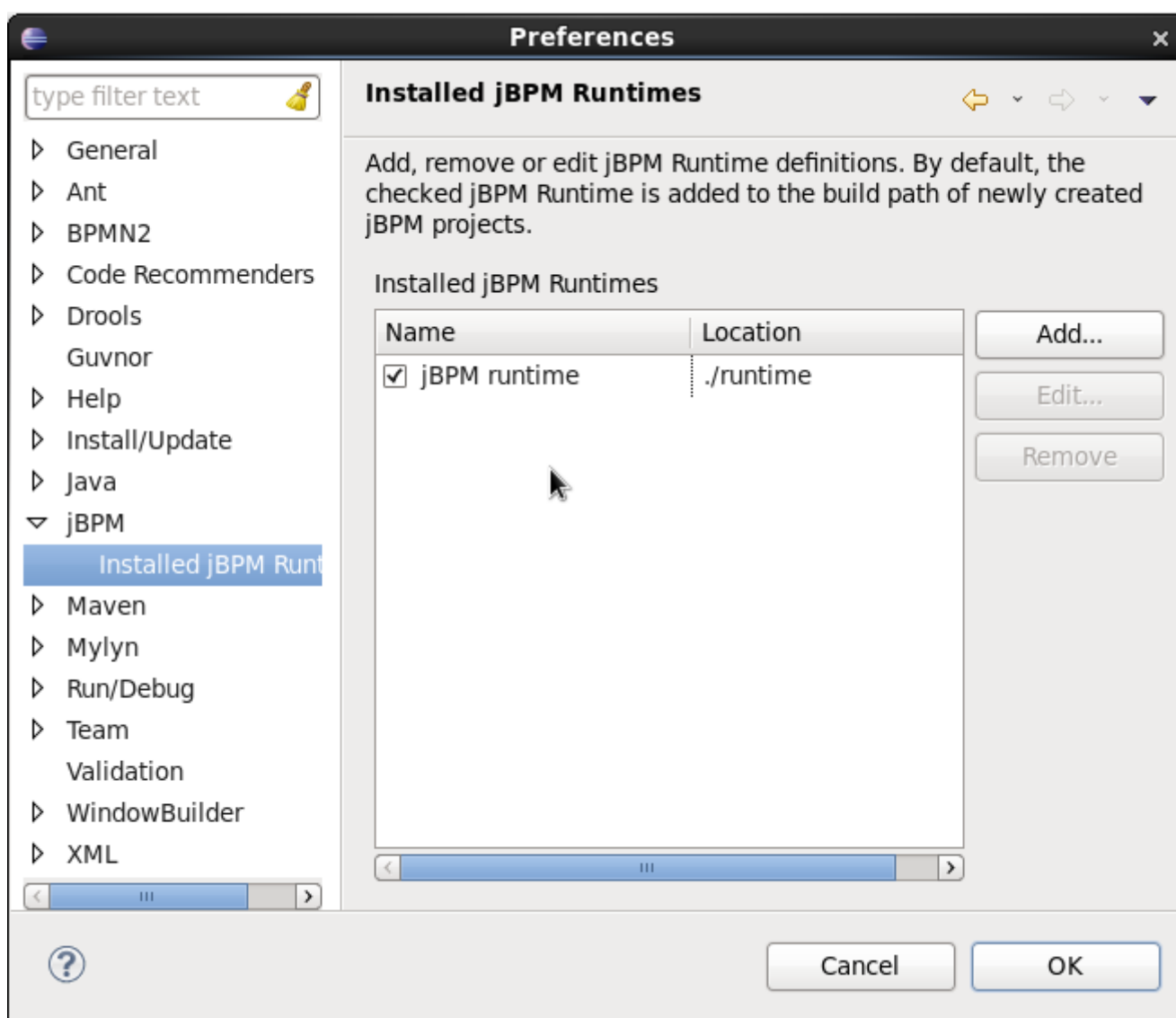
18.1.4. jBPM Runtime

A jBPM runtime is a collection of JAR files that represent one specific release of the jBPM project JARs. To create a runtime, download the binary distribution of the version of jBPM you want to

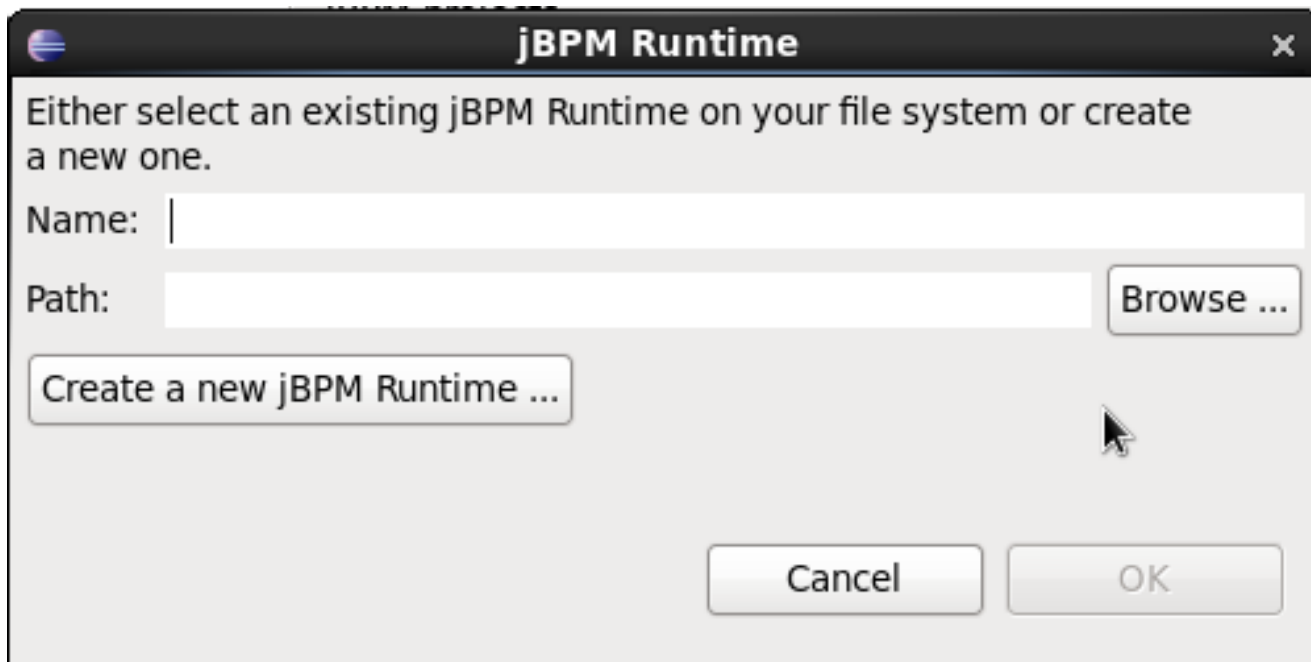
use and unzip on your local file system. You must then point the IDE to the release of your choice by selecting the folder where these JARs are located. If you want to create a new runtime based on the latest jBPM project JARs included in the plugin itself, you can also easily do that. You are required to specify a default jBPM runtime for your Eclipse workspace, but each individual project can override the default and select the appropriate runtime for that project specifically.

18.1.4.1. Defining a jBPM Runtime

To define one or more jBPM runtimes using the Eclipse preferences view you open up your Preferences, by selecting the "Preferences" menu item in the menu "Window". A "Preferences" dialog should show all your settings. On the left side of this dialog, under the jBPM category, select "Installed jBPM runtimes". The panel on the right should then show the currently defined jBPM runtimes. For example, if you used the jBPM Installer, it should look like the figure below.



To define a new jBPM runtime, click on the "Add" button. A dialog such as the one shown below should pop up, asking for the name of your runtime and the location on your file system where it can be found.



In general, you have two options:

1. If you simply want to use the default JAR files as included in the jBPM Eclipse plugin, you can create a new jBPM runtime automatically by clicking the "Create a new jBPM Runtime ..." button. A file browser will show up, asking you to select the folder on your file system where you want this runtime to be created. The plugin will then automatically copy all required dependencies to the specified folder. Make sure to select a unique name for the newly created runtime and click "OK" to register this runtime.



Tip

Note that creating a jBPM runtime from the default JAR files as included in the jBPM Eclipse plugin is only recommended to get you started the first time and for very simple use cases. The runtime that is created this way only contains the minimal set of JARs, and therefore doesn't support a significant set of features, including for example persistence. Make sure to create a full runtime (using the second approach) for real development.

2. If you want to use one specific release of the jBPM project, you should create a folder on your file system that contains all the necessary jBPM libraries and dependencies (for example by downloading the binary distribution and unzipping it on your local file system). Instead of creating a new jBPM runtime as explained above, give your runtime a unique name and click the "Browse ..." button to select the location of this folder containing all the required JARs. Click "OK" to register this runtime.

After clicking the OK button, the runtime should show up in your table of installed jBPM runtimes, as shown below. Click on the checkbox in front of one of the installed runtimes to make it the

default jBPM runtime. The default jBPM runtime will be used as the runtime of all your new jBPM projects (in case you didn't select a project-specific runtime).

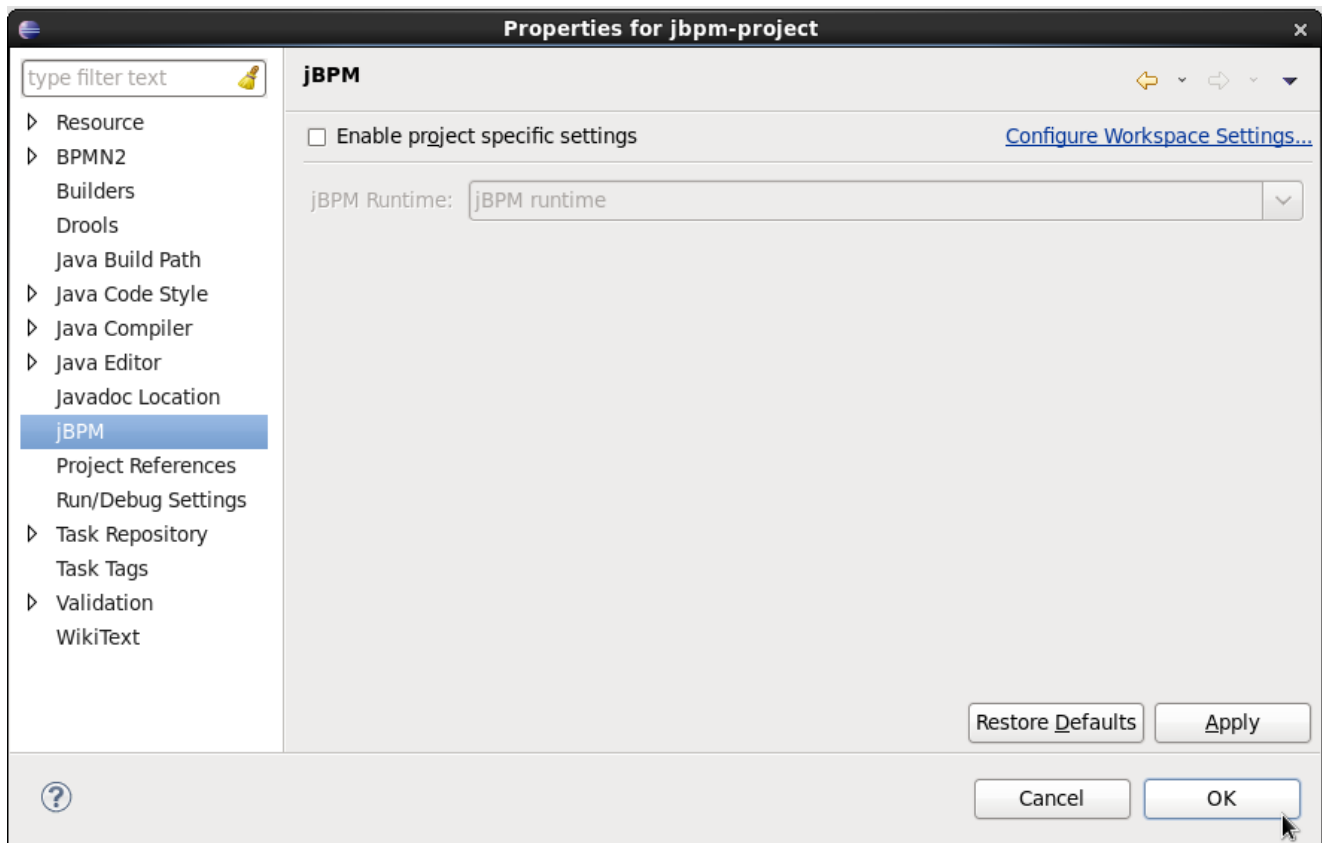
You can add as many jBPM runtimes as you need. Note that you will need to restart Eclipse if you changed the default runtime and you want to make sure that all the projects that are using the default runtime update their classpath accordingly.

18.1.4.2. Selecting a runtime for your jBPM project

Whenever you create a jBPM project (using the New jBPM Project wizard or by converting an existing Java project to a jBPM project), the plugin will automatically add all the required JARs to the classpath of your project.

When creating a new jBPM project, the plugin will automatically use the default Drools runtime for that project, unless you specify a project-specific one. You can do this in the final step of the New jBPM Project wizard, as shown below, by deselecting the "Use default Drools runtime" checkbox and selecting the appropriate runtime in the drop-down box. If you click the "Configure workspace settings ..." link, the workspace preferences showing the currently installed jBPM runtimes will be opened, so you can add new runtimes there.

You can change the runtime of a jBPM project at any time by opening the project properties and selecting the jBPM category, as shown below. Mark the "Enable project specific settings" checkbox and select the appropriate runtime from the drop-down box. If you click the "Configure workspace settings ..." link, the workspace preferences showing the currently installed jBPM runtimes will be opened, so you can add new runtimes there. If you deselect the "Enable project specific settings" checkbox, it will use the default runtime as defined in your global workspace preferences.



18.1.5. jBPM Maven Project Wizard

The aim of the new Maven project wizard is to set up an executable sample project to start using processes immediately (but not as normal Java project with all jBPM dependencies added using a jBPM library but by using Maven (and thus a pom.xml) to define your project's properties and dependencies. This wizard will set up a Maven project using a pom.xml, and include a sample process and Java class to execute it. To create a new jBPM Maven project, in the "File" menu select "New" and then "Project ..." and under the jBPM category, select "jBPM Project (Maven)". Give your project a name and click finish. The result should be as shown below.

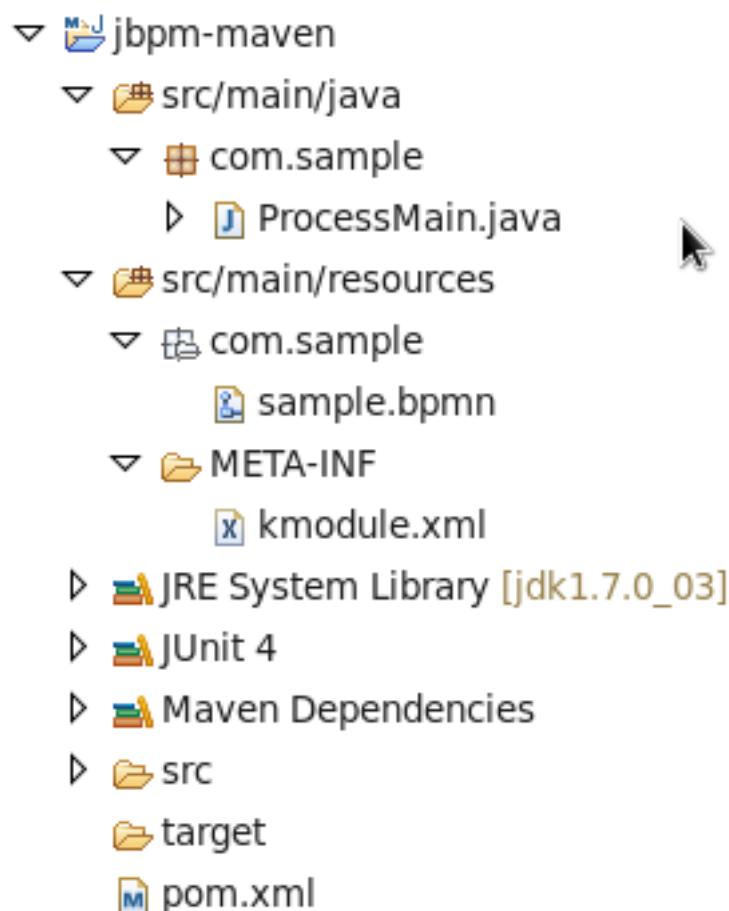


Figure 18.6.

The pom.xml that is generated for your project contains the following:

```
<?xml version="1.0" encoding="UTF-8"?><project xmlns="http://maven.apache.org/POM/4.0.0"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"          xsi:schemaLocation="http://
maven.apache.org/POM/4.0.0 http://maven.apache.org/xsd/maven-4.0.0.xsd"> <modelVersion>4.0.0</
modelVersion>
  <groupId>com.sample</groupId>          <artifactId>jbpm-example</artifactId>
  <version>1.0.0-SNAPSHOT</version> <name>jBPM :: Sample Maven Project</name> <description>A
sample jBPM Maven project</description> <properties>          <version.org.jbpm>6.0.0.Final</
version.org.jbpm> </properties> <repositories> <repository> <id>jboss-public-repository-
group</id> <name>JBoss Public Repository Group</name> <url>http://repository.jboss.org/
nexus/content/groups/public/</url> <releases> <enabled>true</enabled>
<updatePolicy>never</updatePolicy> </releases> <snapshots> <enabled>true</enabled>
  <updatePolicy>daily</updatePolicy> </snapshots> </repository> </repositories>
  <dependencies> <dependency> <groupId>org.jbpm</groupId> <artifactId>jbpm-test</
artifactId> <version>${version.org.jbpm}</version> </dependency> </dependencies></
project>
</project xmlns="http://maven.apache.org/
POM/4.0.0"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance"
  xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/
xsd/
maven-4.0.0.xsd"> <modelVersion>4.0.0</
```

```

modelVersion> <groupId>com.sample</
groupId> <artifactId>jbpm-example</
artifactId> <version>1.0.0-SNAPSHOT</

version> <name>jBPM :: Sample Maven Project</
name> <description>A sample jBPM Maven project</

description>
<properties> <version.org.jbpm>6.0.0.Final</
version.org.jbpm> </

properties>
<repositories>
<repository> <id>jboss-public-repository-group</
id> <name>JBoss Public Repository Group</
name> <url>http://repository.jboss.org/nexus/content/groups/public/</
url>
<releases> <enabled>true</
enabled> <updatePolicy>never</
updatePolicy> </
releases>
<snapshots> <enabled>true</
enabled> <updatePolicy>daily</
updatePolicy> </
snapshots> </
repository> </

repositories>
<dependencies>
<dependency> <groupId>org.jbpm</
groupId> <artifactId>jbpm-test</
artifactId> <version>${version.org.jbpm}</
version> </
dependency> </
dependencies></

```

In the properties section, you can specify which version of jBPM you would like to use (by default it uses 6.0.0.Final). It adds the JBoss Nexus Maven repository (where all the jBPM JARs and their dependencies are located) to your project and configures the dependencies.



Note

By default, only the `jbpm-test` JAR is specified as a dependency, as this has transitive dependencies to almost all of the core dependencies you will need. You are free to update the dependencies section however to include only the dependencies you need.

The project also contains a sample process, under `src/main/resources`, in the `com.sample` package, and a `kmodule.xml` configuration file under the `META-INF` folder. The `kmodule.xml` defines which resources (processes, rules, etc.) are to be loaded as part of your project. In this case, it is defining a `kbase` called "kbase" that will load all the resources in the `com.sample` folder:

```
<kmodule xmlns="http://www.drools.org/xsd/kmodule"> <kbase name="kbase" packages="com.sample" /></kmodule>
kmodule"> <kbase name="kbase"
packages="com.sample" />
```

Finally, it also contains a Java class that can be used to execute the sample process. It will first create a kbase called "kbase" (by inspecting the kmodule.xml file and thus loading the `sample.bpmn` process) and then use a `RuntimeManager` to get access to a `KieSession` and `TaskService`. In this case, it is used to start a process and then complete the tasks created by this process one by one.

18.1.6. Drools Eclipse plugin

The Drools Eclipse Plugin, which is bundled as part of the same Eclipse Update Site as the jBPM Eclipse Plugin, provides similar features for creating and editing business rules, and execute them using the Drools engine. This for example allows you to create and edit `.drl` files containing business rules. You can combine your processes and rules inside one project and execute them together on the same `KieSession`.

18.2. Debugging

This section describes how to debug processes using the jBPM Eclipse plugin. This means that the current state of your running processes can be inspected and visualized during the execution. Note that we currently don't allow you to put breakpoints on the nodes within a process directly. You can however put breakpoints inside any Java code you might have (i.e. your application code that is invoking the engine or invoked by the engine, listeners, etc.) or inside rules (that could be evaluated in the context of a process). At these breakpoints, you can then inspect the internal state of all your process instances.

When debugging the application, you can use the following debug views to track the execution of the process:

1. The process instances view, showing all running process instances (and their state). When double-clicking a process instance, the process instance view visually shows the current state of that process instance at that point in time.
2. The audit view, showing the audit log (note that you should probably use a threaded file logger if you want to session to save the audit event to the file system on regular intervals, so the audit view can be update to show the latest state).
3. The global data view, showing the globals.
4. Other views related to rule execution like the working memory view (showing the contents (data) in the working memory related to rule execution), the agenda view (showing all activated rules), etc.

18.2.1. The Process Instances View

The process instances view shows the process instances currently running in the selected ksession. To be able to use the process instances view, first open the Process Instances view (Window - Show View - Other ... and under the Drools category select Process Instances and Process Instance). Tip: it might be useful to drag the Process Instance view to the Outline View and slightly enlarge it, as shown in the screenshot below, so you can see both the Process Instances and Process Instance views at the same time.

Next, use a (regular) Java breakpoint to stop your application at a specific point (for example right after starting a new process instance). In the Debug perspective, select the ksession you would like to inspect, and the Process Instances view should show the process instances that are currently active inside that ksession. For example, the screenshot below shows one running process instance (with id "1"). When double-clicking a process instance, the process instance viewer will graphically show the progress of that process instance. An example where the process instance is waiting for a human actor to perform "Task 1" is shown below.



Note

The process instances view shows the process instances currently active inside the selected ksession. Note that, when using persistence, process instances are not kept in memory inside the ksession, as they are stored in the database as soon as the command completes. Therefore, you will not be able to use the Process Instances view when using persistence. For example, when executing a JUnit test using the JbpmJUnitBaseTestCase, make sure to call "super(true, false);" in the constructor to create a runtime manager that is not using persistence.

The screenshot shows the Eclipse IDE in the Debug perspective. The main window displays the source code of `ProcessTest.java` with a breakpoint at line 28. The `ProcessInstances` view shows a single active process instance with id=1. The `Process Instance` view shows a graphical representation of the process flow, with the current state being 'Task 1'.

Process Instances View:

id	processName	processId	nodeInstances
1	"Hello World" (id=5908)	"com.sample.bpmn.hello" (id=5907)	Object[] (id=5917)

Process Instance View:

```

graph LR
    Start(( )) --> Task1[Task 1]
    Task1 --> Task2[Task 2]
    Task2 --> End(( ))
  
```



Tip






When you double-click a process instance in the process instances view and the process instance view complains that it cannot find the process, this means that the plugin wasn't able to find the process definition of the selected process instance in the cache of parsed process definitions. To solve this, simply change the process definition in question and save again (so it will be parsed) or rebuild the project that contains the process definition in question.

18.2.2. The Audit View

The audit view can be used to show the all the events inside an audit log in a tree-based manner. An audit log is an XML-based log file which contains a log of all the events that occurred while executing a specific ksession. To create a logger, use `KieServices` to create a new logger and attach it to a ksession. Be sure to close the logger after usage.

```
KieRuntimeLogger logger = KieServices.Factory.get().getLoggers()
    .newThreadedFileLogger(ksession, "mylogfile", 1000);
// do something with the ksession here
logger.close();
```

To be able to use the Audit View, first open it (Window - Show View - Other ... and under the Drools category select Audit). To open up a log file in the audit view, open the selected log file in the audit view (using the "Open Log" action in the top right corner), or simply drag and drop the log file from the Package Explorer or Navigator into the audit view. A tree-based view is generated based on the data inside the audit log. An event is shown as a subnode of another event if the child event is caused by (a direct consequence of) the parent event. An example is shown below.

- ▼  RuleFlow started: ruleflow[com.sample.ruleflow]
- ▼  RuleFlow node triggered: Start in process ruleflow[com.sample.ruleflow]
- ▼  RuleFlow node triggered: Hello in process ruleflow[com.sample.ruleflow]
- ▼  RuleFlow node triggered: End in process ruleflow[com.sample.ruleflow]
-  RuleFlow completed: ruleflow[com.sample.ruleflow]



Tip

Note that the file-based logger will only save the events on close (or when a certain threshold is reached). If you want to make sure the events are saved on a regular interval (for example during debugging), make sure to use a threaded file logger, so the audit view can be update to show the latest state. When creating a threaded

file logger, you can specify the interval after which events should be saved to the file (in milliseconds).

18.3. Synchronizing with Workbench Repositories

From Eclipse, you can synchronize your local workspace with one or more repositories that are managed inside the workbench application. This enables collaboration between developers using Eclipse and users of the web-based workbench (business analysts or end users for example). Synchronization between the workbench repositories and your local version of these projects is done using Git (a popular distributed source code version control system).

When creating and executing processes inside Eclipse, you are creating them on your local file system. You can however also import an existing repository from the Workbench, apply changes and push these changes back into the Workbench repositories. We are using existing Git tools for this. Note that this section will describe how to do this using the EGit tooling (Eclipse Tooling for Git which comes by default with most versions of Eclipse), but feel free to use your preferred Git tool instead.



Note

This section is not intended to explain what Git is, or how to use EGit, in detail. If you don't have any experience with Git and/or EGit, it might be recommended to read up on them first if necessary.

18.3.1. Importing a workbench repository

To import an existing repository from the workbench, you can use the EGit import wizard. In the File menu, select "Import ..." and in the Git category, select "Projects from Git" and click "Next >". This should open a new dialog where you should select the location of the repository you would like to import. Since we are connecting to a repository that is managed by the workbench application, select "URI" and click "Next >" once more.

Use the following URI to connect to your workbench repositories:

```
ssh://<hostname>:8001/<repository_name>
```

For example, if you are running the workbench application on your local host (for example by using the jbpm-installer), and you want to import the jbpm-playground repo, use the following URI:

```
ssh://localhost:8001/jbpm-playground
```

Note that you can change the port that is used by the server to provide ssh access to the git repository if necessary, using the system property `org.uberfire.nio.git.ssh.port`

Fill in the URI of the repository you would like to import, as for example shown below, and click "Next >".

Import Projects from Git

Source Git Repository

Enter the location of the source repository.

Location

URI: Local File...

Host:

Repository path:

Connection

Protocol:

Port:

Authentication

User:

Password:

Store in Secure Store

Figure 18.7.

You will be asked to select which branch you would like to import. Select the master branch and click "Next >" again.

Finally, you need to specify where on your local file system you would like this repository to be created. Fill in the directory (you can use the Browse button to select the folder in question, and if necessary you can create a new folder there as well) and click "Next >". This will now download the repository to the folder you just selected.

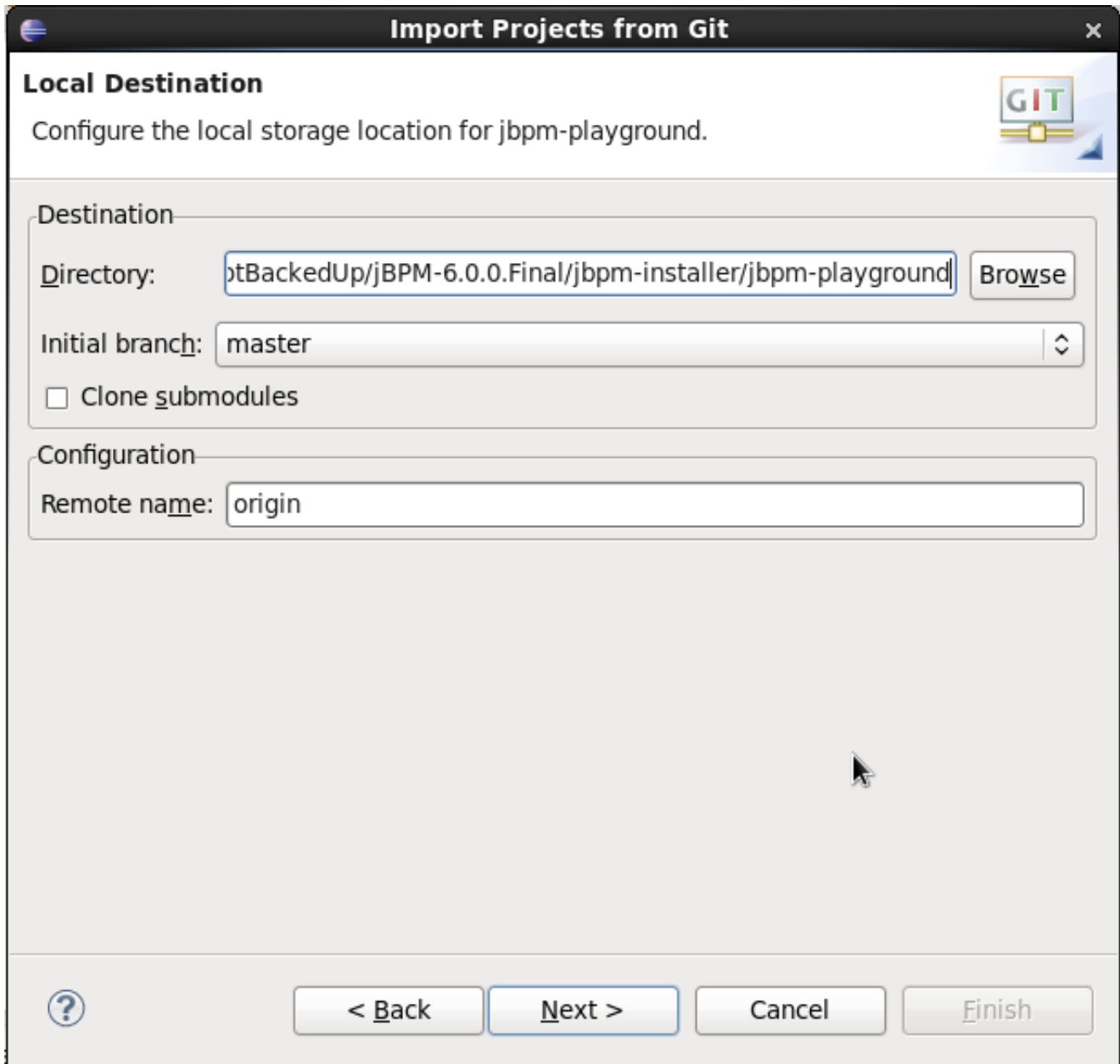


Figure 18.8.

You still need to import the repository you just downloaded as a project in your Eclipse workspace. Select "Import as general project" and after clicking "Next >", give it a name and click "Finish". After doing so, your workspace should now contain your repository, and you should be able to browse, open and edit the various assets inside.

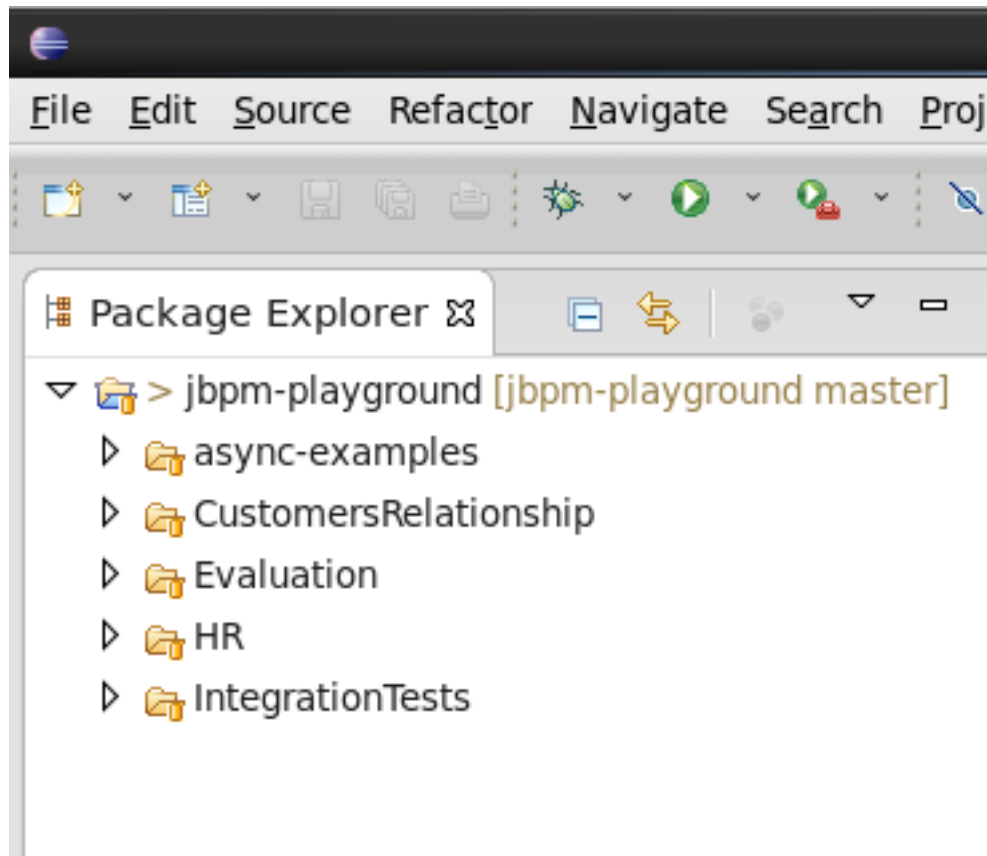


Figure 18.9.

18.3.2. Committing changes to the workbench

You can commit and push changes (you do locally) back to the workbench repositories. To commit changes, right-click on your repository project and select "Team -> Commit ...". A new dialog pops up, showing all the changes you have on your local file system. Select the files you want to commit (if you double-click them, you can get an overview of the changes you did for that file), provide an appropriate commit message and click "Commit".

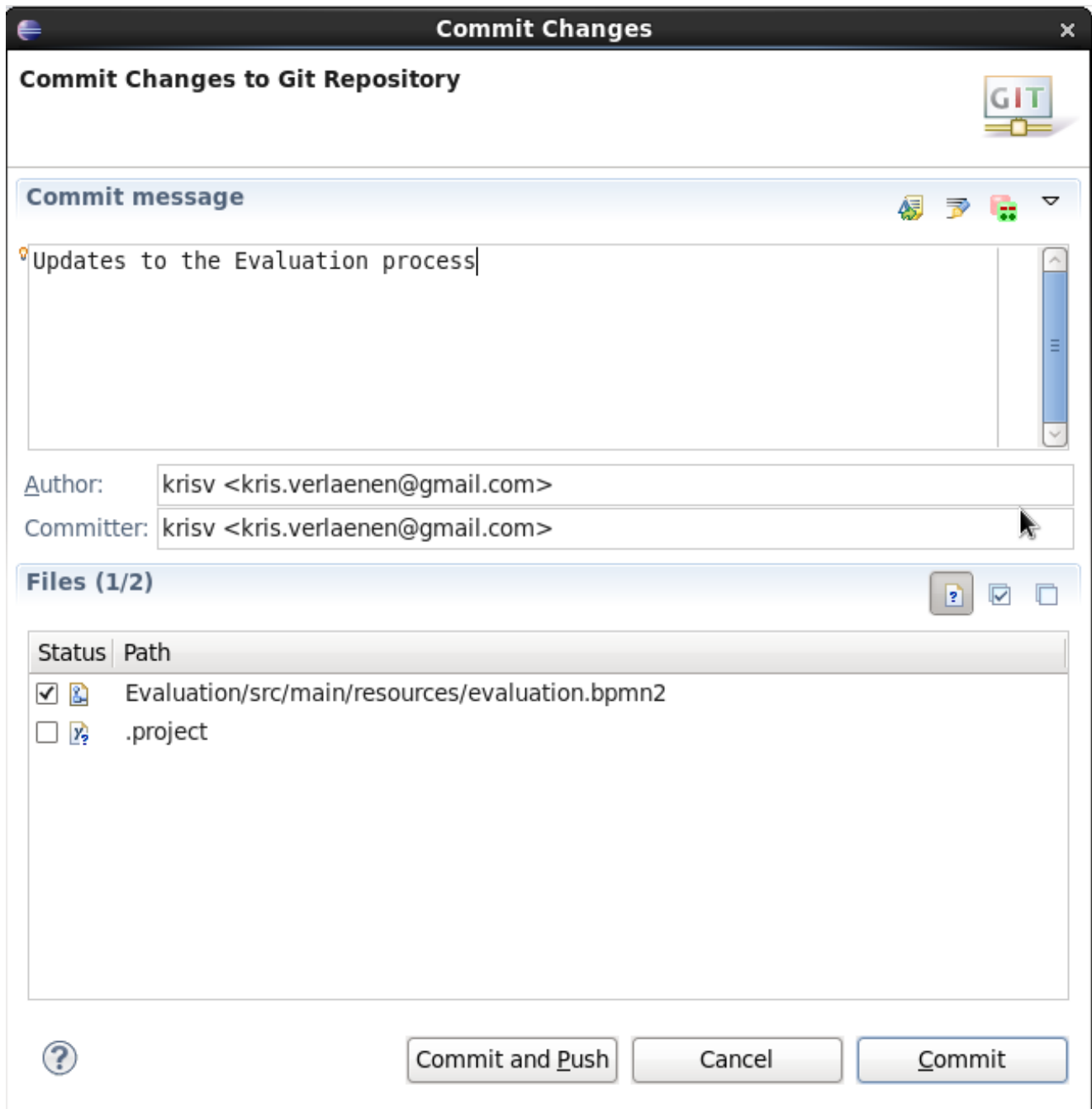


Figure 18.10.

Once you've committed your change to your local git, you still need to push it to the workbench repository. Right-click your project again, and select "Team -> Push to Upstream".



Note

You are only allowed to push changes upstream if your local version includes all recent changes (otherwise you might be overriding someone else's changes). You

might be forced to update (and if necessary resolve conflicts) before you are allowed to commit any changes.

18.3.3. Updating from to the workbench

To retrieve the latest changes from the workbench repository, right-click your repository project and select "Team -> Fetch from Upstream". This will fetch all changes from the workbench repository, but not yet apply them to your local version. Now right-click your project again and select "Team -> Merge ...". In the dialog that pops up next, you need to select "origin/master" branch (under Remote Tracking) to indicate that you want to merge in all changes from the original repository in the workbench, and click "Merge".

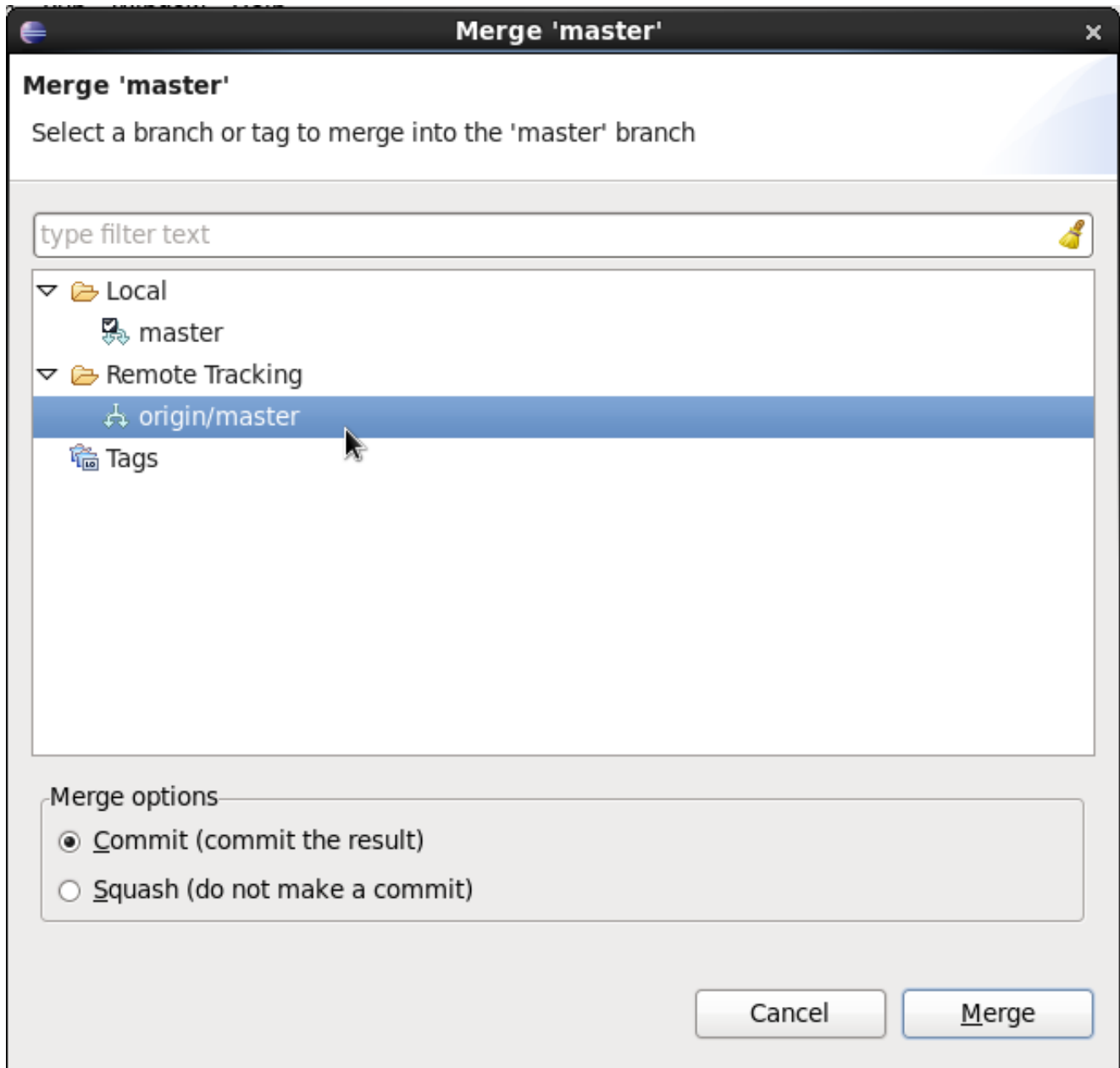


Figure 18.11.



Note

It is possible that you have committed and/or conflicting changes in your local version, you might have to resolve these conflicts and commit the merge results before you will be able to complete the merge successfully. It is recommended to update regularly, before you start updating a file locally, to avoid merge conflicts being detected when trying to commit changes.

18.3.4. Working on individual projects

When you import a repository, it will download all the projects that are inside that repository. It is however useful to mount one specific project as a separate Java project in Eclipse. When you do this, Eclipse will be able to interpret the information in the project pom.xml file (that you created in the workbench), download and include any dependencies you specified, compile any Java classes you have in your project (that you for example created with the data modeler), etc.

To do so, right-click on one of the projects in your repository project and select "Import ..." and under the Maven category, select "Existing Maven Projects" (as shown below) and click Next.

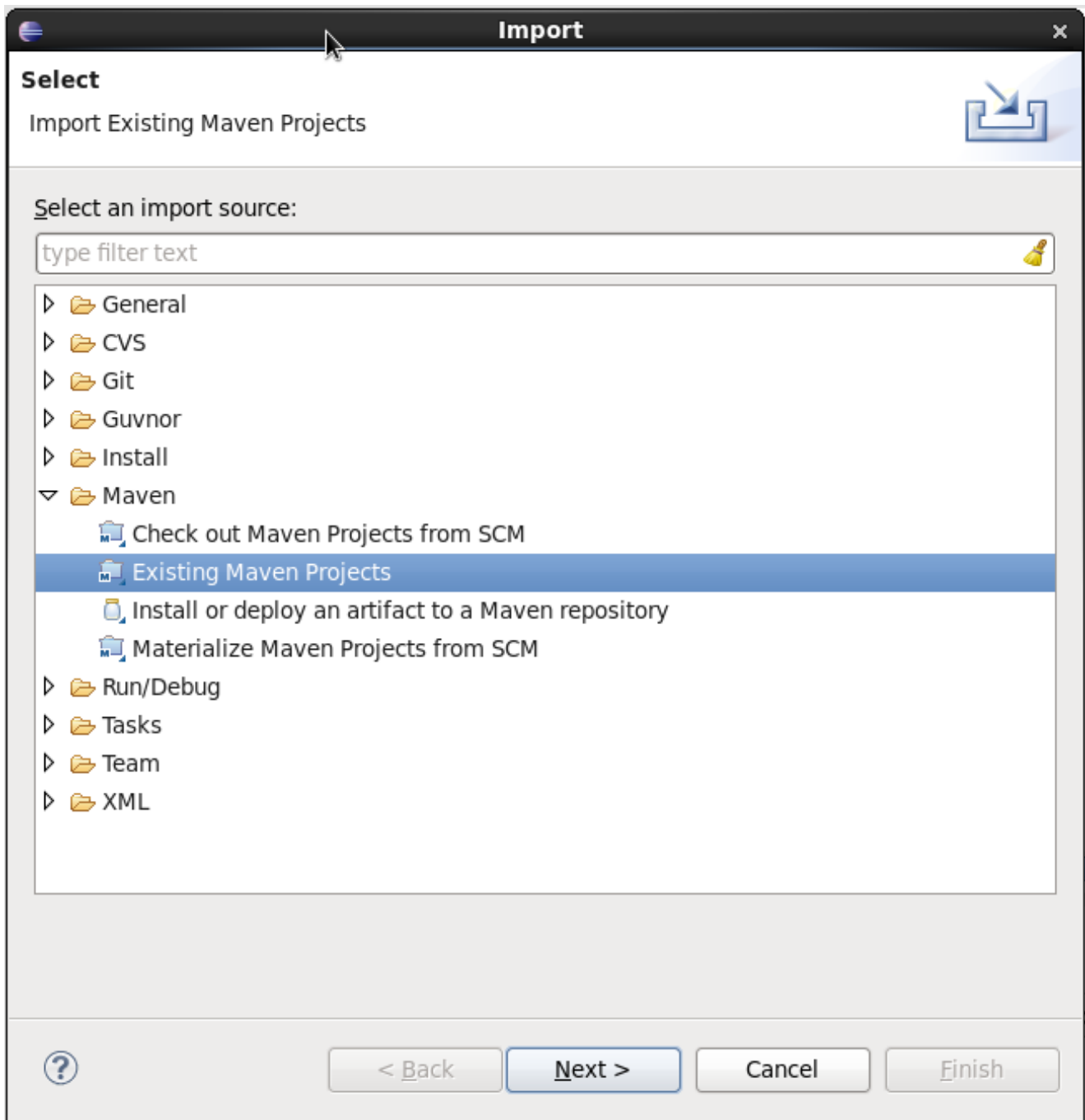


Figure 18.12.

In the next page, you should see the pom.xml of the project you selected. Click Finish.

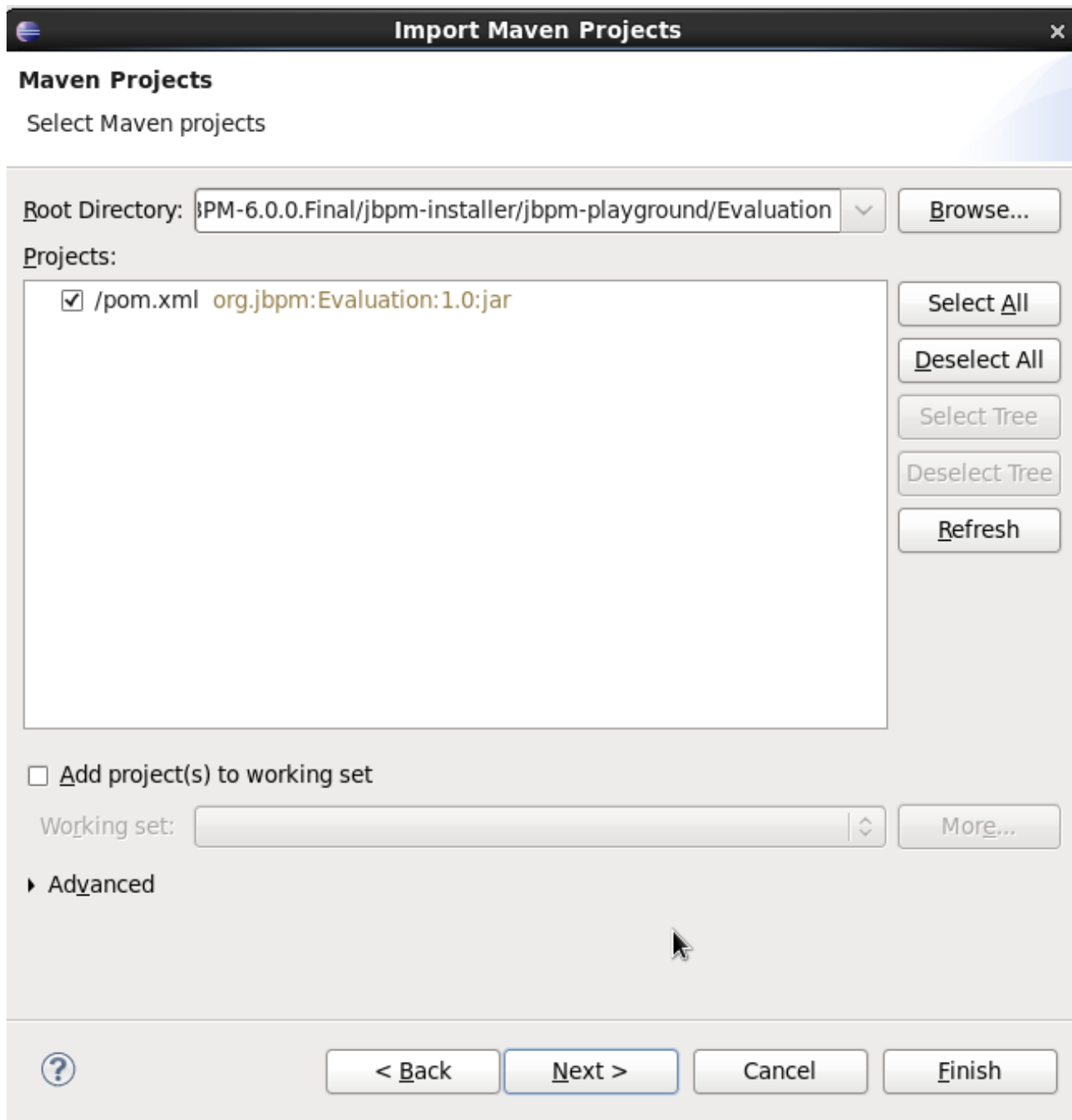


Figure 18.13.

If your project requires some of the jBPM libraries to correctly compile and/or execute any Java classes in your project (for example if you have test classes in your project that start up a jBPM engine and execute some tests for your project, or if you are using the data modeler, which will add some annotations to the generated Java classes), you still need to add the jBPM libraries to the classpath of your project. To do so, simply convert your project into a jBPM project, which will add the jBPM library to your project's classpath. Right-click your project and select "Configure ->

Convert to jBPM Project". Your project should now have a jBPM Library added to its classpath (it might be necessary to clean your project to pick up this change and recompile all Java classes).

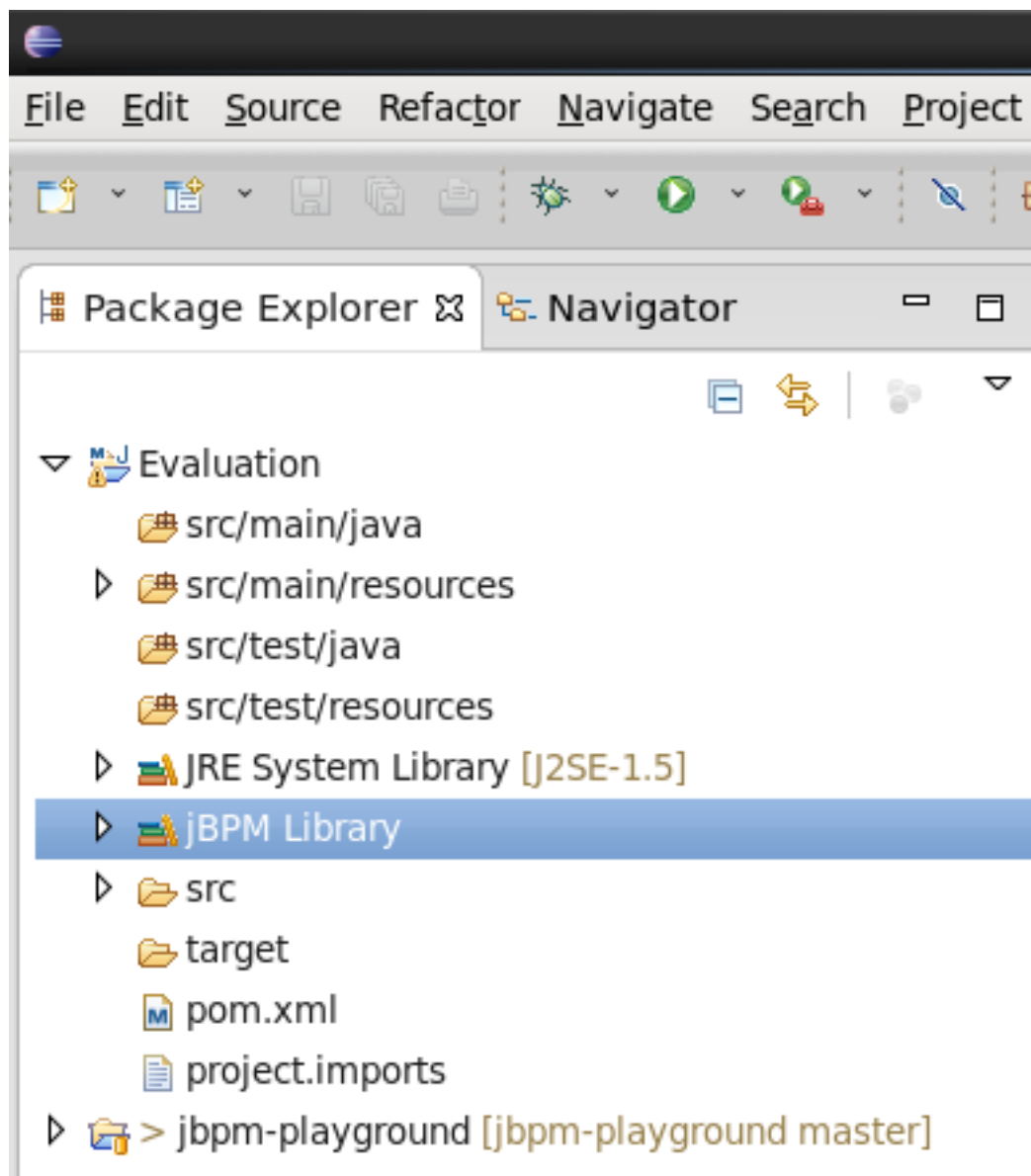


Figure 18.14.

Chapter 19. Eclipse BPMN 2.0 Modeler

19.1. Overview

The Eclipse BPMN 2.0 Modeler allows you to specify business processes, choreographies, etc. using the BPMN 2.0 XML syntax (including BPMNDI for the graphical information). The editor itself is based on the Eclipse Graphiti framework and the Eclipse BPMN 2.0 EMF meta-model.

Features:

- It supports almost all BPMN 2.0 process constructs and attributes (including lanes and pools, annotations and all the BPMN2 node types).
- Added additional support for the few custom attributes that jBPM introduces using a special jBPM Target Runtime.
- Allows you to configure which elements and attributes you want use when modeling processes (so we can limit the constructs for example to the subset currently supported by jBPM, which is a profile supported by default, or even more if you like).

The BPMN2 Modeler project is being developed at eclipse.org, sponsored by Red Hat/JBoss. Red Hat understands the benefits of developing software in the community, and therefore, the Eclipse BPMN 2.0 Modeler was developed not just for the jBPM project only, but it can be used in a much broader context and is fully spec compliant. jBPM-specific features are developed as part of a separate jBPM Target Runtime. We welcome other organizations in contributing to this modeler as well and (re)using the generic functionality and/or defining their own target runtime if necessary. Not only is this a good thing for the community, but it also leaves the path open for the jBPM suite to evolve as new features are requested by customers.

Many thanks go out to the people at Codehoop that did a great job in creating a first version of this editor.

19.2. Installation

The jBPM installer is capable of downloading and installing an Eclipse installation, including the Eclipse BPMN2 Modeler and the Drools and jBPM Eclipse plugin (with a full jBPM runtime pre-configured).



Tip

Using the jBPM installer is definitely the recommended starting point for most users.

You can however also download and install the jBPM Eclipse Plugin manually. To do so, you need Eclipse 3.6.2 (Helios) or newer. To install, startup Eclipse and install the Eclipse BPMN 2.0 Modeler from the following update site (from menu Help -> Install new software and then add the update site in question by clicking the Add button, filling in a name and the correct URL as shown below). It will automatically download all other dependencies as well (e.g. Graphiti etc.)

Eclipse 3.6 (Helios): <http://download.eclipse.org/bpmn2-modeler/updates/helios>

Eclipse 3.7 - 4.2.1 (Indigo - Juno): <http://download.eclipse.org/bpmn2-modeler/updates/juno>

Eclipse 4.3 (Kepler): <http://download.eclipse.org/bpmn2-modeler/updates/kepler>

The project is hosted at eclipse.org and open for anyone to contribute. The project home page can be found here:

<http://http://eclipse.org/bpmn2-modeler/>

Sources are available here (using Eclipse Public License v1.0):

<https://git.eclipse.org/c/bpmn2-modeler/org.eclipse.bpmn2-modeler.git>

A community forum for posting questions and exchanging ideas is also available here:

<http://www.eclipse.org/forums/>

A Bugzilla bug tracking system is available for reporting new bugs, or checking the status of existing bugs, here:

<https://bugs.eclipse.org/bugs/buglist.cgi?product=BPMN2Modeler>

19.3. Documentation

The Eclipse BPMN 2.0 Modeler documentation is available at:

<http://eclipse.org/bpmn2-modeler/documentation.php>

It contains various screencasts but also a full user guide, describing all its features in detail:

<http://eclipse.org/bpmn2-modeler/documentation/UserGuide-v1.0.pdf>

Here are some screenshots of the editor in action.

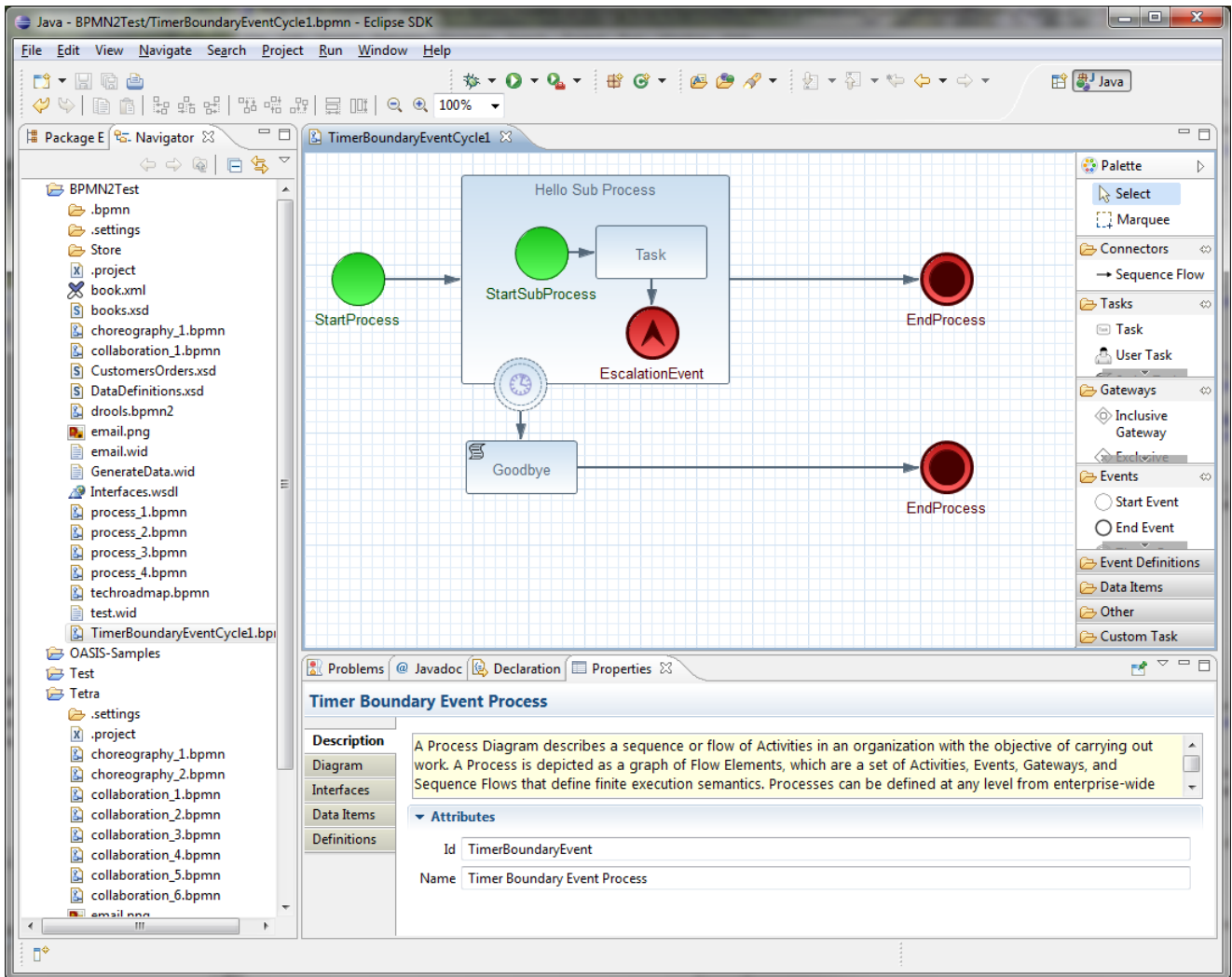


Figure 19.1.

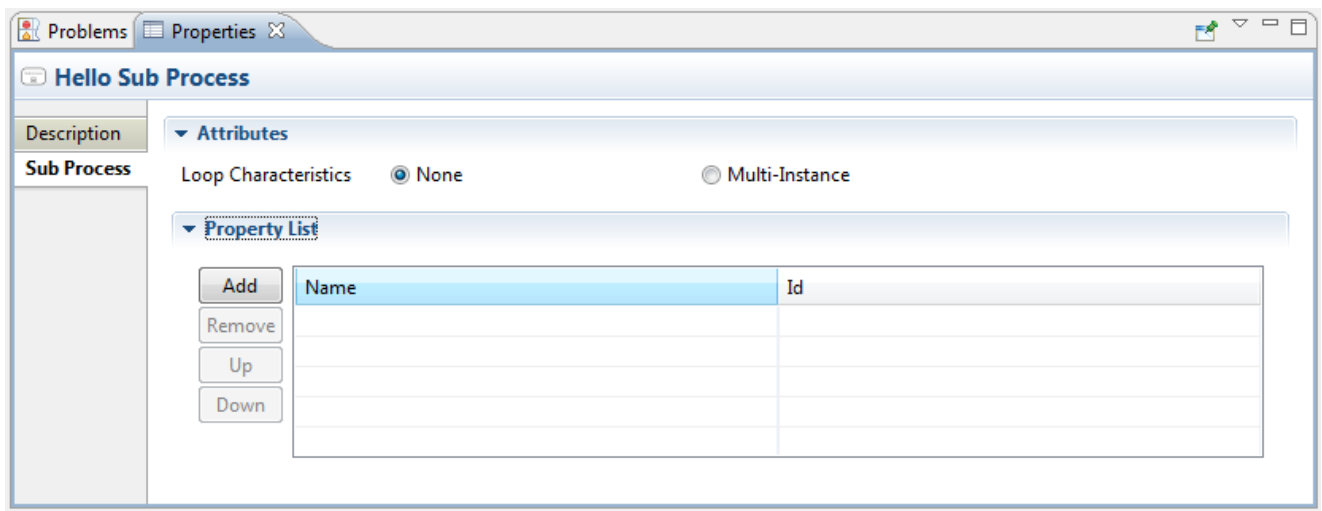


Figure 19.2.

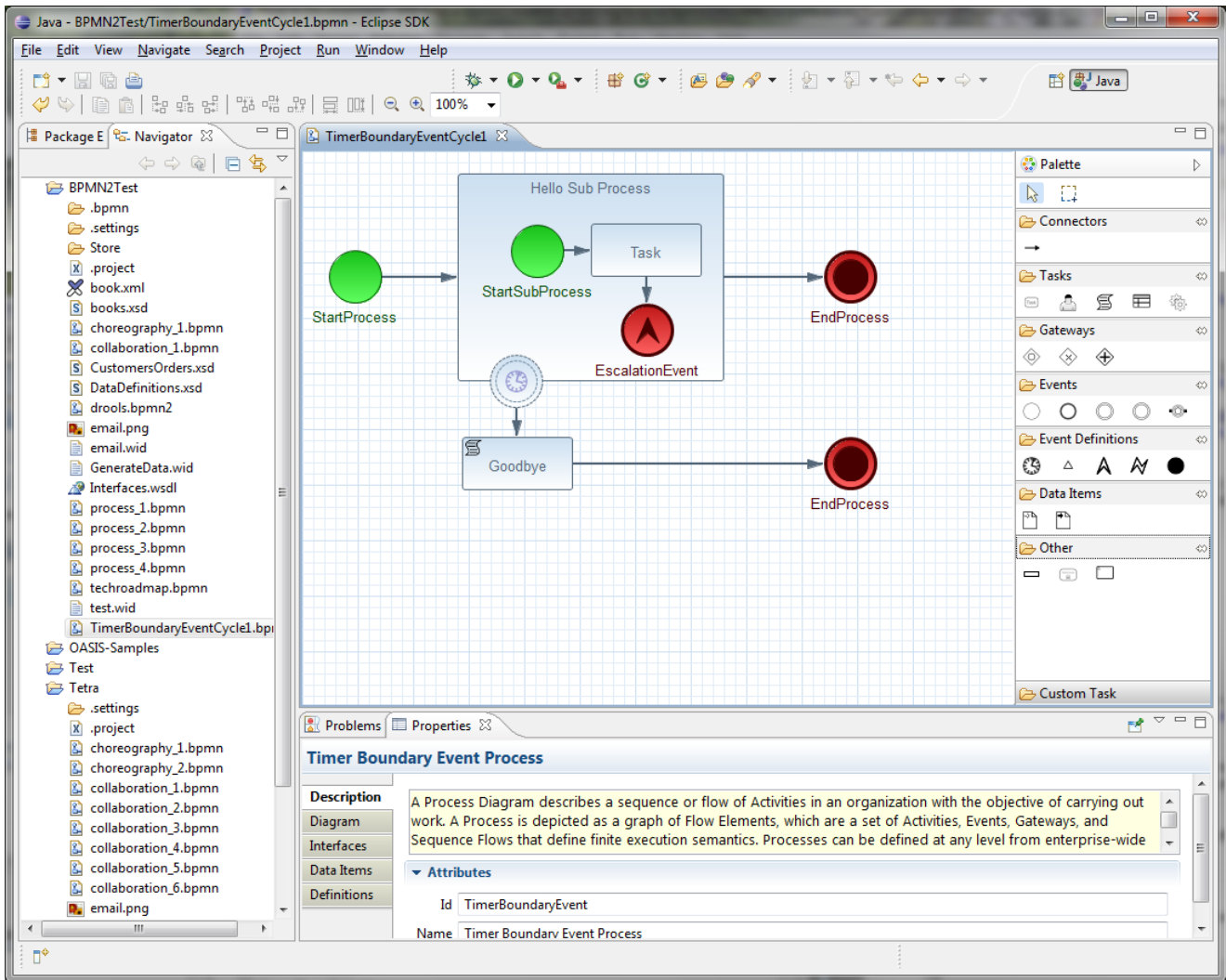


Figure 19.3.

Part V. Integration

Integrating jBPM with other technologies, frameworks, etc.

Chapter 20. Integration

20.1. Maven

Apache Maven is used by jBPM for two main purposes:

- as deployment units that gets installed into runtime environment for execution
- as dependency management tool for building systems based on jBPM - embedding jBPM into application

20.1.1. Maven artifacts as deployment units

Since version 6, jBPM provides simplified and complete deployment mechanism that is based entirely on Apache Maven artifacts. These artifacts also known as **kjars** are simple JAR files that include a descriptor for KIE system to produce KieBase and KieSession. Descriptor of the kjar is represented as XML file named kmodule.xml and it can be:

- empty to apply all defaults
- custom configuration of KieBase and KieSession

```
<kmodule xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http://www.drools.org/xsd/kmodule">
</kmodule>
```

Empty kmodule.xml that provides all defaults for the kjar:

- single default KieBase that
 - contains all assets from all packages
 - event processing mode set to - cloud
 - equality behaviour set to - identity
 - declarative agenda is disabled
 - scope set to - ApplicationScope - valid for CDI integrations only
- single default stateless KieSession that
 - is bound to above (single, default) KieBase

- clock type is set to - real time
- scope set to - ApplicationScope - valid for CDI integrations only
- single default stateful KieSession that
 - is bound to above (single, default) KieBase
 - clock type is set to - real time
 - scope set to - ApplicationScope - valid for CDI integrations only

All these and more can be configured manually via kmodule.xml when defaults are not enough. The complete set of elements can be found in xsd schema [https://github.com/droolsjbpm/droolsjbpm-knowledge/blob/6.0.x/kie-api/src/main/resources/org/kie/api/kmodule.xsd] of kmodule.xml.

```

<kmodule xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
        xmlns="http://www.drools.org/xsd/kmodule">
  <kbase name="defaultKieBase" default="true" eventProcessingMode="cloud" equalsBehavior="identity" declarativeAgenda="true">
    <ksession name="defaultKieSession" type="stateful" default="true" clockType="realtime" scope="javax.enterprise.context.ApplicationScoped">
      <workItemHandlers>
        <workItemHandler name="CustomTask" type="FQCN_OF_HANDLER" />
      </workItemHandlers>
      <listeners>
        <listener type="FQCN_OF_EVENT_LISTENER" />
      </listeners>
    </ksession>
  <ksession name="defaultStatelessKieSession" type="stateless" default="true" clockType="realtime" scope="javax.enterprise.context.ApplicationScoped"/>
  </kbase>
</kmodule>

```

As illustrated in the listing above the kmodule.xml provides flexible way of instructing the runtime engine on what should be configured and how. The example above does not present all available options, but these are the most common when working with processes.



Note

Important to note is that when using RuntimeManager, KieSession instances are created by the RuntimeManager instead of by KieContainer but kmodule.xml (or model in general) is always used as a base of the construction process. KieBase although is always taken from KieContainer.

Kjars are represented same way as any other Maven artifact - by **Group Artifact Version** which is then represented as **ReleaseId** in KIE API. This the the only thing required to deploy kjar into runtime environment such as KIE Workbench.

20.1.2. Use Maven for dependency management

When building systems that embed jBPM as workflow engine the simplest way is to configure all dependencies required by jBPM via Apache Maven. jBPM provides set of BOMs (Bill Of Material) to simplify what artifacts needs to be declared. Common way to start with integration of custom application and jBPM is to define dependency management:

```
<properties>
  <project.build.sourceEncoding>UTF-8</project.build.sourceEncoding>
  <version.org.drools>6.0.0.Final</version.org.drools>
  <version.org.jbpm>6.0.0.Final</version.org.jbpm>
  <hibernate.version>4.2.0.Final</hibernate.version>
  <hibernate.core.version>4.2.0.Final</hibernate.core.version>
  <slf4j.version>1.6.4</slf4j.version>
  <jboss.javaee.version>1.0.0.Final</jboss.javaee.version>
  <logback.version>1.0.9</logback.version>
  <h2.version>1.3.161</h2.version>
  <btm.version>2.1.4</btm.version>
  <junit.version>4.8.1</junit.version>
</properties>
<dependencyManagement>
  <dependencies>
    <!-- define drools BOM -->
    <dependency>
      <groupId>org.drools</groupId>
      <artifactId>drools-bom</artifactId>
      <type>pom</type>
      <version>${version.org.drools}</version>
      <scope>import</scope>
    </dependency>
    <!-- define drools BOM -->
    <dependency>
      <groupId>org.jbpm</groupId>
      <artifactId>jbpm-bom</artifactId>
      <type>pom</type>
      <version>${version.org.jbpm}</version>
      <scope>import</scope>
    </dependency>
  </dependencies>
</dependencyManagement>
```

Above should be declared in top level pom.xml so all modules that need to use KIE (drools and jBPM) API can access it.

Next, module(s) that would operate on KIE API should declare following dependencies:

```
<dependency>
  <groupId>org.jbpm</groupId>
  <artifactId>jbpm-flow</artifactId>
</dependency>
<dependency>
  <groupId>org.jbpm</groupId>
  <artifactId>jbpm-flow-builder</artifactId>
```

```

</dependency>
<dependency>
  <groupId>org.jbpm</groupId>
  <artifactId>jbpm-bpmn2</artifactId>
</dependency>
<dependency>
  <groupId>org.jbpm</groupId>
  <artifactId>jbpm-persistence-jpa</artifactId>
</dependency>
<dependency>
  <groupId>org.jbpm</groupId>
  <artifactId>jbpm-human-task-core</artifactId>
</dependency>
<dependency>
  <groupId>org.jbpm</groupId>
  <artifactId>jbpm-runtime-manager</artifactId>
</dependency>
<dependency>
  <groupId>org.slf4j</groupId>
  <artifactId>slf4j-api</artifactId>
  <version>${slf4j.version}</version>
</dependency>

```

Above are the main runtime dependencies, regardless of where the application is deployed (application server, servlet container, standalone app). A good practice is to test the workflow components to ensure they work properly before actual deployment and thus following test dependencies should be defined:

```

<!-- test dependencies -->
<dependency>
  <groupId>org.jbpm</groupId>
  <artifactId>jbpm-shared-services</artifactId>
  <classifier>btm</classifier>
  <scope>test</scope>
</dependency>
<dependency>
  <groupId>ch.qos.logback</groupId>
  <artifactId>logback-classic</artifactId>
  <version>${logback.version}</version>
  <scope>test</scope>
</dependency>
<dependency>
  <groupId>junit</groupId>
  <artifactId>junit</artifactId>
  <version>${junit.version}</version>
  <scope>test</scope>
</dependency>
<dependency>
  <groupId>org.hibernate</groupId>
  <artifactId>hibernate-entitymanager</artifactId>
  <version>${hibernate.version}</version>
  <scope>test</scope>
</dependency>
<dependency>
  <groupId>org.hibernate</groupId>

```

```
<artifactId>hibernate-core</artifactId>
<version>${hibernate.core.version}</version>
<scope>test</scope>
</dependency>
<dependency>
  <groupId>com.h2database</groupId>
  <artifactId>h2</artifactId>
  <version>${h2.version}</version>
  <scope>test</scope>
</dependency>
<dependency>
  <groupId>org.codehaus.btm</groupId>
  <artifactId>btm</artifactId>
  <version>${btm.version}</version>
  <scope>test</scope>
</dependency>
```

Last but not least, define the JBoss Maven repository for artifacts resolution:

```
<repositories>
  <repository>
    <id>jboss-public-repository-group</id>
    <name>JBoss Public Repository Group</name>
    <url>http://repository.jboss.org/nexus/content/groups/public/</url>
    <releases>
      <updatePolicy>never</updatePolicy>
    </releases>
    <snapshots>
      <updatePolicy>daily</updatePolicy>
    </snapshots>
  </repository>
</repositories>
```

That should allow to configure jBPM in your application and provide access to KIE API to operate on processes, rules, events.

20.2. CDI

20.2.1. Overview

jBPM 6 comes with out of the box integration with CDI (Contexts and Dependency Injection). Although most of the API can be used in CDI world there are some dedicated modules that are designed especially for CDI containers. The most important one is `jbpm-services-cdi` that provides cdi wrappers on top of `jbpm-services`, these shall be used in most of the cases were CDI is available for jBPM integration. It provides following set of services:

- `DeploymentService`
- `ProcessService`

- UserTaskService
- RuntimeDataService
- DefinitionService

These services are first class citizens for CDI world so they are available for injection in any other CDI bean.

20.2.1.1. DeploymentService

Service responsible for deploying DeploymentUnits into runtime environment. By deploying given deployment unit becomes ready for execution and has RuntimeManager created for it. DeploymentService can next be used to retrieve:

- RuntimeManager instance for given deployment id
- DeployedUnit that represents complete deployment process for given deployment id
- list of all deployed units known to the deployment service

Deployment service stores the deployed units by default in memory and thus in case of a need to restore all previously deployed units, component that uses deployment service needs to store that information itself. Common places for such a store are database, file system, repository of some sort, etc. Deployment service will fire CDI events on deployment and undeployment to allow application components to react real time to these events to be able to store deployments or remove them from the store when they are undeployed.

- DeploymentEvent with qualifier @Deploy will be fired on deployment
- DeploymentEvent with qualifier @Undeploy will be fired on undeployment

use CDI observer mechanism to get notification on above events. First to save deployments in the store of your choice:

```
public void saveDeployment(@Observes @Deploy DeploymentEvent event) {  
    // store deployed unit info for further needs  
    DeployedUnit deployedUnit = event.getDeployedUnit();  
}
```

next to remove it when it was undeployed

```
public void removeDeployment(@Observes @Undeploy DeploymentEvent event) {  
    // remove deployment with id event.getDeploymentId()  
}
```



Note

Deployment service comes with deployment synchronization mechanism that allows to persist deployed units into data base (since version 6.2) that is by default enabled. See jbpm services section for more details.

Due to the fact that there might be several implementation of `DeploymentService` use of qualifiers is needed to instruct CDI container which one shall be injected. jBPM comes with two out of the box:

- `@Kjar` - `KmoduleDeploymentService` that is tailored to work with `KmoduleDeploymentUnits` that are small descriptor on top of a `kjar` - recommended to use in most of the cases
- `@Vfs` - `VFSDeploymentService` that allows to deploy assets directly from VFS (Virtual File System) that is provided by UberFire framework [<http://droolsjbpm.github.io/uberfire/>]. Due to that fact `VFSDeploymentService` and `VFSDeploymentUnit` are not bundled with jbpm core modules but with `jbpm-console-ng` modules.

The general practice is that every implementation of `DeploymentService` should come with dedicated implementation of `DeploymentUnit` as these two provided out of the box.

20.2.1.2. FormProviderService

`FormProviderService` provides access to form representations usually displayed on UI for both process forms and user task forms. It is built on concept of isolated `FormProviders` that can provide different capabilities and be backed by different technologies. `FormProvider` interface describes contract for the implementations

```
public interface FormProvider {  
  
    int getPriority();  
  
    String render(String name, ProcessDesc process, Map<String, Object> renderContext);  
  
    String render(String name, Task task, ProcessDesc process, Map<String, Object> renderContext);  
}
```

Implementations of `FormProvider` interface should always define priority as this is the main driver for the `FormProviderService` to ask for the content of the form of a given provider. `FormProviderService` will collect all available providers and iterate over them asking for the form content (rendered) in their priority order. The lower the number the higher priority it gets during evaluation, e.g. provider with priority 5 will be evaluated before provider with priority 10. `FormProviderService` will iterate over available providers as long as one delivers the content. In the worse case scenario, simple text based forms will be returned.

jBPM comes with following FormProviders out of the box:

- Freemarker based implementation to support jbpm version 5 process and task forms - priority 3
- Default forms provider, considered last resort if none of the other providers deliver content this one will always provide simplest possible forms - lowest priority (1000)
- when form modeler is used there is additional FormProvider available to deliver forms modeled in that tool - priority 2

20.2.1.3. RuntimeDataService

RuntimeDataService provides access to actual data that is available on runtime such as

- available processes to be executed - with various filters
- active process instances - with various filters
- process instance history
- process instance variables
- active and completed nodes of process instance

Default implementation of RuntimeDataService is observing deployment events and index all deployed processes to expose them to the calling components. So whatever gets deployed RuntimeDataService will be aware of that.

20.2.1.4. DefinitionService

Service that provides access to process details stored as part of BPMN2 XML.



Note

Before using any method that provides information, **buildProcessDefinition** must be invoked to populate repository with process information taken from BPMN2 content.

BPMN2DataService provides access to following data:

- overall description of process for given process definition
- collection of all user tasks found in the process definition

- information about defined inputs for user task node
- information about defined outputs for user task node
- ids of reusable processes (call activity) defined within given process definition
- information about process variables defined within given process definition
- information about all organizational entities (users and groups) included in the process definition. Depending on the actual process definition the returned values for users and groups can contain
 - actual user or group name
 - process variable that will be used to get actual user or group name on runtime e.g. #{manager}

20.2.2. Configuring CDI integration

To make use of `jbpm-services-cdi` in your system you'll need to provide some beans for the out of the box services to satisfy all dependencies they have. There are several beans that depends on actual scenario

- entity manager and entity manager factory
- user group callback for human tasks
- identity provider to pass authenticated user information to the services

When running in JEE environment like an JBoss Application Server following producer bean should satisfy all requirements of the `jbpm-services-cdi`

```
public class EnvironmentProducer {

    @PersistenceUnit(unitName = "org.jbpm.domain")
    private EntityManagerFactory emf;

    @Inject
    @Selectable
    private UserGroupInfoProducer userGroupInfoProducer;

    @Inject
    @Kjar
    private DeploymentService deploymentService;

    @Produces
    public EntityManagerFactory getEntityManagerFactory() {
        return this.emf;
    }

    @Produces
    public org.kie.api.task.UserGroupCallback produceSelectedUserGroupCallback() {
        return userGroupInfoProducer.produceCallback();
    }
}
```

```

}

@Produces
public UserInfo produceUserInfo() {
    return userGroupInfoProducer.produceUserInfo();
}

@Produces
@Named("Logs")
public TaskLifecycleEventListener produceTaskAuditListener() {
    return new JPATaskLifecycleEventListener(true);
}

@Produces
public DeploymentService getDeploymentService() {
    return this.deploymentService;
}

@Produces
public IdentityProvider produceIdentityProvider() {
    return new IdentityProvider() {
        // implement IdentityProvider
    };
}
}

```

Then beans.xml for the application should enable proper alternative for user group callback (that will be taken based on `@Selectable` qualifier)

```

<beans xmlns="http://java.sun.com/xml/ns/javaee" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://java.sun.com/xml/ns/javaee http://docs.jboss.org/cdi/beans_1_0.xsd">

    <alternatives>
        <class>org.jbpm.kie.services.cdi.producer.JAASUserGroupInfoProducer</class>
    </alternatives>

</beans>

```



Note

org.jbpm.kie.services.cdi.producer.JAASUserGroupInfoProducer is just an example here which usually is the good fit for JBoss Application Server to reuse security settings on application server regardless of what it actually is (LDAP, DB, etc). Check Human Task section for more alternatives for UserGroupCallback.

Optionally there can be several other producers provided to deliver:

- WorkItemHandlers

- Process, Agenda, WorkingMemory event listeners

These components can be provided by implementing following interfaces

```

/**
 * Allows to provide custom implementations to deliver WorkItem name and WorkItemHandler instance pairs
 * for the runtime.
 * <br/>
 * It will be invoked by RegisterableItemsFactory implementation (especially InjectableRegisterableItemsFactory
 * in CDI world) for every KieSession. Recommendation is to always produce new instances to avoid unexpected
 * results.
 *
 */
public interface WorkItemHandlerProducer {

    /**
     * Returns map of (key = work item name, value work item handler instance) of work items
     * to be registered on KieSession
     * <br/>
     * Parameters that might be given are as follows:
     * <ul>
     * <li>ksession</li>
     * <li>taskService</li>
     * <li>runtimeManager</li>
     * </ul>
     *
     * @param identifier - identifier of the owner - usually RuntimeManager that allows the producer to filter out
     * and provide valid instances for given owner
     * @param params - owner might provide some parameters, usually KieSession, TaskService, RuntimeManager instance
     * @return map of work item handler instances (recommendation is to always return new instances when this method is called)
     */
    Map<String, WorkItemHandler> getWorkItemHandlers(String identifier, Map<String, Object> params);
}

```

and

```

/**
 * Allows do define custom producers for know EventListeners. Intention of this is that there might be several
 * implementations that might provide different listener instance based on the context they are executed in.
 * <br/>
 * It will be invoked by RegisterableItemsFactory implementation (especially InjectableRegisterableItemsFactory
 * in CDI world) for every KieSession. Recommendation is to always produce new instances to avoid unexpected
 * results.
 *
 * @param <T> type of the event listener - ProcessEventListener, AgendaEventListener, WorkingMemoryEventListener
 */
public interface EventListenerProducer<T> {

    /**
     * Returns list of instances for given (T) type of listeners
     * <br/>
     * Parameters that might be given are as follows:
     * <ul>
     * <li>ksession</li>
     * <li>taskService</li>
     *
     */
}

```

```

* <li>runtimeManager</li>
* </ul>
* @param identifier - identifier of the owner - usually RuntimeManager that allows the producer to filter out
* and provide valid instances for given owner
* @param params - owner might provide some parameters, usually KieSession, TaskService, RuntimeManager instance
* @return list of listener instances (recommendation is to always return new instances when this method is invoked)
*/
List<T> getEventListeners(String identifier, Map<String, Object> params);
}

```

Beans implementing these two interfaces will be collected on runtime and consulted when building `KieSession` by `RuntimeManager`. See `RuntimeManager` section for more details on this.

A complete runnable example of application built with CDI can be found here [<https://github.com/jsvitak/jbpm-6-examples/tree/master/rewards-cdi-jsf>].

20.2.3. RuntimeManager as CDI bean



Note

Even though `RuntimeManager` can be directly injected, it's recommended to utilize `jbpm` services when frameworks like CDI, `ejb` or `Spring` is used. `jbpm` services bring in significant amount of features that encapsulate best practices when using `RuntimeManager`.

`RuntimeManager` itself can be injected as CDI bean into any other CDI bean within the application. It has then requirement to get `RuntimeEnvironment` properly produces to allow `RuntimeManager` to be correctly initialized. `RuntimeManager` comes with three predefined strategies and each of them gets CDI qualifier so it can be referenced:

- `@Singleton`
- `@PerRequest`
- `@PerProcessInstance`

Producer that was defined in `Configuration` section should be now enhanced with producer methods to provide `RuntimeEnvironment`

```

public class EnvironmentProducer {

    //add same producers as for services

    @Produces
    @Singleton
    @PerRequest
    @PerProcessInstance
}

```

```

public RuntimeEnvironment produceEnvironment(EntityManagerFactory emf) {

    RuntimeEnvironment environment = RuntimeEnvironmentBuilder.Factory.get()
        .newDefaultBuilder()
        .entityManagerFactory(emf)
        .userGroupCallback(getUserGroupCallback())
        .registerableItemsFactory(InjectableRegisterableItemsFactory.getFactory(beanManager, null))
        .addAsset(ResourceFactory.newClassPathResource("BPMN2-
ScriptTask.bpmn2"), ResourceType.BPMN2)
        .addAsset(ResourceFactory.newClassPathResource("BPMN2-
UserTask.bpmn2"), ResourceType.BPMN2)
        .get();
    return environment;
}
}

```

In this example single producer method is capable of providing RuntimeEnvironment for all strategies of RuntimeManager by specifying all qualifiers on the method level.

Once complete producer is available, RuntimeManager can be injected into application's CDI bean

```

public class ProcessEngine {

    @Inject
    @Singleton
    private RuntimeManager singletonManager;

    public void startProcess() {

        RuntimeEngine runtime = singletonManager.getRuntimeEngine(EmptyContext.get());
        KieSession ksession = runtime.getKieSession();

        ProcessInstance processInstance = ksession.startProcess("UserTask");

        singletonManager.disposeRuntimeEngine(runtime);
    }
}

```

That's all what needs to be configured to make use of CDI power with jBPM.



Note

An obvious limitation of injecting directly RuntimeManager via CDI is that there might be only one RuntimeManager in the application. That in some case can be desired and that's why there is such option. In general recommended approach is to make use of DeploymentService whenever there is a need to have many RuntimeManagers active within application.

As an alternative to DeploymentService, RuntimeManagerFactory can be injected and then RuntimeManager instance can be created manually by the application. In such case EnvironmentPro-

ducer stays same as for DeploymentService and following is an example of simple ProcessEngine bean

```
public class ProcessEngine {

    @Inject
    private RuntimeManagerFactory managerFactory;

    @Inject
    private EntityManagerFactory emf;

    @Inject
    private BeanManager beanManager;

    public void startProcess() {
        RuntimeEnvironment environment = RuntimeEnvironmentBuilder.Factory.get()
            .newDefaultBuilder()
            .entityManagerFactory(emf)
            .addAsset(ResourceFactory.newClassPathResource("BPMN2-ScriptTask.bpmn2"), ResourceType.BPMN2)
            .addAsset(ResourceFactory.newClassPathResource("BPMN2-UserTask.bpmn2"), ResourceType.BPMN2)
            .registerableItemsFactory(InjectableRegisterableItemsFactory.getFactory(beanManager, null))
            .get();

        RuntimeManager manager = managerFactory.newSingletonRuntimeManager(environment);
        RuntimeEngine runtime = manager.getRuntimeEngine(EmptyContext.get());
        KieSession ksession = runtime.getKieSession();

        ProcessInstance processInstance = ksession.startProcess("UserTask");

        manager.disposeRuntimeEngine(runtime);
        manager.close();
    }
}
```

20.3. Spring

jBPM can be configured in many ways with Spring though the two most frequently used approaches are:

- direct use of runtime manager API
- use of jbpm services

While both approaches are tested and valid, which one to choose is a matter of the system functionality. Before selecting one of the approaches the most important question to ask is:

Will my system run multiple runtime managers at the same time?

If the answer to this question is no, then go ahead with direct Runtime Manager API as it will be the simplest way to use jBPM within your application. But when answer is yes, then go ahead with

jbpm services as they encapsulate runtime manager API with best practices by providing dynamic runtime environment for your BPM logic - also known as execution server.

20.3.1. Direct use of Runtime Manager API

This is the standard (and the simplest) way to get up and running with jBPM in your application. You only configure it once and run as part of the application. With the `RuntimeManager` usage, both process engine and task service will be managed in complete synchronization, meaning there is no need from end user to deal with "plumbing" code to make these two work together.

To provide spring based way of setting up jBPM, few factory beans were added:

- `org.kie.spring.factorybeans.RuntimeEnvironmentFactoryBean`
- `org.kie.spring.factorybeans.RuntimeManagerFactoryBean`
- `org.kie.spring.factorybeans.TaskServiceFactoryBean`

FactoryBeans provide standard way to configure Spring application spring xml though there are not custom spring xml tags equivalent for them.

20.3.1.1. RuntimeEnvironmentFactoryBean

Factory responsible for producing instances of `RuntimeEnvironment` that are consumed by `RuntimeManager` upon creation. It allows to create following types of `RuntimeEnvironment` (that mainly means what is configured by default):

- `DEFAULT` - default (most common) configuration for `RuntimeManager`
- `EMPTY` - completely empty environment to be manually populated
- `DEFAULT_IN_MEMORY` - same as `DEFAULT` but without persistence of the runtime engine
- `DEFAULT_KJAR` - same as `DEFAULT` but knowledge asset are taken from KJAR identified by `releaseid` or `GAV`
- `DEFAULT_KJAR_CL` - build directly from classpath that consists `kmodule.xml` descriptor

Mandatory properties depends on the selected type but knowledge information must be given for all types. That means that one of the following must be provided:

- `knowledgeBase`
- `assets`
- `releaseId`
- `groupId`, `artifactId`, `version`

Next for DEFAULT, DEFAULT_KJAR, DEFAULT_KJAR_CL persistence needs to be configured:

- entity manager factory
- transaction manager

Transaction Manager must be Spring transaction manager as based on its presence entire persistence and transaction support is configured. Optionally EntityManager can be provided to be used instead of always creating new one from EntityManagerFactory - e.g. when using shared entity manager from Spring. All other properties are optional and are meant to override the default given by type of the environment selected.

20.3.1.2. RuntimeManagerFactoryBean

FactoryBean responsible for creation of RuntimeManager instances of given type based on provided runtimeEnvironment. Supported types:

- SINGLETON
- PER_REQUEST
- PER_PROCESS_INSTANCE

where default is SINGLETON when no type is specified. Every runtime manager must be uniquely identified thus identifier is a mandatory property. All instances created by this factory are cached to be able to properly dispose them using destroy method (close()).

20.3.1.3. TaskServiceFactoryBean

Creates instance of TaskService based on given properties. Following are mandatory properties that must be provided:

- entity manager factory
- transaction manager

Transaction Manager must be Spring transaction manager as based on its presence entire persistence and transaction support is configured. Optionally EntityManager can be provided to be used instead of always creating new one from EntityManagerFactory - e.g. when using shared entity manager from Spring. In addition to above there are optional properties that can be set on task service instance:

- userGroupCallback - implementation of UserGroupCallback to be used, defaults to MVELUserGroupCallbackImpl
- userInfo - implementation of UserInfo to be used, defaults to DefaultUserInfo

- listener - list of TaskLifecycleEventListener that will be notified upon various operations on tasks

This factory creates single instance of task service only as it's intended to be shared across all other beans in the system.

20.3.1.4. Sample configuration of RuntimeManager with Spring

Following section aims at giving complete spring configuration for single runtime manager within spring application context.

1. Setup entity manager factory and transaction manager:

```
<bean id="jbpmEMF"
class="org.springframework.orm.jpa.LocalContainerEntityManagerFactoryBean">
  <property name="persistenceUnitName" value="org.jbpm.persistence.spring.jta"/>
</bean>

<bean id="btmConfig" factory-method="getConfiguration"
class="bitronix.tm.TransactionManagerServices"></bean>

<bean id="BitronixTransactionManager" factory-method="getTransactionManager"
class="bitronix.tm.TransactionManagerServices" depends-on="btmConfig" destroy-
method="shutdown" />

<bean id="jbpmTxManager" class="org.springframework.transaction.jta.JtaTransactionManager">
  <property name="transactionManager" ref="BitronixTransactionManager" />
  <property name="userTransaction" ref="BitronixTransactionManager" />
</bean>
```

with this we have ready persistence configuration that gives us:

- JTA transaction manager (backed by bitronix - for unit tests or servlet containers)
- entity manager factory for persistence unit named org.jbpm.persistence.spring.jta

2. Configure resource that we are going to use - business process

```
<bean id="process" factory-method="newClassPathResource"
class="org.kie.internal.io.ResourceFactory">
  <constructor-arg>
    <value>jbpm/processes/sample.bpmn</value>
  </constructor-arg>
</bean>
```

this configures single process that will be available for execution - sample.bpmn that will be taken from class path. This is the simplest way to get your processes included when trying out jbpm.

3. Configure RuntimeEnvironment with our infrastructure (entity manager, transaction manager, resources)

```

<bean id="runtimeEnvironment"
class="org.kie.spring.factorybeans.RuntimeEnvironmentFactoryBean">
  <property name="type" value="DEFAULT"/>
  <property name="entityManagerFactory" ref="jbpmEMF"/>
  <property name="transactionManager" ref="jbpmTxManager"/>
  <property name="assets">
    <map>
      <entry key-ref="process"><util:constant static-
field="org.kie.api.io.ResourceType.BPMN2"/></entry>
    </map>
  </property>
</bean>

```

that gives us default runtime environment ready to be used to create instance of a Runtime-Manager.

4. Create RuntimeManager with the environment we just setup

```

<bean id="runtimeManager" class="org.kie.spring.factorybeans.RuntimeManagerFactoryBean"
destroy-method="close">
  <property name="identifier" value="spring-rm"/>
  <property name="runtimeEnvironment" ref="runtimeEnvironment"/>
</bean>

```

with just four steps you are ready to execute your processes with Spring and jBPM 6, utilizing EntityManagerFactory and JTA transaction manager.

Complete spring configuration file can be found here [<https://github.com/droolsjbpm/droolsjbpm-integration/blob/master/kie-spring/src/test/resources/jbpm/jta-emf/jta-emf-spring.xml>].

This is just one configuration setup that jBPM 6 supports - JTA transaction manager and EntityManagerFactory, others are:

- JTA and SharedEntityManager
- Local Persistence Unit and EntityManagerFactory
- Local Persistence Unit and SharedEntityManager

For more details about difference configuration options look at the example configuration files [<https://github.com/droolsjbpm/droolsjbpm-integration/tree/master/kie-spring/src/test/resources/jbpm>] and test cases [<https://github.com/droolsjbpm/droolsjbpm-integration/tree/master/kie-spring/src/test/java/org/kie/spring/jbpm>].

20.3.2. jBPM services with Spring

In case more dynamic nature is required in your Spring application then more appropriate could be to build up so called execution server based on jbpm services. jBPM services has been designed in a way to make them framework agnostic and in case framework specific addons are required they will be brought by additional module. So the code logic of the services is embedded in jbpm-kie-services. These are pure java services and by that can be easily consumed by Spring application.

Dynamic nature means that processes (And other assets like data model, rules, forms, etc) can be added and removed without restarting application.

There is almost no code involved to completely configure jBPM services in spring besides single interface that needs to be implemented - IdentityProvider that depends on your security configuration. One built with Spring Security can be like following though it might not cover all features one can have for Spring application.

```
import java.util.ArrayList;
import java.util.Collections;
import java.util.List;

import org.kie.internal.identity.IdentityProvider;
import org.springframework.security.core.Authentication;
import org.springframework.security.core.GrantedAuthority;
import org.springframework.security.core.context.SecurityContextHolder;

public class SpringSecurityIdentityProvider implements IdentityProvider {

    public String getName() {

        Authentication auth = SecurityContextHolder.getContext().getAuthentication();
        if (auth != null && auth.isAuthenticated()) {
            return auth.getName();
        }
        return "system";
    }

    public List<String> getRoles() {
        Authentication auth = SecurityContextHolder.getContext().getAuthentication();
        if (auth != null && auth.isAuthenticated()) {
            List<String> roles = new ArrayList<String>();

            for (GrantedAuthority ga : auth.getAuthorities()) {
                roles.add(ga.getAuthority());
            }

            return roles;
        }

        return Collections.emptyList();
    }

    public boolean hasRole(String role) {
        return false;
    }
}
```

```
}
}
```

20.3.2.1. Configure jBPM services in Spring application

As usual, first thing to start with is transaction configuration:

```
<context:annotation-config />
<tx:annotation-driven />
<tx:jta-transaction-manager />

<bean                                     id="transactionManager"
  class="org.springframework.transaction.jta.JtaTransactionManager" />
```

Next configuration of JPA and persistence follows:

```
<bean                                     id="entityManagerFactory"
  class="org.springframework.orm.jpa.LocalContainerEntityManagerFactoryBean"
  on="transactionManager">
  <property name="persistenceXmlLocation" value="classpath:/META-INF/jbpm-persistence.xml" />
</bean>
```

Configure security and user/group information providers

```
<util:properties id="roleProperties" location="classpath:/roles.properties" />

<bean                                     id="userGroupCallback"
  class="org.jbpm.services.task.identity.JBossUserGroupCallbackImpl">
  <constructor-arg name="userGroups" ref="roleProperties"></constructor-arg>
</bean>

<bean id="identityProvider" class="org.jbpm.spring.SpringSecurityIdentityProvider"/>
```

Configure runtime manager factory that is Spring context aware and by that can interact with spring container in correct way and supporting services (transactional command service and task service)

```
<bean                                     id="runtimeManagerFactory"
  class="org.kie.spring.manager.SpringRuntimeManagerFactoryImpl">
  <property name="transactionManager" ref="transactionManager" />
  <property name="userGroupCallback" ref="userGroupCallback" />
</bean>
```

```

<bean id="transactionCmdService"
      class="org.jbpm.shared.services.impl.TransactionalCommandService">
  <constructor-arg name="emf" ref="entityManagerFactory"></constructor-arg>
</bean>

<bean id="taskService" class="org.kie.spring.factorybeans.TaskServiceFactoryBean" destroy-
method="close">
  <property name="entityManagerFactory" ref="entityManagerFactory"/>
  <property name="transactionManager" ref="transactionManager"/>
  <property name="userGroupCallback" ref="userGroupCallback"/>
  <property name="listeners">
    <list>
      <bean class="org.jbpm.services.task.audit.JPATaskLifecycleEventListener">
        <constructor-arg value="true"/>
      </bean>
    </list>
  </property>
</bean>

```

Configure jBPM services as spring beans

```

<!-- definition service -->
<bean id="definitionService" class="org.jbpm.kie.services.impl.bpmn2.BPMN2DataServiceImpl"/>

<!-- runtime data service -->
<bean id="runtimeDataService" class="org.jbpm.kie.services.impl.RuntimeDataServiceImpl">
  <property name="commandService" ref="transactionCmdService"/>
  <property name="identityProvider" ref="identityProvider"/>
  <property name="taskService" ref="taskService"/>
</bean>

<!-- -- deployment service -->
<bean id="deploymentService" class="org.jbpm.kie.services.impl.KModuleDeploymentService"
      depends-on="entityManagerFactory" init-method="onInit">
  <property name="bpmn2Service" ref="definitionService"/>
  <property name="emf" ref="entityManagerFactory"/>
  <property name="managerFactory" ref="runtimeManagerFactory"/>
  <property name="identityProvider" ref="identityProvider"/>
  <property name="runtimeDataService" ref="runtimeDataService"/>
</bean>

<!-- process service -->
<bean id="processService" class="org.jbpm.kie.services.impl.ProcessServiceImpl" depends-
on="deploymentService">
  <property name="dataService" ref="runtimeDataService"/>
  <property name="deploymentService" ref="deploymentService"/>
</bean>

<!-- user task service -->
<bean id="userTaskService" class="org.jbpm.kie.services.impl.UserTaskServiceImpl" depends-
on="deploymentService">
  <property name="dataService" ref="runtimeDataService"/>
  <property name="deploymentService" ref="deploymentService"/>
</bean>

```

```
<!-- register runtime data service as listener on deployment service so it can receive notification
about deployed and undeployed units -->
<bean id="data" class="org.springframework.beans.factory.config.MethodInvokingFactoryBean"
depends-on="deploymentService">
  <property name="targetObject" ref="deploymentService"></property>
  <property name="targetMethod"><value>addListener</value></property>
  <property name="arguments">
    <list>
      <ref bean="runtimeDataService" />
    </list>
  </property>
</bean>
```

And this is all is needed to build fully featured execution server with Spring and jBPM services. A complete Spring web application with this setup can be found here [<https://github.com/mswider-ski/spring-jbpm-app>].

20.4. Ejb

jBPM since version 6.2 provides out of the box integration layer with Enterprise Java Beans (EJB) for both local and remote interaction.

Ejb services are brought by following modules:

- `jbpm-services-ejb-api`

API module that extends `jbpm-services-api` with EJB specific interfaces and objects

- `jbpm-services-ejb-impl`

EJB extension to core services

- `jbpm-services-ejb-timer`

jBPM Scheduler Service implementation backed by EJB Timer Service

- `jbpm-services-ejb-client`

EJB remote client implementation for remote interaction, provides JBoss AS support out of the box

EJB layer is based on `jbpm` services and thus provides almost same capabilities as the core module though there are some imiliations when it comes to remote interfaces. Main difference is for the `DeploymentService` that has been limited for remote `ejb` service to following methods:

- `deploy`
- `undeploy`
- `activate`

- deactivate
- isDeployed

Main rationale behind is to avoid returning runtime objects such as `RuntimeManager` over EJB remote as it won't bring any value because it will be "disconnected" state.

All other services do provide exact same set of functionality as core module.

20.4.1. Ejb services implementation

Ejb services as an extension of core services provide EJB based execution semantic and based on various EJB specific features.

- `DeploymentServiceEJBImpl`

is implemented as ejb singleton with container managed concurrency and lock type set to write

- `DefinitionServiceEJBImpl`

is implemented as ejb singleton with container managed concurrency with overall lock type set to read, except `buildProcessDefinition` method that has lock type set to write

- `ProcessServiceEJBImpl`

is implemented as stateless session bean

- `RuntimeDataServiceEJBImpl`

is implemented as ejb singleton with majority of methods with lock type read, except following that are with lock type write:

- `onDeploy`
- `onUnDeploy`
- `onActivate`
- `onDeactivate`
- `UserTaskServiceEJBImpl`

is implemented as stateless session bean

Transactions

Transaction is managed by EJB container thus there is no need to setup any sort of transaction manager or user transaction within application code.

Identity provider

Identity provider by default is backed by EJBContext and will rely on caller principal information for both name and roles. When inspecting IdentityProvider interface there are two methods related to roles:

- `getRoles`

this method returns empty list due to the fact EJBContext does not provide options to fetch all roles for given user

- `hasRole`

this method will delegate to context's `isCallerInRole` method

This means that ejb must be secured according to JEE security practices to authenticate and authorize users so valid information will be available. In case no authentication/authorization is configured for EJB services an anonymous user is always assumed.

In addition to that, EJB services accept CDI sytly injection for IdentityProvider in case another (non ejb) security model is used. Simply create valid CDI bean that implements `org.kie.internal.identity.IdentityProvider` and make it available for injection with application and such implementation will take precedence over EJBContext based identity provider.

Deployment synchronization

Deployment synchronization is enabled by default and will attempt to synchronize any deployments every 3 seconds. It is implemented as ejb singleton with container managed concurrency and lock type set to write. Under the covers it utilizes EJB TimerService to schedule the synchronization jobs.

EJB Scheduler Service

jBPM uses scheduler service to deal with time based activities such as timer events, deadlines, etc. When running in EJB environment and EJB Timer Service based scheduler will be used. It will be automatically registered for all instances of RuntimeManager. When it comes to cluster support application server specific configuration might be required.

UserGroupCallback and UserInfo selection

UserGroupCallback and UserInfo might differ for various applications and thus should be sort of pluggable. With EJB we could not make it directly available for injections as they could not be injected with common type so there is another mechanism that allows to select one of provided out of the box implementation or to give a custom one. This mechanism is based on ssystem properties:

- `org.jbpm.ht.callback`

specify what implementation of user group callback will be selected

- mvel - default mostly used for testing
 - ldap - ldap backed implementation - requires additional configuration via `jbpm.usergroup.callback.properties` file
 - db - data base backed implementation - requires additional configuration via `jbpm.usergroup.callback.properties` file
 - jaas - delegates to container to fetch information about user data
 - props - simple property based callback - requires additional file that will keep all information (users and groups)
 - custom - custom implementation that requires to have additional system property set (FQCN of the implementation) - `org.jbpm.ht.custom.callback`
- `org.jbpm.ht.userinfo`
- specify what implementation of `UserInfo` shall be used, one of:
- ldap - backed by ldap - requires configuration via `jbpm-user.info.properties` file
 - db - backed by data base - requires configuration via `jbpm-user.info.properties` file
 - props - backed by simple property file
 - custom - custom implementation that requires to have additional system property set (FQCN of the implementation) - `org.jbpm.ht.custom.userinfo`

System properties can either be added to the startup configuration of the server (jvm) which is recommended or be set programmatically before services will be used - for example with custom `@Startup` bean that will configure it properly for selected callback and user info.

A example application that utilizes EJB services can be found here [<https://github.com/jsvitak/jbpm-6-examples/tree/master/rewards-basic>].

20.4.2. Local interface

Local EJB services are brought via dedicated local interfaces that extends core services:

- `org.jbpm.services.ejb.api.DefinitionServiceEJBLocal`
- `org.jbpm.services.ejb.api.DeploymentServiceEJBLocal`
- `org.jbpm.services.ejb.api.ProcessServiceEJBLocal`
- `org.jbpm.services.ejb.api.RuntimeDataServiceEJBLocal`
- `org.jbpm.services.ejb.api.UserTaskServiceEJBLocal`

These interfaces should be used as injection points and shall be annotated with `@EJB`:

```
@EJB
private DefinitionServiceEJBLocal bpmn2Service;

@EJB
private DeploymentServiceEJBLocal deploymentService;

@EJB
private ProcessServiceEJBLocal processService;

@EJB
private RuntimeDataServiceEJBLocal runtimeDataService;
```

Once injected operations can be invoked on them as with core modules, there are no restrictions to their usage.

20.4.3. Remote interface

Remote EJB services are defined as dedicated remote interfaces that extends core services:

- org.jbpm.services.ejb.api.DefinitionServiceEJBRemote
- org.jbpm.services.ejb.api.DeploymentServiceEJBRemote
- org.jbpm.services.ejb.api.ProcessServiceEJBRemote
- org.jbpm.services.ejb.api.RuntimeDataServiceEJBRemote
- org.jbpm.services.ejb.api.UserTaskServiceEJBRemote

These can be used similar way as local interfaces except for handling custom types. Custom types can be defined:

- globally

such types are available on application classpath - included in the enterprise application

- locally to the deployment unit

such types are declared as project (kjar) dependency and are resolved on deployment time. Globally available types do not require any special handling as they will be available for EJB container when remote requests are handled - marshalling of incoming data. Though local custom types won't be visible by default to EJB container as they are not on application classpath. Thus special handling of such types is required.

EJB services provides easy yet rather powerful mechanism to resolve the issue - it comes with two additional types:

- org.jbpm.services.ejb.remote.api.RemoteObject

Serializable wrapper class for single value parameters

- org.jbpm.services.ejb.remote.api.RemoteMap

Dedicated java.util.Map implementation to simplify remote invocation of service methods that accept custom object input. This map is backed by an internal map that holds already serialized content to avoid additional serialization on sending time. That removes the burden of ensuring that container will know about all custom data model classes as part of global classpath.

This implementation does not support all methods that are usually not used when sending data. It shall be considered only as a wrapper only and not actual and complete implementation of a map.

These special objects will perform eager serialization to bytes using ObjectOutputStream to remove the need of serialization from the EJB client/container. Though it might be worse in case of performance it does overcome much more complicated handling of class loaders on EJB container side to allow use of custom types defined in the project.

Here is an example code needed to work with local types and remote EJB:

```
// start a process with custom types via remote EJBMap<String, Object> parameters = new
RemoteMap();Person person = new org.jbpm.test.Person("john", 25, true);parameters.put("person",
person);Long processInstanceId = processService.startProcess(deploymentUnit.getIdentifier(),
"custom-data-project.work-on-custom-data", parameters);// fetch task data and
complete task with custom types via remote EJBMap<String, Object> data =
userTaskService.getTaskInputContentByTaskId(taskId); Person fromTaskPerson =
data.get("_person");fromTaskPerson.setName("John Doe"); RemoteMap outcome = new
RemoteMap();outcome.put("person_", fromTaskPerson); userTaskService.complete(taskId,
"john", outcome);

EJBMap<String, Object> parameters = new
RemoteMap();Person person = new org.jbpm.test.Person("john", 25,
true);parameters.put("person",
person);Long processInstanceId = processService.startProcess(deploymentUnit.getIdentifier(),
"custom-data-project.work-on-custom-data",
parameters);// fetch task data and complete task with custom types via remote
EJBMap<String, Object> data =
userTaskService.getTaskInputContentByTaskId(taskId);
Person fromTaskPerson =
data.get("_person");fromTaskPerson.setName("John
Doe");
RemoteMap outcome = new
RemoteMap();outcome.put("person_",
fromTaskPerson);
userTaskService.complete(taskId, "john",
```

Similar way RemoteObject can be used for example to send evnet to process instance:

```
// send event with custom type via remote EJB
Person person = new org.jbpm.test.Person("john", 25, true);

RemoteObject myObject = new RemoteObject(person);

processService.signalProcessInstance(processInstanceId, "MySignal", myObject);
```

These illustrates how to wrap custom data when interacting with remote EJB services. Next section will introduce how to make a connection to a remote service vai client code.

20.4.3.1. Remote EJB client

Remote client support is provided by implemetation of ClientServiceFactory interface that is facede for application server specific code:

```
/**
 * Generic service factory used for remote look ups that are usually container specific.
 *
 */
public interface ClientServiceFactory {

    /**
     * Returns unique name of given factory implementation
     * @return
     */
    String getName();

    /**
     * Returns remote view of given service interface from selected application
     * @param application application identifier on the container
     * @param serviceInterface remote service interface to be found
     * @return
     * @throws NamingException
     */
    <T> T getService(String application, Class<T> serviceInterface) throws NamingException;
}
```

Implementations can be dynamically registered using ServiceLoader mechanism and by default there is only one available for JBoss AS/EAP/Wildfly. Each ClientServiceFactory must provide name which will be used to register it within the client registry so it can be then easily looked up.

Here is a code used to get hold of default JBoss based remote client:

```
// get hold of valid client service factory
ClientServiceFactory factory = ServiceFactoryProvider.getProvider("JBoss");

// application is the name known to application server aka module name
String application = "sample-war-ejb-app";

// get given service out of the factory
```

```
DeploymentServiceEJBRemote deploymentService = factory.getService(application,
DeploymentServiceEJBRemote.class);
```

With service available all know to its interface methods are ready to be used.

When working with JBoss AS and remote client you can add following maven dependency to bring in all EJB client libraries:

```
<dependency>
  <groupId>org.jboss.as</groupId>
  <artifactId>jboss-as-ejb-client-bom</artifactId>
  <version>7.2.0.Final</version> <!-- use valid version for the server you run on -->
  <optional>true</optional>
  <type>pom</type>
</dependency>
```

20.5. OSGi

All core jBPM JARs (and core dependencies) are OSGi-enabled. That means that they contain MANIFEST.MF files (in the META-INF directory) that describe their dependencies etc. These manifest files are automatically generated by the build. You can plug these JARs directly into an OSGi environment.

OSGi is a dynamic module system for declarative services. So what does that mean? Each JAR in OSGi is called a bundle and has its own Classloader. Each bundle specifies the packages it exports (makes publicly available) and which packages it imports (external dependencies). OSGi will use this information to wire the classloaders of different bundles together; the key distinction is you don't specify what bundle you depend on, or have a single monolithic classpath, instead you specify your package import and version and OSGi attempts to satisfy this from available bundles.

It also supports side by side versioning, so you can have multiple versions of a bundle installed and it'll wire up the correct one. Further to this Bundles can register services for other bundles to use. These services need initialisation, which can cause ordering problems - how do you make sure you don't consume a service before its registered? OSGi has a number of features to help with service composition and ordering. The two main ones are the programmatic ServiceTracker and the XML based Declarative Services. There are also other projects that help with this; Spring DM, iPOJO, Gravity.

The following jBPM JARs are OSGi-enabled:

- jbpm-flow
- jbpm-flow-builder
- jbpm-bpmn2

Part VI. Advanced Topics

Some more advanced topics

Chapter 21. Domain-specific Processes

21.1. Introduction

jBPM provides the ability to create and use domain-specific task nodes in your business processes. This simplifies development when you're creating business processes that contain tasks dealing with other technical systems.

When using jBPM, we call these domain-specific task nodes "*custom work items*" or (custom) "*service nodes*". There are two separate aspects to creating and using custom work items:

- Adding a node with a custom work item to a process definition using the Eclipse editor or jBPM designer.
- Creating a custom *work item handler* that the jBPM engine will use when executing the custom work item in a running process.

With regards to a BPMN2 process, custom work items are certain types of `<task>` nodes. In most cases, custom work items are `<task>` nodes in a BPMN2 process definition, although they can also be used with certain other task type nodes such as, among others, `<serviceTask>` or `<sendTask>` nodes.



Tip

When creating custom work items, it's important to separate the data associated with the work item, from how the work item should be handled. In other words, separate the *what* from the *how*. That means that custom work items should be:

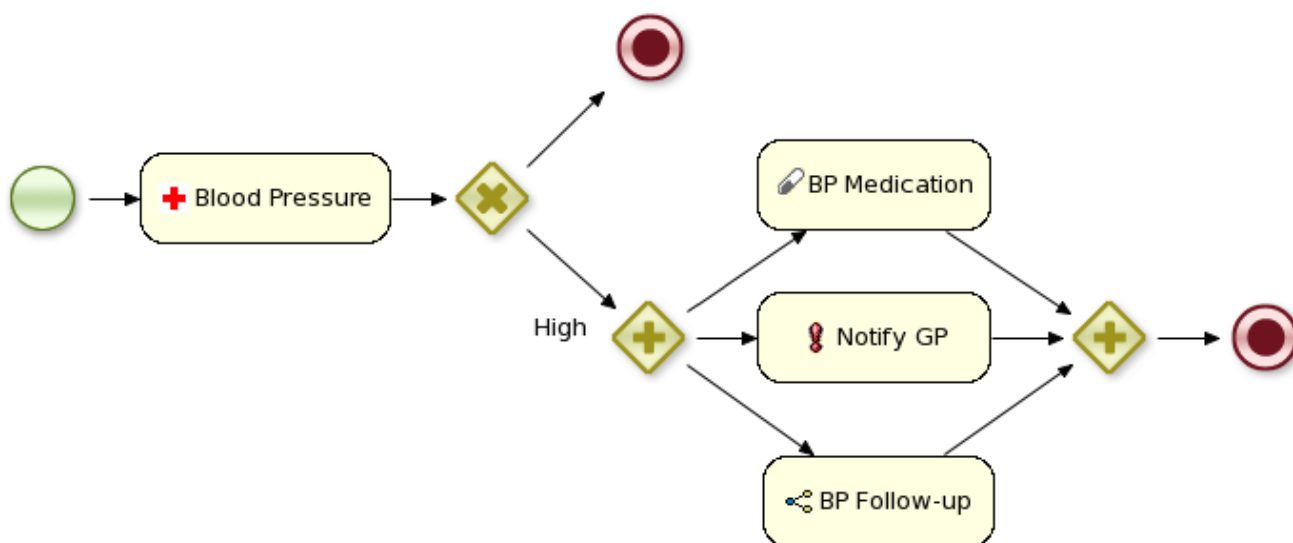
- declarative (*what*, not *how*)
- high-level (no code)

On the other hand, custom work item *handlers*, which are Java classes, should be:

- procedural (*how*, not *what*)
- low-level (because it's code!)

Work item handlers should almost never contain any data.

Users can thus easily define their own set of domain-specific service nodes and integrate them with the process language. For example, the next figure shows an example of a healthcare-related BPMN2 process. The process includes domain-specific service nodes for measuring blood pressure, prescribing medication, notifying care providers and following-up on the patient.



21.2. Overview

Before moving on to an example, this section explains what custom work items and custom work item handlers are.

21.2.1. Work Item Definitions

In short, we use the term *custom work item* when we're describing a node in your process that represents a domain-specific task and as such, contains extra properties and is handled by a `WorkItemHandler` implementation.

Because it's a domain-specific *task*, that means that a *custom work item* is equivalent to a `<task>` or `<task>`-type node in BPMN2. However, a *WorkItem* is also Java class instance that's used when a `WorkItemHandler` instance is called to complete the task or work item.

Depending on the BPMN2 editor you're using, you can create a custom work item definition in one of two ways:

- If you're using *Designer*, then this means creating a MVEL based definition and adding the definition in Designer itself. A description of this can be found in the ??? section in the ??? chapter. Once this is done, a new service node will appear on the BPMN 2.0 palette.
- If you're using the *Eclipse BPMN 2.0 modeler plugin* (which can be found here [<http://eclipse.org/bpmn2-modeler/>]), then you'll can modify the BPMN2 `<task>` or `<task>`-type element to work with `WorkItemHandler` implementations. See the ??? section in the ??? chapter.

21.2.2. Work Item Handlers

A *work item handler* is a Java class used to execute (or abort) work items. That also means that the class implements the `org.kie.runtime.instance.WorkItemHandler` interface. While jBPM provides some custom `WorkItemHandler` instances (listed below), a Java developer with a

minimal knowledge of jBPM can easily create a new work item handler class with its own custom business logic.

Among others, jBPM offers the following `WorkItemHandler` implementations:

- In the `jbpm-bpmn2` module, `org.jbpm.bpmn2.handler` package:
 - `ReceiveTaskHandler` (for use with BPMN element `<receiveTask>`)
 - `SendTaskHandler` (for use with BPMN element `<sendTask>`)
 - `ServiceTaskHandler` (for use with BPMN element `<serviceTask>`)
- In the `jbpm-workitems` module, in various packages under the `org.jbpm.process.workitem` package:
 - `ArchiveWorkItemHandler`

There are a many more `WorkItemHandler` implementations present in the `jbpm-workitems` module. If you're looking for specific integration logic with Twitter, for example, we recommend you take a look at the classes made available there.

In general, a `WorkItemHandler`'s `.executeWorkItem(...)` and `.abortWorkItem(...)` methods will do the following:

1. Extract information about the task being executed (or aborted) from the `WorkItem` instance
2. Execute the necessary business logic. This might be mean interacting with a web service, database, or other technical component.
3. Inform the process engine that the work item has been completed (or aborted) by calling one of the following two methods on the `WorkItemManager` instance passed to the method:

```
WorkItemManager.completeWorkItem(long workItemId, Map<String, Object> results)
WorkItemManager.abortWorkItem(long workItemId)
```

In order to make sure that your custom work item handler is used for a particular process instance, it's necessary to register the work item handler before starting the process. This makes the engine aware of your `WorkItemHandler` so that the engine can use it for the proper node. For example:

```
ksession.getWorkItemManager().registerWorkItemHandler("Notification",
    new NotificationWorkItemHandler());
```

The `ksession` variable above is a `StatefulKnowledgeSession` (and also a `KieSession`) instance. The example code above comes from the example that we will go through in the next session.

Work item handler life cycle management

Work item handler is registered on kie session and then can be used whenever process engine encounters a node that should be handled by that handler. Depending on the implementation of the handler (e.g. some handler might keep state or depend on some resources such as data base connection) there might be a need to maintain life cycle of the handler. To ease the way of doing that jBPM comes with two additional interfaces that handler might implement:

- *org.kie.internal.runtime.Closeable* - allows auto close of the handler whenever owner (work item handler manager) of it is closed or disposed. This is useful in case a handler can be quickly and frequently recreated so the engine will have it for the execution and when disposed it will dispose as well all handlers of Closeable type.
- *org.kie.internal.runtime.Cacheable* - allows handlers to be cached and reused to avoid recreation of the objects. There might be several reasons of doing so - expensive bootstrap of the handler, dependency to external resources - socket connections, db connections, web service client. While this brings powerful feature to the work item handler management it does put additional requirement on the implementation - needs to deal with exceptions internally and recover from any failures. In case recovery cannot be performed it needs to remove itself from the cache.

Closeable interface is handled for all use cases, while Cacheable is available only when RuntimeManager is used. RuntimeManager provides caching capabilities via its CacheManager (available via InternalRuntimeManager in case self removal is required).



Tip

You can use different work item handlers for the same process depending on the system on which it runs: by registering different work item handlers on different systems, you can customize how a custom work item is processed on a particular system. You can also substitute mock `WorkItemHandler` instances when testing.

21.3. Example: Notifications

Let's start by showing you how to include a simple work item for sending notifications. A work item is defined by a unique name and includes additional parameters that describe the work in more detail. Work items can also return information after they have been executed, specified as results.

Our notification work item could be defined using a work definition with four parameters and no results. For example:

- Name: "Notification"
- Parameters:
 - From [String type]
 - To [String type]

- Message [String type]
- Priority [String type]

21.3.1. The Notification Work Item Definition

21.3.1.1. Creating the work item definition

In our example we will create a MVEL work item definition that defines a "Notification" work item. Using MVEL is the default way to This file will be placed in the project classpath in a directory called `META-INF`. The work item configuration file for this example, `MyWorkDefinitions.wid`, will look like this:

```
import org.drools.core.process.core.datatype.impl.type.StringDataType;
[
  // the Notification work item
  [
    "name" : "Notification",
    "parameters" : [
      "Message" : new StringDataType(),
      "From" : new StringDataType(),
      "To" : new StringDataType(),
      "Priority" : new StringDataType(),
    ],
    "displayName" : "Notification",
    "icon" : "icons/notification.gif"
  ]
]
```

The project directory structure could then look something like this:

```
project/src/main/resources/META-INF/MyWorkDefinitions.wid
```

We also want to *add* a specific icon to be used in the process editor with the work item. To add this, you will need `.gif` or `.png` images with a pixel size of 16x16. We put them in a directory outside of the `META-INF` directory, for example, here:

```
project/src/main/resources/icons/notification.gif
```

21.3.1.2. Registering the work definition

The jBPM Eclipse editor uses the configuration mechanisms supplied by Drools to register work item definition files. That means adding a `drools.workDefinitions` property to the `drools.rulebase.conf` file in the `META-INF`.

The `drools.workDefinitions` property represents a list of files containing work item definitions, separated using spaces. If you want to *exclude* all other work item definitions and only use your definition, you could use the following:

```
drools.workDefinitions = MyWorkDefinitions.wid
```

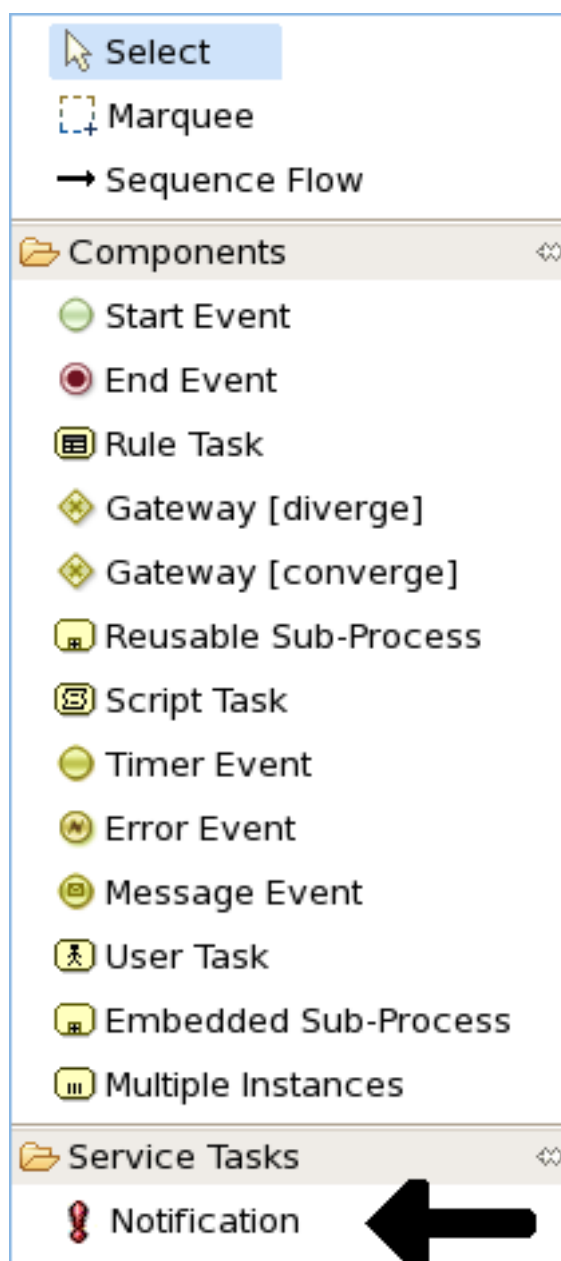
However, if you only want to add the newly created node definition to the existing palette nodes, you can define the `drools.workDefinitions` property as follows:

```
drools.workDefinitions = MyWorkDefinitions.wid WorkDefinitions.conf
```

We recommended that you use the extension `.wid` for your own definitions of domain specific nodes. The `.conf` extension used with the default definition file, `WorkDefinitions.conf`, for backward compatibility reasons.

21.3.1.3. Using your new work item in your processes

We've created our work item definition and configured it, so now we can start using it in our processes. The process editor contains a separate section in the palette where the different service nodes that have been defined for the project appear.



Using drag and drop, a notification node can be created inside your process. The properties can be filled in using the properties view.

Besides any custom properties, the following three properties are available for all work items:

1. **Parameter Mapping:** Allows you to map the value of a variable in the process to a parameter of the work item. This allows you to customize the work item based on the current state of the actual process instance (for example, the priority of the notification could be dependent of some process-specific information).
2. **Result Mapping:** Allows you to map a result (returned once a work item has been executed) to a variable of the process. This allows you to use results in the remainder of the process.

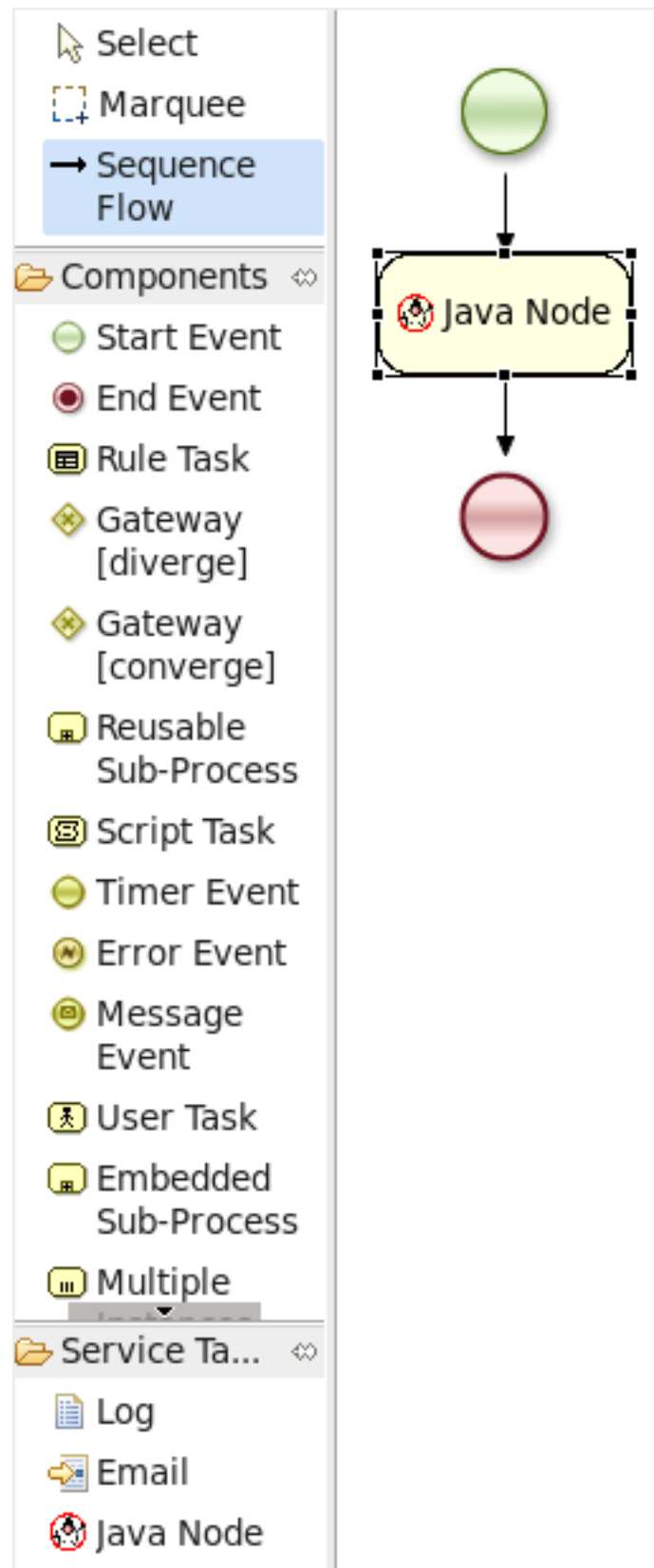
3. `wait for completion`: By default, the process waits until the requested work item has been completed before continuing with the process. It is also possible to continue immediately after the work item has been requested (and not waiting for the results) by setting `wait for completion` to `false`.

Here is an example that creates a domain specific node to execute Java, asking for the class and method parameters. It includes a custom `java.gif` icon and consists of the following files and resulting screenshot:

```
import org.drools.core.process.core.datatype.impl.type.StringDataType;
[
  // the Java Node work item located in:
  // project/src/main/resources/META-INF/JavaNodeDefinition.wid
  [
    "name" : "JavaNode",
    "parameters" : [
      "class" : new StringDataType(),
      "method" : new StringDataType(),
    ],
    "displayName" : "Java Node",
    "icon" : "icons/java.gif"
  ]
]
```

```
// located in: project/src/main/resources/META-INF/drools.rulebase.conf
drools.workDefinitions = JavaNodeDefinition.wid WorkDefinitions.conf

// icon for java.gif located in:
// project/src/main/resources/icons/java.gif
```



21.3.2. The `NotificationWorkItemHandler`

21.3.2.1. Creating a new work item handler

Once we've created our `Notification` work item definition (see the sections above), we can then create a custom implementation of a *work item handler* that will contain the logic to send the notification.

In order to execute our *Notification* work items, we first create a `NotificationWorkItemHandler` that implements the `WorkItemHandler` interface:

```
package com.sample;

import org.kie.api.runtime.process.WorkItem;
import org.kie.api.runtime.process.WorkItemHandler;
import org.kie.api.runtime.process.WorkItemManager;

public class NotificationWorkItemHandler implements WorkItemHandler {

    public void executeWorkItem(WorkItem workItem, WorkItemManager manager) {
        // extract parameters
        String from = (String) workItem.getParameter("From");
        String to = (String) workItem.getParameter("To");
        String message = (String) workItem.getParameter("Message");
        String priority = (String) workItem.getParameter("Priority");

        // send email
        EmailService service = ServiceRegistry.getInstance().getEmailService();
        service.sendEmail(from, to, "Notification", message);

        // notify manager that work item has been completed
        manager.completeWorkItem(workItem.getId(), null);
    }

    public void abortWorkItem(WorkItem workItem, WorkItemManager manager) {
        // Do nothing, notifications cannot be aborted
    }
}
```

The `ServiceRegistry` class is simply a made-up class that we're using for this example. In your own `WorkItemHandler` implementations, the code containing your domain-specific logic would go here.

Notifying the `WorkItemManager` instance when your a work item has been completed is crucial. For many synchronous actions, like sending an email in this case, the `WorkItemHandler` implementation will notify the `WorkItemManager` in the `executeWorkItem(...)` method.

This `WorkItemHandler` sends a notification as an email and then notifies the `WorkItemManager` that the work item has been completed.

Note that not all work items can be completed directly. In cases where executing a work item takes some time, execution can continue *asynchronously* and the work item manager can be notified later.

In these situations, it might also be possible that a work item is *aborted* before it has been completed. The `WorkItemHandler.abortWorkItem(...)` method can be used to specify how to abort such work items.



Tip

Remember, if the `WorkItemManager` is not notified about the completion, the process engine will never be notified that your service node has completed.

21.3.2.2. Registering the work item handler

`WorkItemHandler` instances need to be registered with the `WorkItemManager` in order to be used. In this case, we need to register an instance of our `NotificationWorkItemHandler` in order to use it with our process containing a `Notification` work item. We can do that like this:

```
StatefulKnowledgeSession ksession = kbase.newStatefulKnowledgeSession();
ksession.getWorkItemManager().registerWorkItemHandler(
    "Notification",
    new NotificationWorkItemHandler()
);
```

This is the drools name of the `<task>` (or other task type) node. See below for an example. This is the instance of our custom work item handler instance!

If we were to look at the BPMN2 syntax for our process with the `Notification` process, we would see something like the following example. Note the use of the `tns:taskName` attribute in the `<task>` node. This is necessary for the `WorkItemManager` to be able to see which `WorkItemHandler` instance should be used with which task or work item.

```
<?xml version="1.0" encoding="UTF-8"?>
<definitions id="Definition"
    xmlns="http://www.omg.org/spec/BPMN/20100524/MODEL"
    xs:schemaLocation="http://www.omg.org/spec/BPMN/20100524/MODEL BPMN20.xsd"
    ...
    xmlns:tns="http://www.jboss.org/drools">
    ...
    <process isExecutable="true" id="myCustomProcess" name="Domain-Specific Process" >
```

...

```
<task id="_5" name="Notification Task" tns:taskName="Notification" >
```

...



Tip

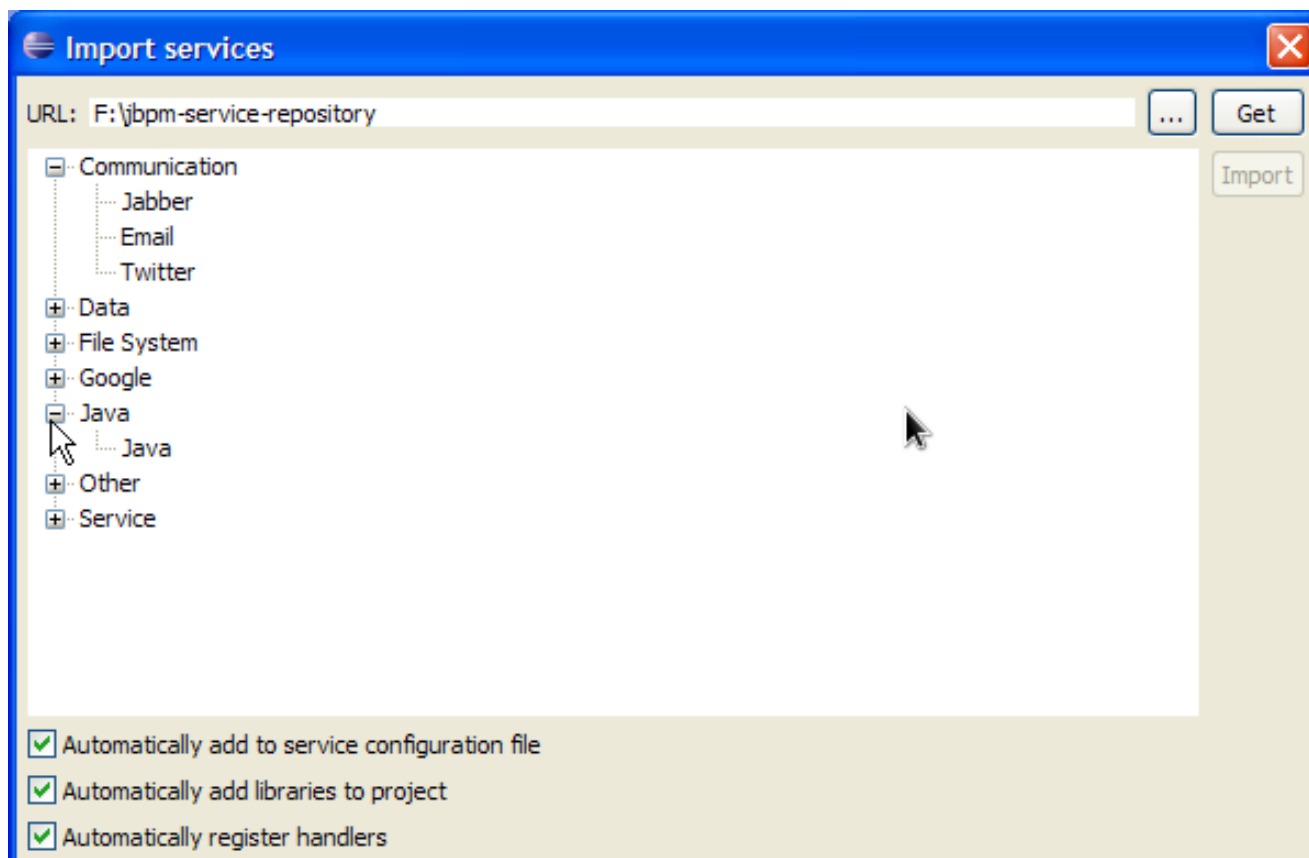
Different work item handlers could be used depending on the context. For example, during testing or simulation, it might not be necessary to actually execute the work items. In this case specialized dummy work item handlers could be used during testing.

21.4. Service Repository

A lot of these domain-specific services are generic, and can be reused by a lot of different users. Think for example about integration with Twitter, doing file system operations or sending email. Once such a domain-specific service has been created, you might want to make it available to other users so they can easily import and start using it.

A service repository allows you to import services by browsing the repository looking for services you might need and importing these services into your workspace. These will then automatically be added to your palette and you can start using them in your processes. You can also import additional artefacts like for example an icon, any dependencies you might need, a default handler that will be used to execute the service (although you're always free to override the default, for example for testing), etc.

To browse the repository, open the wizard to import services, point it to the right location (this could be to a directory in your file system but also a public or private URL) and select the services you would like to import. For example, in Eclipse, right-click your project that contains your processes and select "Configure ... -> Import jBPM services ...". This will open up a repository browser. In the URL field, fill in the URL of your repository (see below for the URL of the public jBPM repository that hosts some common service implementations out-of-the-box), or use the "..." button to browse to a folder on your file system. Click the Get button to retrieve the contents of that repository.



Select the service you would like to import and then click the Import button. Note that the Eclipse wizard allows you to define whether you would like to automatically configure the service (so it shows up in the palette of your processes), whether you would also like to download any dependencies that might be needed for executing the service and/or whether you would like to automatically register the default handler, so make sure to mark the right checkboxes before importing your service (if you are unsure what to do, leaving all check boxes marked is probably best).

After importing your service, (re)open your process diagram and the new service should show up in your palette and you can start using it in your process. Note that most services also include documentation on how to use them (e.g. what the different input and output parameters are) when you select them browsing the service repository.

Click on the image below to see a screencast where we import the Twitter service in a new jBPM project and create a simple process with it that sends an actual tweet. Note that you need the necessary Twitter keys and secrets to be able to programmatically send tweets to your Twitter account. How to create these is explained here [<http://docs.jboss.org/jbpm/v6.0/repository/Twitter/>], but once you have these, you can just drop them in your project using a simple configuration file.

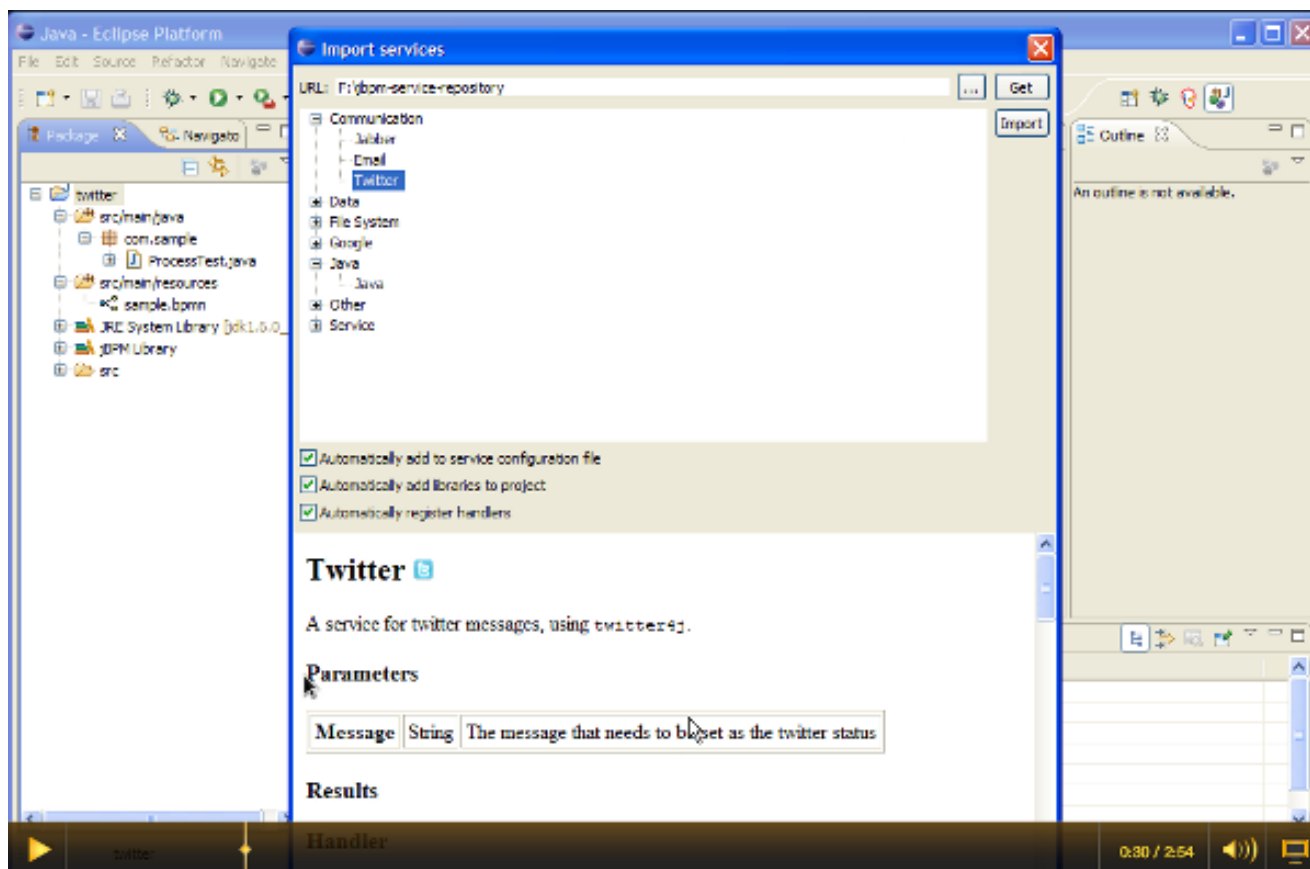


Figure 21.1.

[<http://people.redhat.com/kverlaen/twitter-repository.swf>]

21.4.1. Public jBPM service repository

We are building a public service repository that contains predefined services that people can use out-of-the-box if they want to:

<http://docs.jboss.org/jbpm/v6.0/repository/>

This repository contains some integrations for common services like Twitter integration or file system operations that you can import. Simply point the import wizard to this URL to start browsing the repository.

If you have an implementation of a common service that you would like to contribute to the community, do not hesitate to contact someone from the development team. We are always looking for contributions to extend our repository.

21.4.2. Setting up your own service repository

You can set up your own service repository and add your own services by creating a configuration file that contains the necessary information (this is an extended version of the normal work defin-

ition configuration file as described earlier in this chapter) and putting the necessary files (like an icon, dependencies, documentation, etc.) in the right folders.

The extended configuration file contains the normal properties (like name, parameters, results and icon), with some additional ones. For example, the following extended configuration file describes the Twitter integration service (as shown in the screencast above):

```
import org.drools.core.process.core.datatype.impl.type.StringDataType;
[
  [
    "name" : "Twitter",
    "description" : "Send a Twitter message",
    "parameters" : [
      "Message" : new StringDataType()
    ],
    "displayName" : "Twitter",
    "eclipse:customEditor" :
"org.drools.eclipse.flow.common.editor.editpart.work.SampleCustomEditor",
    "icon" : "twitter.gif",
    "category" : "Communication",
    "defaultHandler" : "org.jbpm.process.workitem.twitter.TwitterHandler",
    "documentation" : "index.html",
    "dependencies" : [
      "file:./lib/jbpm-twitter.jar",
      "file:./lib/twitter4j-core-2.2.2.jar"
    ]
  ]
]
```

- The icon property should refer to a file with the given file name in the same folder as the extended configuration file (so it can be downloaded by the import wizard and used in the process diagrams). Icons should be 16x16 GIF files.
- The category property defines the category this service should be placed under when browsing the repository.
- The defaultHandler property defines the default handler implementation (i.e. the Java class that implements the `WorkItemHandler` interface and can be used to execute the service). This can automatically be registered as the handler for that service when importing the service from the repository.
- The documentation property defines a documentation file that describes what the service does and how it works. This property should refer to a HTML file with the given name in the same folder as the extended configuration file (so it can be shown by the import wizard when browsing the repository).
- The dependencies property defines additional dependencies that are necessary to execute this service. This usually includes the handler implementation JAR, but could also include additional external dependencies. These dependencies should also be located on the repository on the

given location (relative to the folder where the extended configuration file is located), so they can be downloaded by the import wizard when importing the service.

The root of your repository should also contain an `index.conf` file that references all the folders that should be processed when searching for services on the repository. Each of those folders should then contain:

- An extended configuration file with the same name as the folder (e.g. `Twitter.conf`)
- The icon as references in the configuration file
- The documentation as references in the configuration file
- The dependencies as references in the configuration file (for example in a `lib` folder)

You can create your own hierarchical structure, because if one of those folders also contains an `index.conf` file, that will be used to scan additional sub-folders. Note that the hierarchical structure of the repository is not shown when browsing the repository using the import wizard, as the `category` property in the configuration file is used for that.

Chapter 22. Exception Management

22.1. Overview

This chapter will describe how to deal with unexpected behavior in your business processes using both BPMN2 and technical mechanisms.

The first section will explain Technical Exceptions: we'll go through an example that uses both BPMN2 and `WorkItemHandler` implementations in order to isolate and handle exceptions caused by a technical component. We will also explain how to modify the example to suit other use cases.

The second section will define and explain the types of (BPMN2) exceptions that can happen or be used in a business process.

22.2. Introduction

What happens to a business process when something unexpected happens during the process? Most of the time, when creating and designing a new process definition, the first step is to describe the *normative* or desirable behaviour. However, a process definition that only describes all of the normal tasks and their execution order is incomplete.

The next step is to think about what might go *wrong* when the business process is run. What would happen if any of the human or technical actors in the process do *not* respond in unexpected ways? Will any of the technical systems that the process interacts with return unexpected results -- or not return any results at all?

Deviations from the normative or "happy" flow of a business process are called *exceptions*. In some cases, exceptions might not be that unusual, such as trying to debit an empty bank account. However, some processes might contain many complex situations involving exceptions, all of which must be handled correctly.



Note

The rest of chapter assumes that you know how to create custom `<task>` nodes and how to implement and register `WorkItemHandler` implementations. More information about these topics can be found in the Domain-specific Processes chapter.

22.3.1. Technical Exceptions

Technical exceptions happen when a technical component of a business process acts in an unexpected way. When using Java based systems, this often results in a literal Java Exception being thrown by the system.

Technical components used in a process can fail in a way that can not be described using BPMN2. In this case, it's important to handle these exceptions in expected ways.

The following types of code might throw exceptions:

- Any code that is present in the process definition itself
- Any code that is executed during a process and is not part of jBPM
- Any code that interacts with a technical component outside of the process engine

However, those are somewhat abstract definitions. We can narrow down the places at which an exception might be thrown. Technical exceptions can occur at the following points:

1. Code present in `<scriptTask>` nodes or in the jbpm-specific `<onEntry>` and `<onExit>` elements
2. Code executed in `WorkItemHandlers` associated with `<task>` and task-type nodes

It is *much easier* to ensure correct exception handling for `<task>` and other task-type nodes that use `WorkItemHandler` implementations, than for code executed directly in a `<scriptTask>`.

Exceptions thrown by `<scriptTask>` can cause the process to fail in an unrecoverable fashion. While there are certain things that you can do to contain the damage, a process that has failed in this way can not be restarted or otherwise recovered. This also applies for other nodes in a process definition that contain script code in the node definition, such as the `<onEntry>` and `<onExit>` elements.

When jBPM engine does throw an exception generated by the code in a `<scriptTask>` the exception thrown is a special Java exception called the `WorkflowRuntimeException` that contains information about the process.



Warning

Again, exceptions generated by a `<scriptTask>` node (and other nodes containing script code) will leave the process *unrecoverable*. In fact, often, the code that starts the process itself will end up throwing the exception generated by the business process, without returning a reference to the process instance.

For this reason, it's important to limit the scope of the code in these nodes to operations dealing with process variables. Using a `<scriptTask>` to interact with a different technical component, such as a database or web service has *significant risks* because any exceptions thrown will corrupt or abort the process.

`<task>` nodes, `<serviceTask>` nodes and the rest of the task-type nodes are explicitly meant for interacting with other systems -- not `<scriptTask>` nodes! Use `<task>`-type nodes to interact with other technical components.

22.3.1.1. Handling exceptions in `WorkItemHandler` instances

`WorkItemHandler` classes are used when your process interacts with other technical systems. For an introduction to them and how to use them in processes, please see the Domain-specific Processes chapter.

While you can build exception handling into your own `WorkItemHandler` implementations, there are also two “handler decorator” classes that you can use to *wrap* a `WorkItemHandler` implementation.

These two wrapper classes include logic that is executed when an exception is thrown during the execution (or abortion) of a work item.

Table 22.1. Exception Handling `WorkItemHandler` wrapper classes

Decorator classes in the <code>org.jbpm.bpmn2.handler</code> package	Description
<code>SignallingTaskHandlerDecorator</code>	This class wraps an existing <code>WorkItemHandler</code> implementation. When the <code>.executeWorkItem(...)</code> or <code>.abortWorkItem(...)</code> methods of the original <code>WorkItemHandler</code> instance throw an exception, the <code>SignallingTaskHandlerDecorator</code> will catch the exception and signal the process instance using a configurable event type. The exception thrown will be passed as part of the event. This functionality can be used to signal an <i>Event SubProcess</i> defined in the process definition.
<code>LoggingTaskHandlerDecorator</code>	This class reacts to all exceptions thrown by the <code>.executeWorkItem(...)</code> or <code>.abortWorkItem(...)</code> <code>WorkItemHandler</code> methods by logging the errors. It also saves any exceptions thrown so to an internal list so that they can be retrieved later for inspection or further logging. Lastly, the content and format of the message logged upon an exception are configurable.

While the two classes described above should cover most cases involving exception handling, a Java developer with some experience with jBPM should be able to create a `WorkItemHandler` that executes custom code upon an exception.

If you do decide to write a custom `WorkItemHandler` that includes exception handling logic, keep the following checklist in mind:

1. Are you catching all possible exceptions that you want to (and no more, or less)?

2. Are you making sure to either complete or abort the work item after an exception has been caught? If not, are there mechanisms to retry the process later? Or are incomplete process instances acceptable?
3. >
What other actions should be taken when an exception is caught? Do you want to simply log the exception, or is it also important to interact with other technical systems? Do you want to trigger a (BPMN2) subprocess that will handle the exception?



Important

When you use the `WorkItemManager` to signal that the work item has been completed or aborted, make sure to do that *after you've sent any signals* to the process instance. Depending on how you've defined your process, calling `WorkItemManager.completeWorkItem(...)` or `WorkItemManager.abortWorkItem(...)` will trigger the completion of the process instance. This is because these methods trigger the jBPM process engine to continue the process flow.

In the next section, we'll describe an example that uses the `SignallingTaskHandlerDecorator` to signal an *event subprocess* when a work item handler throws an exception.

22.3.2. Technical Exception Examples

22.3.2.1. Example: service task handlers

We'll go through one example in this section, and then look quickly at how you can change it to get the behavior you want. The example involves an `<error>` event that's caught by an (*Error Event SubProcess*).

When an *Error Event* is thrown, the containing process will be interrupted. This means that after the process flow attached to the error event has executed, the following will happen:

1. process execution will stop, and no other parts of the process will execute
2. the process instance will end up in an aborted state (instead of completed)

The example we'll go through contains an `<error>`, but at the end of the section, we'll show how you can change the process to use a `<signal>` instead.



Tip

The code and BPMN2 process definition shown in the next section are available in the `jbpm-examples` module. See the `org.jbpm.examples.exceptions.ExceptionHandlingErrorExample` class for the Java code. The BPMN2 process definition is available in the `excep-`

tions/ExceptionHandlingWithError.bpmn2 file in the src/main/resources directory of the jbpmm-examples module.

22.3.2.1.1. BPMN2 configuration

Let's look at the BPMN2 process definition first. Besides the definition of the process, the BPMN2 elements defined before the actual process definition are also important. Here's an image of the BPMN2 process that we'll be using in the example:

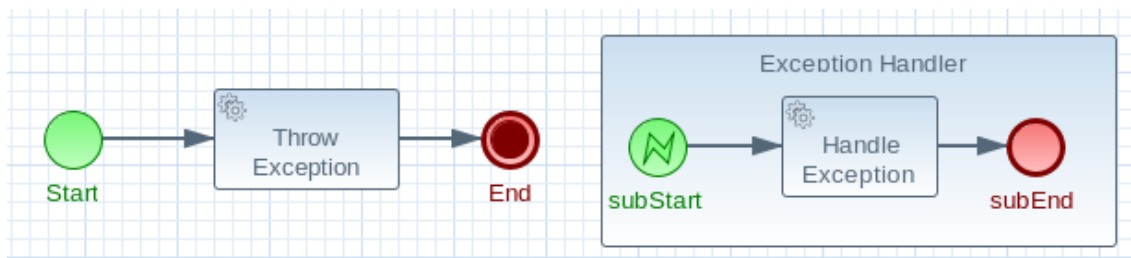


Figure 22.1.

The BPMN2 process fragment below is part of the process shown above, and contains some notes on the different BPMN2 elements.



Note

If you're viewing this on a web browser, you may need to widen or narrow your browser window in order to see the "callout" or note numbers on the right hand side of the code.

```
<itemDefinition id="_stringItem" structureRef="java.lang. String"/>
<message id="_message" itemRef="_stringItem"/>

                                <interface                                id="_serviceInterface"
name="org.jbpm.examples.exceptions.service.ExceptionService">
  <operation id="_serviceOperation" name="throwException">
    <inMessageRef>_message</inMessageRef>
  </operation>
</interface>

<error id="_exception" errorCode="code" structureRef="_ex ceptionItem"/>

<itemDefinition id="_exceptionItem" structureRef="org.kie .api.runtime.process.WorkItem"/>
<message id="_exceptionMessage" itemRef="_exceptionItem"/ >

                                <interface                                id="_handlingServiceInterface"
name="org.jbpm.examples.exceptions.service.ExceptionService">
  <operation id="_handlingServiceOperation" name="handleException">
    <inMessageRef>_exceptionMessage</inMessageRef>
  </operation>
</interface>
```

```

<process id="ProcessWithExceptionHandlingError" name="Service Process" isExecutable="true"
processType="Private">
  <!-- properties -->
  <property id="serviceInputItem" itemSubjectRef="_string Item"/>
  <property id="exceptionInputItem" itemSubjectRef="_exceptionItem"/>

  <!-- main process -->
  <startEvent id="_1" name="Start" />
    <serviceTask id="_2" name="Throw Exception" implementation="Other"
operationRef="_serviceOperation">

  <!-- rest of the serviceTask element and process definition... -->

  <subProcess id="_X" name="Exception Handler" triggeredByEvent="true" >
    <startEvent id="_X-1" name="subStart">
      <dataOutput id="_X-1_Output" name="event"/>
      <dataOutputAssociation>
        <sourceRef>_X-1_Output</sourceRef>
        <targetRef>exceptionInputItem</targetRef>
      </dataOutputAssociation>
      <errorEventDefinition id="_X-1_ED_1" errorRef="_exception" />
    </startEvent>

    <!-- rest of the subprocess definition... -->

  </subProcess>

</process>

```

This `<itemDefinition>` element defines a data structure that we then use in the `serviceInputItem` property in the process.

This `<message>` element (1st reference) defines a *message* that has a `String` as its content (as defined by the `<itemDefintion>` element on line above). The `<interface>` element below it refers to it (2nd reference) in order to define what type of content the service (defined by the `<interface>`) expects.

This `<error>` element (1st reference) defines an error for use later in the process: an *Event SubProcess* is defined that is triggered by this *error* (2nd reference). The content of the error is defined by the `<itemDefintion>` element defined below the `<error>` element.

This `<itemDefintion>` element (1st reference) defines an item that contains a `WorkItem` instance. The `<message>` element (2nd reference) then defines a *message* that uses this *item definition* to define its content. The `<interface>` element below that refers to the `<message>` definition (3rd reference) in order to define the type of content that the service expects.

In the process itself, a `<property>` element (4th reference) is defined as having the content defined by the initial `<itemDefintion>`. This is helpful because it means that the *Event SubProcess* can then store the *error* it receives in that property (5th reference).



Caution

When you're using a `<serviceTask>` to call a Java class, make sure to double check the class name in your BPMN2 definition! A small typo there can cost you time later when you're trying to figure out what went wrong.

22.3.2.1.2. `SignallingTaskHandlerDecorator` and `WorkItemHandler` configuration

Now that BPMN2 process definition is (hopefully) a little clearer, we can look at how to set up jBPM to take advantage of the above BPMN2.

In the (BPMN2) process definition above, we define two different `<serviceTask>` activities. The `org.jbpm.bpmn2.handler.ServiceTaskHandler` class is the default task handler class used for `<serviceTask>` tasks. If you don't specify a `WorkItemHandler` implementation for a `<serviceTask>`, the `ServiceTaskHandler` class will be used.

In the code below, you'll see that we actually wrap or decorate the `ServiceTaskHandler` class with a `SignallingTaskHandlerDecorator` instance. We do this in order to define the what happens when the `ServiceTaskHandler` throws an exception.

In this case, the `ServiceTaskHandler` will throw an exception because it's configured to call the `ExceptionHandler.throwException` method, which throws an exception. (See the `_handlingServiceInterface <interface>` element in the BPMN2.)

In the code below, we also configure which (error) event is sent to the process instance by the `SignallingTaskHandlerDecorator` instance. The `SignallingTaskHandlerDecorator` does this when an exception is thrown in a `task`. In this case, since we've defined an `<error>` with the `errorCode` "code" in the BPMN2, we set the signal to `Error-code`.



Important

When signalling the jBPM process engine with an event of some sort, you should keep in mind the rules for signalling process events.

- Error events can be signalled by sending an "Error-" + `<the errorCode attribute value>` value to the session.
- Signal events can be signalled by sending the name of the signal to the session.

```
import java.util.HashMap;
import java.util.Map;

import org.jbpm.bpmn2.handler.ServiceTaskHandler;
import org.jbpm.bpmn2.handler.SignallingTaskHandlerDecorator;
```

```

import org.jbpm.examples.exceptions.service.ExceptionService;
import org.kie.api.KieBase;
import org.kie.api.io.ResourceType;
import org.kie.api.runtime.KieSession;
import org.kie.api.runtime.process.ProcessInstance;
import org.kie.internal.builder.KnowledgeBuilder;
import org.kie.internal.builder.KnowledgeBuilderFactory;
import org.kie.internal.io.ResourceFactory;

public class ExceptionHandlingErrorExample {

    public static final void main(String[] args) {
        runExample();
    }

    public static ProcessInstance runExample() {
        KieSession ksession = createKieSession();

        String eventType = "Error-code";
        SignallingTaskHandlerDecorator signallingTaskWrapper
            = new SignallingTaskHandlerDecorator(ServiceTaskHandler.class, eventType);
        signallingTaskWrapper.setWorkItemExceptionParameterName(ExceptionService.exceptionParameterName);
        ksession.getWorkItemManager().registerWorkItemHandler("Service
Task", signallingTaskWrapper);

        Map<String, Object> params = new HashMap<String, Object>();
        params.put("serviceInputItem", "Input to Original Service");
        ProcessInstance processInstance = ksession.startProcess("ProcessWithExceptionHandlingError", params);

        return processInstance;
    }

    private static KieSession createKieSession() {
        KnowledgeBuilder kbuilder = KnowledgeBuilderFactory.newKnowledgeBuilder();
        kbuilder.add(ResourceFactory.newClassPathResource("exceptions/
ExceptionHandlingWithError.bpmn2"), ResourceType.BPMN2);
        KieBase kbase = kbuilder.newKnowledgeBase();
        return kbase.newKieSession();
    }
}

```

Here we define the name of the event that will be sent to the process instance if the wrapped `WorkItemHandler` implementation throws an exception. The `eventType` string is used when instantiating the `SignallingTaskHandlerDecorator` class.

Then we construct an instance of the `SignallingTaskHandlerDecorator` class. In this case, we simply give it the *class name* of the `WorkItemHandler` implementation class to instantiate, but another constructor is available that we can pass an *instance* of a `WorkItemHandler` implementation to (necessary if the `WorkItemHandler` implementation does not have a no-argument constructor).

When an exception is thrown by the wrapped `WorkItemHandler`, the `SignallingTaskHandlerDecorator` saves it as a parameter in the `WorkItem` instance with a parameter name that we configure the `SignallingTaskHandlerDecorator` to give it (see the code below for the `ExceptionService`).

22.3.2.1.3. ExceptionService setup and configuration

In the BPMN2 process definition above, a service interface is defined that references the `ExceptionService` class:

```
<inter
face id="_handlingServiceInterface" name="org.jbpm.examples.exceptions.service.ExceptionService">
  <operation id="_handlingServiceOperation" name="handleException">
```

In order to fill in the blanks a little bit, the code for the `ExceptionService` class has been included below. In general, you can specify any Java class with the default or an other no-argument constructor and have it executed during a `<serviceTask>`

```
public class ExceptionService {

    public static String exceptionParameterName = "my.exception.parameter.name";

    public void handleException(WorkItem workItem) {
        System.out.println( "Handling exception caused by work item '" + workItem.getName() + "' (id:
" + workItem.getId() + ")");

        Map<String, Object> params = workItem.getParameters();
        Throwable throwable = (Throwable) params.get(exceptionParameterName);
        throwable.printStackTrace();
    }

    public String throwException(String message) {
        throw new RuntimeException("Service failed with input: " + message );
    }

    public static void setExceptionParameterName(String exceptionParam) {
        exceptionParameterName = exceptionParam;
    }

}
```

22.3.2.1.4. Changing the example to use a `<signal>`

In the example above, the thrown Error Event interrupts the process: no other flows or activities are executed once the Error Event has been thrown.

However, when a *Signal Event* is processed, the process will continue after the *Signal Event SubProcess* (or whatever other activities that the Signal Event triggers) has been executed. Furthermore, this implies that the the process will *not* end up in an aborted state, unlike a process that throws an Error Event.

In the process above, we use the `<error>` element in order to be able to use an Error Event:

```
<error id="_exception" errorCode="code" structureRef="_exceptionItem"/>
```

When we want to use a Signal Event instead, we remove that line and use a `<signal>` element:

```
<signal id="exception-signal" structureRef="_exceptionItem"/>
```

However, we must also change all references to the `"_exception"` `<error>` so that they now refer to the `"exception-signal"` `<signal>`.

That means that the `<errorEventDefintion>` element in the `<startEvent>`,

```
<errorEventDefinition id="_X-1_ED_1" errorRef="_exception" />
```

must be changed to a `<signalEventDefintion>` which would like like this:

```
<signalEventDefinition id="_X-1_ED_1" signalRef="exception-signal"/>
```

In short, we have to make the following changes to the `<startEvent>` in the Event SubProcess:

1. It will now contain a `<signalEventDefintion>` instead of a `<errorEventDefintion>`
2. The `errorRef` attribute in the `<erroEventDefintion>` is now a `signalRef` attribute in the `<signalEventDefintion>`.
3. The `id` attribute in the `signalRef` is of course now the id of the `<signal>` element. Before it was id of `<error>` element.
4. Lastly, when we signal the process in the Java code, we do not signal `"Error-code"` but simply `"exception-signal"`, the id of the `<signal>` element.

22.3.2.2. Example: logging exceptions thrown by bad `<scriptTask>` nodes

In this section, we'll briefly describe what's possible when dealing with `<scriptTask>` nodes that throw exceptions, and then quickly go through an example (also available in the `jbpm-examples` module) that illustrates this.

22.3.2.2.1. Introduction

If you're reading this, then you probably already have a problem: you're either expecting to run into this problem because there are scripts in your process definition that might throw an exception, or you're already running a process instance with scripts that are causing a problem.

Unfortunately, if you're running into this problem, then there is not much you can do. The only thing that you *can* do is retrieve more information about exactly what's causing the problem. Luckily, when a `<scriptTask>` node causes an exception, the exception is then wrapped in a `WorkflowRuntimeException`.

What type of information is available? The `WorkflowRuntimeException` instance will contain the information outlined in the following table. All of the fields listed are available via the normal `get*` methods.

Table 22.2. Information contained in `WorkflowRuntimeException` instances.

Field name	Type	Description
<code>processInstanceId</code>	<code>long</code>	The id of the <code>ProcessInstance</code> instance in which the exception occurred. This <code>ProcessInstance</code> may not exist anymore or be available in the database if using persistence!
<code>processId</code>	<code>String</code>	The id of the process definition that was used to start the process (i.e. "ExceptionScriptTask" in <code>ksession.startProcess("ExceptionScriptTask");</code>)
<code>nodeId</code>	<code>long</code>	The value of the (BPMN2) id attribute of the node that threw the exception.
<code>nodeName</code>	<code>String</code>	The value of the (BPMN2) name attribute of the node that threw the exception.
<code>variables</code>	<code>Map<String, Object></code>	The map containing the variables in the process instance (<i>experimental</i>).
<code>message</code>	<code>String</code>	The short message indicating what went wrong.
<code>cause</code>	<code>Throwable</code>	The original exception that was thrown.

22.3.2.2.2. Example: Exceptions thrown by a `<scriptTask>`.

The following code illustrates how to extract extra information from a process instance that throws a `WorkflowRuntimeException` exception instance.

```
import org.jbpm.workflow.instance.WorkflowRuntimeException;
import org.kie.api.KieBase;
import org.kie.api.io.ResourceType;
import org.kie.api.runtime.KieSession;
import org.kie.api.runtime.process.ProcessInstance;
import org.kie.internal.builder.KnowledgeBuilder;
import org.kie.internal.builder.KnowledgeBuilderFactory;
import org.kie.internal.io.ResourceFactory;

public class ScriptTaskExceptionExample {

    public static final void main(String[] args) {
        runExample();
    }

    public static void runExample() {
        KieSession ksession = createKieSession();
        Map<String, Object> params = new HashMap<String, Object>();
        String varName = "var1";
        params.put( varName , "valueOne" );
        try {
            ProcessInstance processInstance = ksession.startProcess("ExceptionScriptTask", params);
        } catch( WorkflowRuntimeException wfre ) {
            String msg = "An exception happened in "
                + "process instance [" + wfre.getProcessInstanceId()
                + "] of process [" + wfre.getProcessId()
                + "] in node [id: " + wfre.getNodeId()
                + ", name: " + wfre.getNodeName()
                + "] and variable " + varName + " had the value [" + wfre.getVariables().get(varName)
                + "];
            System.out.println(msg);
        }
    }

    private static KieSession createKieSession() {
        KnowledgeBuilder kbuilder = KnowledgeBuilderFactory.newKnowledgeBuilder();
        kbuilder.add(ResourceFactory.newClassPathResource("exceptions/ScriptTaskException.bpmn2"), ResourceType.BPMN2);
        KieBase kbase = kbuilder.newKnowledgeBase();
        return kbase.newKieSession();
    }
}
```

22.4.1. Business Exceptions

Business Exceptions are exceptions that are designed and managed in the BPMN2 specification of a business process. In other words, Business Exceptions are exceptions which happen at the process or workflow level, and are not related to the technical components.

Many of the elements in BPMN2 related to Business Exceptions are related to *Compensation* and *Business Transactions*. Compensation, in particular, is complexer than many other parts of the BPMN2 specification.

Full support for *compensation* and *business transactions* is expected with the release of jBPM 6.1 or 6.2. Once that has been implemented, this section will contain more information about using those BPMN2 features with jBPM.

22.4.1.1. Business Exceptions elements in BPMN2

The following attempts to briefly describe Compensation and Business Transaction related elements in BPMN2. For more complete information about these elements and their uses, see the BPMN2 specification, Bruce Silver's book *BPMN Method and Style* or any of the other available books about the use of BPMN2.

Table 22.3. BPMN2 Exception Handling Elements

BPMN2 Element types	Description
Errors	<p>Error Events can be used to signal when a process has encountered an unexpected situation: signalling an error is often called <i>throwing</i> an error.</p> <p>Boundary Error Events in a different part of the process can then be used to <i>catch</i> the error and initiate a sequence of activities to handle the exception.</p> <p>Errors themselves can be extended with extra information that is passed from the throwing to catching event. This is done with the use of an Item Definition.</p>
Compensation	<p>Exception handling activities <i>associated</i> with the normal activities in a Business Transaction are triggered by <i>Compensation Events</i>.</p> <p>There are 3 types of compensation events: Intermediate (a.k.a. Boundary) (catch) events, Start (catch) events, and Intermediate or End (throw) events.</p>

BPMN2 Element types	Description
	<p>Compensation Boundary (catch) events may only be attached to activities (e.g. tasks) that could cause an exception. These Boundary events are then <i>associated</i> (not linked!) with a Task that will be executed if the Boundary event catches a (thrown) Compensation signal.</p> <p>Start (catch) events are used when defining an <i>Compensation Event SubProcess</i>, which requires them in order to be able to catch a (thrown) Compensation signal.</p> <p>Compensation Intermediate and End events are used in order to throw Compensation Events. These events often follow decision nodes that determine whether the workflow executed up to that point has succeeded. If not, the path including the Intermediate or End Event is chosen in order to trigger Compensation for the activities that did not succeed.</p>

BPMN2 contains a number of constructs to model exceptions in business processes. There are several advantages to doing exception handling at the business process level (as opposed to handling it with code):

- *Transparency*
 - Being able to quickly see what happens in exceptional situations means that the results and performance of a process is more easily monitored and measured.
 - It also increases how easily a process can be implemented as well as how maintainable a process definition is.
- *Business Logic Isolation*
 - Again, the idea behind using a business process is to isolate the business logic from the technical code. This simplifies the complexity of the system and increases how quickly you can create new business processes and change existing ones.
 - Implementing exception handling at a technical level often takes more time because it's often complex and specific to a system.

22.4.1.2. Designing a workflow with Business Exceptions

Where are business exceptions likely to occur? There is academic research on this, but some possible examples are:

- When an interaction with an external party or 3rd party system does not go as planned
- When you can not fully check the the input data in your process (like a client's address information, for example)
- In general, if there are parts of your process that are particularly dependent on one of the following, a business exception will be a good idea:
 - Company policy or policy governing certain (in-house) procedures
 - Laws governing the business process (such as age requirements, for example)

Chapter 23. Flexible Processes

Case management and its relation to BPM is a hot topic nowadays. There definitely seems to be a growing need amongst end users for more flexible and adaptive business processes, without ending up with overly complex solutions. Everyone seems to agree that using a process-centric approach only in many cases leads to complex solutions that are hard to maintain. The "knowledge workers" no longer want to be locked into rigid processes but wants to have the power and flexibility to regain more control over the process themselves.

The term case management is often used in that context. Without trying to give a precise definition of what it might or might not mean, as this has been a hot topic for discussion, it refers to the basic idea that many applications in the real world cannot really be described completely from start to finish (including all possible paths, deviations, exceptions, etc.). Case management takes a different approach: instead of trying to model what should happen from start to finish, let's give the end user the flexibility to decide what should happen at runtime. In its most extreme form for example, case management doesn't even require any process definition at all. Whenever a new case comes in, the end user can decide what to do next based on all the case data.

A typical example can be found in healthcare (clinical decision support to be more precise), where care plans can be used to describe how patients should be treated in specific circumstances, but people like general practitioners still need to have the flexibility to add additional steps and deviate from the proposed plan, as each case is unique. And there are similar examples in claim management, help desk support, etc.

So, should we just throw away our BPM system then? No! Even at its most extreme form (where we don't model any process up front), you still need a lot of the other features a BPM system (usually) provides: there still is a clear need for audit logs, monitoring, coordinating various services, human interaction (e.g. using task forms), analysis, etc. And, more importantly, many cases are somewhere in between, or might even evolve from case management to more structured business process over time (when we for example try to extract common approaches from many cases). If we can offer flexibility as part of our processes, can't we let the users decide how and where they would like to apply it?

Let me give you two examples that show how you can add more and more flexibility to your processes. The first example shows a care plan that shows the tasks that should be performed when a patient has high blood pressure. While a large part of the process is still well-structured, the general practitioner can decide himself which tasks should be performed as part of the sub-process. And he also has the ability to add new tasks during that period, tasks that were not defined as part of the process, or repeat tasks multiple times, etc. The process uses an ad-hoc sub-process to model this kind of flexibility, possibly augmented with rules or event processing to help in deciding which fragments to execute.



Figure 23.1. Healthcare: high blood pressure

The second example actually goes a lot further than that. In this example, an internet provider could define how cases about internet connectivity problems will be handled by the internet provider. There are a number of actions the case worker can select from, but those are simply small process fragments. The case worker is responsible for selecting what to do next and can even add new tasks dynamically. As you can see, there is not process from start to finish anymore, but the user is responsible for selecting which process fragments to execute.

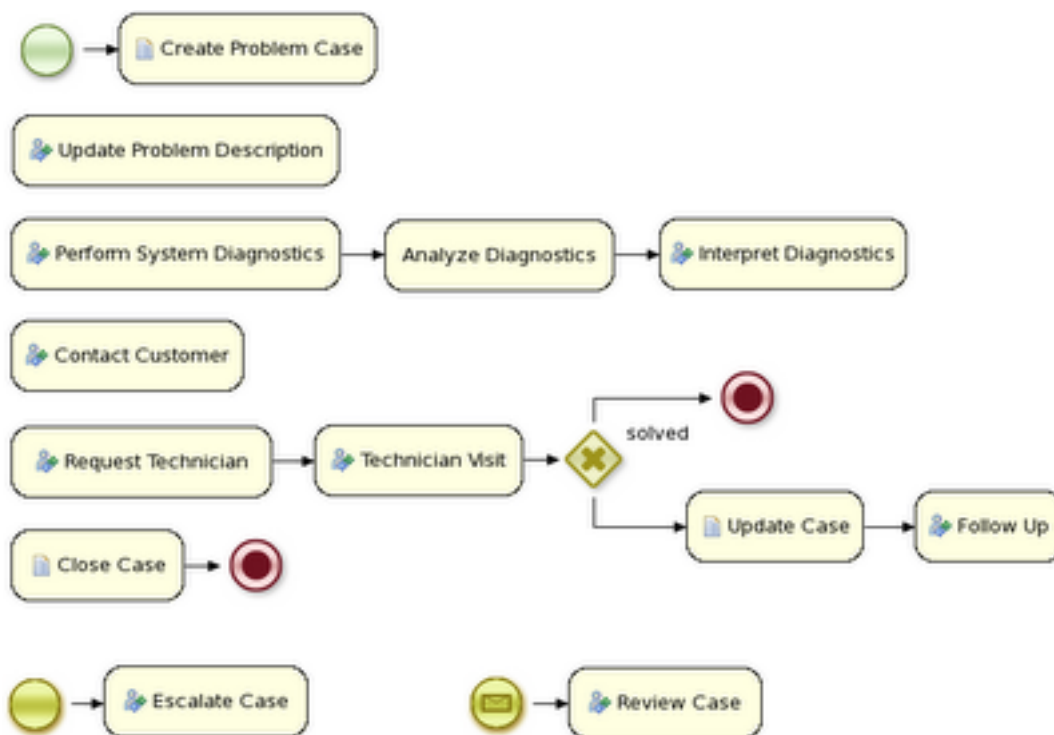


Figure 23.2. Telecom: process fragments

And in its most extreme form, we even allow you to create case instances without a process definition, where what needs to be performed is selected purely at runtime. This however doesn't mean you can't figure out anymore what 's actually happening. For example, meetings can be very ad hoc and dynamic, but we usually want a log of what was actually discussed. The following screenshot shows how our regular audit view can still be used in this case, and the end user could then for example get a lot more info about what actually happened by looking at the data associated with each of those steps. And maybe, over time, we can even automate part of that by using a semi-structured process.

- ▼  started: Company Meeting
 - ▼  List Attendees
 -  Agenda Overview
 -  Agenda Topic: New Hires
 -  Agenda Topic: Customer Feedback
 -  Agenda Topic Moved to Next Meeting: Company Party
 -  Questions?
 - ▼  Question: Fix Problems with Coffee Machine?
-  completed: Company Meeting

Figure 23.3. Audit log for dynamic case

Chapter 24. Concurrency and asynchronous execution

24.1. Concurrency

In the following text, we will refer to two types of "multi-threading": logical and technical. Technical multi-threading is what happens when multiple threads or processes are started on a computer, for example by a Java or C program. Logical multi-threading is what we see in a BPM process after the process reaches a parallel gateway, for example. From a functional standpoint, the original process will then split into two processes that are executed in a parallel fashion.

Of course, the jBPM engine supports logical multi-threading: for example, processes that include a parallel gateway. We've chosen to implement logical multi-threading using one thread: a jBPM process that includes logical multi-threading will only be executed in one technical thread. The main reason for doing this is that multiple (technical) threads need to be able to communicate state information with each other if they are working on the same process. This requirement brings with it a number of complications. While it might seem that multi-threading would bring performance benefits with it, the extra logic needed to make sure the different threads work together well means that this is not guaranteed. There is also the extra overhead incurred because we need to avoid race conditions and deadlocks.

24.1.1. Engine execution

In general, the jBPM engine executes actions in serial. For example, when the engine encounters a script task in a process, it will synchronously execute that script and wait for it to complete before continuing execution. Similarly, if a process encounters a parallel gateway, it will sequentially trigger each of the outgoing branches, one after the other. This is possible since execution is almost always instantaneous, meaning that it is extremely fast and produces almost no overhead. As a result, the user will usually not even notice this. Similarly, action scripts in a process are also synchronously executed, and the engine will wait for them to finish before continuing the process. For example, doing a `Thread.sleep(...)` as part of a script will not make the engine continue execution elsewhere but will block the engine thread during that period.

The same principle applies to service tasks. When a service task is reached in a process, the engine will also invoke the handler of this service synchronously. The engine will wait for the `completeWorkItem(...)` method to return before continuing execution. It is important that your service handler executes your service asynchronously if its execution is not instantaneous.

An example of this would be a service task that invokes an external service. Since the delay in invoking this service remotely and waiting for the results might be too long, it might be a good idea to invoke this service asynchronously. This means that the handler will only invoke the service and will notify the engine later when the results are available. In the mean time, the process engine then continues execution of the process.

Human tasks are a typical example of a service that needs to be invoked asynchronously, as we don't want the engine to wait until a human actor has responded to the request. The human task handler will only create a new task (on the task list of the assigned actor) when the human task node is triggered. The engine will then be able to continue execution on the rest of the process (if necessary) and the handler will notify the engine asynchronously when the user has completed the task.

24.1.2. Multiple knowledge sessions and persistence

The simplest way to run multiple processes is to run them all using one knowledge session. However, there are cases in which it's necessary to run multiple processes in different knowledge sessions, even in different (technical) threads. Both are supported by jBPM.

When we add persistence (using a database, for example) to a situation in which we have multiple knowledge sessions (and processes), there is a guideline that users should be aware of. The following paragraphs explain why this guideline is important to follow.



Tip

Please make sure to use a database that allows row-level locks as well as table-level locks.

For example, a user could have a situation in which there are 2 (or more) threads running, each with its own knowledge session instance. On each thread, jBPM processes are being started using the local knowledge session instance.

In this use case, a race condition exists in which both thread A and thread B will have coincidentally simultaneously finished a process. At this point, because persistence is being used, both thread A and B will be committing changes to the database. If row-level locks are not possible, then the following situation can occur:

- Thread A has a lock on the `ProcessInstanceInfo` table, having just committed a change to that table.
- Thread A wants a lock on the `SessionInfo` table in order to commit a change there.
- Thread B has the opposite situation: it has a lock on the `SessionInfo` table, having just committed a change there.
- Thread B wants a lock on the `ProcessInstanceInfo` table, even though Thread A already has a lock on it.

This is a deadlock situation which the database and application will not be able to solve. However, if row-level locks are possible (and enabled!!) in the database (and tables used), then this situation will not occur.

24.2. Asynchronous execution

24.2.1. Asynchronous handlers

How can we implement an asynchronous service handler? To start with, this depends on the technology you're using. If you're only using Java, you could execute the actual service in a new thread:

```
public class MyServiceTaskHandler implements WorkItemHandler {

    public void executeWorkItem(WorkItem workItem, WorkItemManager manager) {
        new Thread(new Runnable() {
            public void run() {
                // Do the heavy lifting here ...
            }
        }).start();
    }

    public void abortWorkItem(WorkItem workItem, WorkItemManager manager) {
    }
}
```

It's advisable to have your handler contact a service that executes the business operation, instead of having it perform the actual work. If anything goes wrong with a business operation, it doesn't affect your process. The loose coupling that this provides also gives you greater flexibility in reusing services and developing them.

For example, you can have your human task handler simply invoke the human task service to add a task there. To implement an asynchronous handler, you usually have to simply do an asynchronous invocation of this service. This usually depends on the technology you use to do the communication, but this might be as simple as asynchronously invoking a web service, or sending a JMS message to the external service.

24.2.2. jbpm executor

In version 6, jBPM introduces new component called jbpm executor which provides quite advanced features for asynchronous execution. It delivers generic environment for background execution of commands. Commands are nothing more than business logic encapsulated within simple interface. It does not have any process runtime related information, that means no need to complete work items, or anything of that sort. It purely focuses on the business logic to be executed. It receives data via CommandContext and returns results of the execution with ExecutionResults.

Before looking into details on jBPM support for asynchronous execution let's look at what are the common requirements for such execution:

- allows asynchronous execution of given piece of business logic

Concurrency and asynchronous execution

- allows to retry in case of resources are temporarily unavailable e.g. external system interaction
- allows to handle errors in case all retries have been attempted
- provides cancellation option
- provides history log of execution

When confronting these requirements with the "simple async handler" (executed as separate thread) you can directly notice that all of these would need to be implemented all over again by different systems. Due to that a common, generic component has been provided out of the box to simplify and empower usage.

jBPM executor operates on commands, which are essential piece of code that is going to be executed as background job.

```
/**
 * Executor's Command are dedicated to contain purely business logic that should be executed.
 * It should not have any reference to underlying process engine and should not be concerned
 * with any process runtime related logic such as completing work item, sending signals, etc.
 * <br/>
 * Information that are taken from process will be delivered as part of data instance of
 * <code>CommandContext</code>. Depending on the execution context that data can vary but
 * in most of the cases following will be given:
 * <ul>
 * <li></li>
 * <li>businessKey - usually unique identifier of the caller</li>
 * <li>callbacks - FQCN of the <code>CommandCallback</code> that shall be used on command completion</li>
 * </ul>
 * When executed as part of the process (work item handler) additional data can be expected:
 * <ul>
 * <li>workItem - the actual work item that is being executed with all its parameters</li>
 * <li>processInstanceId - id of the process instance that triggered this work</li>
 * <li>deploymentId - if given process instance is part of an active deployment</li>
 * </ul>
 * Important note about implementations is that it shall always be possible to be initialized with default constructor
 * as executor service is an async component so it will initialize the command on demand using reflection.
 * In case there is a heavy logic on initialization it should be placed in another service implementation that
 * can be looked up from within command.
 */
public interface Command {

    /**
     * Executed this command's logic.
     * @param ctx - contextual data given by the executor service
     * @return returns any results in case of successful execution
     * @throws Exception in case execution failed and shall be retried if possible
     */
    public ExecutionResults execute(CommandContext ctx) throws Exception;
}
```

Looking at the interface above, there is no specific integration with the jBPM runtime engine, it's decoupled from it to put main focus on the actual logic that shall be executed as part of that

command rather to worry about integration with process engine. This design promotes reuse of already existing logic by simply wrapping it with Command implementation.

Input data is transferred from process engine to command via CommandContext. It acts purely as data transfer object and puts single requirement on the data it holds - all objects must be serializable.

```
/**
 * Data holder for any contextual data that shall be given to the command upon execution.
 * Important note that every object that is added to the data container must be serializable
 * meaning it must implement <code>java.io.Serializable</code>
 *
 */
public class CommandContext implements Serializable {

    private static final long serialVersionUID = -1440017934399413860L;
    private Map<String, Object> data;

    public CommandContext() {
        data = new HashMap<String, Object>();
    }

    public CommandContext(Map<String, Object> data) {
        this.data = data;
    }

    public void setData(Map<String, Object> data) {
        this.data = data;
    }

    public Map<String, Object> getData() {
        return data;
    }

    public Object getData(String key) {
        return data.get(key);
    }

    public void setData(String key, Object value) {
        data.put(key, value);
    }

    public Set<String> keySet() {
        return data.keySet();
    }

    @Override
    public String toString() {
        return "CommandContext{" + "data=" + data + '}';
    }
}
```

Next outcome is provided to process engine via ExecutionResults, which is very similar in nature to the CommandContext and acts as data transfer object.

Concurrency and asynchronous execution

```
/**
 * Data holder for command's result data. Whatever command produces should be placed in
 * this results so they can be later on referenced by name by the requester - e.g. process instance.
 *
 */
public class ExecutionResults implements Serializable {

    private static final long serialVersionUID = -1738336024526084091L;
    private Map<String, Object> data = new HashMap<String, Object>();

    public ExecutionResults() {
    }

    public void setData(Map<String, Object> data) {
        this.data = data;
    }

    public Map<String, Object> getData() {
        return data;
    }

    public Object getData(String key) {
        return data.get(key);
    }

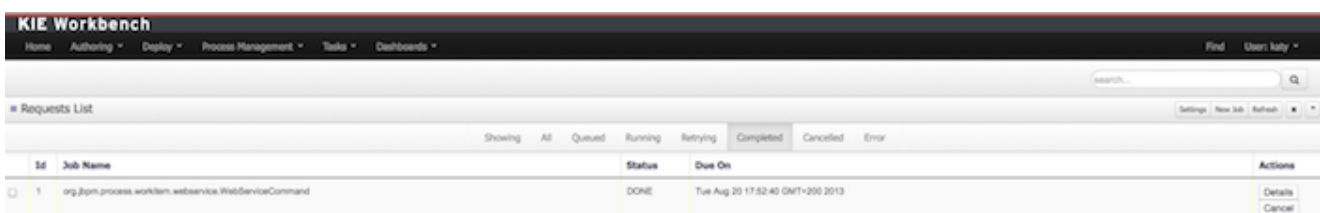
    public void setData(String key, Object value) {
        data.put(key, value);
    }

    public Set<String> keySet() {
        return data.keySet();
    }

    @Override
    public String toString() {
        return "ExecutionResults{" + "data=" + data + '}';
    }

}
```

Executor covers all requirements listed above and provides user interface as part of jbpms console and kie workbench (kie-wb) applications.



The screenshot shows the KIE Workbench interface. At the top, there is a navigation bar with 'Home', 'Authoring', 'Deploy', 'Process Management', 'Tools', and 'Dashboards'. A search bar and user information 'User: kelly' are also visible. Below the navigation bar, there is a 'Requests List' section with a search bar and a 'Settings' button. The main content area displays a table with columns for 'Id', 'Job Name', 'Status', 'Due On', and 'Actions'. The table contains one row with the following data:

Id	Job Name	Status	Due On	Actions
1	org.jbpm.process.workitem.webservice.WebServiceCommand	DONE	Tue Aug 20 17:52:40 GMT+000 2013	Details Cancel

Figure 24.1.

Above screenshot illustrates history view of executor's job queue. As can be seen on it there are several options available:

- view details of the job
- cancel given job
- create new job

24.2.2.1. WorkItemHandler backed with jbpm executor

jbPM (again in version 6) provides an out of the box async work item handler that is backed by the jbpm executor. So by default all features that executor delivers will be available for background execution within process instance. AsyncWorkItemHandler can be configured in two ways:

- as generic handler that expects to get the command name as part of work item parameters
- as specific handler for given type of work item - for example web service

Option 1 is by default configured for jbpm console and kie-wb web applications and is registered under **async** name in every ksession that is bootstrapped within the applications. So whenever there is a need to execute some logic asynchronously following needs to be done at modeling time (using jbpm web designer):

- specify async as TaskName property
- create data input called CommandClass
- assign fully qualified class name for the CommandClass data input

Next follow regular way to complete process modeling. Note that all data inputs will be transferred to executor so they must be serializable.

Second option allows to register different instances of AsyncWorkItemHandler for different work items. Since it's registered for dedicated work item most likely the command will be dedicated to that work item as well. If so CommandClass can be specified on registration time instead of requiring it to be set as work item parameters. To register such handlers for jbpm console or kie-wb additional class is required to inform what shall be registered. A CDI bean that implements WorkItemHandlerProducer interface needs to be provided and placed on the application classpath so CDI container will be able to find it. Then at modeling time TaskName property needs to be aligned with those used at registration time.

24.2.2.2. Configuration

jbpm executor is configurable to allow fine tuning of its environment. In general jbpm executor runs as a thread pool that periodically checks for waiting jobs and executes them when needed. Configuration of jbpm executor is done via system properties:

- org.kie.executor.disabled = true|false - allows to completely disable executor component

- `org.kie.executor.pool.size` = Integer - allows to specify thread pool size where default is 1
- `org.kie.executor.retry.count` = Integer - allows to specify number of retries in case of errors while running a job
- `org.kie.executor.interval` = Integer - allows to specify interval (in seconds) that executor will use while checking for waiting jobs where default is 3 seconds
- `org.kie.executor.timeunit` = String - allows to specify timer unit used for calculating interval, value must be a valid constant of `java.util.concurrent.TimeUnit`, by default it's `SECONDS`.

24.2.2.3. Reoccurring jobs

jbpm executor introduced (in version 6.2) extension to jobs (aka commands) that allow single job to be executed multiple times. That feature is brought to the executor via additional interface that command should implement.

```
/**
 * Marks given executor command it is reoccurring and shall be rescheduled after completion
 * of single instance.
 *
 */
public interface Reoccurring {

    /**
     * Returns next time to be scheduled. Date must be in future as jobs cannot be scheduled in past.
     * Returns null in case it should not be scheduled any more.
     * @return
     */
    Date getScheduleTime();
}
```

Reoccurring interface is very simple and enforces implementation to provide the next schedule time that the command should be executed at. It must already be valid date that is not in the past. In case no more invocation of given command should happen return value of this method should be null.

An excellent example of such command is `org.jbpm.executor.commands.LogCleanupCommand` that provides easy and convenient way to schedule periodic clean up of jBPM log tables on defined time intervals. See this article [<http://mswidorski.blogspot.com/2014/12/keep-your-jbpm-environment-healthy.html>] to see it in action and how to configure and run it.

24.2.2.4. Run jobs on same server node on which it was scheduled

By default jbpm executor is cluster ready and by that will distribute jobs across all cluster members. That might result in execution of given job on different cluster member than it was scheduled which is not always desired. To override this mechanism job can set 'Owner' as part of their data when being registered where owner is the executor instance that is scheduling the job.

Concurrency and asynchronous execution

```
CommandContext ctx = new CommandContext();
ctx.setData("some data", "data...");
ctx.setData("Retries", 0);
ctx.setData("Owner", ExecutorService.EXECUTOR_ID);
```

That will ensure that only the instance that scheduled the job will be the one which will execute it. Note that it might impact the time when the job is executed especially in cases where given cluster member will be unavailable.

Chapter 25. Release Notes

25.1. jBPM 6.4

25.1.1. New and Noteworthy in jBPM 6.4.0

The following features were added to jBPM 6.4

25.1.1.1. New jBPM Process & Task Dashboard

The jBPM Process Dashboard has been entirely rewritten in this version and now is based on a native workbench perspective instead of a separated web application. The main goal is to deliver a better user experience, thanks to a much more appealing as well as polished user interface.

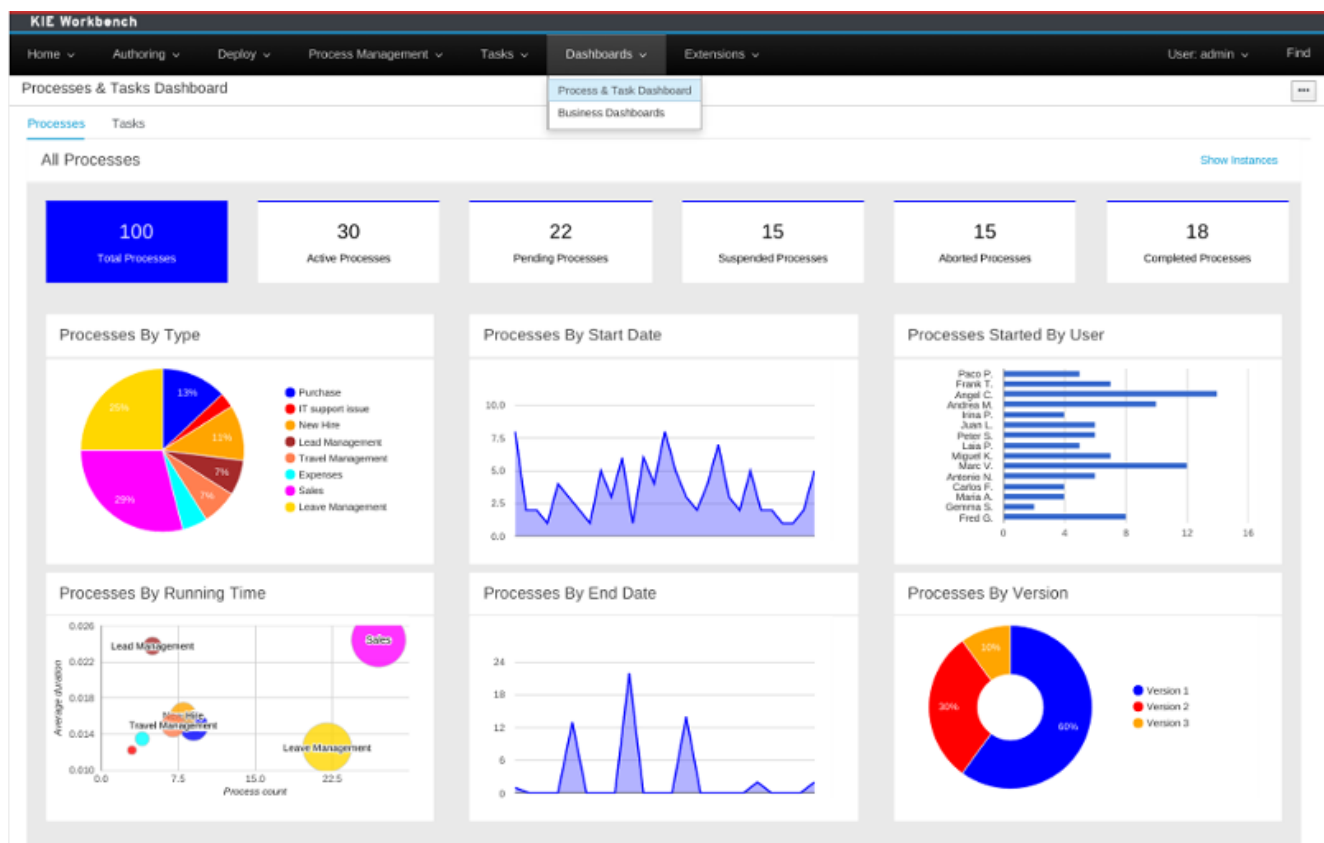


Figure 25.1.

This dashboard version also provides the ability to navigate from the graphical indicators to any of the related process or task instances. Now, end users can easily find out the instances that are related to a given indicator and deep into their details as well.

The screenshot displays the KIE Workbench interface. On the left, the 'Processes & Tasks Dashboard' shows a table of active customer relationship processes. On the right, the 'Instance Details' panel provides a comprehensive overview of a specific process instance, including its state, deployment information, and current activities.

Id	Deployment Id	Process Id	Process name	Initiator	Status
4	org.jbpm:Customer...	CustomersRelation...	Customer Relation...	salaboy	Active
3	org.jbpm:Customer...	CustomersRelation...	Customer Relation...	salaboy	Active
2	org.jbpm:Customer...	CustomersRelation...	Customer Relation...	salaboy	Active

Figure 25.2.

The resulting dashboard is more fluent, more interactive and with a better integration with the jBPM runtime.

25.1.1.2. Task variables auditing

By default process variables are stored in audit tables (VariableInstanceLog) that allows simplified access to variable values without need to load individual process instances. Moreover that provides option to search by process variables and process variable values e.g. to find process instances that have given value for given variable.

This was missing for task variables as task variables were not stored in any audit tables. This has been improved in version 6.4.0 and now task variables are stored in audit table (TaskVariableImpl) by default. It does follow the same mechanism as for process variables - variable.toString() is the value stored in table. With this services and query APIs have been enhanced to take advantage of this support and to search for tasks by their variables.

25.1.1.3. Process and task variables indexation

By default process and task variables are indexed with simplest possible mechanism - that is variable.toString() while for some object this can be sufficient, like simple types, for others it can cause significant problems when performing queries. To solve the problem process and task variables are equipped with pluggable indexation. This is realized by two interfaces that shall be implemented to provide custom indexation behavior.

- org.kie.internal.process.ProcessVariableIndexer
- org.kie.internal.task.api.TaskVariableIndexer

details about how to use the indexers can be found in Audit log section of the documentation

25.1.1.4. Ability to show bussiness data at task list.

The user can now create a specific filter that provides domain specific columns to be added to a task list. When the user creates a custom filter for a specific task name the task variables are enabled as columns.

The custom filter that activates the capability to display task variables as columns is set a filter with the restriction Name="taskName".

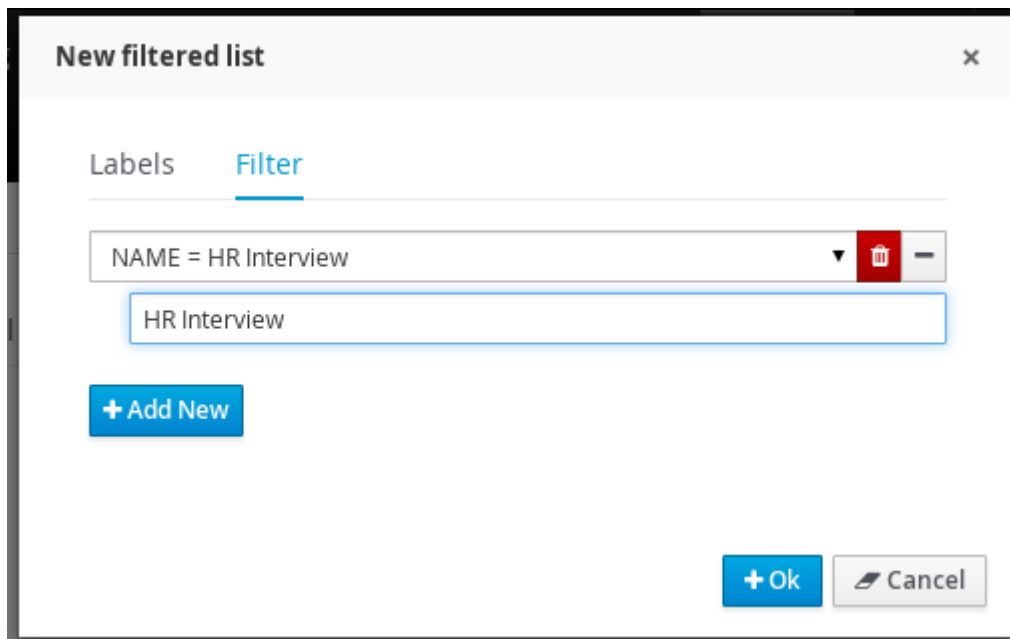








Figure 25.3. Filter by task name creation

When the filter with the restriction over a specific task name is applied, the task associated variables appear as a selectable columns, to the task list.

Tasks List New Task      

Active × Personal × Group × All × Admin × **HR ×** +

Task	Description	Actions	in_name
HR Interview	Candidate: Anne Jones	<input type="button" value="Claim"/>	Anne Jones
HR Interview	Candidate: David Smith	<input type="button" value="Claim"/>	David Smith
HR Interview	Candidate: Carl Lane	<input type="button" value="Claim"/>	Carl Lane
HR Interview	Candidate: Coral Teller	<input type="button" value="Claim"/>	Coral Teller

- Id
- Description
- Process Name
- Process Id
- Priority
- Status
- CreatedOn
- DueOn
- Comment
- nodeName
- in_name
- TaskName
- GroupId

Figure 25.4. task list with task name restriction applied

25.1.2. New and Noteworthy in KIE Workbench 6.4.0

25.1.2.1. Authoring - Imports - Consistent terminology

The Workbench used to have a section in the Project Editor for "Import Suggestions" which was really a way for Users to register classes provided by the Java Runtime environment to be available to Rule authoring. Furthermore Editors had a "Config" tab which was where Users were expected to import classes from other packages to that in which the rule resides.

Neither term was clear and both were inconsistent with each other and other aspects of the Workbench.

We have changed these terms to (hopefully) be clearer in their meaning and to be consistent with the "Data Object" term used in relation to authoring Java classes within the Workbench.

Project: [mortgages:mortgages:0.0.1]

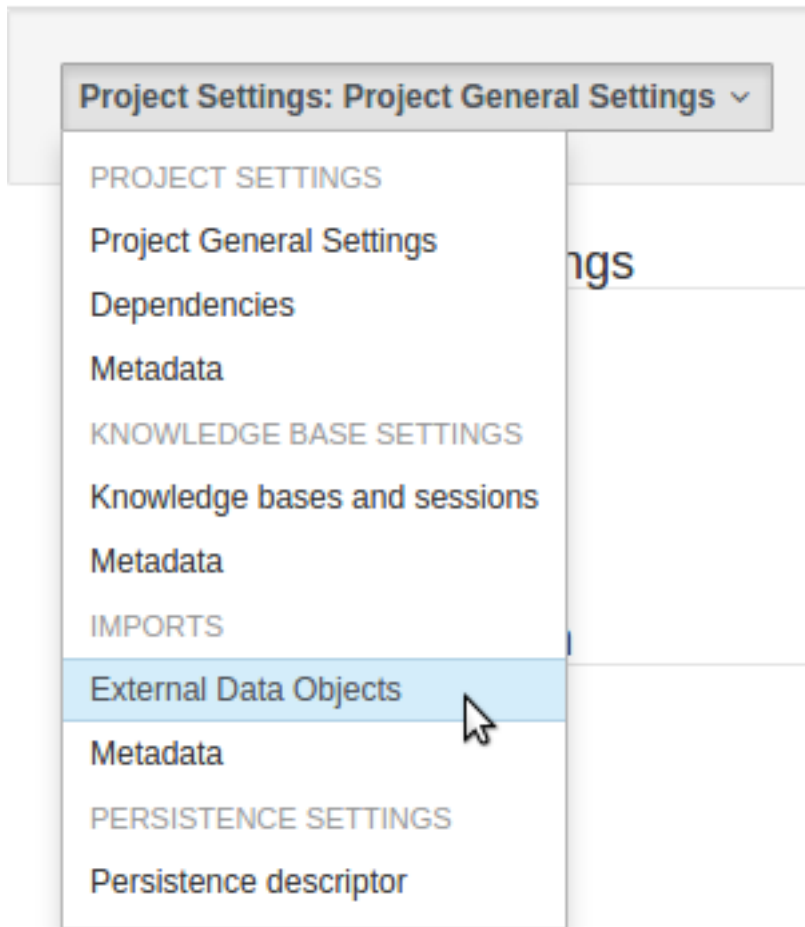


Figure 25.5. Project Editor - External Data Objects

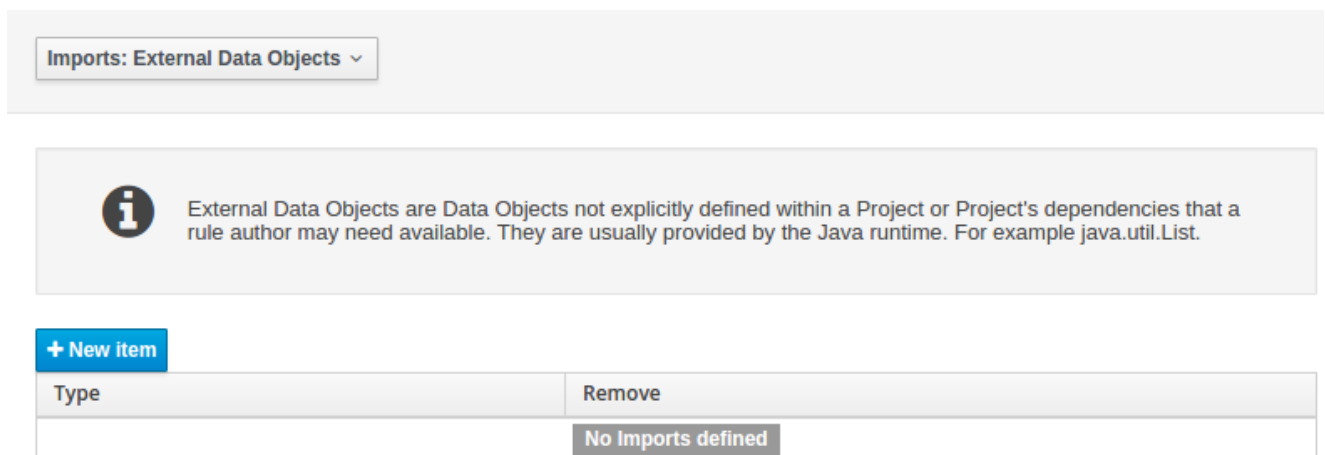


Figure 25.6. Project Editor - Defining External Data Objects

Bankruptcy history.rdr1 - Guided Rules

Editor Overview Source Data Objects

EXTENDS None selected

WHEN

- There is a LoanApplication [a]
 - The following exists:
 - There is a Bankruptcy with:
 - any of the following:
 - yearOfOccurrence greater than 1990
 - amountOwed greater than 10000

Figure 25.7. Asset Editors - Data Objects

The Data Object screen lists all Data Objects in the same package as the asset and allows other Data Objects from other packages to be imported.

Editor Overview Source Data Objects

i By default only Data Objects within the same package as the asset are available for authoring. Additional Data Objects can be imported from other packages.

+ New item

Type	Remove
org.mortgages.Applicant	
org.mortgages.Bankruptcy	
org.mortgages.IncomeSource	
org.mortgages.LoanApplication	
java.lang.String	Remove

Figure 25.8. Asset Editors - Defining Data Objects available for authoring

25.1.2.2. Disable automatic build

When navigating Projects with the Project Explorer the workbench automatically builds the selected project, displaying build messages in the Message Console. Whilst this is beneficial it can have a detrimental impact on performance of the workbench when authoring large projects. The auto-

matic build can now be disabled with the `org.kie.build.disable-project-explorer` System Property. Set the value to `true` to disable. The default value is `false`.

25.1.2.3. Support for SCP style git Repository URLs

When cloning git Repositories it is now possible to use SCP style URLs, for example `git@github.com:user/repository.git`. If your Operating System's public keystore is password protected the passphrase can be provided with the `org.uberfire.nio.git.ssh.passphrase` System Property.

25.1.2.4. Authoring - Duplicate GAV detection

When performing any of the following operations a check is now made against all Maven Repositories, resolved for the Project, for whether the Project's GroupId, ArtifactId and Version pre-exist. If a clash is found the operation is prevented; although this can be overridden by Users with the `admin` role.



Note

The feature can be disabled by setting the System Property `org.guvnor.project.gav.check.disabled` to `true`.

Resolved repositories are those discovered in:-

- The Project's POM `<repositories>` section (or any parent POM).
- The Project's POM `<distributionManagement>` section.
- Maven's global `settings.xml` configuration file.

Affected operations:-

- Creation of new Managed Repositories.
- Saving a Project definition with the Project Editor.
- Adding new Modules to a Managed Multi-Module Repository.
- Saving the `pom.xml` file.
- Build & installing a Project with the Project Editor.
- Build & deploying a Project with the Project Editor.
- Asset Management operations building, installing or deloying Projects.

- REST operations creating, installing or deploying Projects.

Users with the `Admin` role can override the list of Repositories checked using the "Repositories" settings in the Project Editor.

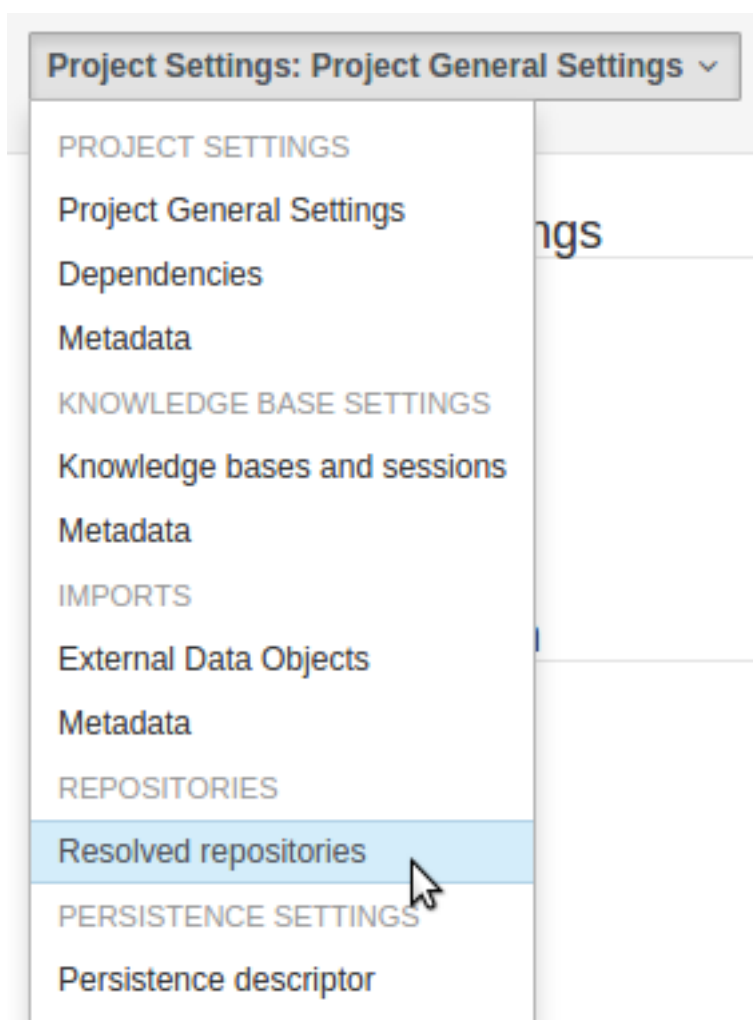



Figure 25.9. Project Editor - Viewing resolved Repositories


Repositories: Resolved repositories ▾

 These are the Maven Repositories resolved for the Project from the Project's pom, the Project's Distribution Management configuration and Maven's global settings.

Include	Id	URL	Source
<input checked="" type="checkbox"/>	local	/home/manstis/.m2/repository	Local
<input checked="" type="checkbox"/>	jboss-developer-repository-group	https://repository.jboss.org/nexus/content/groups/developer/	Maven settings
<input checked="" type="checkbox"/>	jboss-origin-repository-group	https://origin-repository.jboss.org/nexus/content/groups/ea/	Maven settings
<input checked="" type="checkbox"/>	jboss-public-repository-group	http://repository.jboss.org/nexus/content/groups/public/	Maven settings

Figure 25.10. Project Editor - The list of resolved Repositories

Conflicting Repositories ✕

 The following Repositories already contain Artifact "mortgages:mortgages:0.0.1".

Id	URL	Source
local	/home/manstis/.m2/repository	Local

+ Ok
Override

Figure 25.11. Duplicate GAV detected

25.2. jBPM 6.3

25.2.1. New and Noteworthy in jBPM 6.3.0

The following features were added to jBPM 6.3.

25.2.1.1. Process engine extensions

- JavaScript as script language

You can now use JavaScript as dialect in scripts (script task and on-entry and on-exit scripts) and for constraints (for example on gateways). Same as with the Java and MVEL dialect, you have direct access to variables, globals and to the `kcontext` variable (giving you access to the `ProcessContext`).

For example, you can write something like:

```
kcontext.setVariable('surname', "tester");
var text = 'Hello ';
print(text + kcontext.getVariable('name') + '\n');
try {
    somethingInvalid;
} catch(err) {
    print(err + '\n');
}
```

- Async continuation

Async continuation simplifies usage of asynchronous processing of process activities. Simply marking process activity as async will instruct the engine to complete current processing (including committing transaction) before entering that activity. This in turn will allow more control over what is executed in sequence and improve overall manageability of process execution. Here [<http://mswidorski.blogspot.com/2015/04/asynchronous-continuation-in-jbpm-63.html>] you can read an article describing this in details.

- Signal scopes

Version 6.3 comes with improved support for signaling process instances. Based on concepts of signals defined in BPMN2 jBPM provides additional characteristic to them - the scope. Scope defines how to propagate the signal:

- process instance scope - signals only elements within the same process instance, other process instances won't be affected
- default (ksession) scope - signals all elements that are waiting for given signal and are known to running ksession
- project scope - signals all components within given project (that means managed by the same instance of runtime manager)
- external scope - pluggable scope that allow to customize signal propagation - jBPM 6.3 comes with JMS based implementation which is enabled in workbench (receiving part)

More about the improved signaling can be found in this article [<http://mswidorski.blogspot.com/2015/09/improved-signaling-in-jbpm-63.html>].

- Improved search capabilities when using jbpm services (RuntimeDataService) that allows
 - search by correlation key
 - search by process variable name
 - search by process variable name and value
- Throw async signals

If there are several process instances from different process definitions, all of them waiting the same signal and only one of these process instances throws a RuntimeException all others not related will not move forward as well, because they are executed sequentially in the same transaction. That creates heavy dependency between unrelated process instances. Asynchronous throw event solves the problem by individually signaling each process instance in background.

25.2.1.2. Case management API

The core process engine has always contained the flexibility to model adaptive and flexible processes. These kinds of features are typically also required in the context of case management. To simplify picking up some of these more advanced features, we created a (wrapper) API that exposes some of these features in a simple API. Note that this API simply relies on other existing features / API and can easily be extended. The API and implementation is added as part of a new `jbpm-case-mgmt` module.

- Process instance description

Each case can have a unique name, specific to that case.

- Case roles

A case can keep track of who is participating by using case roles. These roles can be defined as part of the case definition (by giving them a name and (optionally) a cardinality). Case roles could also be defined dynamically (at runtime). For active case instances, specific users can be assigned to roles.

- Ad-hoc cases

One can start a new case without even having a case definition. Whatever happens inside this case is completely determined at runtime.

- Case file

A case can contain any kind of data, from simple key-value pairs to custom data objects or documents.

- Ad-hoc tasks

Using the ad-hoc constructs available in BPMN2, one can model optional process fragments, where only at runtime it is decided which of these fragments should be executed (and how many times). This could be driven by end users (selecting optional fragments for execution) or automatically (for example by rules that trigger certain fragments under certain conditions, or whenever triggered by external services).

- Dynamic tasks

It is possible to add new tasks dynamically, even if they weren't defined upfront (in the case definition). This includes human tasks, service tasks and other processes.

- Milestones

You can define milestones as part of the case definition (or even dynamically) and keep track of which milestones were reached for specific case instances.

25.2.1.3. Remote API

The remote REST API for accessing the workbench received the following extensions:

- Process instance image

Through the remote REST API you can now retrieve an image that represents the status of a particular process instance, annotated on the process diagram. This will generate the same image as you could already see in the workbench by looking at the process instance diagram, i.e. active nodes will be marked with a red border and completed nodes have a gray background. This is generated based on the SVG of the process diagram, which can automatically be generated by designer whenever saving a process.



Note

A new `SVGImageProcessor` has been used to add the necessary annotations based on the audit log data. Note that this processor (in the `jbpm-process-svg` module) could be extended to support more advanced visualizations.

This feature is unfortunately not active by default! In order to activate this feature, it is necessary to follow the following steps:

1. Open the `org.kie.workbench.KIEWebapp/profiles/jbpm.xml` file in the kie-wb war.
2. Towards the top of this `jbpm.xml` file, you'll see the following xml element:

```
<storesvgonsave enabled="false"/>
```

Change the `false` value here to `true`.

3. (Re)Deploy the war

Furthermore, only process definitions that have been opened in the designer *after this modification* will be available via the REST operations described below. However, providing process images by default via REST (without having to turn on an option or open the process definition in designer) is on the roadmap.

2 new REST operation URLs have been made available to provide the image:

- The following URL provides an image of the process definition:

```
{server}/jbpm-console/rest/runtime/{deploymentId}/process/{processDefId}/image
```

The `deploymentId` URL parameter corresponds to the deployment id, while the `processDefId` parameter corresponds to the process (definition) id.

- The following URL provides an image of the process definition, with the active nodes marked to correspond to the process instance URL parameter passed:

```
{server}/jbpm-console/rest/runtime/{deploymentId}/process/  
{processDefId}/image/{procInstId}
```

The `deploymentId` URL parameter corresponds to the deployment id, the `processDefId` parameter corresponds to the process (definition) id, and the `procInstId` URL parameter corresponds to the process instance id.

25.2.1.4. OSGi

The remote clients - `kie-remote-client` for accessing the workbench embedded in the workbench and `kie-server-client` for the separate (unified) execution server - are now also available as an OSGi feature.

25.2.1.5. jBPM Designer Data I/O Editor

jBPM Designer includes a new dialog for editing data inputs and outputs on activities in Business Processes. The dialog combines the functions of the dialogs in previous versions of jBPM Designer for editing data inputs and outputs, and for defining assignments between data inputs/outputs and process variables. The dialog allows the user to:

- create and edit data inputs and data outputs on activities
- define assignments from process variables or constants to data inputs, and from data outputs to process variables

The dialog is accessed by editing the Assignments property for activities which have this property, such as User Tasks, or by editing the DataInputAssociations or DataOutputAssociations property for activities which have one of these properties. The dialog is also available by clicking on a new button associated with those activities for which it is relevant:

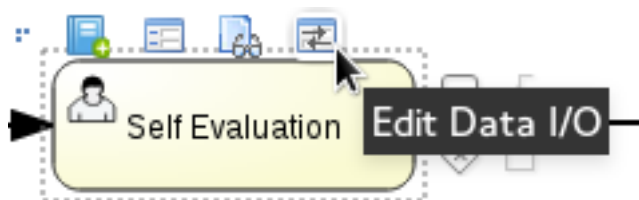


Figure 25.12.

25.2.1.6. jBPM executor

jBPM executor has been significantly enhanced in version 6.3 where the biggest improvement was to provide support for JMS based notification mechanism to improve performance for immediate job execution. Instead of always relying on poll based mechanism, in case of immediate job request the executor is notified via JMS. Though it still provides same set of capabilities:

- retry mechanism
- error handling
- search capabilities to look through job requests

Retry mechanism was static in prior versions, which means that the retry happened directly with next execution cycle. That made it rather low in terms of usage as in case there was a temporary problem e.g. network issue, system not available. It has been improved as well and allows configurable retry delay to be specified on each job individually. This delay can be given as time expressions that will be calculated from current time stamp. Retry delay can be given as:

- single time expression - 5m or 2h
- comma separated list of time expressions that should be used for subsequent retries - 10s,10m,1h,1d

In case number of retry delays is smaller than number of retries it will use last available value from the list of retry delays. Which for single value means it will always be the same value.

More information about executor enhancements can be found in these two articles: Shift gears with jBPM executor [<http://mswidorski.blogspot.com/2015/08/shift-gears-with-jbpm-executor.html>]and Asynchronous processing [<http://mswidorski.blogspot.com/2015/08/asynchronous-processing-with-jbpm-63.html>]

25.2.1.7. Unified KIE Execution Server

jBPM 6.3 brings in fully featured Unified KIE Execution Server that is based on successful KIE Execution Server that was released with 6.2 and covered rules use case. In 6.3 this execution

server has been enhanced and now support for rules and process (including user tasks and asynchronous jobs). It provides lightweight mechanism for executing your business assets. Number of environments can be built with with it:

- single execution server (similar to workbench)
- execution server per kjar
- execution server per domain knowledge (set of k jars)
- and more...

It is prepared to run on almost any container where tested configuration include following:

- JBoss EAP 6.4
- Wildfly 8.1 and 8.2
- Tomcat 7 and 8
- WebSphere 8.5.5.x
- Weblogic 12c

To get started with KIE Execution Server look at this blog series [<http://mswidorski.blogspot.com/2015/09/unified-kie-execution-server-part-1.html>] that provides KIE Execution Server introduction.

25.2.1.8. Process and Task Lists UI Improvements

The process and task lists screens are now backed up by the Dashbuilder's DataSet APIs and data providers. This enable these runtime screens to retrieve the data in a much more efficient way and enable the users to apply more advanced filters.

The initial version for creating filters is provided with jBPM 6.3.0.Final and it will be extended and polished in future versions.

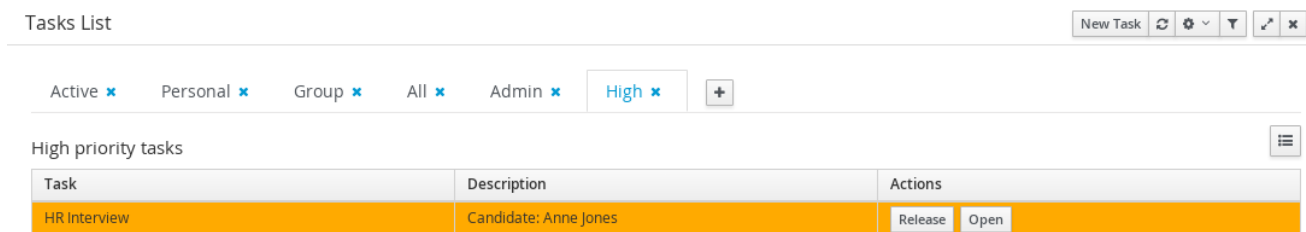


Figure 25.13.

A new button to restore the default filters if needed is provided.

New filters can be created using the + button. This enable users to have custom filters. There is one filter per tab.

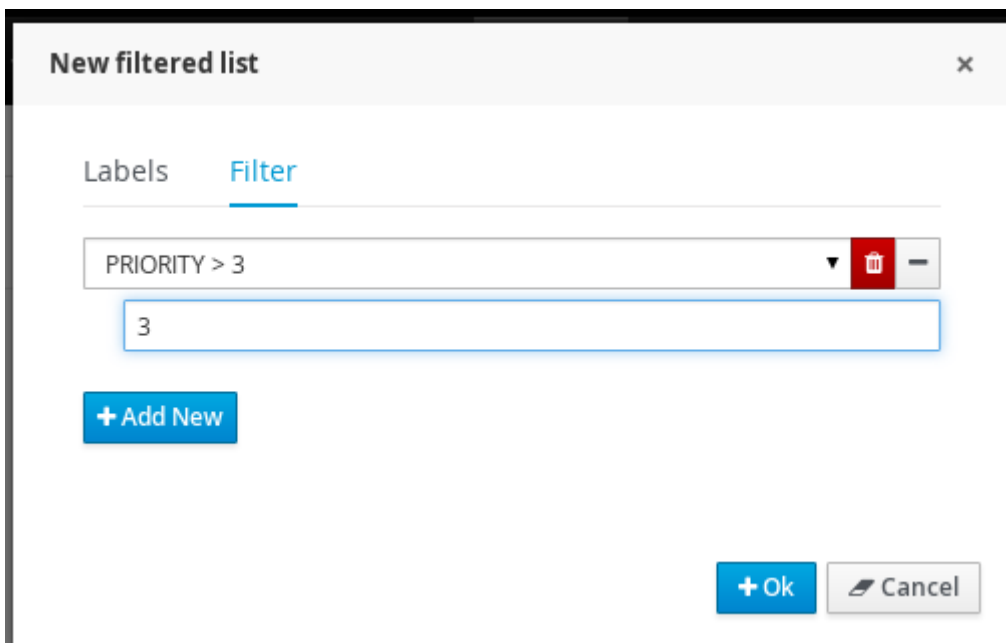


Figure 25.14.

Users can create as many custom filters as they want. These filters will be stored in the user preferences.

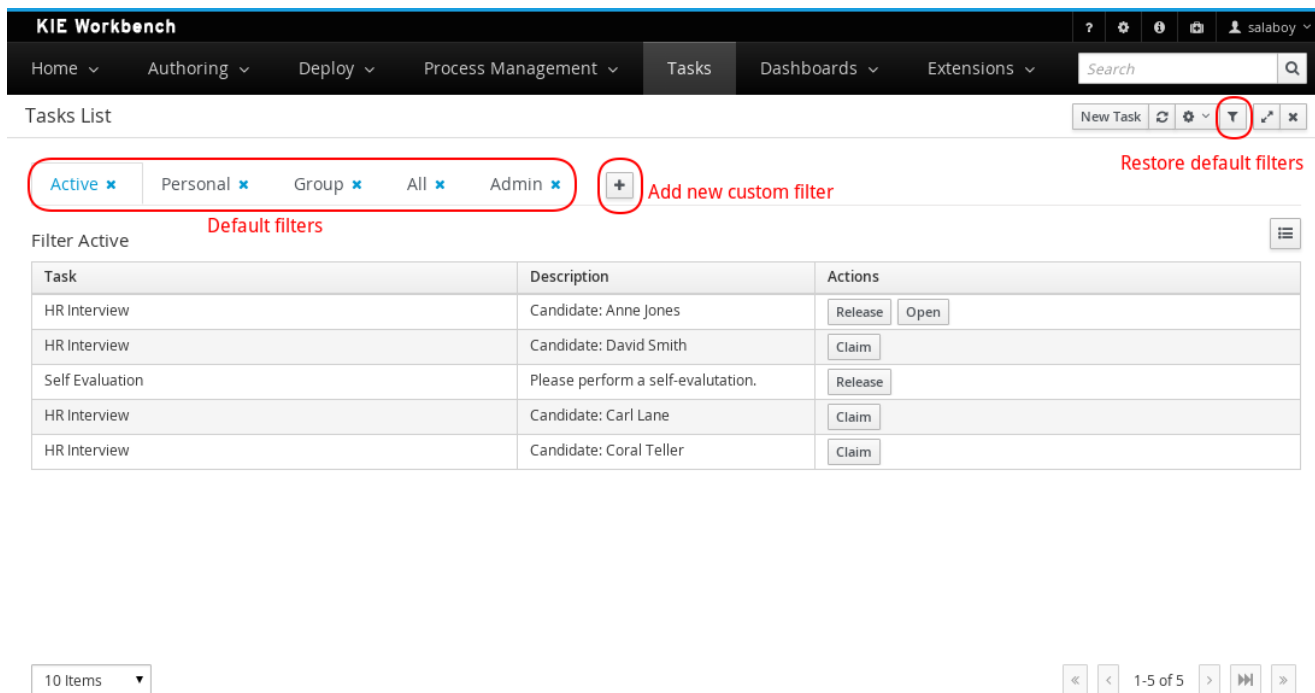



Figure 25.15.

The process instance list now provides domain specific columns to be added in custom filters. When the user creates a custom filter for a specific process definition the process variables are enabled as columns, to the process instance list. This feature will be added to the task list as well in future versions.



Note

Only Process Variables with values will be listed in the column picker inside the custom filter tab.

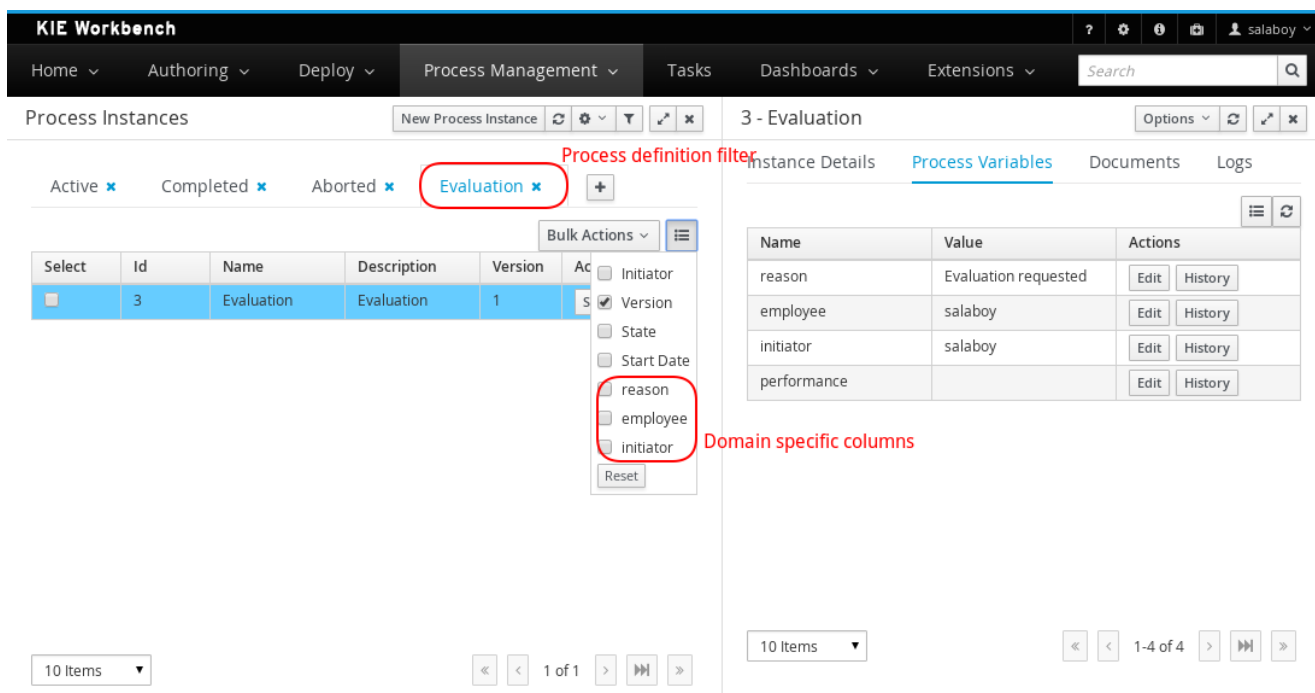


Figure 25.16.

25.2.2. New and Noteworthy in KIE Workbench 6.3.0

25.2.2.1. Real Time Validation and Verification for the Decision Tables

Decision tables used to have a Validation-button for validating the table. This is now removed and the table is validated after each cell value change. The validation and verification checks include:

- Redundancy
- Subsumption
- Conflicts

- Missing Columns

These checks are explained in detail in the workbench documentation.

25.2.2.2. Improved DRL Editor

The DRL Editor has undergone a face lift; moving from a plain TextArea to using ACE Editor and a custom DRL syntax highlighter.

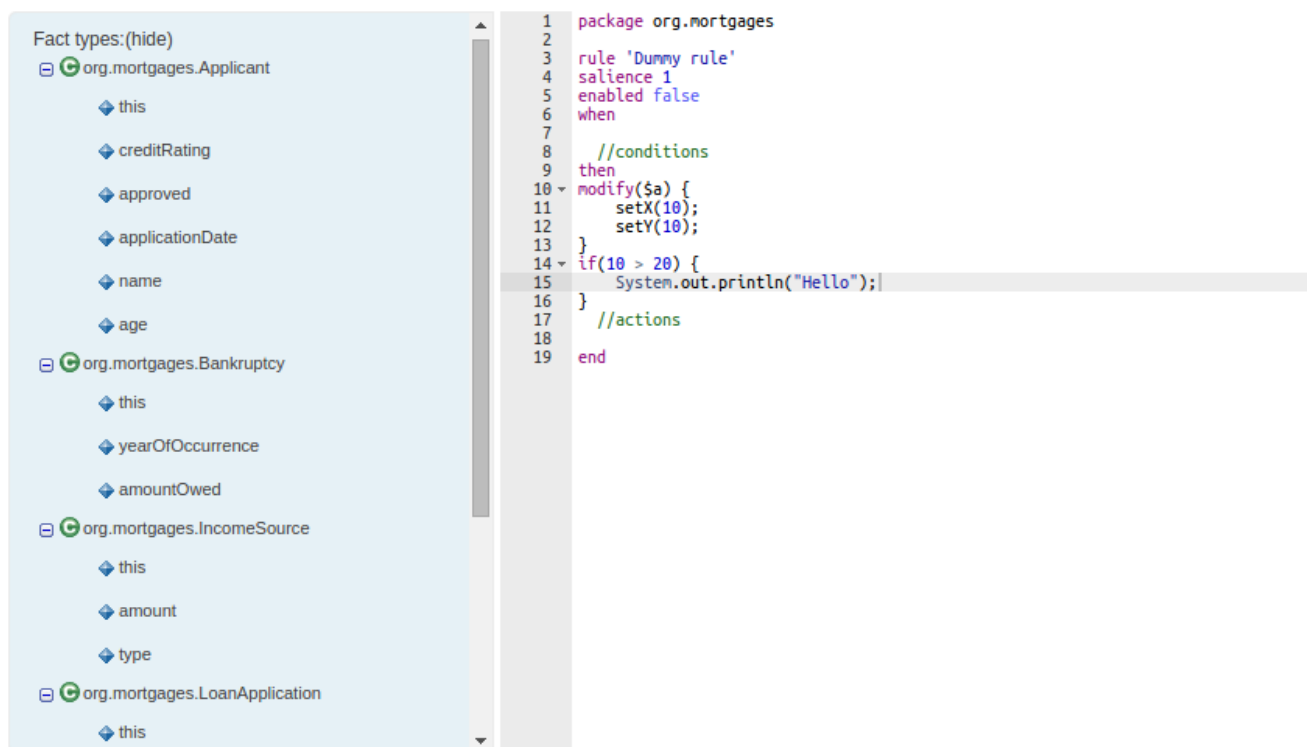


Figure 25.17. ACE Editor

25.2.2.3. Asset locking

To avoid conflicts when editing assets, a new locking mechanism has been introduced that makes sure that only one user at a time can edit an asset. When a user begins to edit an asset, a lock will automatically be acquired. This is indicated by a lock symbol appearing on the asset title bar as well as in the project explorer view. If a user starts editing an already locked asset a pop-up notification will appear to inform the user that the asset can't currently be edited, as it is being worked on by another user. As long as the editing user holds the lock, changes by other users will be prevented. Locks will automatically be released when the editing user saves or closes the asset, or logs out of the workbench. Every user further has the option to force a lock release in the metadata tab, if required.

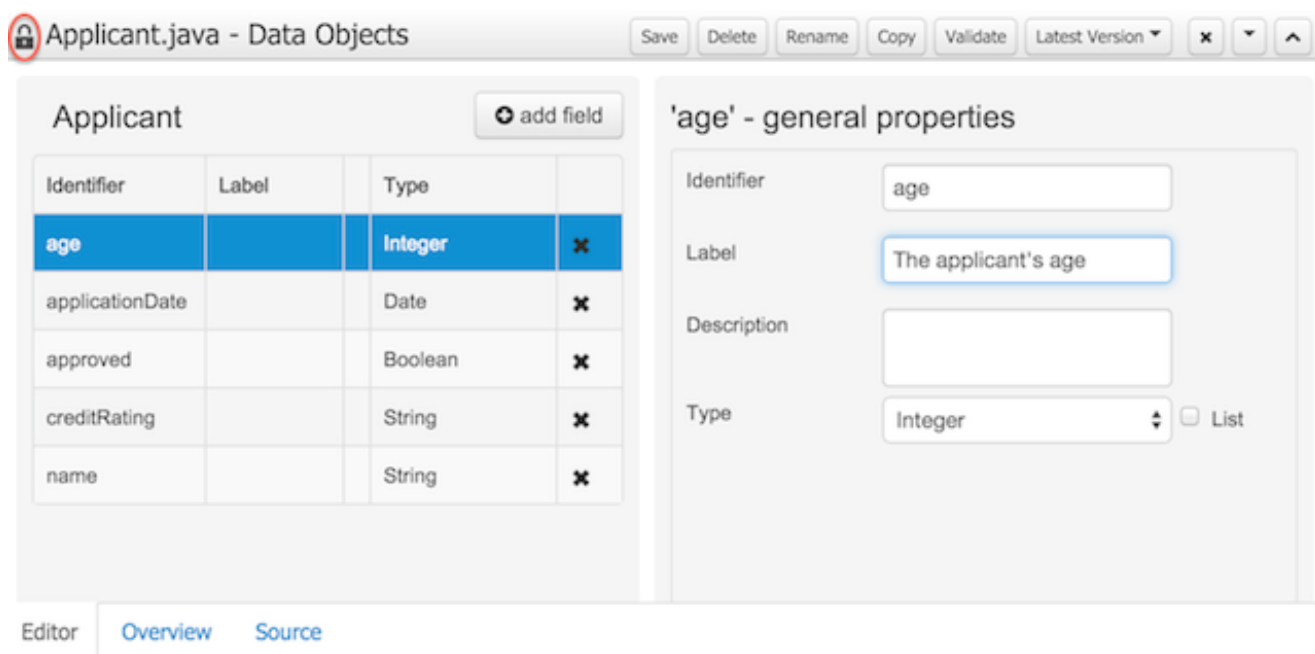


Figure 25.18. Editing an asset automatically acquires a lock

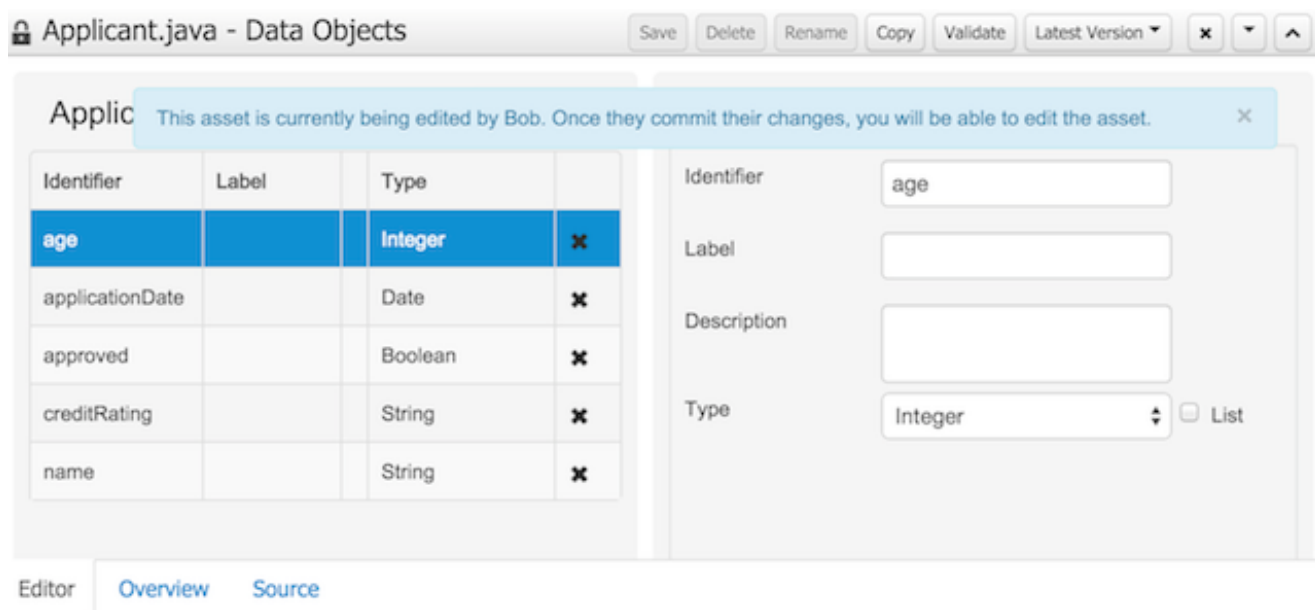


Figure 25.19. Locked assets cannot be edited by other users

25.2.2.4. Data Modeller Tool Windows

Drools and jBPM configurations, Persistence (see Generation of JPA enabled Data Models) and Advanced configurations were moved into "Tool Windows". "Tool Windows" are a new concept introduced in latest Uberfire version that enables the development of context aware screens. Each

"Tool Window" will contain a domain editor that will manage a set of related Data Object parameters.

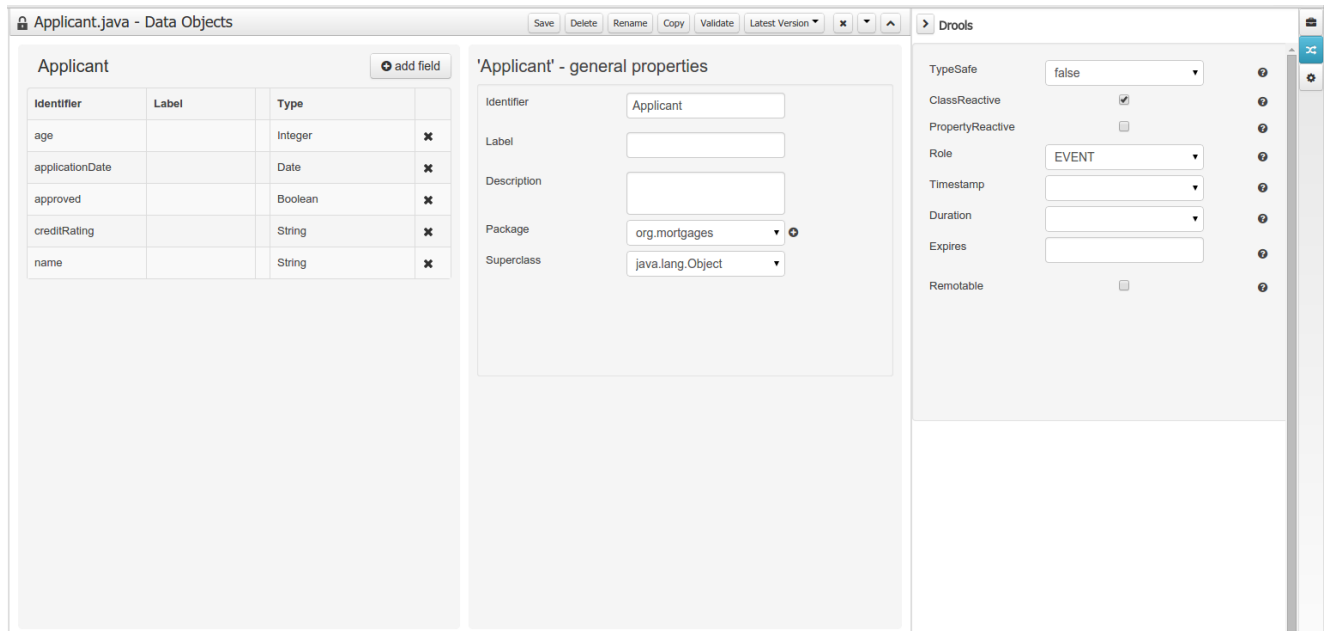


Figure 25.20. Drools and jBPM domain tool window

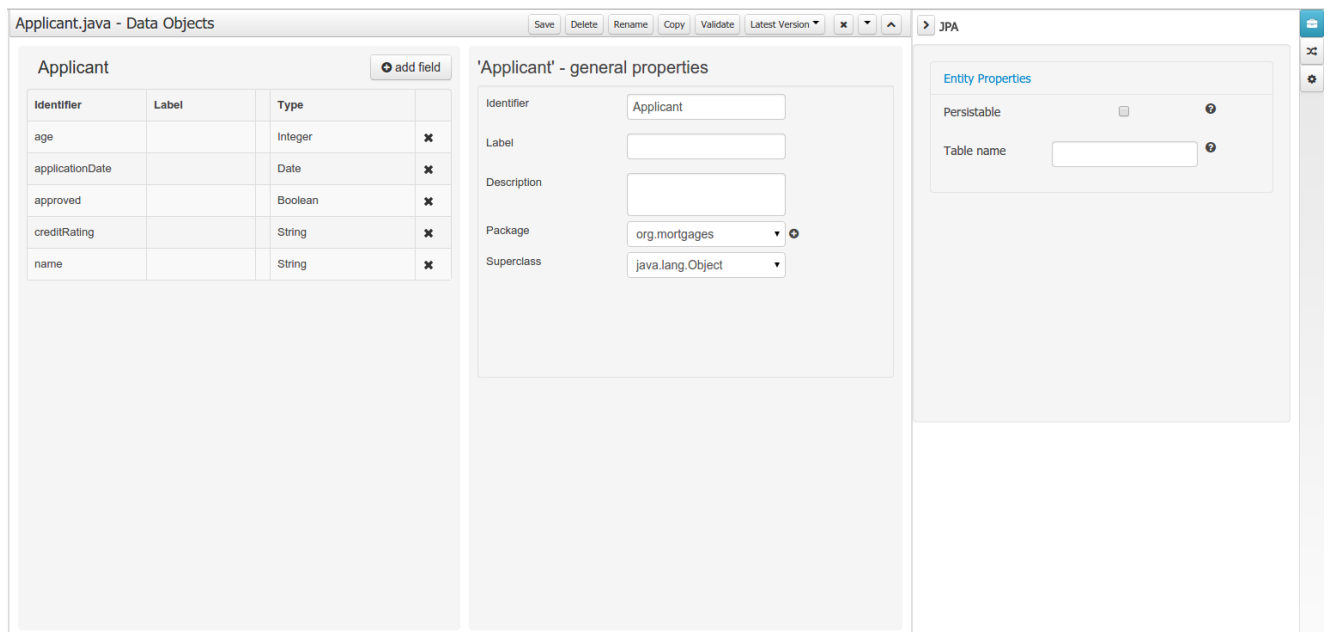


Figure 25.21. Persistence tool window

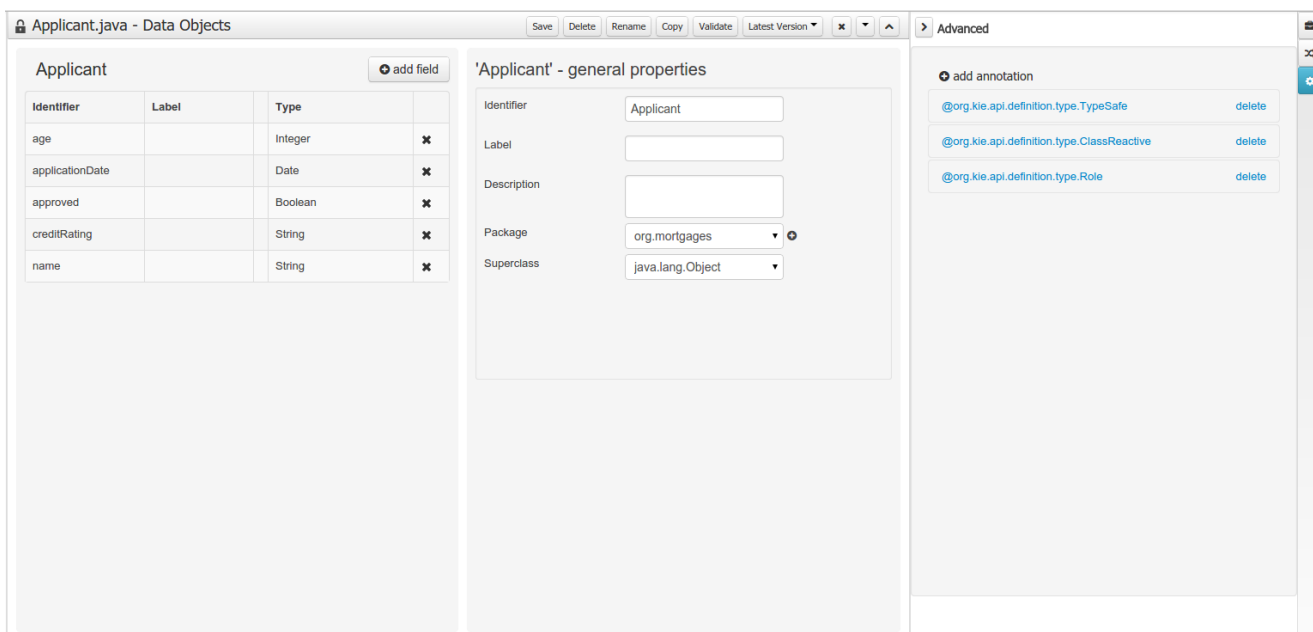


Figure 25.22. Advanced configurations tool window

25.2.2.5. Generation of JPA enabled Data Models

Data modeller was extended to support the generation of persistable Data Objects. The persistable Data Objects are based on the JPA specification and all the underlying metadata are automatically generated.

- "The New -> Data Object" Data Objects can be marked as persistable at creation time.

Create new Data Object ×

* Data Object

Package

Persistable ?

Figure 25.23. New Data Object

- The Persistence tool window contains the JPA Domain editors for both Data Object and Field. Each editor will manage the by default generated JPA metadata

The screenshot shows the 'Invoice.java - Data Objects' window with the following components:

- Invoice** (Title bar)
- Buttons: Save, Delete, Rename, Copy, Validate, Latest Version, Close, Maximize, Minimize, Refresh
- Invoice** (Left Panel): A table with columns Identifier, Label, Type, and an action column. The table contains one row: Identifier: Id, Label: (empty), Type: Long, Action: ✕. There is an 'add field' button.
- 'Invoice' - general properties** (Middle Panel): Identifier: Invoice, Label: (empty), Description: (empty), Package: org.mortgages, Superclass: java.lang.Object.
- JPA** (Right Panel): Entity Properties. Persistable: , Table name: INVOICE.

Figure 25.24. Data Object level JPA domain editor

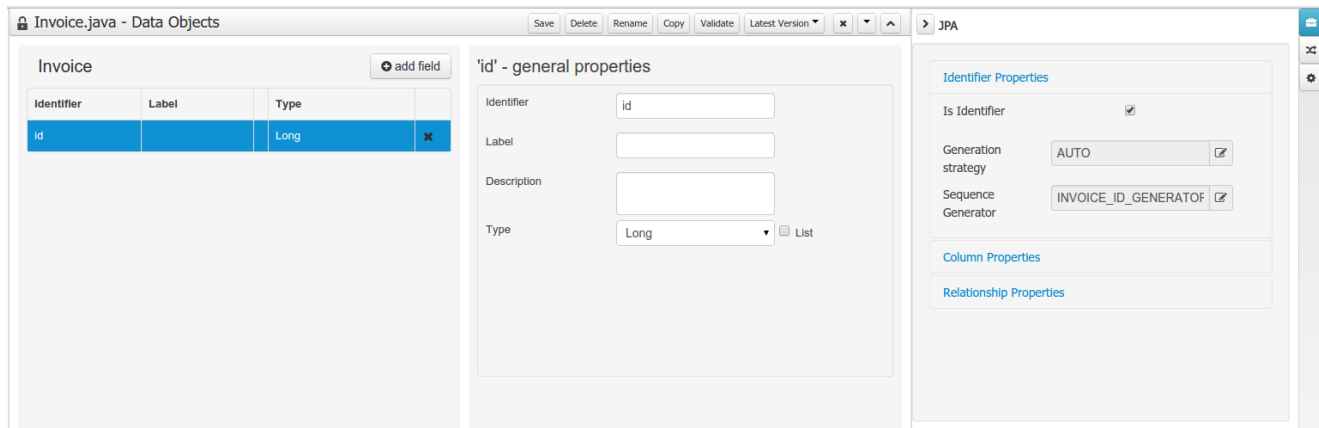


Figure 25.25. Field level JPA domain editor

- Persistence configuration screen was added to the project editor.

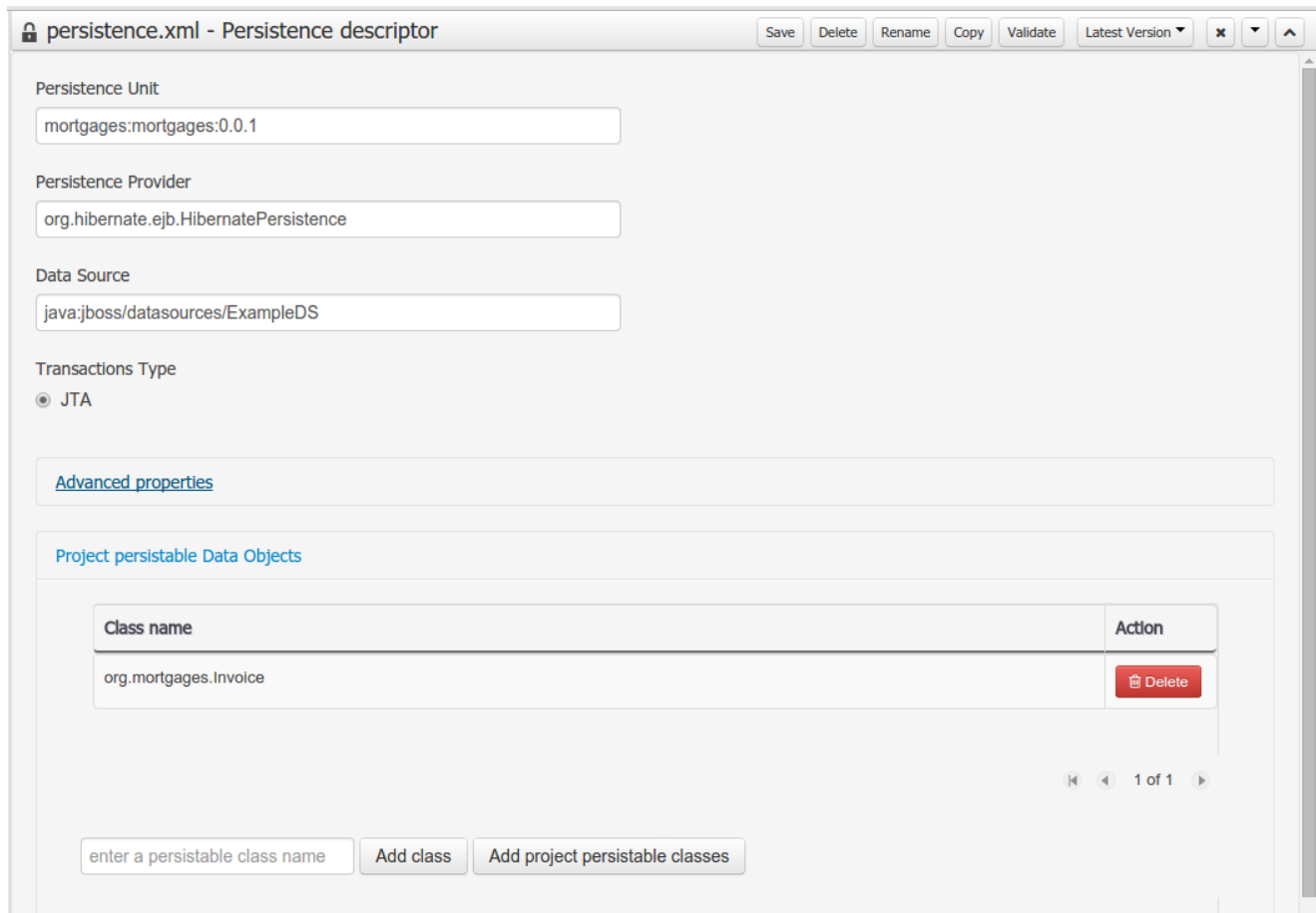


Figure 25.26. Persistence configuration

25.2.2.6. Data Set Authoring

A new perspective for authoring data set definitions has been added. Data set definitions make it possible to retrieve data from external systems like databases, CSV/Excel files or even use a Java class to generate the data. Once the data is available it can be used, for instance, to create charts and dashboards from the Perspective Editor just feeding the charts from any of the data sets available.

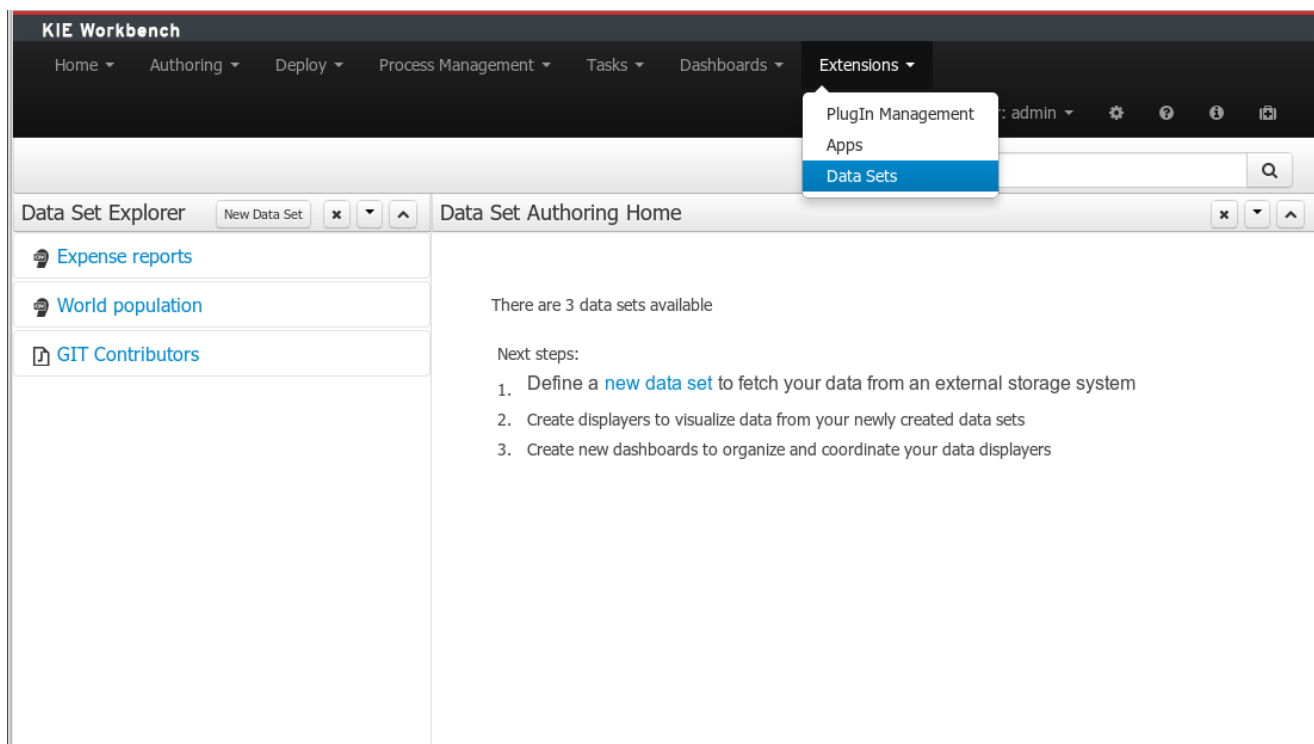


Figure 25.27. Data Sets Authoring Perspective

25.3. jBPM 6.2

25.3.1. New and Noteworthy in jBPM 6.2.0

The following features were added to the jBPM core on top of 6.1.

25.3.1.1. jBPM services

jBPM services modules have been significantly refactored to provide clear separation between the logic they bring and various frameworks that can be used to consume those services. With version 6.2 following modules are available:

- jbpm-services-api - clear services api that shall be used by any client code that consumes services

- jbpm-kie-services - core implementation of the services that do not have any framework specific code (e.g. CDI)
- jbpm-services-cdi - CDI specific code on top of jbpm-kie-services
- jbpm-services-ejb-api - ejb related extensions to services api - mainly to provide remote capabilities for the interfaces
- jbpm-services-ejb-impl - ejb specific code on top of jbpm-kie-services
- jbpm-services-ejb-client - ejb client implementation to interact with services over remote ejb invocation - currently JBoss specific implementation available
- jbpm-service-ejb-timer - ejb timer service backed by JEE timer service provided by container

jbPM services are intended to be base of execution server (regardless of what framework is used to build it up completely) so should be considered as first choice when embedding jbpm in custom applications. With 6.2 capabilities it already provides support for most common frameworks used - CDI, EJB, Spring (should simply rely on core implementation). See this article [<http://mswidorski.blogspot.com/2014/11/cross-framework-services-in-jbpm-62.html>] for details and example.

25.3.1.2. Process engine extensions

1. Lazy initialization of runtime engine components by RuntimeManager to make runtime engine creation lightweight

RuntimeEngine has been enhanced to lazy initialize its components (KieSession, TaskService, AuditService) to improve overall performance of retrieving RuntimeEngine instances from RuntimeManager.

2. Life cycle management for work item handlers and event listeners

Handler and listeners can implement additional interface to be managed by runtime engine, see work item handler life cycle management for more details.

3. Deployments are now by default stored in data base (as deployment descriptors) to survive server restarts

Prior to version 6.2 deployments that were handled by DeploymentService implementation were not persisted so they required to be handled separately - in case of kie-workbench they were stored inside system.git repo. With version 6.2 deployment service will persist that information directly into db which will make it easier in many cases including clustering as it will not require VFS clustering (Zookeeper and Helix) setup.

4. Extension to deployment descriptor to specify classes (by FQCN) that should be added to JAXB context for remote interfaces interaction

Deployment descriptor accept new set of elements

```
<remoteable-classes>    ...    <remotable-class>org.jbpm.test.CustomClass</remotable-class>
...</remoteable-classes>
able-classes>
...    <remotable-
class>org.jbpm.test.CustomClass</remotable-class>
...
```

5. Classpath scanning for classes to be included in JAXB context for remote interfaces interaction

Classes annotated with `javax.xml.bind.annotation.XmlRootElement` and `org.kie.api.remote.Remotable` will be automatically added to JAXB context of given deployment as soon as they are defined as project dependency. At the same time all classes included in project itself are also added to deployment's JAXB context.

6. jbpmm executor has been enhanced to provide support for:

- requeue failed jobs so they can be executed once the error that caused them to is resolved.
- reoccurring jobs that allows single definition to be repeatedly invoked based on time intervals, e.g. daily jobs to clean up history log tables. See this article [<http://mswidorski.blogspot.com/2014/12/keep-your-jbpm-environment-healthy.html>] for details and example.

7. CRON support for intermediate and boundary timer events

8. Enhanced support for multi instance activities to support completion condition as MVEL expression

25.3.1.3. OSGi

While a number of core jars were OSGi-ready (in v5 already), a significant number of additional jars were now added to this list, including for example the human task service, the runtime managers, full persistence, etc. As a result, full core engine functionality is now available on top of OSGi. Specific extensions and tests showing it in action are available for Apache Karaf and Aries Blueprint (in the `droolsjbpm-integration` repository).

25.3.1.4. Camel handler

A new out-of-the-box service task has been implemented for using Apache Camel to connect a process to the outside world using some of the numerous Camel endpoint URIs. The service task allows you to for example specify how to pass data to an FTP endpoint by configuring properties such as hostname, port, username, payload, etc. for some common endpoints like (S)FTP, File, JMS, XSLT, etc. but you can use virtually any of the available endpoints by defining the URI yourself (<http://camel.apache.org/uris.html>).

25.3.1.5. Form Modeler improvements

Support for JavaScript code:

- Added field property on simple fields to allow the user to add JavaScript code on the onchange event. This will allow the user to add richer functionalities on the forms.
- Simplified the autogenerated field id's in order to allow the user to access the inputs directly via JavaScript.

New field types:

- Added configurable ComboBox and RadioGroup fields. This new fields types allow the user to add ComboBoxes and Radio Button groups selecting their data source from the list of the Sources registered on the application.
- Added support to simple types Lists (`java.util.List<String>`, `java.util.List<Integer>`, `java.util.List<Long>`...). This fields allow the user to upload multiple basic values (strings, numbers, dates and booleans) storing them on `java.util.List`

25.3.2. New and Noteworthy in KIE Workbench 6.2.0

25.3.2.1. Download Repository or Part of the Repository as a ZIP

This feature makes it possible to download a repository or a folder from the repository as a ZIP file.

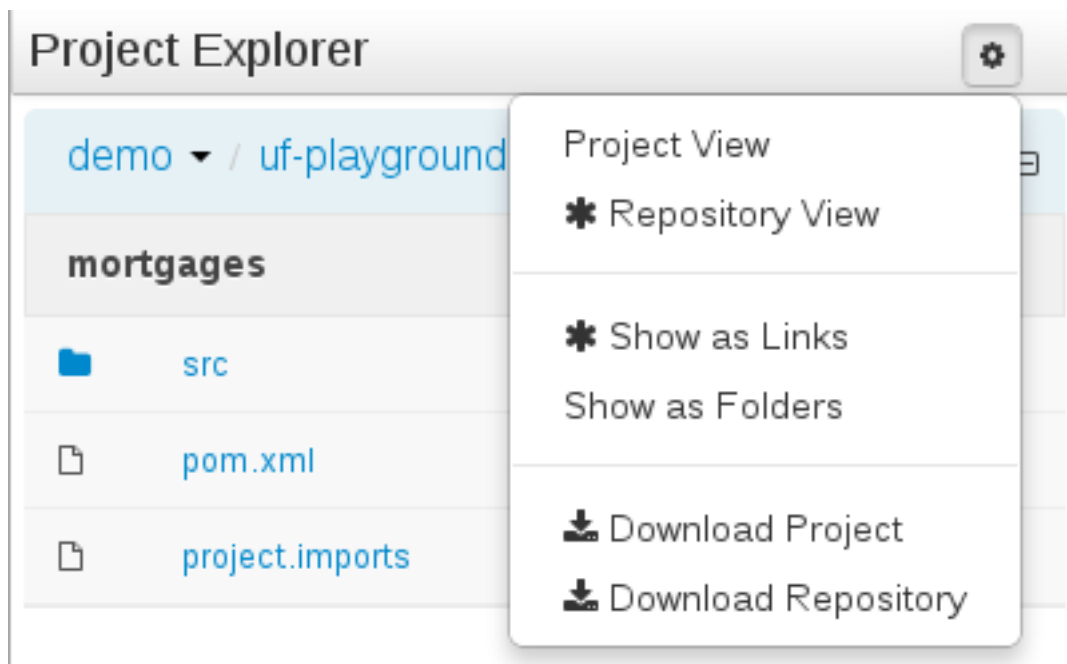


Figure 25.28. Download current repository or project

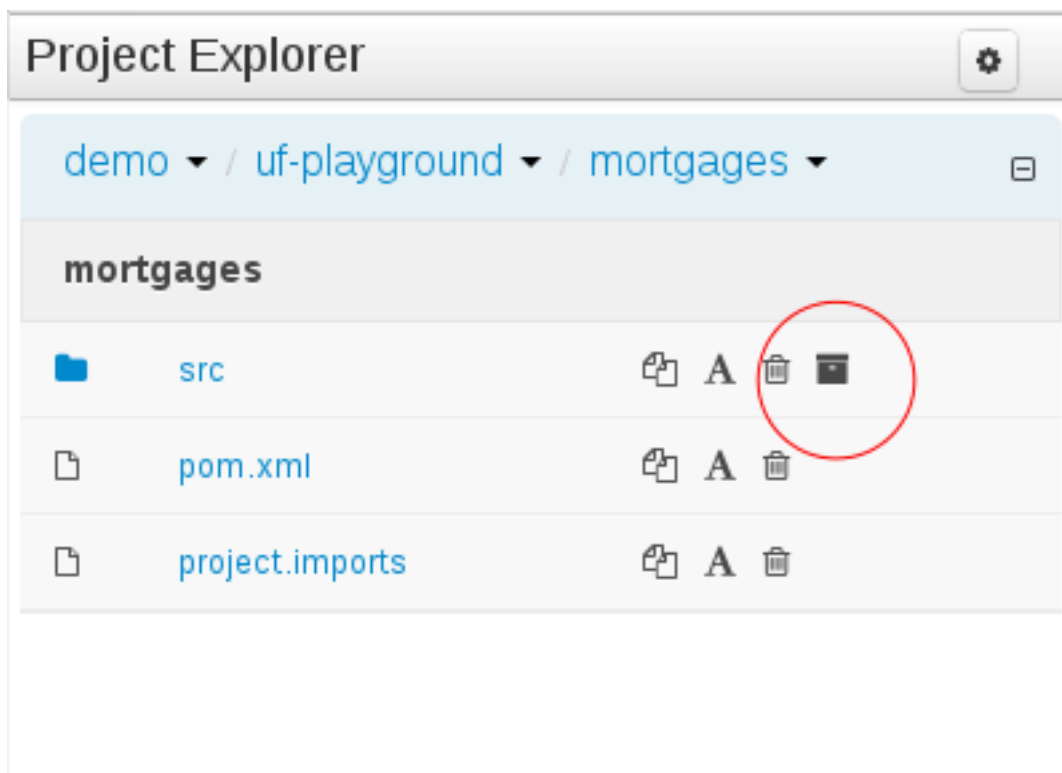


Figure 25.29. Download a folder

25.3.2.2. Project Editor permissions

The ability to configure role-based permissions for the Project Editor have been added.

Permissions can be configured using the `WEB-INF/classes/workbench-policy.properties` file.

The following permissions are supported:

- Save button

`feature.wb_project_authoring_save`

- Delete button

`feature.wb_project_authoring_delete`

- Copy button

`feature.wb_project_authoring_copy`

- Rename button

`feature.wb_project_authoring_rename`

- Build & Deploy button

`feature.wb_project_authoring_buildAndDeploy`

25.3.2.3. Unify validation style in Guided Decision Table Wizard.

All of our new screens use GWT-Bootstrap widgets and alert users to input errors in a consistent way.

One of the most noticeable differences was the Guided Decision Table Wizard that alerted errors in a way inconsistent with our use of GWT-Bootstrap.

This Wizard has been updated to use the new look and feel.

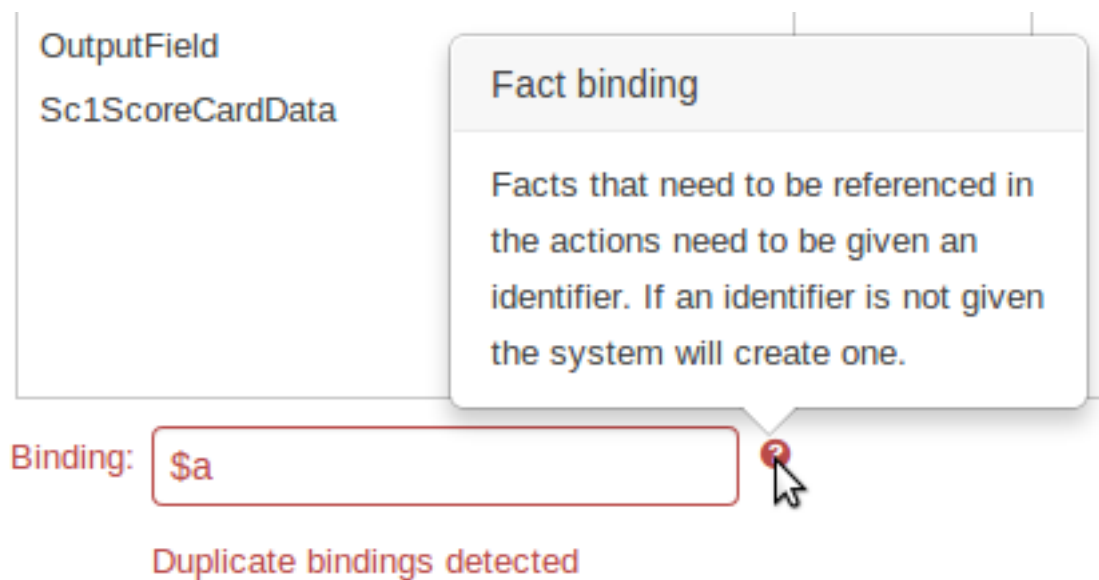


Figure 25.30. New Guided Decision Table Wizard validation

25.3.2.4. Improved Wizards

During the re-work of the Guided Decision Table's Wizard to make its validation consistent with other areas of the application we took the opportunity to move the Wizard Framework to GWT-Bootstrap too.

The resulting appearance is much more pleasing. We hope to migrate more legacy editors to GWT-Bootstrap as time and priorities permit.

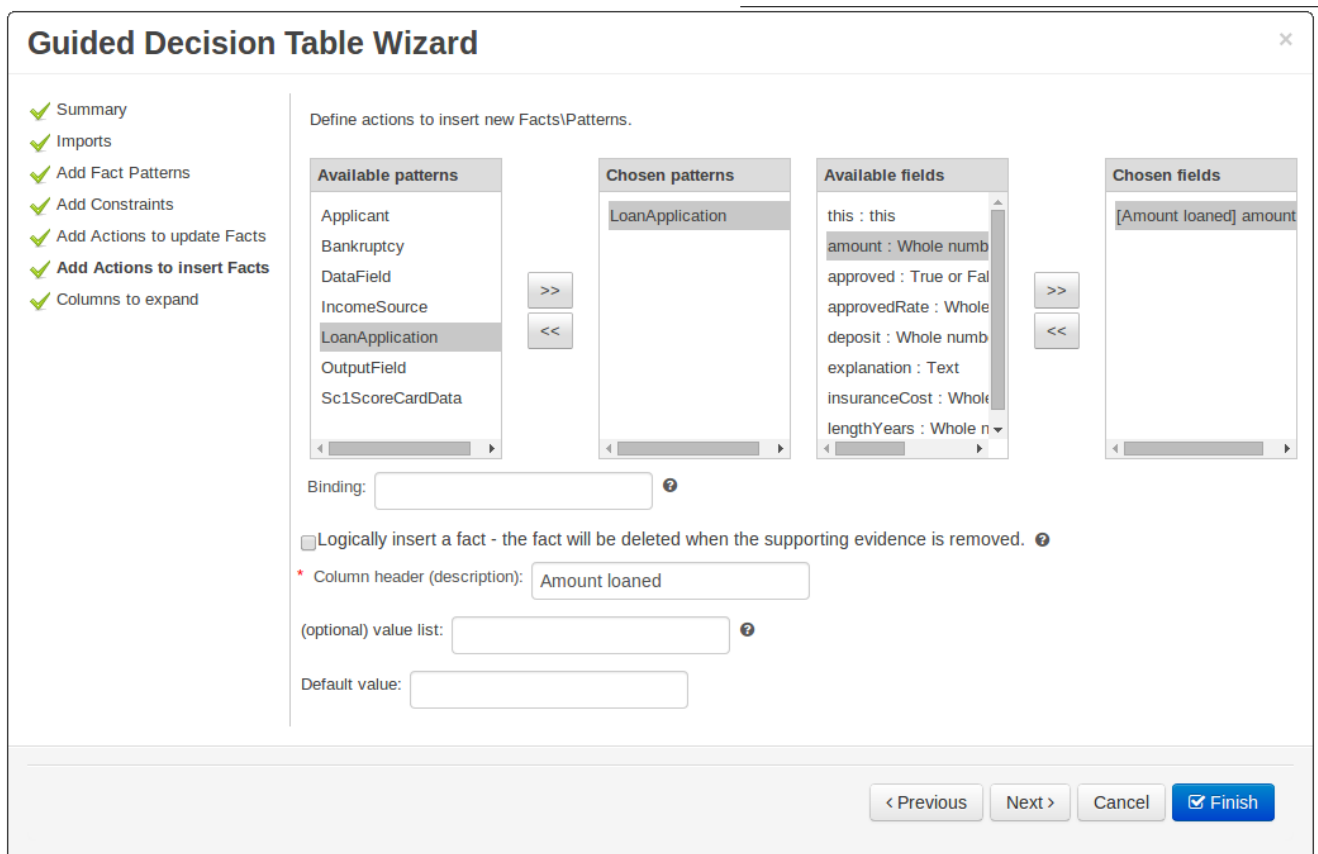


Figure 25.31. New Wizard Framework

25.3.2.5. Consistent behaviour of XLS, Guided Decision Tables and Guided Templates

Consistency is a good thing for everybody. Users can expect different authoring metaphores to produce the same rule behaviour (and developers know when something is a bug!).

There were a few inconsistencies in the way XLS Decision Tables, Guided Decision Tables and Guided Rule Templates generated the underlying rules for empty cells. These have been eliminated making their operation consistent.

- If all constraints have null values (empty cells) the Pattern is not created.

Should you need the Pattern but no constraints; you will need to include the constraint `this != null`.

This operation is consistent with how XLS and Guided Decision Tables have always worked.

- You can define a constraint on a String field for an empty String or white-space by delimiting it with double-quotation marks. The enclosing quotation-marks are removed from the value when generating the rules.

The use of quotation marks for other String values is not required and they can be omitted. Their use is however essential to differentiate a constraint for an empty String from an empty cell - in which case the constraint is omitted.

25.3.2.6. Improved Metadata Tab

The Metadata tab provided in previous versions was redesigned to provide a better asset versioning information browsing and recovery. Now every workbench editor will provide an "Overview tab" that will enable the user to manage the following information.

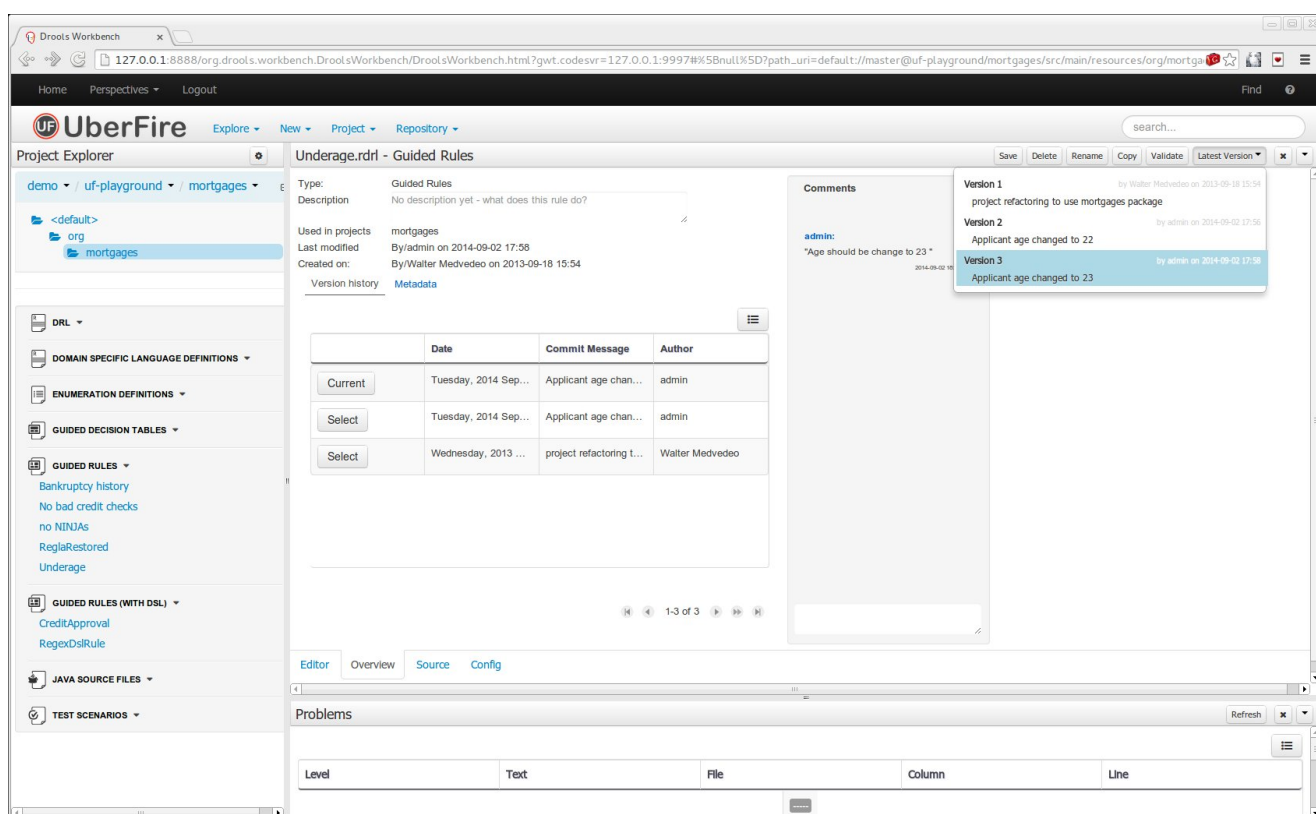


Figure 25.32. Improved Metadata Tab

- Versions history

The versions history shows a tabular view of the asset versions and provides a "Select" button that will enable the user to load a previously created version.

Type: Guided Rules
Description: No description yet - what does this rule do?
Used in projects: mortgages
Last modified: By/admin on 2014-09-02 17:58
Created on: By/Walter Medvedeo on 2013-09-18 15:54

[Version history](#) [Metadata](#)

	Date	Commit Message	Author
Current	Tuesday, 2014 Sep...	Applicant age chan...	admin
Select	Tuesday, 2014 Sep...	Applicant age chan...	admin
Select	Wednesday, 2013 ...	project refactoring t...	Walter Medvedeo

1-3 of 3

Comments

admin:
"Age should be change to 23 "
2014-09-02 18:01

Figure 25.33. Versions history

- Metadata

The metadata section gets access to additional file attributes.

The screenshot displays a metadata section on the left and a comments area on the right. The metadata section includes fields for Type (Guided Rules), Description (No description yet - what does this rule do?), Used in projects (mortgages), Last modified (By/admin on 2014-09-02 17:58), and Created on (By/Walter Medvedeo on 2013-09-18 15:54). It also features tabs for Version history and Metadata, a Categories section with a plus icon, a Note (Applicant age changed to 23), and a URI (git://master@uf-playground/mortgages/src/main/resources/org/mortgages/Underage.rdl). Below these are input fields for Subject, Type, External link, and Source. The comments area on the right, titled 'Comments', shows a comment by 'admin' stating 'Age should be change to 23 ' with a timestamp of 2014-09-02 18:01.

Figure 25.34. Metadata section

- Comments area

The redesigned comments area enables much clearer discussions on a file.

- Version selection dropdown

The "Version selector dropdown" located at the menu bar provides the ability to load and restore previous versions from the "Editor tab", without having to open the "Overview tab" to load the "Version history".

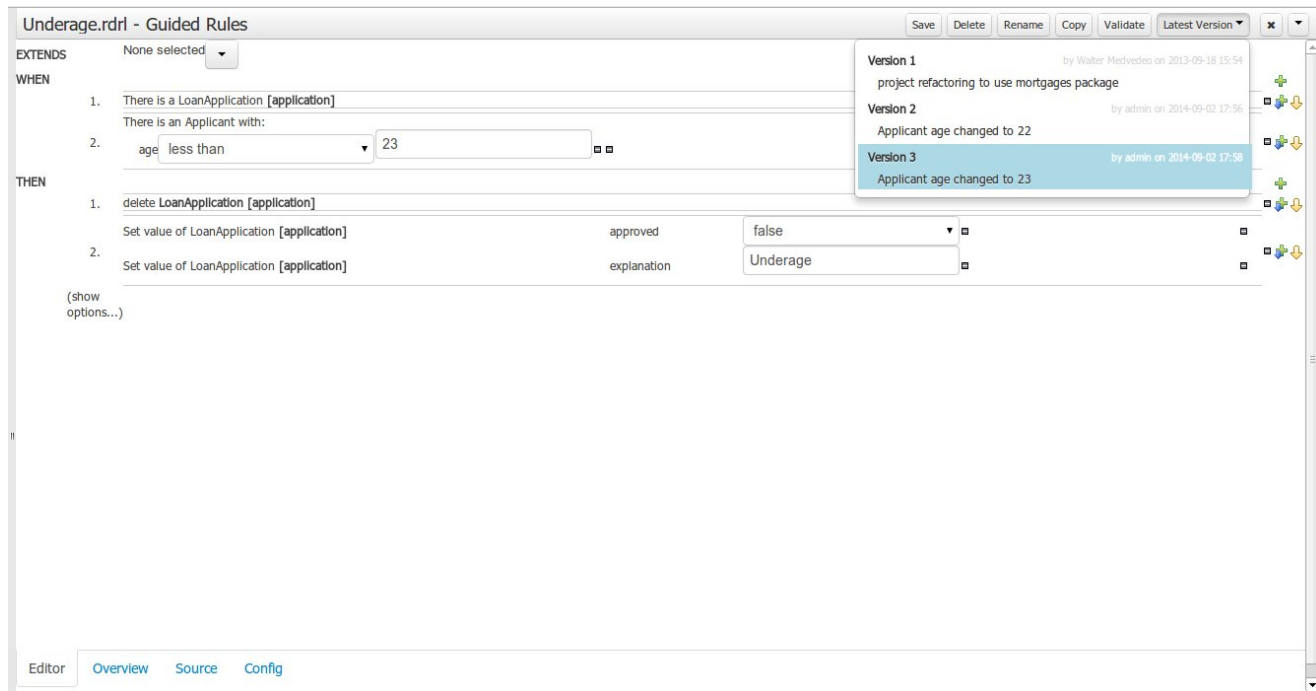


Figure 25.35. Version selection dropdown

25.3.2.7. Improved Data Objects Editor

The Java editor was unified to the standard workbench editors functioning. It means that and now every data object is edited on his own editor window.

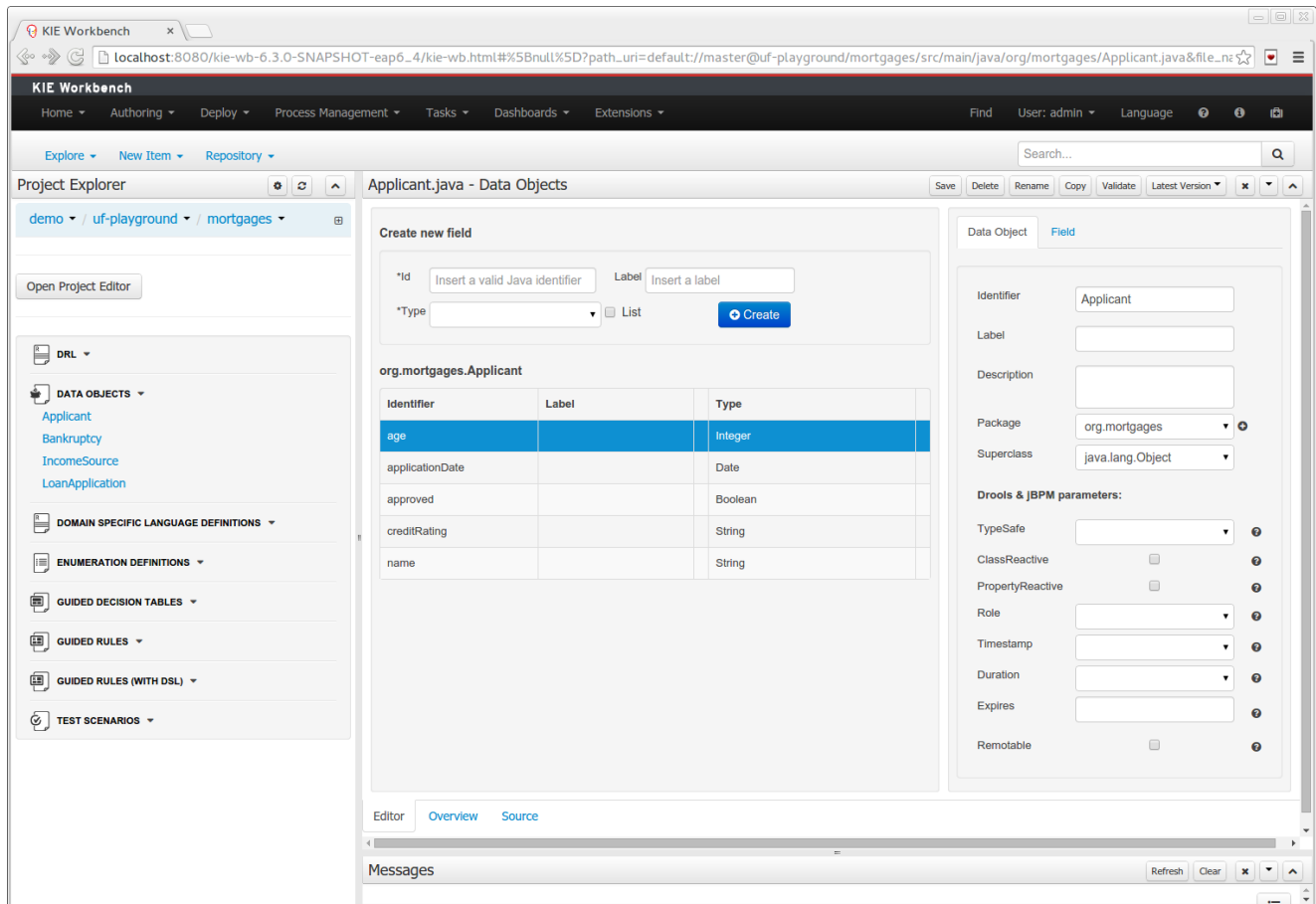


Figure 25.36. Improved Data Object Editor

- "New -> Data Object" option was added to create the data objects.
- Overview tab was added for every file to manage the file metadata and have access to the file versions history.
- Editable "Source Tab" tab was added. Now the Java code can be modified by administrators using the workbench.
- "Editor" - "Source Tab" round trip is provided. This will let administrators to do manual changes on the generated Java code and go back to the editor tab to continue working.
- Class usages detection. Whenever a Data Object is about to be deleted or renamed, the project will be scanned for the class usages. If usages are found (e.g. in drl files, decision tables, etc.) the user will receive an alert. This will prevent the user from breaking the project build.

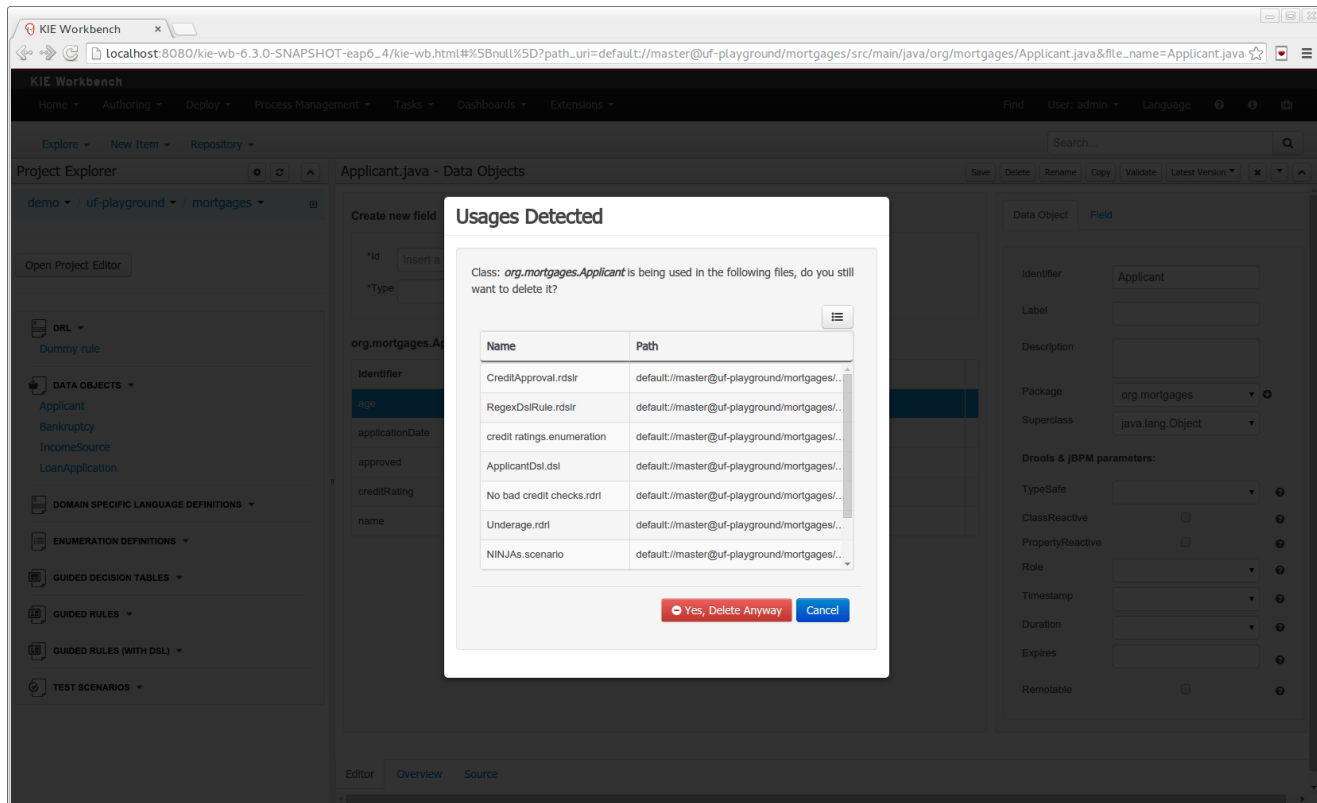


Figure 25.37. Usages detection

25.3.2.8. Execution Server Management UI

A new perspective called **Management** has been added under **Servers** top level menu. This perspective provides users the ability to manage multiple execution servers with multiple containers. Available features includes connect to already deployed execution servers; create new, start, stop, delete or upgrade containers.

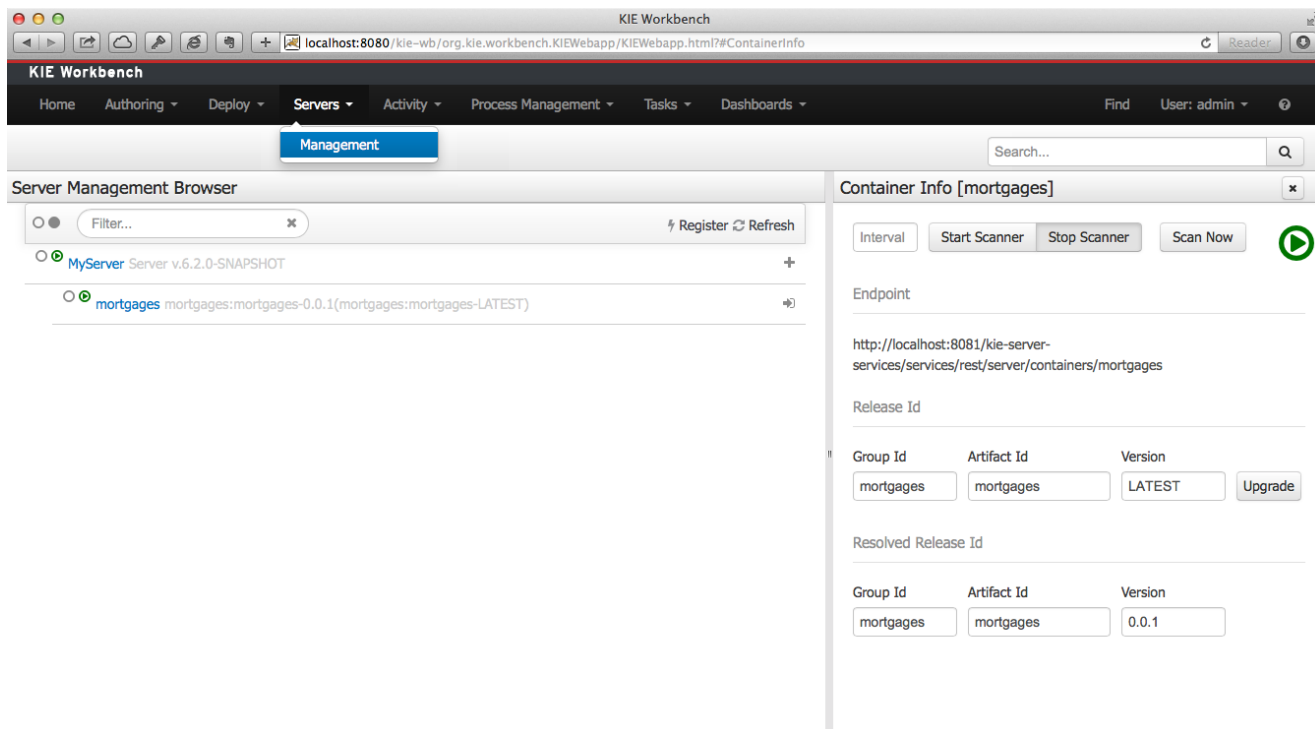



Figure 25.38. Management perspective

 **Note**
Current version of Execution Server just supports rule based execution.

25.3.2.9. Social Activities

A brand new feature called **Social Activities** has been added under a new top level menu item group called **Activity**.

This new feature is divided in two different perspectives: **Timeline Perspective** and **People Perspective**.

The **Timeline Perspective** shows on left side the recent assets created or edited by the logged user. In the main window there is the "Latest Changes" screen, showing all the recent updated assets and an option to filter the recent updates by repository.











Recent Assets	Latest Changes
 anotherDRL.drl edited today	Showing updates for: <input type="text" value="Latest Changes"/>
 sampleDrl.drl edited today	 Finance.java admin added 05/09/2014 11:48:52
 Finance.java added today	 admin edited 05/09/2014 11:49:35 "JIRA[1234]"
 Finance.java edited today	 sampleDrl.drl  director edited 05/09/2014 11:47:15 "JIRA[123]"
	 anotherDRL.drl  admin edited 05/09/2014 11:46:38 "rule changed for X"

Figure 25.39. Timeline Perspective

The **People Perspective** is the home page of an user. Showing his infos (including a gravatar picture from user e-mail), user connections (people that user follow) and user recent activities. There is also a way to edit an user info. The search suggestion can be used to navigate to a user profile, follow him and see his updates on your timeline.





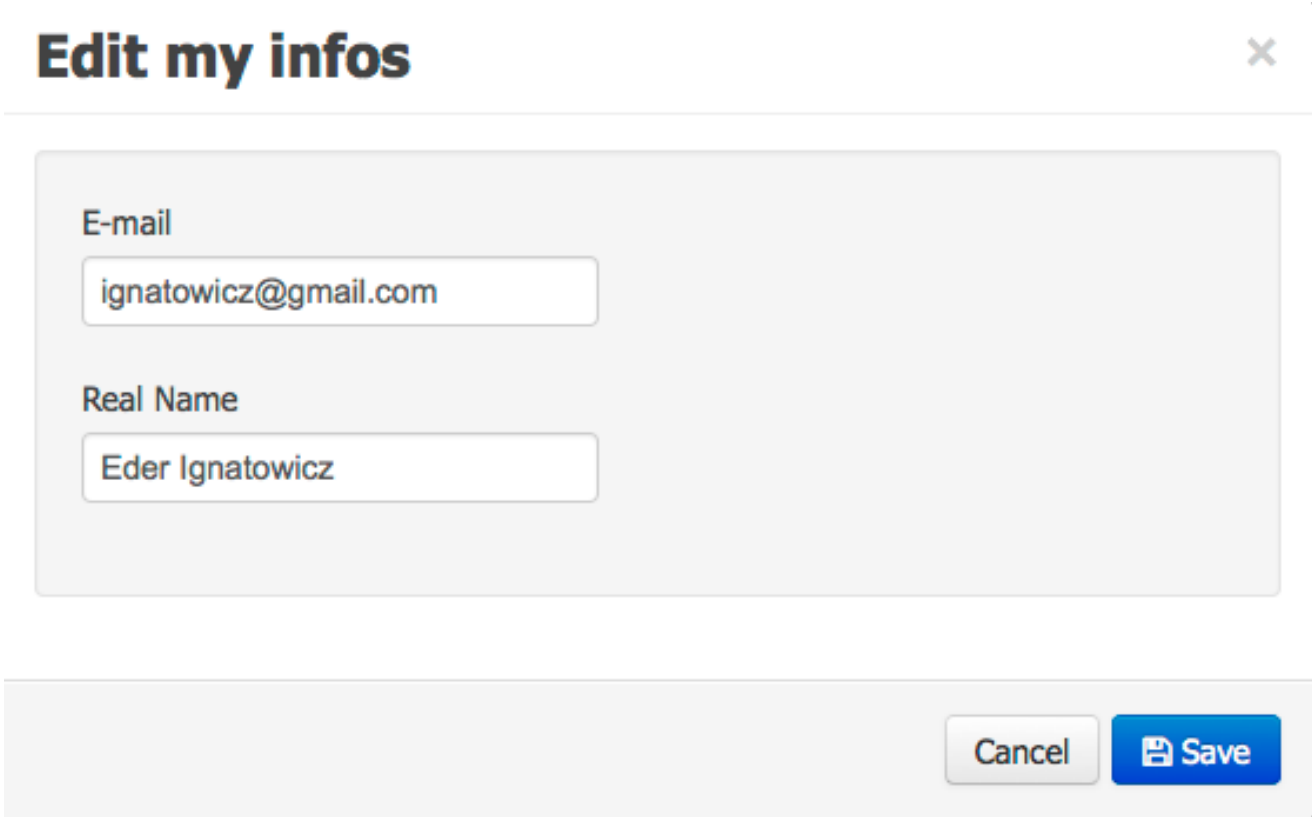
Eder Ignatowicz's Profile	Eder Ignatowicz's Recent Activities
<input type="text" value="search users..."/>	Connections:
	
User name:admin	 anotherDRL.drl edited today
E-mail:ignatowicz@gmail.com	 sampleDrl.drl edited today
Edit my infos	

Figure 25.40. People Perspective



Edit my infos ×

E-mail
ignatowicz@gmail.com

Real Name
Eder Ignatowicz

Cancel Save

Figure 25.41. Edit User Info

25.3.2.10. Contributors Dashboard

A brand new perspective called **Contributors** has been added under a new top level menu item group called **Activity**. The perspective itself is a dashboard which shows several indicators about the contributions made to the managed organizations / repositories within the workbench. Every time a organization/repository is added/removed from the workbench the dashboard itself is updated accordingly.

This new perspective allows for the monitoring of the underlying activity on the managed repositories.

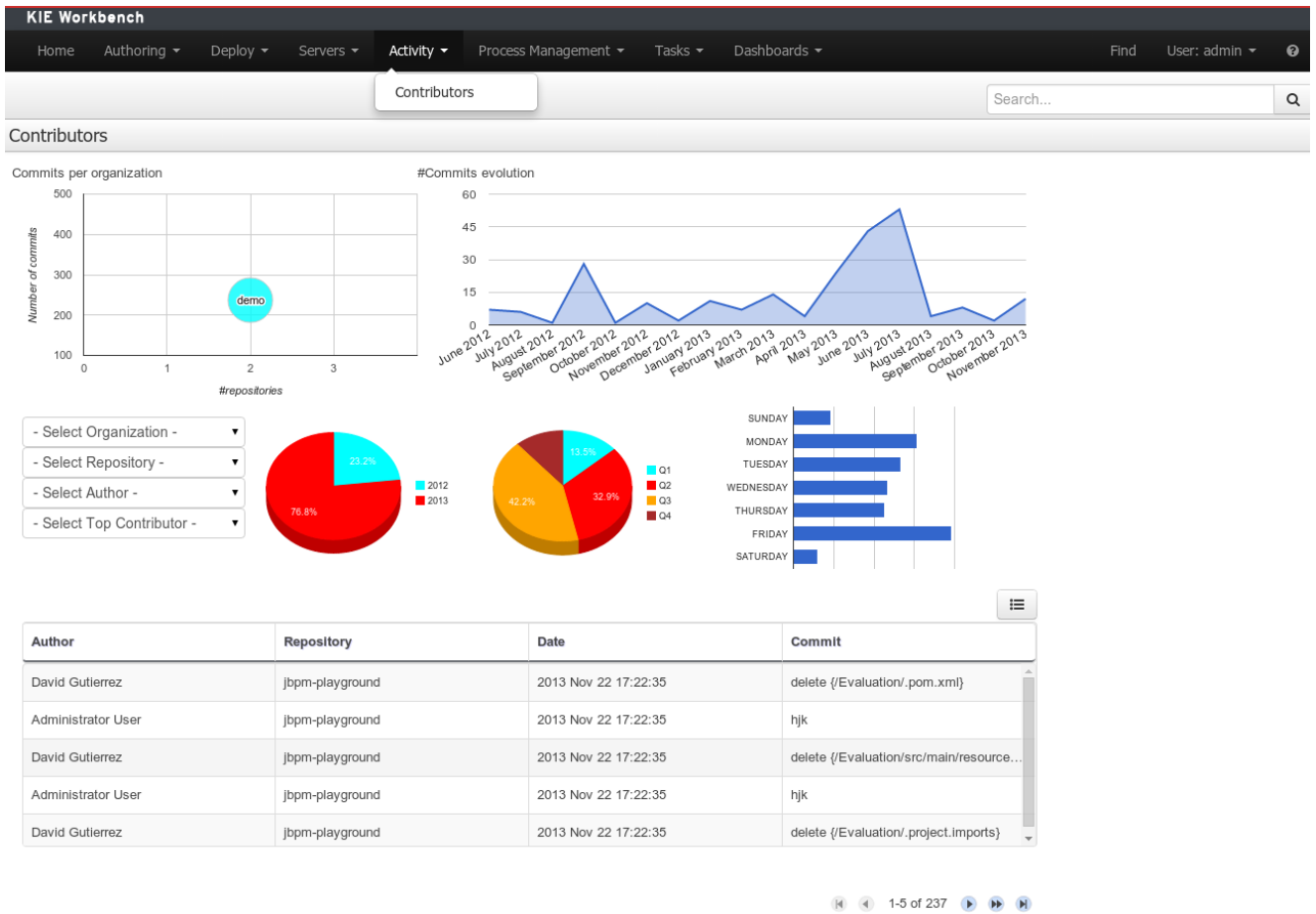


Figure 25.42. Contributors perspective

25.3.2.11. Package selector

The location of new assets whilst authoring was driven by the context of the Project Explorer.

This has been replaced with a Package Selector in the New Resource PopUp.

The location defaults to the Project Explorer context but different packages can now be more easily chosen.

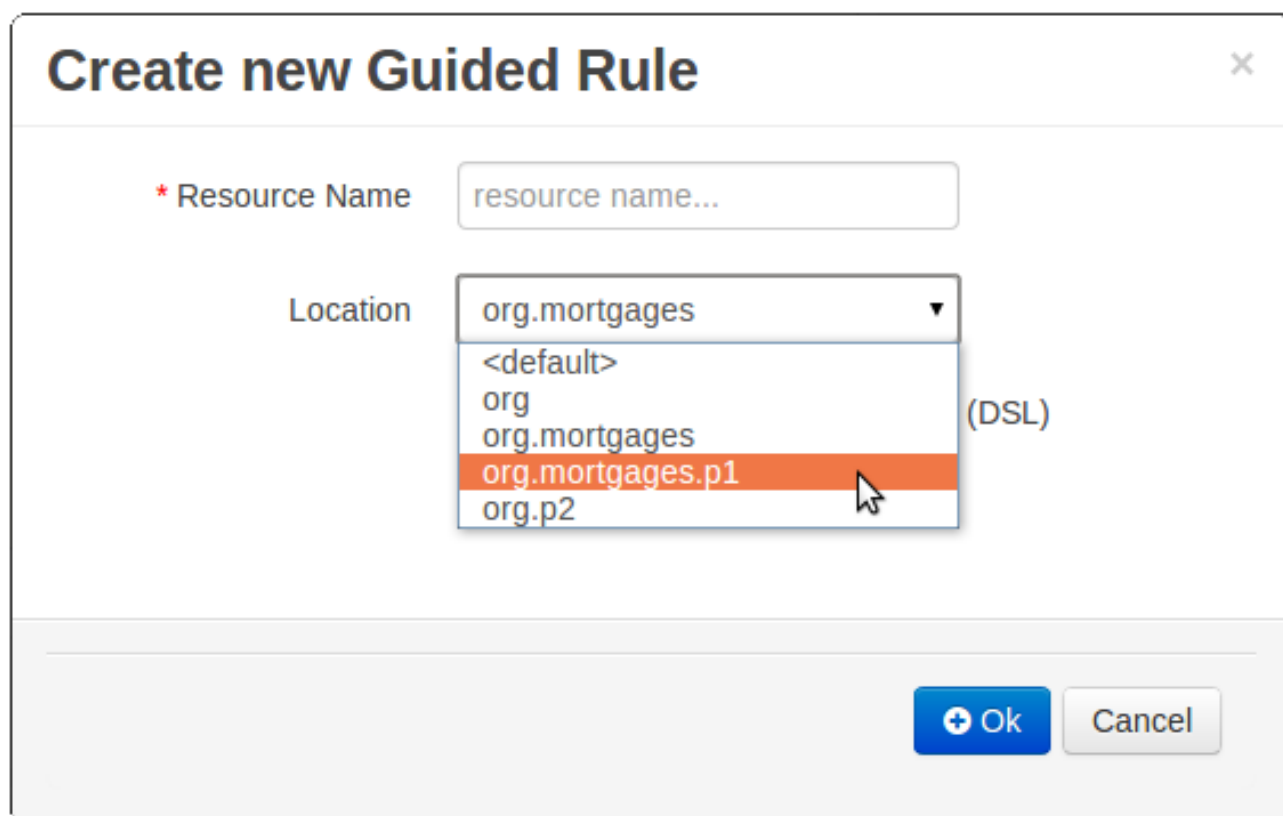



Figure 25.43. Package selector

25.3.2.12. Improved visual consistency



All Popups have been refactored to use GWT-Bootstrap widgets.


Whilst a simple change it brings greater visual consistency to the application as a whole.

Condition column configuration ✕

Pattern: LoanApplication [application] 


Calculation type: Literal value Formula Predicate

Field:  

Operator: greater than 

From Entry Point:

Column header (description):

(optional) value list: 

Default value:

Binding:

Hide column:

Figure 25.44. Example Guided Decision Table Editor popup

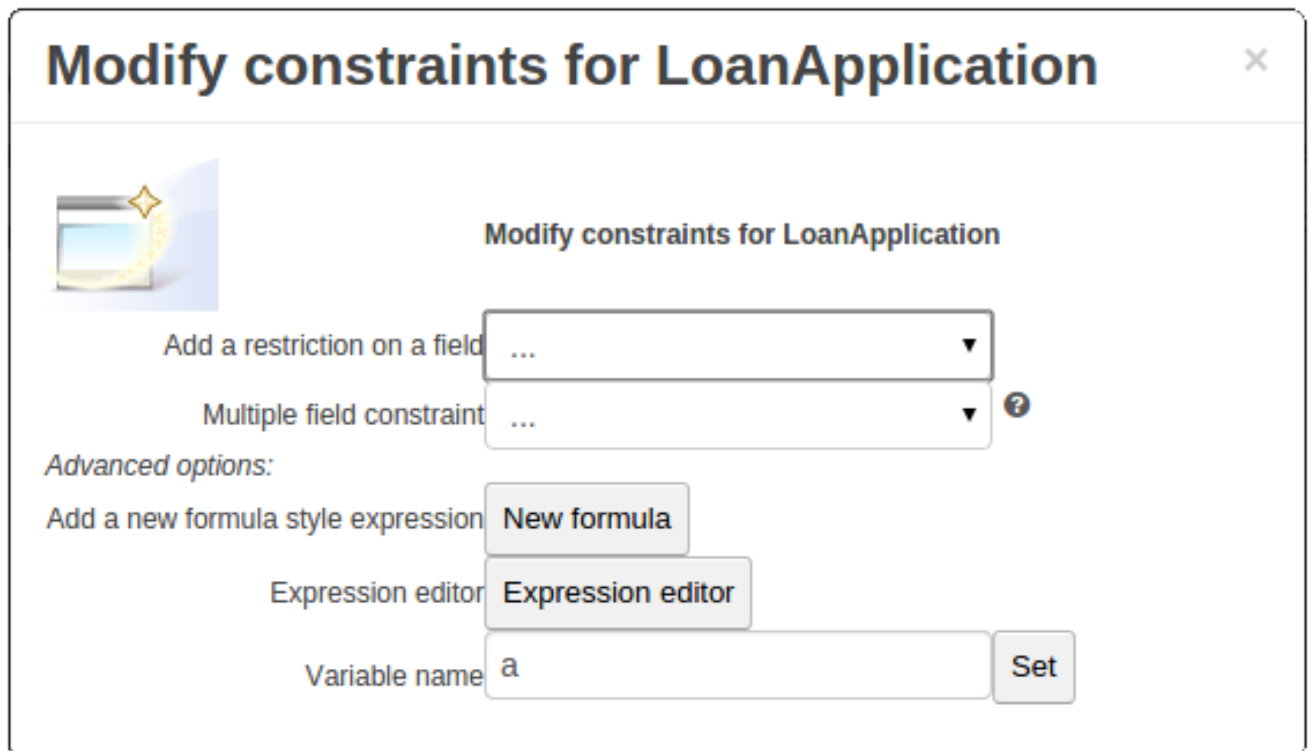


Figure 25.45. Example Guided Rule Editor popup

25.3.2.13. Guided Decision Tree Editor

A new editor has been added to support modelling of simple decision trees.

See the applicable section within the User Guide for more information about usage.

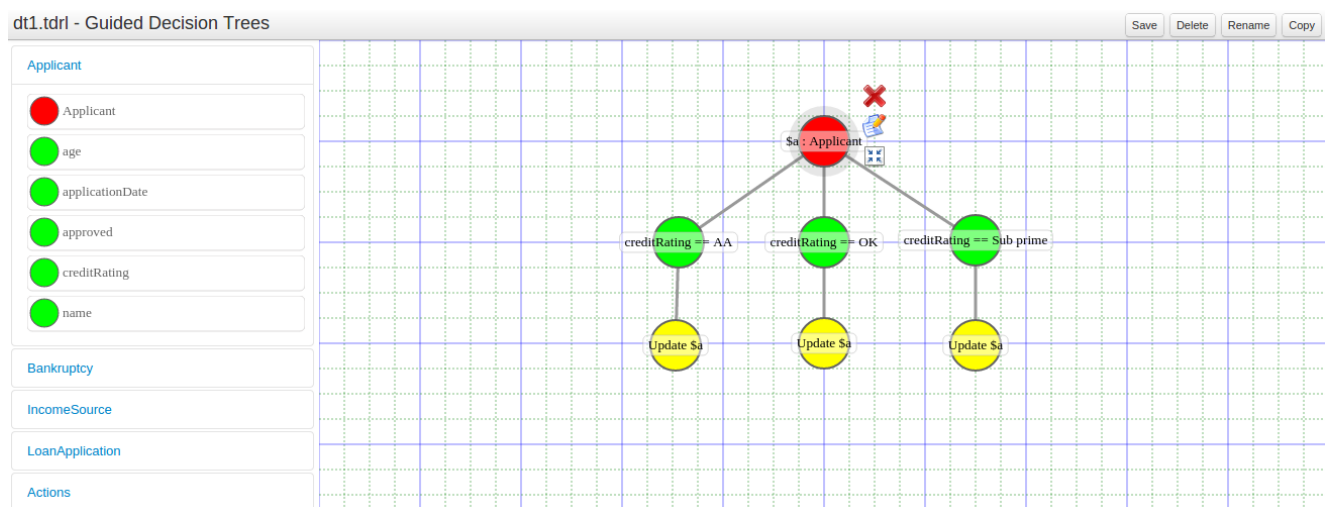


Figure 25.46. Example Guided Decision Tree

25.3.2.14. Create Repository Wizard

A wizard has been created to guide the repository creation process. Now the user can decide at repository creation time if it should be a managed or unmanaged repository and configure all related parameters.

New Repository ×

✓ **Basic Settings**
Managed Repository Settings

* **Repository Name**

* **In Organizational Unit**

Managed Repository
A managed repository provides project-level version control and project branches for managing the release cycle.

Figure 25.47. Create Repository Wizard 1/2

New Repository ✕

- ✓ Basic Settings
- ✓ Managed Repository Settings

Repository Type:

Single-project Repository
Create a single managed project in this repository. Use this option for simple or self-contained projects.

Multi-project Repository
Integrate multiple projects to create a larger application. The projects in this repository will be managed together, and will all increment version numbers together.

Project Branches:

Automatically Configure Branches (master/dev/release)

Project Settings:

* Name

Description

* Group

* Artifact

* Version

< Previous Next > Cancel ✓ Finish

Figure 25.48. Create Repository Wizard 2/2

25.3.2.15. Repository Structure Screen

The new Repository Structure Screen will let users to manage the projects for a given repository, as well as other operations related to managed repositories like: branch creation, assets promotion and project release.

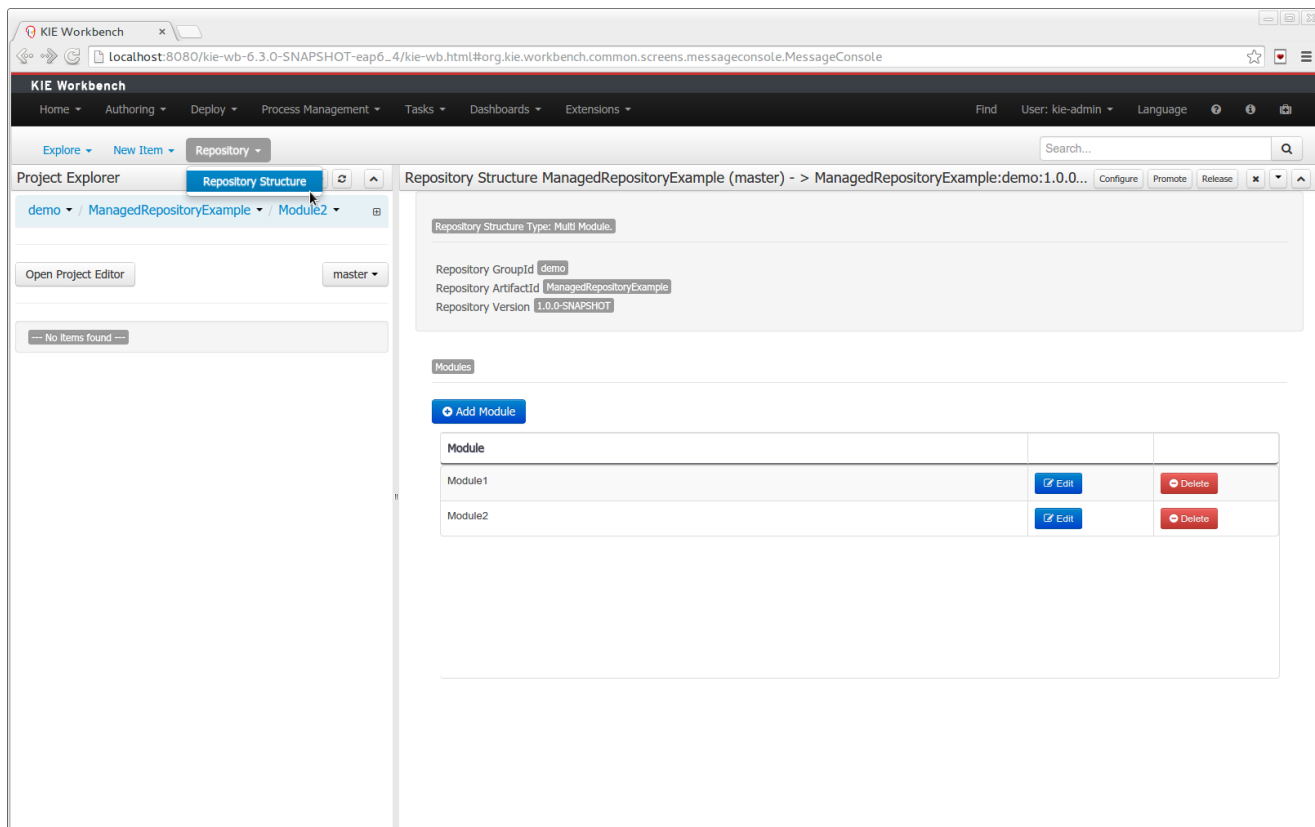


Figure 25.49. Repository Structure Screen for a Managed Repository

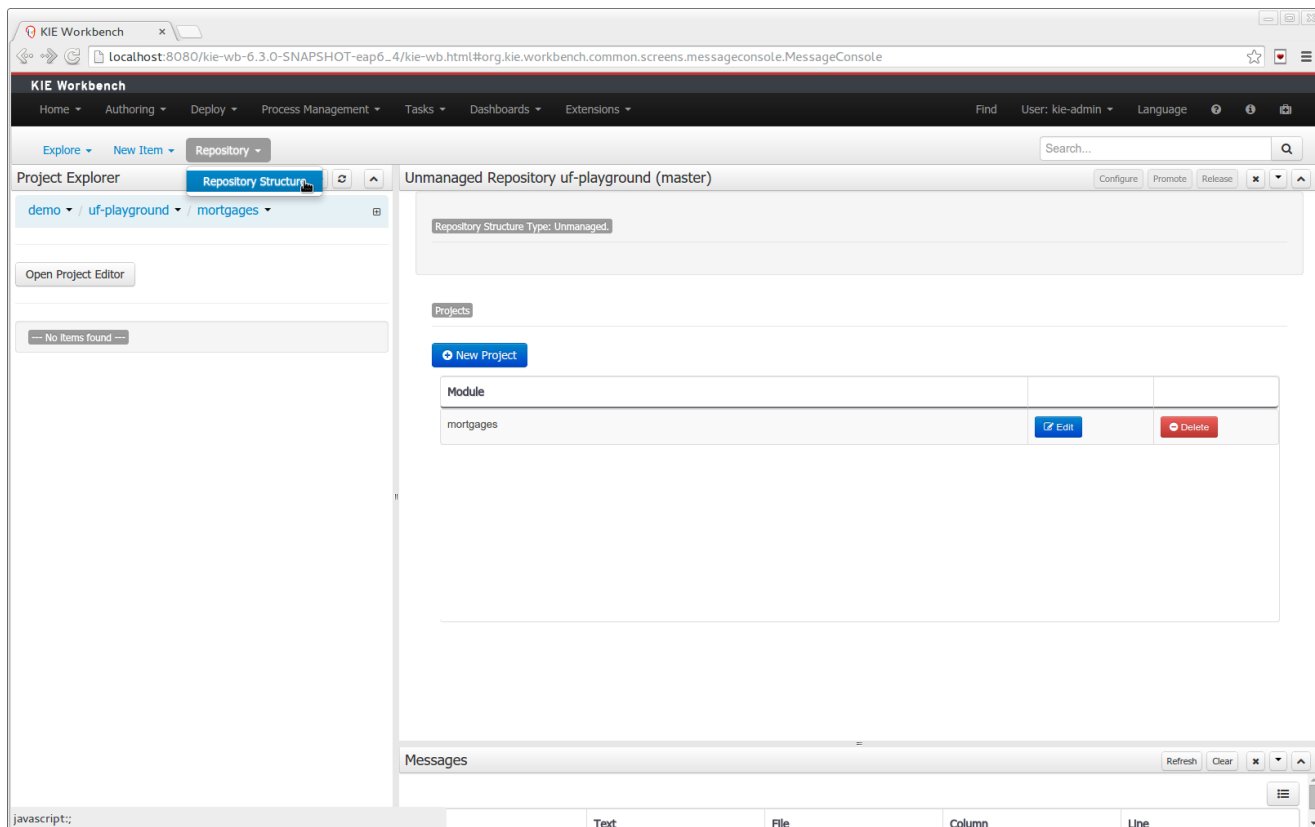


Figure 25.50. Repository Structure Screen for an Unmanaged Repository

25.4. jBPM 6.1

25.4.1. New and Noteworthy in jBPM 6.1.0

jBPM 6.1 comes with a ton of smaller improvements and bug fixes (done over the last few months on top of 6.0.1.Final), and also includes some important new features, adding to the foundation delivered as part of jBPM 6.0.

25.4.1.1. Embedding forms in external applications

Now you can embed and run process/task forms that live inside the Kie-Workbench just adding a JavaScript library to your webapps. Look at the Using forms on client applications section to see the full functionality and usage examples.

25.4.1.2. Attaching documents to forms

Added new file type to manage upload documents on forms and store them on process variables. Using the *Pluggable Variable Persistence* you'll be able to create your own *Marshalling Strategy* and store the document contents on different systems (Database, Alfresco, Google Docs...) or use the default implementation and store them in your File System.

25.4.1.3. Web Service (SOAP) interface for remote API

The execution server, that is part of the jbpm-console web tooling, now also comes with a Web Service interface (in addition to the existing REST, JMS and Java client interfaces).

25.4.1.4. Deployment descriptors

Deployment descriptors have been added as an optional, yet powerful way of configuring deployment units - kjar. Deployment descriptors allow to configure (among others)

- persistence unit names
- work item handlers
- event listeners (process, agenda, task)
- roles (for authorization - see section 1.5)

Deployment descriptors can be configured on various levels for enhanced flexibility to allow simple override functionality. Detailed definition of deployment descriptor can be found in section 14.1.1. Deployment descriptors

25.4.1.5. Role-based authorization at runtime for process definitions and process instances

The process definition and process instance view in the jbpm console now also take the role-based access control restrictions into account that can be defined on the project the process is defined in. You can limit the visibility of a project (or repository as a whole) by associating some roles with it that are required to be able to see the project (or repository). This can be done when creating the repository, or by using the command line interface to connect to the execution server. The deployment descriptor (see previous section) also allows you to further customize these roles at deployment time. At runtime, the views will check if the current logged in user has one of the necessary roles to be able to see that process. If not, the user will not see this process or process instance in the process definition or process instance list respectively.

25.4.1.6. jBPM installer updates

The installer is updated to support:

- Wildfly 8.1 as application server
- Eclipse BPMN2 Modeler 1.0.2
- Eclipse Kepler SR2

25.4.1.7. jBPM Spring integration

Spring integration has been improved to allow complete configuration of jBPM runtime using Spring XML. That essentially means there are number of factory beans provided as part of drool-

sjbpm-integration module that significantly simplifies configuration of jBPM. Moreover it allows various configuration options such as:

- rely on JTA and entity manager factory
- rely on JTA and shared entity manager
- rely on local transactions and entity manager factory
- rely on local transactions and shared entity manager

Details about spring configuration can be found in this article [<http://mswidorski.blogspot.com/2014/01/jbpm-6-with-spring.html>].

25.4.1.8. Other

Smaller enhancements also include:

- Task service (query) improvements, significantly speeding up queries when you have a large numbers of tasks in the database.
- Various improvements to the asynchronous job executor so it can handle larger loads more easily and can be configured (number of parallel threads executing the jobs, retries, etc.).
- Ability to configure task administrator groups in a UserTask (similar to how you already could configure individual task administrators).
- Removed limitation on custom implementations of work item handler, event listeners that had to be placed on global classpath - usually in jbpm-console.war/WEB-INF/lib. With that custom classes can be added as maven dependencies into the project and will be registered on underlying components (ksession).

25.4.2. New and Noteworthy in KIE Workbench 6.1.0

25.4.2.1. Data Modeler - round trip and source code preservation

Full round trip between Data modeler and Java source code is now supported. No matter where the Java code was generated (e.g. Eclipse, Data modeller), data modeler will only update the necessary code blocks to maintain the model updated.

25.4.2.2. Data Modeler - improved annotations

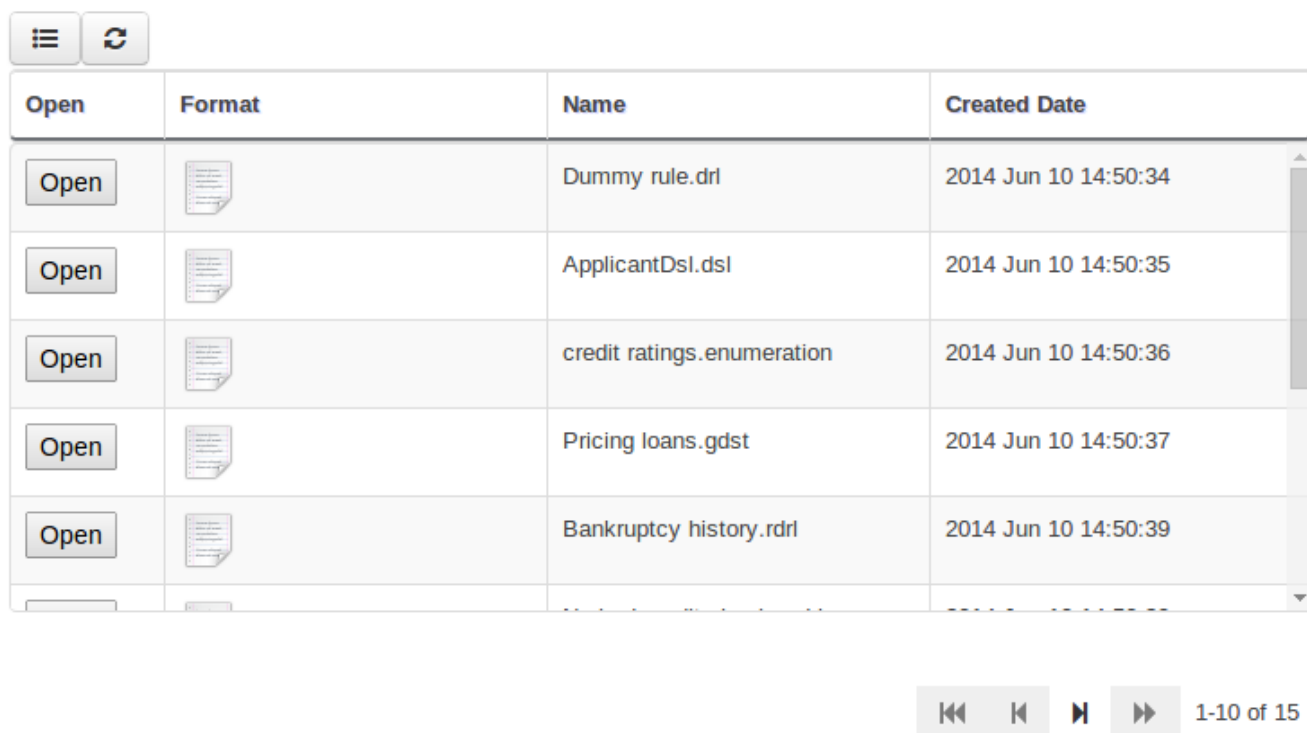
New annotations @TypeSafe, @ClassReactive, @PropertyReactive, @Timestamp, @Duration and @Expires were added in order enrich current Drools annotations managed by the data modeler.






25.4.2.3. Standardization of the display of tabular data

We have standardized the display of tabular data with a new table widget.

The new table supports the following features:

- Selection of visible columns
- Resizable columns
- Moveable columns



Open	Format	Name	Created Date
Open		Dummy rule.drl	2014 Jun 10 14:50:34
Open		ApplicantDsl.dsl	2014 Jun 10 14:50:35
Open		credit ratings.enumeration	2014 Jun 10 14:50:36
Open		Pricing loans.gdst	2014 Jun 10 14:50:37
Open		Bankruptcy history.rdrf	2014 Jun 10 14:50:39

1-10 of 15

Figure 25.51. New table

The table is used in the following scenarios:

- Inbox (Incoming changes)
- Inbox (Recently edited)
- Inbox (Recently opened)
- Project Problems summary
- Artifact Repository browser
- Project Editor Dependency grid
- Project Editor KSession grid
- Project Editor Work Item Handlers Configuration grid
- Project Editor Listeners Configuration grid

- Search Results grid

25.4.2.4. Generation of `modify(x) {...}` blocks

The Guided Rule Editor, Guided Template Editor and Guided Decision Table Editor have been changed to generate `modify(x){...}`

Historically these editors supported the older `update(x)` syntax and hence rules created within the Workbench would not respond correctly to `@PropertyReactive` and associated annotations within a model. This has now been rectified with the use of `modify(x){...}` blocks.

25.5. jBPM 6.0

25.5.1. New and Noteworthy in KIE API 6.0.0

25.5.1.1. New KIE name

KIE is the new umbrella name used to group together our related projects; as the family continues to grow. KIE is also used for the generic parts of unified API; such as building, deploying and loading. This replaces the `droolsjbpm` and `knowledge` keywords that would have been used before.

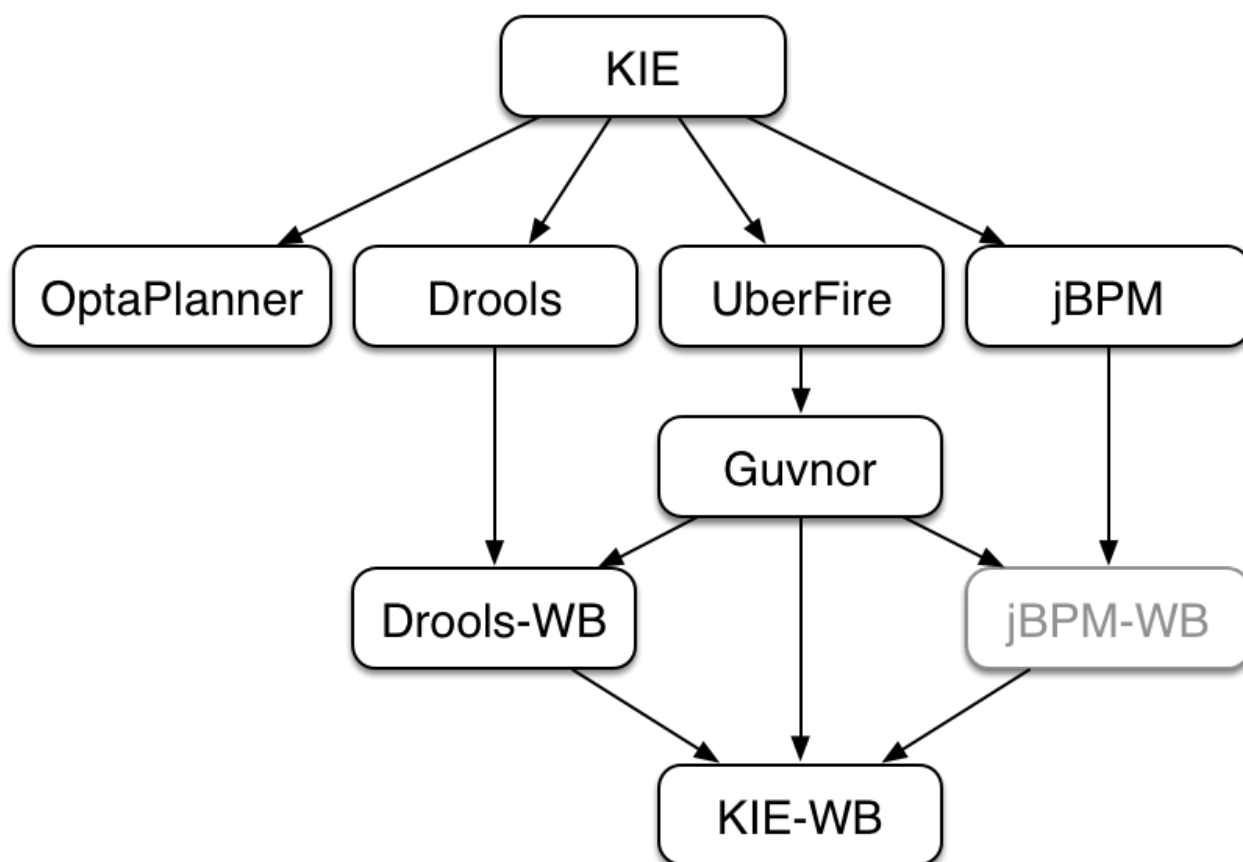


Figure 25.52. KIE Anatomy

25.5.1.2. Maven aligned projects and modules and Maven Deployment

One of the biggest complaints during the 5.x series was the lack of defined methodology for deployment. The mechanism used by Drools and jBPM was very flexible, but it was too flexible. A big focus for 6.0 was streamlining the build, deploy and loading (utilization) aspects of the system. Building and deploying activities are now aligned with Maven and Maven repositories. The utilization for loading rules and processes is now convention and configuration oriented, instead of programmatic, with sane defaults to minimise the configuration.

Projects can be built with Maven and installed to the local M2_REPO or remote Maven repositories. Maven is then used to declare and build the classpath of dependencies, for KIE to access.

25.5.1.3. Configuration and convention based projects

The 'kmodule.xml' provides declarative configuration for KIE projects. Conventions and defaults are used to reduce the amount of configuration needed.

Example 25.1. Declare KieBases and KieSessions

```
<kmodule xmlns="http://www.drools.org/xsd/kmodule">
  <kbase name="kbase1" packages="org.mypackages">
    <ksession name="ksession1"/>
  </kbase>
</kmodule>
```

Example 25.2. Utilize the KieSession

```
KieServices ks = KieServices.Factory.get();
KieContainer kContainer = ks.getKieClasspathContainer();

KieSession kSession = kContainer.newKieSession("ksession1");
kSession.insert(new Message("Dave", "Hello, HAL. Do you read me, HAL?"));
kSession.fireAllRules();
```

25.5.1.4. KieBase Inclusion

It is possible to include all the KIE artifacts belonging to a KieBase into a second KieBase. This means that the second KieBase, in addition to all the rules, function and processes directly defined into it, will also contain the ones created in the included KieBase. This inclusion can be done declaratively in the kmodule.xml file

Example 25.3. Including a KieBase into another declaratively

```
<kmodule xmlns="http://www.drools.org/xsd/kmodule">
```

```
<kbase name="kbase2" includes="kbase1">
  <ksession name="ksession2"/>
</kbase>
</kmodule>
```

or programmatically using the `KieModuleModel`.

Example 25.4. Including a KieBase into another programmatically

```
KieModuleModel kmodule = KieServices.Factory.get().newKieModuleModel();
KieBaseModel kieBaseModel1 = kmodule.newKieBaseModel("KBase2").addInclude("KBase1");
```

25.5.1.5. KieModules, KieContainer and KIE-CI

Any Maven produced JAR with a 'kmodule.xml' in it is considered a KieModule. This can be loaded from the classpath or dynamically at runtime from a Resource location. If the kie-ci dependency is on the classpath it embeds Maven and all resolving is done automatically using Maven and can access local or remote repositories. Settings.xml is obeyed for Maven configuration.

The KieContainer provides a runtime to utilize the KieModule, versioning is built in throughout, via Maven. Kie-ci will create a classpath dynamically from all the Maven declared dependencies for the artifact being loaded. Maven LATEST, SNAPSHOT, RELEASE and version ranges are supported.

Example 25.5. Utilize and Run - Java

```
KieServices ks = KieServices.Factory.get();
KieContainer kContainer = ks.newKieContainer(
    ks.newReleaseId("org.mygroup", "myartefact", "1.0") );

KieSession kSession = kContainer.newKieSession("ksession1");
kSession.insert(new Message("Dave", "Hello, HAL. Do you read me, HAL?"));
kSession.fireAllRules();
```

KieContainers can be dynamically updated to a specific version, and resolved through Maven if KIE-CI is on the classpath. For stateful KieSessions the existing sessions are incrementally updated.

Example 25.6. Dynamically Update - Java

```
KieContainer kContainer.updateToVersion(
    ks.newReleaseId("org.mygroup", "myartefact", "1.1") );
```

25.5.1.6. KieScanner

The `KieScanner` is a Maven-oriented replacement of the `KnowledgeAgent` present in Drools 5. It continuously monitors your Maven repository to check if a new release of a Kie project has been installed and if so, deploys it in the `KieContainer` wrapping that project. The use of the `KieScanner` requires `kie-ci.jar` to be on the classpath.

A `KieScanner` can be registered on a `KieContainer` as in the following example.

Example 25.7. Registering and starting a KieScanner on a KieContainer

```
KieServices kieServices = KieServices.Factory.get();
ReleaseId releaseId = kieServices.newReleaseId( "org.acme", "myartifact", "1.0-SNAPSHOT" );
KieContainer kContainer = kieServices.newKieContainer( releaseId );
KieScanner kScanner = kieServices.newKieScanner( kContainer );

// Start the KieScanner polling the Maven repository every 10 seconds
kScanner.start( 10000L );
```

In this example the `KieScanner` is configured to run with a fixed time interval, but it is also possible to run it on demand by invoking the `scanNow()` method on it. If the `KieScanner` finds, in the Maven repository, an updated version of the Kie project used by that `KieContainer` it automatically downloads the new version and triggers an incremental build of the new project. From this moment all the new `KieBases` and `KieSessions` created from that `KieContainer` will use the new project version.

25.5.1.7. Hierarchical ClassLoader

The `CompositeClassLoader` is no longer used; as it was a constant source of performance problems and bugs. Traditional hierarchical classloaders are now used. The root classloader is at the `KieContext` level, with one child `ClassLoader` per namespace. This makes it cleaner to add and remove rules, but there can now be no referencing between namespaces in DRL files; i.e. functions can only be used by the namespaces that declared them. The recommendation is to use static Java methods in your project, which is visible to all namespaces; but those cannot (like other classes on the root `KieContainer ClassLoader`) be dynamically updated.

25.5.1.8. Legacy API Adapter

The 5.x API for building and running with Drools and jBPM is still available through Maven dependency "knowledge-api-legacy5-adapter". Because the nature of deployment has significantly changed in 6.0, it was not possible to provide an adapter bridge for the `KnowledgeAgent`. If any other methods are missing or problematic, please open a JIRA, and we'll fix for 6.1

25.5.1.9. KIE Documentation

While a lot of new documentation has been added for working with the new KIE API, the entire documentation has not yet been brought up to date. For this reason there will be continued ref-

ferences to old terminologies. Apologies in advance, and thank you for your patience. We hope those in the community will work with us to get the documentation updated throughout, for 6.1

25.5.2. New and Noteworthy in jBPM 6.0.0

25.5.2.1. KIE API

A new public API has been created for interacting with the core engine (shared between jBPM and Drools). This not only handles runtime operations to start processes, etc. but also instantiating sessions, registering listeners, configuration, etc.

New APIs were added in various areas, like for example the TaskService interface was moved to the public API, the new RuntimeManager was introduced and a lot of related interfaces and classes were added as well.

For backwards compatibility with v5, a knowledge-api JAR has been constructed, that implements the old v5 knowledge-api interfaces on top of the v6 engine. Make sure to include this JAR in your classpath if you want to keep using the v5 API.

25.5.2.2. jBPM Core Engine

The execution engine itself has (mostly) remained the same, although we've done various improvements in the following areas:

- RuntimeManager: instantiating a ksession (and an associated task service) has been simplified significantly, by introducing a runtime manager where you can simply ask for a reference to a ksession whenever you need it. The Runtime manager is responsible for initialization, configuration and disposal of the ksession (and task service), and three predefined strategies are available:
 - Singleton: the RuntimeManager reused the same ksession for all requests (and executes the requests in sequence, one at a time)
 - Session per request: the RuntimeManager instantiates a new ksession per request that will be used for executing that request and disposed at the end. Each request will receive its own ksession and they can all be executed in parallel.
 - Session per process instance: the RuntimeManager reuses the same ksession for all requests related to one specific process instance. This might be necessary if you are storing data inside your session (for example for rule evaluations) that you need to be available later in the process as well. Note that the session is disposed after each command but stored in the database so it can be restored whenever necessary.
- jBPM Services (CDI): To simplify integration of jBPM inside CDI-based applications, the jbpm-services module contains various CDI services that you can configure and use inside your application simply by injecting the necessary services (like a RuntimeManager or TaskService for example) inside your application, making integration easier than ever.

- **Timer service:** a Quartz-based timer service is now available, that allows you to dispose your session at any point in time, and the timer service will be responsible for rehydrating a ksession whenever a timer should be fired. This timer service also works in a clustered environment, where multiple nodes can work together on sharing the work load but timers will only be fired once by one of the nodes.
- **Exception and compensation management:** various improvements in this area allow you to use more BPMN2 constructs related to exception and compensation management in your processes, and various strategies have been extended and documented to better handle exceptions in different ways.
- **Asynchronous handlers:** asynchronous execution of interaction with external services can now be implemented by reusing the asynchronous job executor.
- **Asynchronous auditing using JMS:** audit logging can now also be done asynchronously by sending the events to a JMS queue rather than persisting them as part of the engine transaction.

The task service has been refactored significantly as well, and the TaskService APIs have been moved to the public kie-api. Although the TaskService interfaces themselves haven't changed a lot, the internal implementation has been simplified. Auditing for the task-related operations (similar to the runtime engine auditing) has been added.

By default, a local task service will always be used by a ksession to perform various task-related operations (creating a task, being notified when a task is completed). Setting up a remote singleton task service and connecting multiple ksessions to this (using Mina or HornetQ) as was possible in jBPM5 is no longer possible, as it introduces more challenges than it brings advantages. Since the jBPM execution service now also provides a remote API for all task-related operations, we believe this setup is no longer necessary, and has been replaced by the use of a local task service in all use cases.

25.5.2.3. jBPM Designer

jBPM designer has been reimplemented and is fully integrated into the workbench. It now easily integrates with many of the workbench services available. In addition, the following features were added/improved on:

- Improvement of jBPM Simulation engine and the UI. Added ability to specify simulation properties on more node type and added more results graphs such as the the Total Cost graph.
- Many updates to the Designer Toolbar for usability purposes.
- Visual Validation update - it now is a real-time visualization of issues done during process modeling.
- Ability to generate task forms for specific task node.
- Integration with the jBPM Form Modeler for both task and process forms.

- Update to process properties - added grouping of properties into sections making it more user friendly to find properties.
- Update to Object Library - added type specific tasks to palette (rather than having to morph to a certain type after adding a task to the canvas).
- Save/Remove/CopyDelete feature have been added directly into Designer and integrate with the workbench services for those operations.
- Autosave - option for users to enable auto-saving of their business process during modeling.
- Two new default Service Tasks (REST and Web Services)

25.5.2.4. jBPM Data Modeler

A new web-based data modeler is integrated in the workbench, which allows non-technical users to create data models (to be used in your processes and rules) in a user-friendly manner. These models are saved as Java classes (with the necessary annotations) in the project and added to the kjar upon build and deploy. Check the chapter on Data Modeler in the Workbench Part for all the details.

25.5.2.5. Form Modeler

A new web-based form modeler is integrated in the workbench, which allows non-technical users to create forms (for starting processes and/or completing human task). The form modeler is a WYSIWYG editor where you can drag and drop form elements (text boxes, labels, etc.), link it to data that is expected as input or output of the form, customize properties of each element and the layout, etc. These forms are then shown when starting the process or completing a task, integrated into the appropriate runtime views. Check the chapter on Form Modeler in the Workbench Part for all the details.

25.5.2.6. jBPM Console

The jBPM console has been reimplemented and is integrated into the workbench as well. It provides similar features as jBPM5 (starting process instances, inspecting current state and variables, looking at task lists) but is now much more powerful and exposes a lot more features. Check the chapter on Process and Task Management in the Workbench Part for all the details.

25.5.2.7. BAM / Reporting

A new web-based monitoring and reporting tool has been integrated in the workbench. This displays charts, tables, etc. about the current status of your application(s). It comes with some process and task dashboards out-of-the-box (showing for example the number of running process instances, the number of tasks completed per time frame, etc.). These dashboards however can be fully customized to show the data that is relevant to you, including for example your own data sources, making domain-specific charts (for example showing your key performance indicators (KPIs) instead of generic process-related charts). Check the chapter on Business Activity Monitoring in the Workbench Part for all the details.

25.5.2.8. Workbench

A workbench application, based on the UberFire framework, now unifies all web-based editors and tools into one large, configurable web application. It has many features, including:

- Configurable workspace where you layout your own views by dragging and dropping
- Unified login and role-based authentication, where what features you see depends on your role (admin, analyst, developer, user, manager, etc.).
- A new home screen that will guide you through the life cycle of your business processes (authoring, deployment, execution, tasks and reporting).
- Git-based repository that supports versioning and collaboration.
- New project structure where artifacts (processes, rules, etc.) are combined into k jars (we removed the custom binary packages and replaced them with a normal JAR, containing the source artifacts) when a project is built. These k jars now also include not only processes and rules, but also forms, configuration files, data models (Java classes), etc. K jars are Maven artefacts themselves (they have a group, id and version) and exposed as a Maven repository. When creating a k session, Maven can be used to download the necessary k jars for your project from this Maven repository.
- Sample `playground` repositories are (optionally) installed when starting up the workbench the first time, to get you started quickly with some predefined examples.

Check the Workbench Part for all the details.

25.5.2.9. Remote API

The remote API has been redesigned and allows users to remotely connect to a running execution server and pass commands. The remote runtime API exposes (almost) the entire KieSession and TaskService API using REST or JMS, so commands can be sent to the remote execution server for processing and the results are returned. See the chapter on Business Activity Monitoring for all the details.

Guvnor also provides a REST API to access the various repositories, projects and artifacts inside these projects and manage and build them.

25.5.3. New and Noteworthy in KIE Workbench 6.0.0

The workbench has had a big overhaul using a new base project called UberFire. UberFire is inspired by Eclipse and provides a clean, extensible and flexible framework for the workbench. The end result is not only a richer experience for our end users, but we can now develop more rapidly with a clean component based architecture. If you like the Workbench experience you can use UberFire today to build your own web based dashboard and console efforts.

As well as the move to a UberFire the other biggest change is the move from JCR to Git; there is an utility project to help with migration. Git is the most scalable and powerful source repository

bar none. JGit provides a solid OSS implementation for Git. This addresses the continued performance problems with the various JCR implementations, which would slow down once the number of files and number of versions become too high. There has been a big "low tech" drive, to remove complexity. Everything is now stored as a file, including meta data. The database is only there to provide fast indexing and search. So importing and exporting is all standard Git and external sites, like GitHub, can be used to exchange repositories.

In 5.x developers would work with their own source repository and then push JCR, via the team provider. This team provider was not full featured and not available outside Eclipse. Git enables our repository to work any existing Git tool or team provider. While not yet supported in the UI, this will be added over time, it is possible to connect to the repo and tag and branch and restore things.

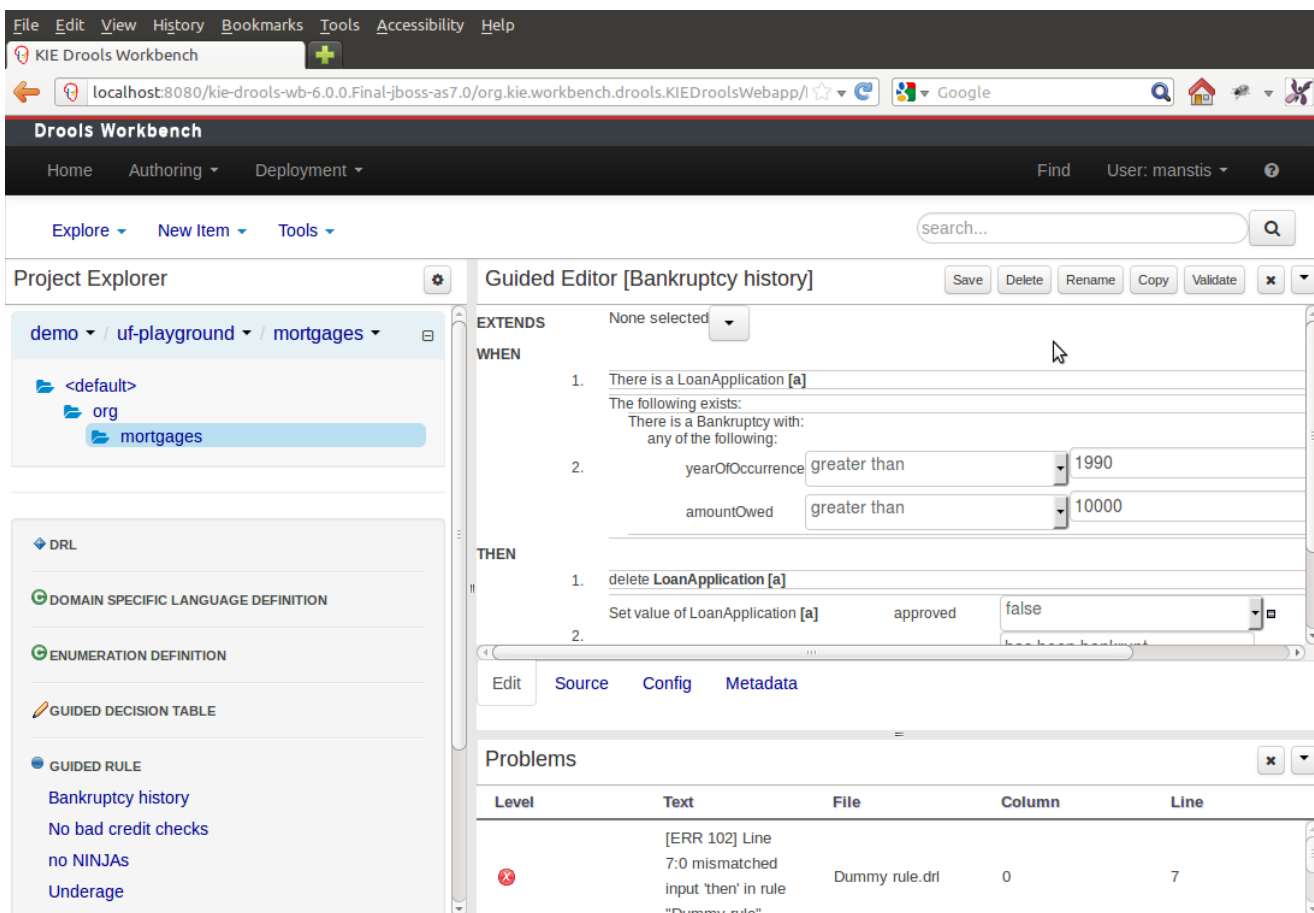


Figure 25.53. Workbench

The Guvnor brand leaked too much from its intended role; such as the authoring metaphors, like Decision Tables, being considered Guvnor components instead of Drools components. This wasn't helped by the monolithic projects structure used in 5.x for Guvnor. In 6.0 Guvnor 's focus has been narrowed to encapsulates the set of UberFire plugins that provide the basis for building a web based IDE. Such as Maven integration for building and deploying, management of Maven repositories and activity notifications via inboxes. Drools and jBPM build workbench distributions using Uberfire as the base and including a set of plugins, such as Guvnor, along with their own plugins for things like decision tables, guided editors, BPMN2 designer, human tasks.

The "Model Structure" diagram outlines the new project anatomy. The Drools workbench is called KIE-Drools-WB. KIE-WB is the uber workbench that combines all the Guvnor, Drools and jBPM plugins. The jBPM-WB is ghosted out, as it doesn't actually exist, being made redundant by KIE-WB.

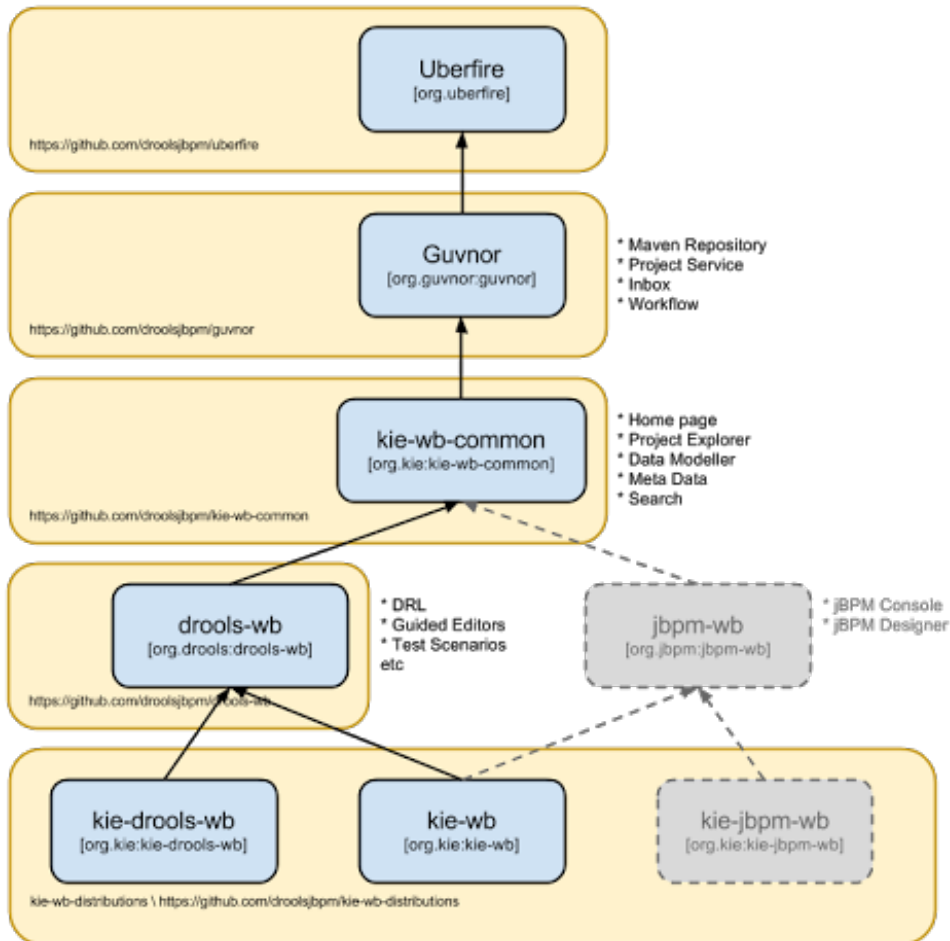


Figure 25.54. Module Structure

Important

KIE Drools Workbench and KIE Workbench share a common set of components for generic workbench functionality such as Project navigation, Project definitions, Maven based Projects, Maven Artifact Repository. These common features are described in more detail throughout this documentation.

The two primary distributions consist of:

- KIE Drools Workbench

- Drools Editors, for rules and supporting assets.
- jBPM Designer, for Rule Flow and supporting assets.
- KIE Workbench
 - Drools Editors, for rules and supporting assets.
 - jBPM Designer, for BPMN2 and supporting assets.
 - jBPM Console, runtime and Human Task support.
 - jBPM Form Builder.
 - BAM.

Workbench highlights:

- New flexible Workbench environment, with perspectives and panels.
- New packaging and build system following KIE API.
 - Maven based projects.
 - Maven Artifact Repository replaces Global Area, with full dependency support.
- New Data Modeller replaces the declarative Fact Model Editor; bringing authoring of Java classes to the authoring environment. Java classes are packaged into the project and can be used within rules, processes etc and externally in your own applications.
- Virtual File System replaces JCR with a default Git based implementation.
 - Default Git based implementation supports remote operations.
 - External modifications appear within the Workbench.
- Incremental Build system showing, near real-time validation results of your project and assets. The editors themselves are largely unchanged; however of note imports have moved from the package definition to individual editors so you need only import types used for an asset and not the package as a whole.

25.5.4. New and Noteworthy in Integration 6.0.0

25.5.4.1. CDI

CDI is now tightly integrated into the KIE API. It can be used to inject versioned KieSession and KieBases.

@Inject

```
@KSession("kbase1")
@KReleaseId( groupId = "jar1", rtifactId = "art1", version = "1.0")
private KieBase kbase1v10;

@Inject
@KBase("kbase1")
@KReleaseId( groupId = "jar1", rtifactId = "art1", version = "1.1")
private KieBase kbase1v11;
```

Figure 25.55. Side by side version loading for 'jar1.KBase1' KieBase

```
@Inject
@KSession("ksession1")
@KReleaseId( groupId = "jar1", rtifactId = "art1", version = "1.0")
private KieSession ksession1v10;

@Inject
@KSession("ksession1")
@KReleaseId( groupId = "jar1", rtifactId = "art1", version = "1.1")
private KieSession ksession1v11;
```

Figure 25.56. Side by side version loading for 'jar1.KBase1' KieBase

25.5.4.2. Spring

Spring has been revamped and now integrated with KIE. Spring can replace the 'kmodule.xml' with a more powerful spring version. The aim is for consistency with kmodule.xml

25.5.4.3. Aries Blueprints

Aries blueprints is now also supported, and follows the work done for spring. The aim is for consistency with spring and kmodule.xml

25.5.4.4. OSGi Ready

All modules have been refactored to avoid package splitting, which was a problem in 5.x. Testing has been moved to PAX.