Extending and Embedding Pentaho Data Integration

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Getting Started

Pentaho software engineers have anticipated that you may want to develop custom plugins to extend Pentaho Data Integration (PDI) functionality or to embed the PDI engine into you own Java applications. To aid experienced Java developers, we provide Java classes and methods, as well as sample Eclipse-based projects with detailed code-level documentation. The instructions in this publication show you how to approach your plugin project. When reading the instructions, we recommended that you open the related sample project and follow along.

Unless specifically stated otherwise, developing custom plugins and extending or embedding PDI is not covered under the standard Pentaho customer support agreement.

Getting Sample Projects

Here is where you can download the zip file that contains the sample projects:

https://pentaho.box.com/s/26f9484b522dc0db97bb

THE FINAL DOWNLOAD LINK WILL BE SUPPLIED BY THE ENGINEERING TEAM.

Note: The sample projects are provided "as is" and are subject to the warranty disclaimer contained in the applicable project license. Sample projects are informational only and are not recommended for use in production. Use in production is at your own risk.

Setting Up a Development Environment

When beginning a new PDI-related project we recommend you start from one of the *sample projects* and adapt it to your development environment.

The sample projects come preconfigured as Eclipse projects, complete with dependencies to a stable release of PDI 4.x. If you are developing for a specific version of PDI, you must replace the dependency `jar` files to match your version of PDI. The PDI classes and methods are stable for any major version of PDI, so you can safely replace the `jar` files and develop for any PDI 4.x release.

Getting PDI Sources

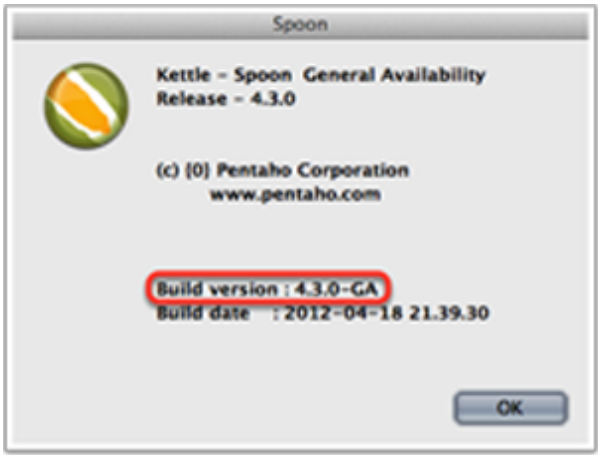
When developing with PDI, also known as the Kettle project to the open source community, it is helpful to have the Kettle sources close by. Including them in development projects makes it possible to trace and step through core PDI code, which helps when debugging your solution.

Note: It is not necessary or supported to modify or compile any of the PDI sources when embedding or extending PDI. Including the PDI sources in your projects is optional.

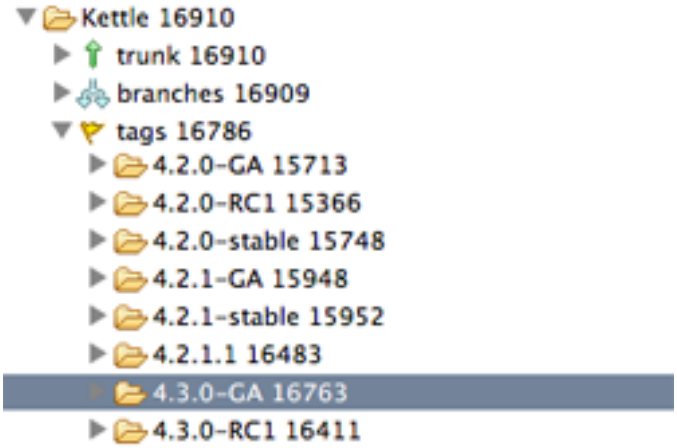
PDI source code is publicly available from the Pentaho SVN repository at *http://source.pentaho.org/svnkettleroot/Kettle/*.

PDI follows the standard project layout for SVN repositories. The version currently in development is hosted in the trunk folder, patch branches are hosted in the branch folders, and released versions are tagged in the tags folder.

If you are developing for a specific version of PDI, for instance 4.4.0, it is important to check-out or export the corresponding tag. To check which version you need to match your installation, select **Help** > **About** from the Spoon menu.



The **Build version** shows you which tag to use to match your installation.



Attach Source to PDI JAR Files

If you checked out *PDI sources*, you may want to associate the source to the matching PDI `jar` files against which you are compiling your plugin. This optional step may improve the debugging experience, as it allows you to trace into PDI core code.

Additional Developer Documentation

Javadoc

The javadoc documentation reflects the most recent stable release of PDI and is available at *`http://javadoc.pentaho.com/kettle/`*.

Pentaho PDI Community Wiki

Additional developer documentation is available in the PDI community wiki: *`http://wiki.pentaho.com/display/EAI/Latest+Pentaho+Data+Integration+%28aka+Kettle%29+Documentation`*.

The “Documentation for (Java) Developers” section has additional information for extending PDI with plugins or embedding the PDI engine.

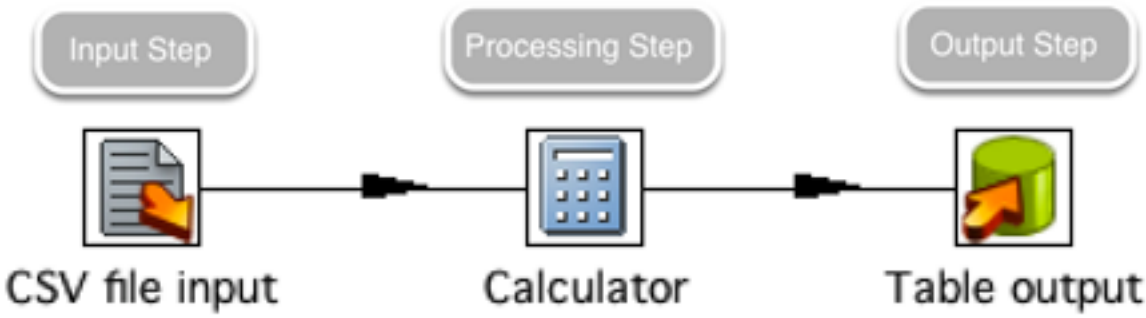
Extending Pentaho Data Integration

To extend the standard PDI functionality, you may want to develop custom plugins to extend its functionality. The instructions in this section address common extending scenarios, with each scenario having its own sample project. The `kettle-sdk-embedding-samples` folder of the *sample code* package stores these sample projects.

- kettle-sdk-step-plugin
- kettle-sdk-jobentry-plugin
- kettle-sdk-database-plugin
- kettle-sdk-partitioner-plugin

Creating Step Plugins

A transformation step implements a data processing task in an ETL data flow. It operates on a stream of data rows. Transformation steps are designed for input, processing, or output. Input steps fetch data rows from external data sources, such as files or a databases. Processing steps work with data rows, perform field calculations, and stream operations, such as joining or filtering. Output steps write the processed data back to storage, files, or databases.



This section explains the architecture and programming concepts for creating your own PDI transformation step plugin. We recommended that you open and refer to the *sample step plugin sources* while following these instructions.

A step plugin integrates with PDI by implementing four distinct Java interfaces. Each interface represents a set of responsibilities performed by a PDI step. Each of the interfaces has a base class that implements the bulk of the interface in order to simplify plugin development.

Unless noted otherwise, all step interfaces and corresponding base classes are part of the `org.pentaho.di.trans.step` package.

Java Interface	Base Class	Main Responsibilities
`StepMetaInterface`	`BaseStepMeta`	• Maintain step settings • Validate step settings • Serialize step settings • Provide access to step classes • Perform row layout changes
`StepDialogInterface`	`org.pentaho.di.ui.trans.step.BaseStepDialog`	• Step settings dialog

Java Interface	Base Class	Main Responsibilities
StepInterface	BaseStep	• Process rows
StepDataInterface	BaseStepData	• Provide storage for row processing

Maintaining Step Settings

Java Interface	*org.pentaho.di.trans.step.StepMetaInterface*
Base class	*org.pentaho.di.trans.step.BaseStepMeta*

The StepMetaInterface is the main Java interface that a plugin implements.

Keep Track Of the Step Settings

The implementing class keeps track of step settings using private fields with corresponding get and set methods. The dialog class implementing StepDialogInterface is uses these methods to copy the user supplied configuration in and out of the dialog.

These interface methods are also used to maintain settings.

```
void setDefault()
```

This method is called every time a new step is created and allocates or sets the step configuration to sensible defaults. The values set here are used by Spoon when a new step is created. This is a good place to ensure that the step settings are initialized to non-null values. Values that are null can be cumbersome to deal with in serialization and dialog population, so most PDI step implementations stick to non-null values for all step settings.

```
public Object clone()
```

This method is called when a step is duplicated in Spoon. It returns a deep copy of the step meta object. It is essential that the implementing class creates proper deep copies if the step configuration is stored in modifiable objects, such as lists or custom helper objects.

See org.pentaho.di.trans.steps.rowgenerator.RowGeneratorMeta.clone() in the PDI source for an example of creating a deep copy.

Serialize Step Settings

The plugin serializes its settings to both XML and a PDI repository. These interface methods provide this functionality.

```
public String getXML()
```

This method is called by PDI whenever a step serializes its settings to XML. It is called when saving a transformation in Spoon. The method returns an XML string containing the serialized step settings. The string contains a series of XML tags, one tag per setting. The helper class, org.pentaho.di.core.xml.XMLHandler, constructs the XML string.

```
public void loadXML()
```

This method is called by PDI whenever a step reads its settings from XML. The XML node containing the step settings is passed in as an argument. Again, the helper class, org.pentaho.di.core.xml.XMLHandler, reads the step settings from the XML node.

```
public void saveRep()
```

This method is called by PDI whenever a step saves its settings to a PDI repository. The repository object passed in as the first argument provides a set of methods for serializing step settings. The passed in transformation id and step id are used by the step as identifiers when calling the repository serialization methods.

```
public void readRep()
```

This method is called by PDI whenever a step reads its configuration from a PDI repository. The step id given in the arguments is used as the identifier when using the repositories serialization methods.

When developing plugins, make sure the serialization code is in synch with the settings available from the step dialog. When testing a step in Spoon, PDI internally saves and loads a copy of the transformation before extending it.

Provide Instances of Other Plugin Classes

The `StepMetaInterface` plugin class is the main class, tying in with the rest of PDI architecture. It is responsible for supplying instances of the other plugin classes implementing `StepDialogInterface`, `StepInterface`, and `StepDataInterface`. The following methods cover these responsibilities. Each method implementation constructs a new instance of the corresponding class, forwarding the passed in arguments to the constructor.

- `public StepDialogInterface getDialog()`
- `public StepInterface getStep()`
- `public StepDataInterface getStepData()`

Each of these methods returns a new instance of the plugin class implementing `StepDialogInterface`, `StepInterface`, and `StepDataInterface`.

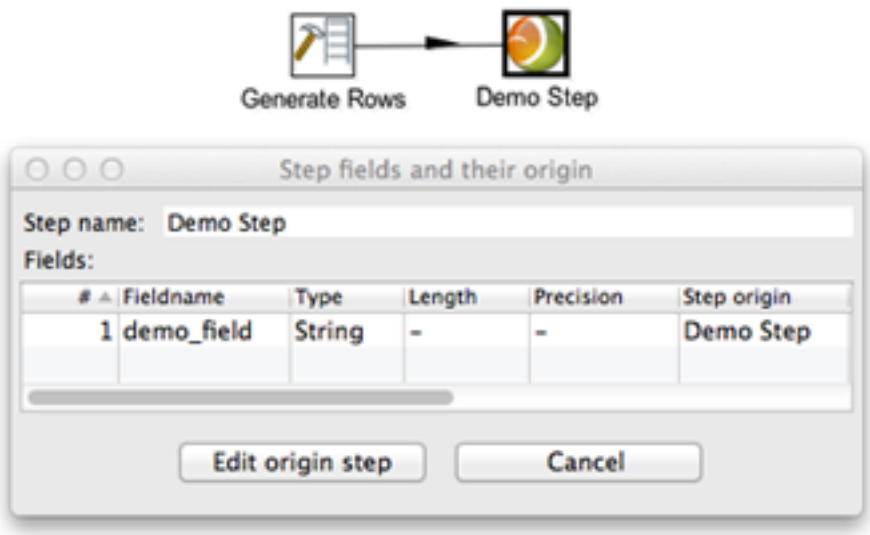
Report Step Changes to the Row Stream

PDI needs to know how a step affects the row structure. A step may be adding or removing fields, as well as modifying the metadata of a field. The method implementing this aspect of a step plugin is `getFields()`.

```
public void getFields()
```

Given a description of the input rows, the plugin modifies it to match the structure for its output fields. The implementation modifies the passed in `RowMetaInterface` object to reflect changes to the row stream. A step adds fields to the row structure. This is done by creating *`ValueMeta`* objects, such as the PDI default implementation of `ValueMetaInterface`, and appending them to the `RowMetaInterface` object. The *Working with Fields* section goes into deeper detail about `ValueMetaInterface`.

This sample transformation uses two steps. The Generate Rows step adds the field, `demo_field`, to a newly inserted row streamed by the Demo step.

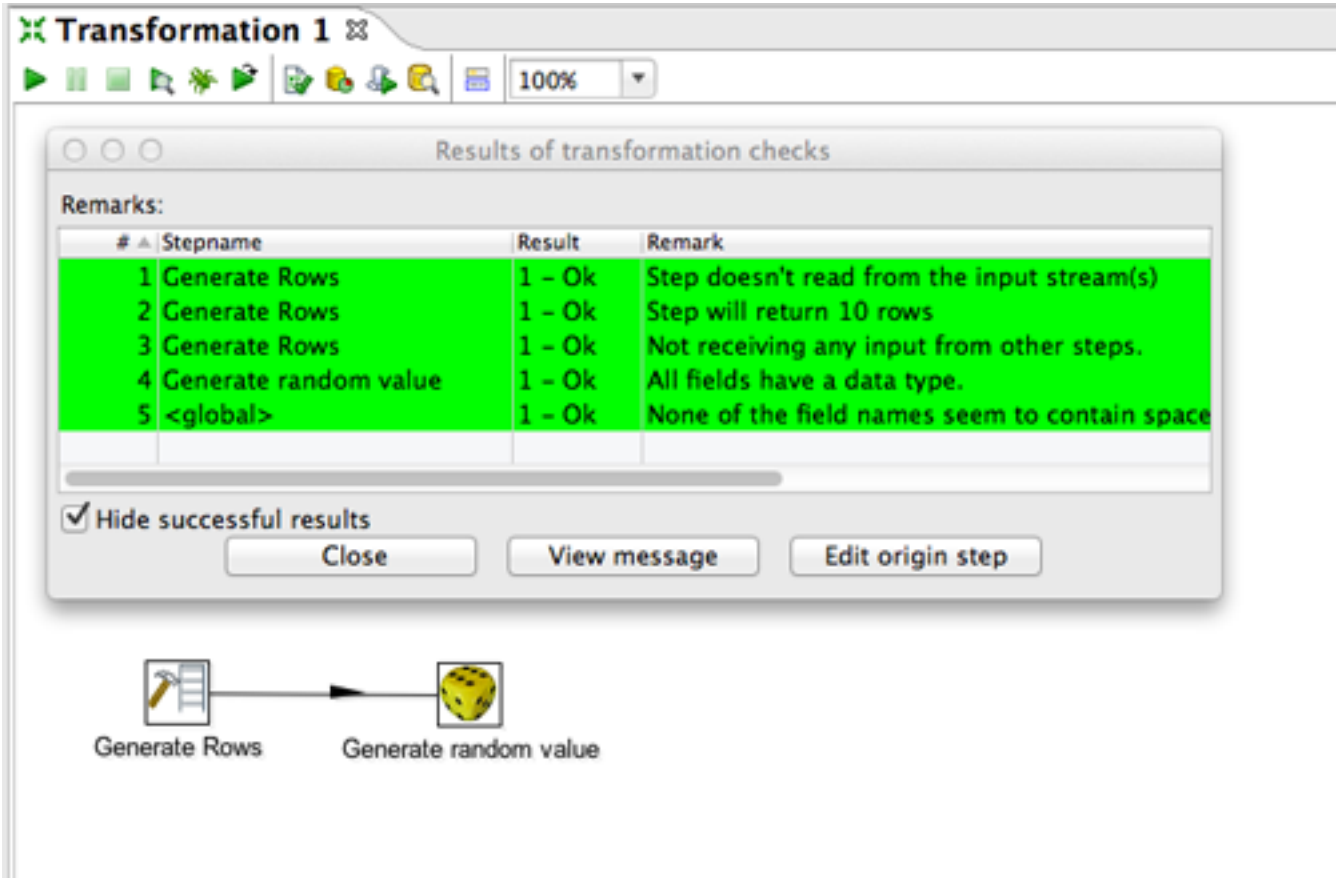


Validate Step Settings

Spoon supports a Validate Transformation feature, which triggers a self-check of all steps. PDI invokes the `check()` method of each step on the canvas, allowing each step to validate its settings.

```
public void check()
```

Each step has the opportunity to validate its settings and verify that the configuration given by the user is reasonable. In addition, a step checks if it is connected to preceding or following steps, if the nature of the step requires that kind of connection. An input step may expect to not have a preceding step for example. The check method passes in a list of check remarks, to which the method appends its validation results. Spoon displays the list of remarks collected from the steps, allowing you to take corrective action in case there are validation warnings or errors.



Implementing the Step Settings Dialog Box

Java Interface	*`org.pentaho.di.trans.step.StepDialogInterface`*
Base class	*`org.pentaho.di.ui.trans.step.BaseStepDialog`*

`StepDialogInterface` is the Java interface that implements the plugin settings dialog.

Maintain the Dialog for Step Settings

The `dialog` class is responsible for constructing and opening the settings dialog for the step. Whenever you open the step settings in Spoon, the system instantiates the `dialog` class passing in the `StepMetaInterface` object and calling `open()` on the dialog. *SWT* is the native windowing environment of Spoon and is the framework used for implementing step dialogs.

```
public String open()
```

This method returns only after the dialog has been confirmed or cancelled. The method must conform to these rules.

- If the dialog is confirmed
  - The `StepMetaInterface` object must be updated to reflect the new step settings
  - If you changed any step settings, the `StepMetaInterface` object Changed flag must be set to `true`
  - `open()` returns the name of the step
- If the dialog is cancelled
  - The `StepMetaInterface` object must not be changed
  - The `StepMetaInterface` object Changed flag must be set to the value it had at the time the dialog opened
  - `open()` must return `null`

The `StepMetaInterface` object has an internal Changed flag that is accessible using `hasChanged()` and `setChanged()`. Spoon decides whether the transformation has unsaved changes based on the Changed flag, so it is important for the dialog to set the flag appropriately.

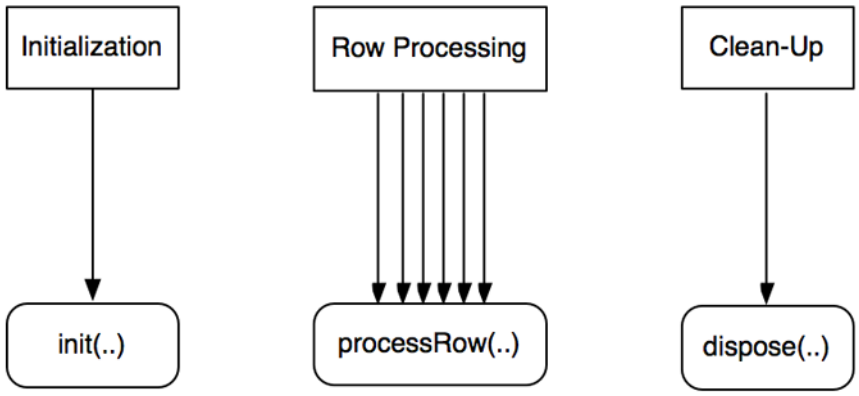
The *sample Step plugin project* has an implementation of the dialog class that is consistent with these rules and is a good basis for creating your own dialog.

Processing Rows

Java Interface	*`org.pentaho.di.trans.step.StepInterface`*
Base class	*`org.pentaho.di.trans.step.BaseStep`*

The class implementing `StepInterface` is responsible for the actual row processing when the transformation runs.

The implementing class can rely on the base class and has only three important methods it implements itself. The three methods implement the step life cycle during transformation execution: initialization, row processing, and clean-up.



During initialization PDI calls the `init()` method of the step once. After all steps have initialized, PDI calls `processRow()` repeatedly until the step signals that it is done processing all rows. After the step is finished processing rows, PDI calls `dispose()`.

The method signatures have a *`StepMetaInterface`* object and a *`StepDataInterface`* object. Both objects can be safely cast down to the specific implementation classes of the step.

Aside from the methods it needs to implement, there is one additional and very important rule: the class must not declare any fields. All variables must be kept as part of the class implementing `StepDataInterface`. In practice this is not a problem, since the object implementing `StepDataInterface` is passed in to all relevant methods, and its fields are used instead of local ones. The reason for this rule is the need to decouple step variables from instances of `StepInterface`. This enables PDI to impolement different threading models to execute a transformation.

Step Initialization

The `init()` method is called when a transformation is preparing to start execution.

```
public boolean init()
```

Every step is given the opportunity to do one-time initialization tasks, such as opening files or establishing database connections. For any steps derived from `BaseStep`, it is mandatory that `super.init()` is called to ensure correct behavior. The method returns `true` in case the step initialized correctly, it returns `false` if there is an initialization error. PDI will abort the execution of a transformation in case any step returns `false` upon initialization.

Row Processing

Once the transformation starts, it enters a tight loop, calling `processRow()` on each step until the method returns `false`. In most cases, each step reads a single row from the input stream, alters the row structure and fields, and passes the row on to the next step. Some steps, such as input, grouping, and sorting steps, read rows from external sources. These steps can read rows in batches or can hold on to the read rows to perform other processing before passing them on to the next step.

```
public boolean processRow()
```

A PDI step queries for incoming input rows by calling `getRow()`, which blocks and returns a row object or `null` in case there is no more input. If there is an input row, the step does the necessary row processing and calls `putRow()` to pass the row on to the next step. If there are no more rows, the step calls `setOutputDone()` and returns `false`.

The method must conform to these rules.

- If the step is done processing all rows, the method calls `setOutputDone()` and returns `false`.
- If the step is not done processing all rows, the method returns `true`. PDI calls `processRow()` again in this case.

The *sample Step plugin project* shows an implementation of `processRow()` that is commly used in data processing steps.

In contrast to that, input steps do not usually expect any incoming rows from previous steps. They are designed to execute `processRow()` exactly once, fetching data from the outside world, and putting them into the row stream by calling `putRow()` repeatedly until done. Examining *existing PDI* steps is a good guide for designing your `processRow()` method.

The row structure object is used during the first invocation of `processRow()` to determine the indexes of fields on which the step operates. The `BaseStep` class already provides a convenient First flag to help implement special processing on the first invocation of `processRow()`. Since the row structure is equal for all input rows, steps cache field index information in variables on their `StepDataInterface` object.

Step Clean-Up

Once the transformation is complete, PDI calls `dispose()` on all steps.

```
Public void dispose()
```

Steps are required to deallocate resources allocated during `init()` or subsequent row processing. Your implementation should clear all fields of the `StepDataInterface` object, and ensures that all open files or connections are properly closed. For any steps derived from `BaseStep`, it is mandatory that `super.dispose()` is called to ensure correct deallocation.

Storing the Processing State

Java Interface	`org.pentaho.di.trans.step.StepDataInterface`
Base class	`org.pentaho.di.trans.step.BaseStepData`

The class implementing `StepInterface` does not store processing state in any of its fields. Instead an additional class implementing `StepDataInterface` is used to store processing state, including status flags, indexes, cache tables, database connections, file handles, and alike. Implementations of `StepDataInterface` declare the fields used during row processing and add accessor functions. In essence the class implementing `StepDataInterface` is used as a place for field variables during row processing.

PDI creates instances of the class implementing `StepDataInterface` at the appropriate time and pass it on to the `StepInterface` object in the appropriate method calls. The base class already implements all necessary interactions with PDI and there is no need to override any base class methods.

Working with Rows

A row in PDI is represented by a Java object array, `Object[]`. Each field value is stored at an index in the row. While the array representation is efficient to pass data around, it is not immediately clear how to determine the field names and types that go with the array. The row array itself does not carry this meta data. Also an object array representing a row usually has empty slots towards its end, so a row can accommodate additional fields efficiently. Consequently, the length of the row array does not equal the amount of fields in the row. The following sections explain how to safely access fields in a row array.

PDI uses internal objects that implement *`RowMetaInterface`* to describe and manipulate row structure. Inside `processRow()` a step can retrieve the structure of incoming rows by calling *`getInputRowMeta()`*, which is provided by the `BaseStep` class. The step clones the `RowMetaInterface` object and passes it to `getFields()` of its *meta class* to reflect any changes in row structure caused by the step itself. Now, the step has `RowMetaInterface` objects describing both the input and output rows. This illustrates how to use `RowMetaInterface` objects to inspect row structure.

There is a similar object that holds information about individual row fields. PDI uses internal objects that implement *`ValueMetaInterface`* to describe and manipulate field information, such as field name, data type, format mask, and alike.

A step looks for the indexes and types of relevant fields upon first execution of `processRow()`. These methods of `RowMetaInterface` are useful to achieve this.

Method	Purpose
`indexOfValue(String valueName)`	Given a field name, determine the index of the field in the row.
`getFieldNames()`	Returns an array of field names. The index of a field name matches the field index in the row array.
`searchValueMeta(String valueName)`	Given a field name, determine the meta data for the field.
`getValueMeta(int index)`	Given a field index, determine the meta data for the field.
`getValueMetaList()`	Returns a list of all field descriptions. The index of the field description matches the field index in the row array.

If a step needs to create copies of rows, use the *`cloneRow()`* methods of `RowMetaInterface` to create proper copies. If a step needs to add or remove fields in the row array, use the static helper methods of *`RowDataUtil`*. For example, if a step is adding a field to the row, call *`resizeArray()`*, to add the field. If the array has enough slots, the field is added. If the array does not have enough slots, it is either physically resized, or the original row is retruned as it is. If a step needs to create new rows from scratch, use *`allocateRowData()`*, which returns a somewhat over-allocated object array to fit the desired number of fields.

Summary Table of Classes and Interfaces for Row Processing

Class/Interface	Purpose
`RowMetaInterface`	Describes and manipulates row structure
`ValueMetaInterface`	Describes and manipulates field structure
`RowDataUtil`	Allocates space in row array

Working With Fields

Data Type

`ValueMetaInterface` objects are used to determine the characteristics of the row fields. They are typically obtained from a `RowMetaInterface` object, which is acquired by a call to `getInputRowMeta()`. The *`getType()`* method returns one of the static constants declared by *`ValueMetaInterface`* to indicate the PDI field type. Each field type maps to a corresponding native Java type for the actual value. This table illustrates the mapping.

PDI data type	Type constant	Java data type	Description
String	TYPE_STRING	`java.lang.String`	A variable unlimited length text encoded in UTF-8 (Unicode)
Integer	TYPE_INTEGER	`java.lang.Long`	A signed long 64-bit integer
Number	TYPE_NUMBER	`java.lang.Double`	A double precision floating point value
BigNumber	TYPE_BIGNUMBER	`java.math.BigDecimal`	An arbitrary unlimited precision number
Date	TYPE_DATE	`java.util.Date`	A date-time value with millisecond precision
Boolean	TYPE_BOOLEAN	`java.lang.Boolean`	A boolean value `true` or `false`
Binary	TYPE_BINARY	`java.lang.byte[]`	An array of bytes that contain any type of binary data.

Do not assume that the Java value of a row field matches these data types directly. This may or may not be true, based on the storage type used for the field.

Storage Types

In addition to the data type of a field, the storage type, *getStorageType()*/*setStorageType()*, is used to interpret the actual field value in a row array. These storage types are available.

Type constant	Actual field data type	Interpretation
STORAGE_TYPE_NORMAL	As listed in previous table	The value in the row array is of the type listed in the data type table above and represents the field value directly.
STORAGE_TYPE_BINARY_STRING	`java.lang.byte[]`	The field has been created using the Lazy Conversion feature. This means it is a non-altered sequence of bytes as read from an external medium, usually a file.
STORAGE_TYPE_INDEXED	`java.lang.Integer`	The row value is an integer index into a fixed array of possible values. The `ValueMetaInterface` object maintains the set of possible values in *getIndex()*/*setIndex()*

Accessing Row Values

In a typical data processing scenario, a step is not interested in dealing with the complexities of the storage type. It just needs the actual data value on which to do processing. In order to safely read the value of a field, the `ValueMetaInterface` object provides a set of accessor methods to get at the actual Java value. The argument is the value from the row array that belongs to the field represented by the `ValueMetaInterface` object. The accessor methods always return a proper data value, regardless of the field storage type.

- *getString()*
- *getInteger()*
- *getNumber()*
- *getBigNumber()*
- *getDate()*
- *getBoolean()*
- *getBinary()*

For each of these methods, `RowMetaInterface` has corresponding methods that require the row array and the index of the field as arguments.

Additional Field Characteristics

ValueMetaInterface represents all aspects of a PDI field, including conversion masks, trim type, and alike. All of these are available using corresponding accessor methods, such as *getConversionMask()* and *getTrimType()*. Refer to the *Javadoc* for a complete overview.

Handling Errors

Transformation steps may encounter errors at many levels. They may encounter unexpected data, or problems with the execution environment. Depending on the nature of the error, the step may decide to stop the transformation by throwing an exception, or support the PDI Error Handling feature, which allows you to divert bad rows to an error handling step.

Throwing a KettleException: Calling a Hard Stop

If a step encounters an error during row processing, it may log an error and stop the transformation. This is done by calling `setErrors(1)`, `stopAll()`, `setOutputDone()`, and returning `false` from `processRow()`. Alternatively, the step can throw a *KettleException*, which also causes the transformation to stop.

It is sensible to stop the transformation when there is a problem with the environment or configuration of a step. For example, when a database connection cannot be made, a required file is not present, or an expected field is not in the row stream. These are errors that affect the execution of the transformation as a whole. If on the other hand the error is related to row data, the step should implement support for the PDI Error Handling feature.

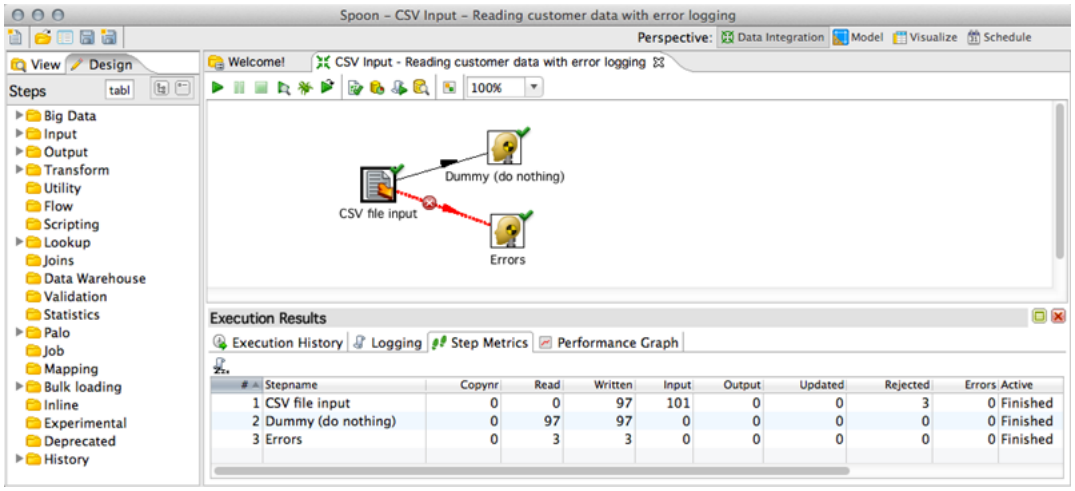
Implementing Per-Row Error Handling

You may want to divert bad rows to a specific error handling step. This capability is referred to as the Error Handling feature. A step supporting this feature overrides the `BaseStep` implementation of *`supportsErrorHandling()`* to return `true`. This enables you to specify a target step for bad rows in the Spoon UI. During runtime, the step checks if you configured a target step for error rows by calling `getStepMeta().isDoingErrorHandling()`. If error rows are diverted, the step passes the offending input row to *`putError()`* and provides additional information about the errors encountered. It does not throw a *`KettleException`*. If you do not configure a step to generate error rows and send them to another step for processing, the step falls back to calling a hard stop.

Most core PDI steps support row-level error handling. The *Number Range* step is a good example. If error handling is enabled, it diverts the row into the error stream. If it is not, the step stops the transformation.

Understanding Row Counters

During transformation execution, each PDI step keeps track of a set of step metrics. These are displayed in Spoon in the **Step Metrics** tab.



Each step metric is essentially a row counter. The counters are manipulated by calling the corresponding increment, decrement, get, and set methods on `BaseStep`. This table provides a list of the counters and the correct way to use them.

Counter Name	Meaning	When to Increment
`linesRead`	Rows received from previous steps	Never increment manually. This is handled by `getRow()`.
`linesWritten`	Rows passed to next steps	Never increment manually. This is handled by `putRow()`.
`linesInput`	Rows read from external sources, such as files, database, and alike	Call `incrementLinesInput()` when a new row is received from an external source.
`linesOutput`	Rows written to external sources, such as files, database, and alike	Call `incrementLinesOutput()` when a row is written to an external system or file.
`linesUpdated`	Rows updated in external sources, such as database, and alike	Call `incrementLinesUpdated()` when a row is updated in an external system or file.
`linesSkipped`	Rows for which part of the processing has been skipped	Call `incrementLinesSkipped()` when a row was skipped. This is relevant when the step implements conditional processing, and the condition for processing a row is not satisfied. For example, an updating step may skip rows that are already up to date.
`linesRejected`	Rows diverted to an error step as part of *error handling*	Never increment manually. This is handled by `putError()`.

Logging for Rows

A step interacts with the PDI logging system by using the logging methods inherited from `BaseStep`.

These methods are used to issue log lines to the PDI logging system on different severity levels. Multi-argument versions of the methods are available to do some basic formatting, which is equivalent to a call to *`MessageFormat.format(message, arguments)`*.

- `public void logMinimal()`
- `public void logBasic()`
- `public void logDetailed()`
- `public void logDebug()`
- `public void logRowlevel()`
- `public void logError()`

These methods query the logging level. They are often used to guard sections of code, that should only be executed with elevated logging settings.

- `public boolean isBasic()`
- `public boolean isDetailed()`
- `public boolean isDebug()`
- `public boolean isRowLevel()`

Steps should log this information at specified levels.

Log Level	Log Information Content
Minimal	Only information that is interesting at very high-levels, for example Transformation Started or Ended; individual steps do not log anything at this level
Basic	Information that may be interesting to you during regular ETL operation
Detailed	Prepared SQL or other query statements, resource allocation and initialization like opening files or connections
Debug	Anything that may be useful in debugging step operations
RowLevel	Anything that may be helpful in debugging problems at the level of individual rows and values
Error	Fatal errors that abort the transformation

Feedback Logging

A transformation defines a feedback size in its settings. The feedback size defines the number of rows after which each step logs a line reporting its progress. This is implemented by calling `checkFeedback()` with an appropriate row counter as argument to determine if feedback should be logged. Feedback logging happens on the basic log-level. Implementation looks like this snippet.

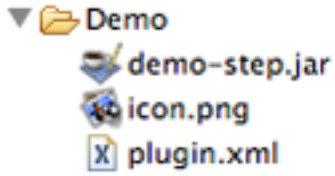
```
if (checkFeedback(getLinesWritten())) {
if(isBasic()) logBasic("linenr "+getLinesWritten());
}
```

It may make sense to use different row counters for checking the feedback size depending on the implementation logic of your step. For example, a step that accumulates incoming rows into one single summary row, should probably use the `linesRead` counter to determine the feedback interval.

The *Excel Output* step has a good example implementation of feedback logging.

Deploying Step Plugins

A step plugin package resides in a folder that includes a `jar` file containing the plugin classes, dependency `jar` files in the `lib` subfolder, other resources needed by the plugin, and the icon for the step plugin as a `.png` or `.gif` file. This image shows the plugin folder for the *sample Step plugin project*.



In order for PDI to recognize a step plugin, the step needs to provide basic descriptive information about itself. It also needs to register itself with PDI by specifying these items.

- A globally unique ID for the step
- The class implementing *StepMetaInterface*
- The label to use for the step
- The tooltip to use for the step
- Optional,internationalization information for the label and tooltip
- The category in the step tree
- The icon file used to represent the step on the canvas

The step must provide this information either as a `plugin.xml` file or as Java annotations. These methods are mutually exclusive.

Alternative 1: Using Plugin.xml

If the step registers itself using the `plugin.xml` file, the file must reside in the plugin folder. The file contents covers the necessary information directly, using the attributes on the plugin tag. Here is an example of a `plugin.xml` file that works for the *sample Step plugin project*.

```
<?xml version="1.0" encoding="UTF-8">
<plugin
  id="DemoStep"
  classname="org.pentaho.di.sdk.samples.steps.demo.DemoStepMeta"
  description="Demo Step"
  tooltip="Demo Step Tooltip"
  category="Transform"
  iconfile="icon.png">
  <libraries>
     <library name="demo-step.jar"/>
     <!-- <library name="lib/some-additional-jar.jar"/> -->
  </libraries>
</plugin>
```

The plugin tag covers the step id, label, description, tooltip, icon file and implementing class. All paths are relative to the step folder. So, in the example, the path indicates that `icon.png` resides in the step folder. The libraries section contains an entry per `jar` file that should be loaded as part of the plugin. This includes the `jar` file containing the plugin classes, as well as any dependency `jar` files.

Description, tooltip, and category can be localized. The Pentaho wiki page contains an example that shows how to supply localized strings in `plugin.xml`. See *http://wiki.pentaho.com/display/COM/PDI+Plugin+Loading*.

Alternative 2: Using Java Annotations

Instead of using the `plugin.xml` file, the class implementing *`StepMetaInterface`* can be annotated to provide the relevant information. The relevant annotation is the *Step annotation*. As an example, the *HL7 input plugin* uses the step annotation method instead of supplying a separate `plugin.xml` file.

If the `i18nPackageName` attribute is supplied in the annotation attributes, the values of name, description, and category description are interpreted as *i18n keys*. The keys may be supplied in the extended form `i18n:<packagename>:<key>` to specify a package that is different from the default package given in the `i18nPackageName` attribute.

Once a step plugin folder is ready, place it in a specific location for PDI to find.

Deploying to Spoon or Carte

To deploy the plugin, copy the step plugin folder to this location:

`design-tools/data-integration/plugins/steps`

After restarting Spoon, the step is available from the configured section in the step tree.

Deploying to Data Integration Server

If you are running a data integration server, copy the step plugin folder to this location:

`server/data-integration-server/pentaho-solutions/system/kettle/plugins/steps`

After restarting the data integration server, the step is available and server can execute transformations containing the step plugin.

Deploying to BA Server

If you plan to execute PDI transformations on a BA server, copy the step plugin folder to this location:

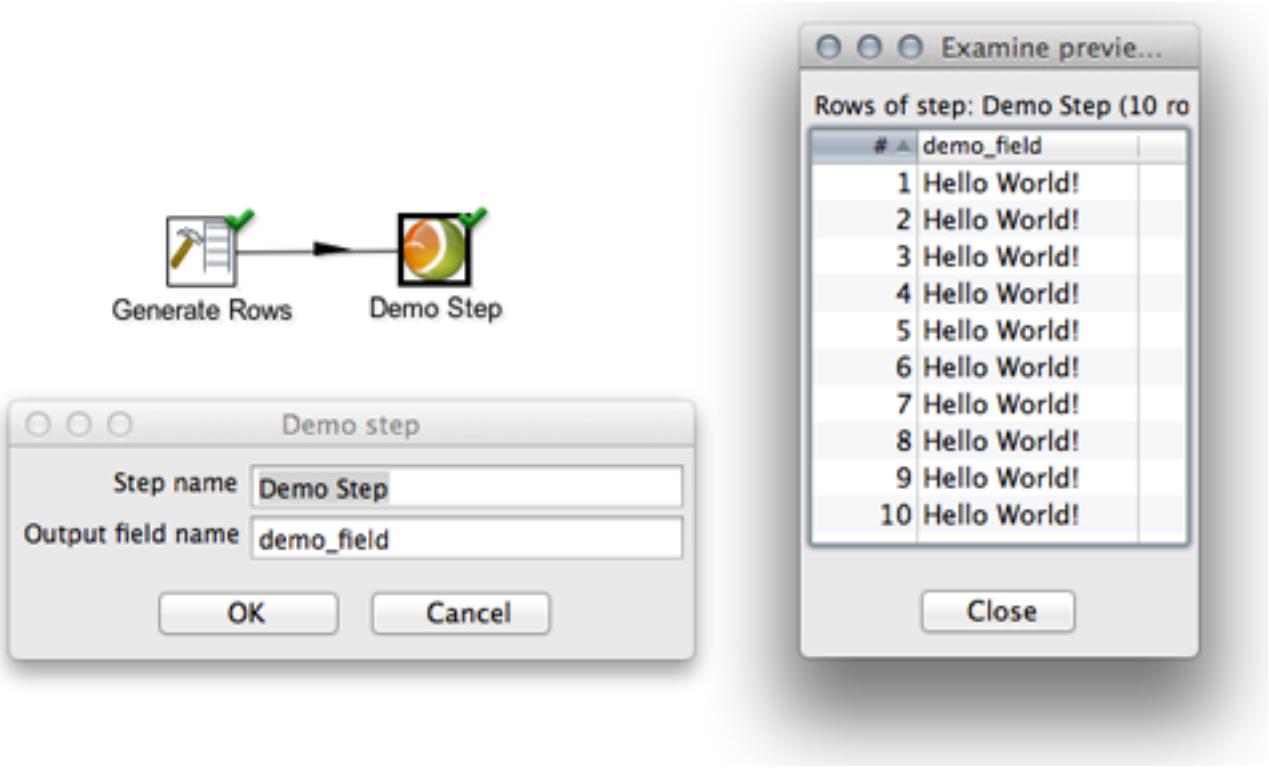
`server/biserver-ee/pentaho-solutions/system/kettle/plugins/steps`

After restarting the BA server, the sample Step plugin is available and the server can execute transformations containing the step plugin.

Sample Step Plugin

The sample Step plugin is designed to show a minimal functional implementation of a step plugin that you can use as a basis to develop your own custom transformation steps.

The sample Step plugin functionality adds a string field to a row stream and fills it with *Hello World!*. This screen shot shows the step configuration dialog and preview window.



Obtaining the Sample Plugin

The sources for the step plugin sample are available from the *download package* in the `kettle-sdk-step-plugin` folder. Before you can build and deploy your plugin, supply the path to a local PDI installation. You can find the path in the `kettle-dir` property in `kettle-sdk-step-plugin/build/build.properties`.

Building and Deploying From the Command Line

The sample Step plugin is built using *Apache Ant*. You can build and deploy the step plugin from the command line by invoking the Ant install target command from the build directory.

```
kettle-sdk-step-plugin $ cd build
build $ ant install
```

The install target compiles the sources, creates `jar` files for the resulting classes, puts together a plugin folder, and finally copies the entire plugin folder into the `plugins/steps` directory of your local PDI installation. Adjust the `kettle-dir` property in `build.properties` so that the Ant process knows where to copy the plugin.

Building and Deploying From Eclipse

You may prefer to import the plugin into Eclipse.

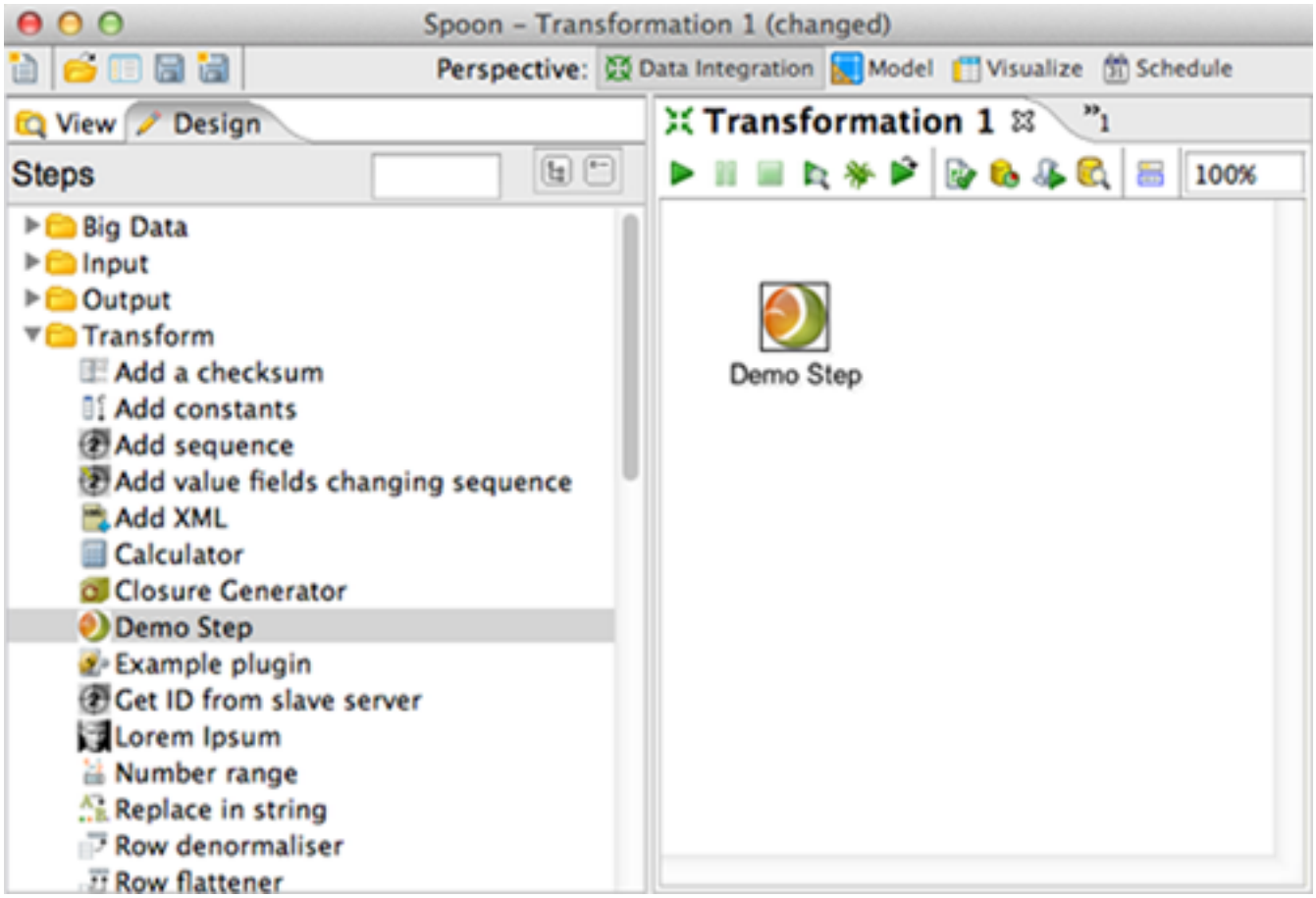
1. From the menu, select **File** > **Import** > **Existing Projects Into Worksapace**.
2. Browse to the `kettle-sdk-step-plugin` folder and choose the project to be imported.

This is how you build and install the plugin.

1. Open the Ant view in Eclipse by selecting **Window** > **Show View** from the main menu and select **Ant**.

   You may have to browse other views in case you have not used the Ant view before.
2. Adjust the `kettle-dir` property in `build.properties` so the Ant process can know where to copy the plugin.
3. Drag the file `build/build.xml` from your project into the Ant view and execute the install target by double-clicking it.
4. After the plugin has been deployed, restart Spoon.

The plugin appears in the **Transform** panel.



Exploring More Steps

PDI sources provide example implementations of transformation steps. Each PDI core step is located in a sub-package of `org.pentaho.di.trans.steps` found in the `src` folder. The corresponding dialog class in located in `org.pentaho.di.ui.trans.steps` found in the `src-ui` folder.

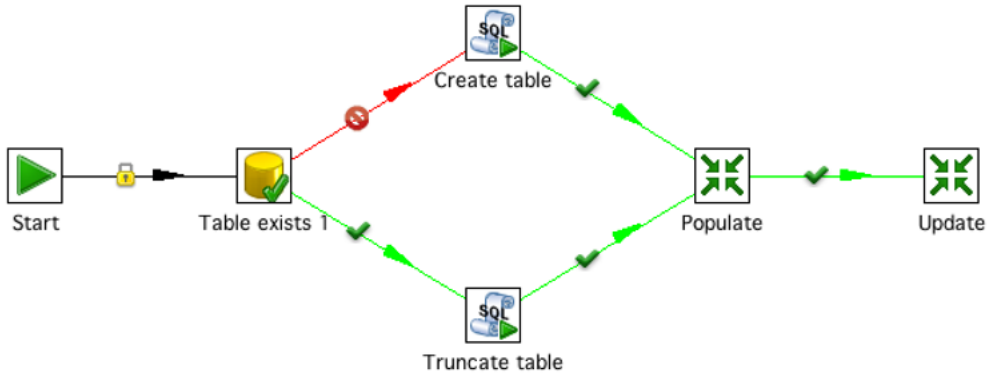
For example, these are the classes that make up the Row Generator step.

- `org.pentaho.di.trans.steps.rowgenerator.RowGeneratorMeta`
- `org.pentaho.di.trans.steps.rowgenerator.RowGenerator`
- `org.pentaho.di.trans.steps.rowgenerator.RowGeneratorData`
- `org.pentaho.di.ui.trans.steps.rowgenerator.RowGeneratorDialog`

The `dialog` classes of the core PDI steps are located in a different package and source folder. They are also assembled into a separate `jar` file. This allows PDI to load the UI-related `jar` file when launching Spoon and avoid loading the UI-related `jar` when it is not needed.

Creating Job Entry Plugins

A job entry implements a logical task in ETL control flow. Job entries are executed in sequence, each job entry generating a boolean result that can be used for conditional branching in the job sequence.



This section explains the architecture and programming concepts for creating your own PDI job entry plugin. We recommended that you open and refer to the *sample job entry plugin sources* while following these instructions.

A job entry plugin integrates with PDI by implementing two distinct Java interfaces. Each interface represents a set of responsibilities performed by a PDI job. Each of the interfaces has a base class that implements the bulk of the interface in order to simplify plugin development.

All job entry interfaces and corresponding base classes are part of the `org.pentaho.di.job.entry` package.

Java Interface	Base Class	Main Responsibilities
`JobEntryInterface`	`JobEntryBase`	• Maintain job entry settings • Serialize job entry settings • Provide access to dialog class • Execute job entry task
`JobEntryDialogInterface`	`JobEntryDialog`	• Job entry settings dialog

Implementing a Job Entry

Java Interface	*`org.pentaho.di.job.entry.JobEntryInterface`*
Base class	*`org.pentaho.di.job.entry.JobEntryBase`*

`JobEntryInterface` is the main Java interface that a plugin implements.

Keep Track of Job Entry Settings

The implementing class keeps track of job entry settings using private fields with corresponding `get` and `set` methods. The dialog class implementing `JobEntryDialogInterface` uses these methods to copy the user supplied configuration in and out of the dialog box.

```
public Object clone()
```

This method is called when a job entry is duplicated in Spoon. It returns a deep copy of the job entry object. It is essential that the implementing class creates proper deep copies if the job entry configuration is stored in modifiable objects, such as lists or custom helper objects.

Serialize Job Entry Settings

The plugin serializes its settings to both XML and a PDI repository.

`public String getXML()`

This method is called by PDI whenever a job entry serializes its settings to XML. It is called when saving a job in Spoon. The method returns an XML string containing the serialized settings. The string contains a series of XML tags, one tag per setting. The helper class, *`org.pentaho.di.core.xml.XMLHandler`*, constructs the XML string.

`public void loadXML()`

This method is called by PDI whenever a job entry reads its settings from XML. The XML node containing the job entry settings is passed in as an argument. Again, the helper class, *`org.pentaho.di.core.xml.XMLHandler`*, is used to read the settings from the XML node.

`public void saveRep()`

This method is called by PDI whenever a job entry saves its settings to a PDI repository. The repository object passed in as the first argument provides a convenient set of methods for serializing job entry settings. When calling repository serialization methods, job id and job entry id are required. The job id is passed in to `saveRep()` as an argument, and the job entry id can be obtained by a call to `getObjectId()` inherited from the base class.

`public void loadRep()`

This method is called by PDI whenever a job entry reads its configuration from a PDI repository. The job entry id given in the arguments is used as the identifier when using the repositories serialization methods. When developing plugins, make sure the serialization code is in synch with the settings available from the job entry dialog. When testing a plugin in Spoon, PDI internally saves and loads a copy of the job before it is executed.

Provide the Name of the Dialog Class

PDI needs to know which class takes care of the settings dialog box for the job entry. The interface method `getDialogClassName()` returns the name of the class implementing the `JobEntryDialogInterface`.

Provide Information About Possible Outcomes

A job entry may support up to three types of outgoing hops: True, False, and Unconditional. Sometimes it does not make sense to support all three. For instance, if the job entry performs a task that does not produce a boolean outcome, like the dummy job entry, it may make sense to suppress the True and False outgoing hops. There are other job entries, which carry an inherent boolean outcome, such as the File Exists job entry. It may make sense in such cases to suppress the unconditional outgoing hop.

The job entry plugin class must implement two methods to indicate to PDI which outgoing hops it supports.

`public boolean evaluates()`

This method returns `true` if the job entry supports the True and False outgoing hops. If the job entry does not support distinct outcomes, it returns `false`.

`public boolean isUnconditional()`

This method returns `true` if the job entry supports the unconditional outgoing hop. If the job entry does not support the unconditional hop, it returns `false`.

Execute the Job Entry Task

The class implementing `JobEntryInterface` executes the actual job entry task.

`public Result execute()`

The `execute()` method is called by PDI when it is time for the job entry to execute its logic. The arguments are a result object, which is passed in from the previously executed job entry, and an integer number indicating the distance of the job entry from the start entry of the job.

The job entry should execute its configured task and report back on the outcome. A job entry does that by calling specified methods on the passed in result object.

`prev_result.setNrErrors()`

The job entry indicates whether it has encountered any errors during execution. If there are errors, `setNrErrors` calls with the number of errors encountered. Typically, this is 1. If there are no errors, `setNrErrors`is called with an argument of zero (0).

`prev_result.setResult()`

The job entry must indicate the outcome of the task. This value determines which output hops follow next. If a job entry does not support evaluation, it need not call `prev_result.setResult()`.

Finally, the passed in `prev_result` object is returned.

Implementing the Job Entry Settings Dialog Box

Java Interface	*`org.pentaho.di.job.entry.JobEntryDialogInterface`*
Base class	*`org.pentaho.di.ui.job.entry.JobEntryDialog`*

`JobEntryDialogInterface` is the Java interface that implements the settings dialog of a job entry plugin.

Maintain the Dialog for Job Entry Settings

The `dialog` class is responsible for constructing and opening the settings dialog for the job entry. When you open the job entry settings in Spoon, the system instantiates the `dialog` class passing in the `JobEntryInterface` object and calling the `open()` method on the dialog. *SWT* is the native windowing environment of Spoon and the framework used for implementing job entry dialogs.

`public JobEntryInterface open()`

This method returns only after the dialog has been confirmed or cancelled. The method must conform to these rules.

- If the dialog is confirmed
  - The `JobEntryInterface` object must be updated to reflect the new settings
  - If you changed any settings, the `JobEntryInterface` object Changed flag must be set to `true`
  - `open()` returns the `JobEntryInterface` object
- If the dialog is cancelled
  - The `JobEntryInterface` object must not be changed
  - The `JobEntryInterface` object Changed flag must be set to the value it had at the time the dialog opened
  - `open()` must return `null`

The `JobEntryInterface` object has an internal Changed flag that is accessible using `hasChanged()` and `setChanged()`. Spoon decides whether the job has unsaved changes based on the Changed flag, so it is important for the dialog to set the flag appropriately.

Additionally, the job entry dialog must make sure that the job entry name is not set to be empty. The dialog may be confirmed only after a non-empty name is set.

The *sample Job Entry plugin project* has an implementation of the `dialog` class that is consistent with these rules and is a good basis for creating your own dialogs.

Logging Job Entries

A job entry interacts with the PDI logging system by using the logging methods inherited from `JobEntryBase`.

These methods are used to issue log lines to the PDI logging system on different severity levels. Multi-argument versions of the methods are available to do some basic formatting, which is equivalent to a call to *`MessageFormat.format(message, arguments)`*.

- `public void logMinimal()`
- `public void logBasic()`
- `public void logDetailed()`
- `public void logDebug()`
- `public void logRowlevel()`
- `public void logError()`

These methods query the logging level. They are often used to guard sections of code, that should only be executed with elevated logging settings.

- `public boolean isBasic()`
- `public boolean isDetailed()`
- `public boolean isDebug()`

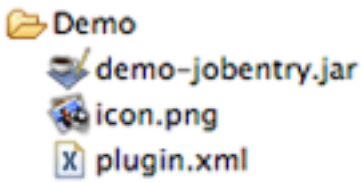
- `public boolean isRowLevel()`

Job entries should log the this information at specified levels:

Log Level	Log Information Content
Minimal	Only information that is interesting at a very high-level, for example Job Started or Ended jobs. Individual job entries do not log anything at this level.
Basic	Information that may be interesting to you during regular ETL operation
Detailed	Prepared SQL or other query statements, resource allocation and initialization like opening files or connections
Debug	Anything that may be useful in debugging job entries
Row Level	Anything that may be helpful in debugging problems at the level of individual rows and values
Error	Fatal errors that abort the job

Deploying Job Entries Plugins

A job entry plugin package resides in a folder containing a `jar` file containing the plugin classes, dependency `jar` files in the `lib` subfolder, additional resources and plugins, and the icon for the job entry plugin as a `.png` or `.gif` file. This image shows the plugin folder for the *sample job entry*.



In order for PDI to recognize a job entry plugin, the job needs to provide basic descriptive information about itself. It also needs to register itself with PDI by specifying these items.

- A globally unique ID for the job entry
- The class implementing `JobEntryInterface`
- The label to use for the job entry
- The tooltip to use for the job entry
- Optional, internationalization information for the label and tooltip
- The category in the job entry tree
- The icon file used to represent the job entry on the canvas

The job entry must provide this information either as a `plugin.xml` file or as Java annotations. These methods are mutually exclusive.

Alternative 1: Using plugin.xml

If the job entry registers itself using the `plugin.xml` file, the file must reside in the plugin folder. The file contents covers the necessary information directly, using the attributes on the plugin tag. Here is an example of a `plugin.xml` file that works for the *sample job entry*.

```
<?xml version="1.0" encoding="UTF-8"?>
<plugin>
   id="DemoJobEntry"
   iconfile="icon.png"
   description="Demo"
   tooltip="Demo Job Entry Tooltip"
   category="Conditions"
   classname="org.pentaho.di.sdk.samples.jobentries.demo.JobEntryDemo">
   <libraries>
      <ibrary name="demo-jobentry.jar"/>
      <!-- specify additional jars to be included when loading -->
      <!-- the job entry plug-in -->
```

```
      <!-- <library name="lib/some-additional-jar.jar"/> -->
   </libraries>
</plugin>
```

The plugin tag covers the step id, label, description, tooltip, icon file, and implementing class. All paths are relative to the job entry folder, so in the above example, the path indicates that the `icon.png` resides in the job entry folder. The libraries section contains an entry for each `jar` file that should be loaded as part of the plugin. This includes the `jar` file containing the plugin classes, as well as any dependency `jar` files.

Description, tooltip, and category can be localized. The Pentaho wiki page contains an example that shows how to supply localized strings in `plugin.xml`. See *http://wiki.pentaho.com/display/COM/PDI+Plugin+Loading*.

Alternative 2: Using Java annotations

Instead of using the `plugin.xml` file, the class implementing `JobEntryInterface` can be annotated to provide the relevant information. The relevant annotation is the *`JobEntry`* annotation, which follows similar rules as the related annotation for *transformation steps*.

Once a job entry plugin folder is ready, place it in a specific location for PDI to find.

Deploying to Spoon/Carte

To deploy the plugin, copy the job entry plugin folder into this location:

`design-tools/data-integration/plugins/jobentries`

After restarting Spoon, the job is available from the configured section in the job entry tree.

Deploying to Data Integration Server

If you are running a data integration server, copy the job entry plugin folder into this location:

`server/data-integration-server/pentaho-solutions/system/kettle/plugins/jobentries`

After restarting the data integration server, the plugin is available to the server and the server can execute jobs containing the Job Entry plugin.

Deploying to BA Server

If you plan to execute PDI jobs on BA-server, copy the job entry plugin folder into this location:

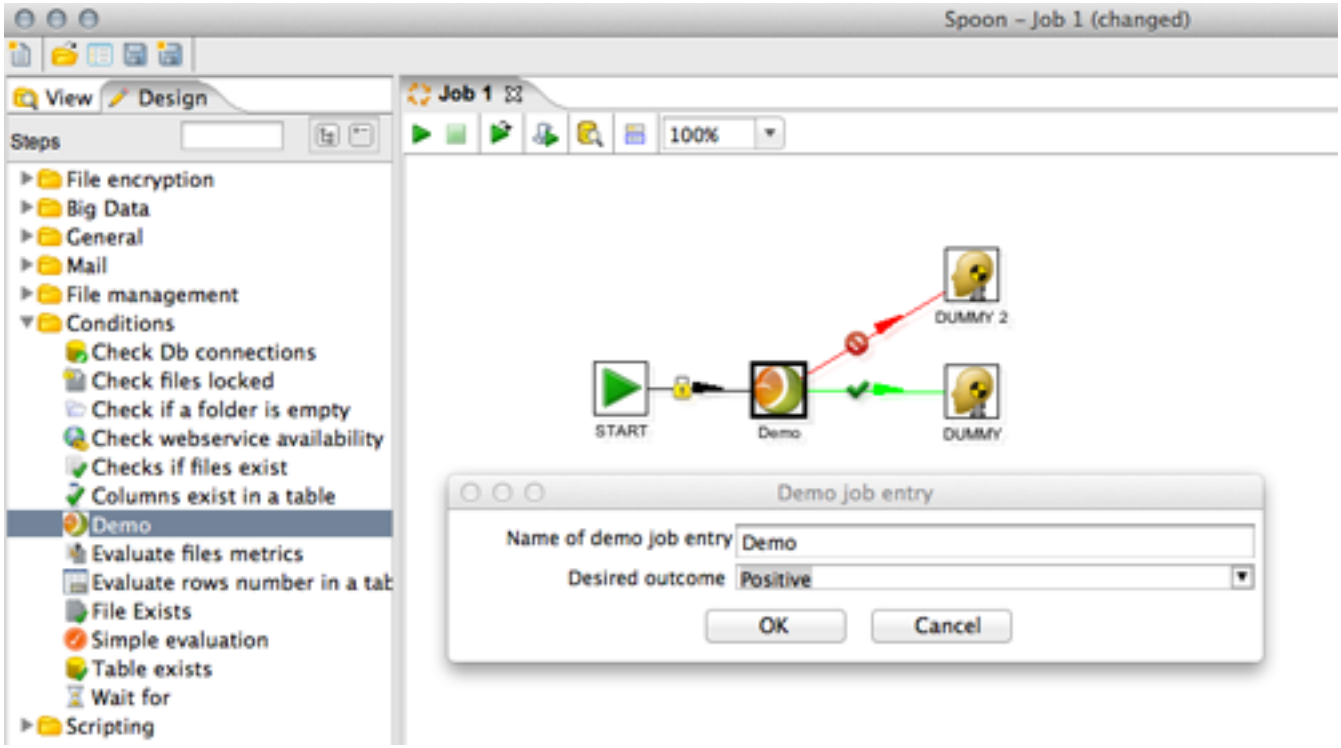
`server/biserver-ee/pentaho-solutions/system/kettle/plugins/jobentries`

After restarting the BA server, the Joh Entry plugin is available to the server and the server can execute jobs containing the Job Entry plugin.

Sample Job Entry Plugin

The sample Job Entry plugin project is designed to show a minimal functional implementation of a job entry plugin that you can use as a basis to develop your own custom job entries.

The sample Job Entry plugin functionality lets you manually configure which outcome to generate. This screen shot shows the job entry configuration dialog and outgoing hops.



Obtaining the Sample Plugin

The sources for the job entry plugin sample are available from the *download package* in the `kettle-sdk-jobentry-plugin` folder. Before you can build and deploy your plugin, you must supply the path to a local PDI installation. You can find the path in the `kettle-dir` property in `kettle-sdk-jobentry-plugin/build/build.properties`.

Building and Deploying From the Command Line

The sample Job Entry plugin is built using *Apache Ant*. You can build and deploy the job entry plugin from the command line by invoking the ant install target command from the build directory.

```
kettle-sdk-jobentry-plugin $ cd build
build $ ant install
```

The install target compiles the sources, creates `jar` files of the resulting classes, puts together a plugin folder, and finally copies the entire plugin folder into the `plugins/jobentries` directory of the local PDI installation. Adjust the `kettle-dir` property in `build.properties` so that the Ant process knows where to copy the plugin.

Building and Deploying from Eclipse

You may prefer to import the plugin into Eclipse.

1. From the menu, select **File** > **Import** > **Existing Projects Into Worksapace**.
2. Browse to the `kettle-sdk-job-entry-plugin` folder and choose the project to be imported.

This is how you build and install the plugin.

1. Open the Ant view in Eclipse by selecting **Window** > **Show View** from the main menu and select **Ant**.

   You may have to browse other views in case you have not used the Ant view before.
2. Adjust the `kettle-dir` property in `build.properties` so the Ant process can know where to copy the plugin.
3. Drag the file `build/build.xml` from your project into the Ant view and execute the install target by double-clicking it.
4. After the plugin has been deployed, restart Spoon.

The job entry plugin appears in the **Conditions** panel.

Exploring More Job Entries

PDI sources provide example implementations of job entries. Each PDI core job entry is located in a sub-package of `org.pentaho.di.job.entries` found in the `src` folder. The corresponding `dialog` class in located in `org.pentaho.di.ui.job.entries` found in the `src-ui` folder.

For example, these are the classes that make up the File Exists job entry:

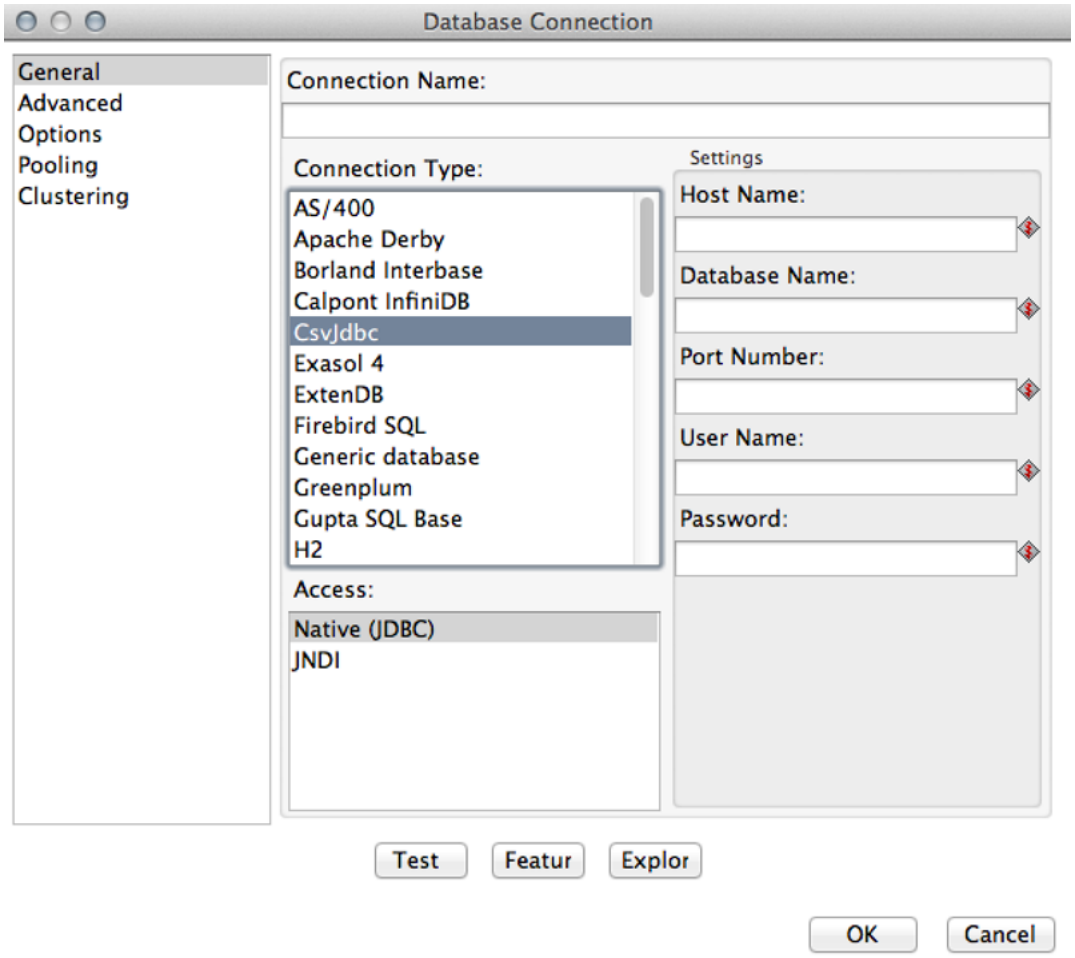
- `org.pentaho.di.job.entries.fileexists.JobEntryFileExists`
- `org.pentaho.di.ui.job.entries.fileexists.JobEntryFileExistsDialog`

The `dialog` classes of the core PDI steps are located in a different package and source folder. They are also assembled into a separate `jar` file. This allows PDI to load the UI-related `jar` file when launching Spoon and avoid loading the UI-related `jar` when it is not needed.

Creating Database Plugins

PDI uses database plugins to help generate correct connection strings, connection settings, and SQL, as well as take into account known special abilities or limitations of database systems.

A database plugin introduces a new entry in the PDI database dialog.



This section explains the architecture and programming concepts for creating your own database plugin. We recommended that you open and refer to the *sample database plugin sources* while following these instructions.

Java Interface	*`org.pentaho.di.core.database.DatabaseInterface`*
Base class	*`org.pentaho.di.core.database.BaseDatabaseMeta`*

PDI database plugins consist of a single Java class that implements the interface *`org.pentaho.di.core.database.DatabaseInterface`*.

There are many methods in `DatabaseInterface`. Most implementations extend *`org.pentaho.di.core.database.BaseDatabaseMeta`*, which provides default implementations for most of the methods in `DatabaseInterface`. It is useful to have a look at *existing PDI database interfaces*, when developing a new database plugin. The following section classifies some of the most commonly overridden methods. They can be roughly classified into three subject areas: information about connection, SQL dialect, and general capability flags.

1. Connection Details

These methods are called when PDI establishes a connection to the database, or the database dialog is populated with database-specific defaults.

- `public String getDriverClass()`
- `public int getDefaultDatabasePort()`
- `public int[] getAccessTypeList()`
- `public boolean supportsOptionsInURL()`
- `public String getURL()`

2. SQL Generation

These methods are called when PDI constructs valid SQL for the database dialect.

- `public String getFieldDefinition()`
- `public String getAddColumnStatement()`
- `public String getSQLColumnExists()`
- `public String getSQLQueryFields()`

3. Capability Flags

These methods are called when PDI determines the run-time characteristics of the database system. For instance, the database systems may support different notions of metadata retrieval.

- `public boolean supportsTransactions()`
- `public boolean releaseSavepoint()`
- `public boolean supportsPreparedStatementMetadataRetrieval()`
- `public boolean supportsResultSetMetadataRetrievalOnly()`

Deploying Database Plugins

A PDI database plugin consists of a folder with a `jar` file containing the plugin class.

In order for PDI to recognize a database plugin, the implementation class needs to provide basic descriptive information about itself. In order to do that, the database plugin must annotate the class implementing `DatabaseInterface` with Java annotations to provide this information. The annotation to use is *`org.pentaho.di.core.plugins.DatabaseMetaPlugin`*.

Supply these annotation attributes.

Attribute	Description
`type`	A globally unique ID for database plugin
`typeDescription`	The label to use in the database dialog

Once the `jar` file is ready, place the plugin folder in a specific location for PDI to find.

Deploying to Spoon or Carte

To deploy the database plugin, copy the plugin folder into this location:

`design-tools/data-integration/plugins/databases`

After restarting Spoon, the new database type is available from the PDI database dialog.

Deploying to Data Integration Server

If you are running data integration server, copy the database plugin folder to this location:

`server/data-integration-server/pentaho-solutions/system/kettle/plugins/databases`

After restarting the data integration server, the plugin is available to the server.

Deploying to BA Server

If you plan to execute PDI jobs on BA-server, copy the job entry plugin folder into the this location:

`server/biserver-ee/pentaho-solutions/system/kettle/plugins/databases`

After restarting the BA server, the plugin is available to the server.

When deploying database plugins, make sure to deploy the corresponding JDBC drivers. Check the PDI Installation Guide, Administrator Guide, data-integration server, and ba-server for instructions about adding JDBC drivers.

Sample Database Plugin

The sample Database plugin project is designed to show a minimal functional implementation of a database plugin that you can use as a basis to develop your own custom database plugins.

The sample Database plugin functionality registers the CSV JDBC driver from *http://csvjdbc.sourceforge.net/* as a database plugin in PDI. This enables reading from CSV files in a directory using basic SQL.

The included sample transformation uses the database plugin to read a basic CSV file through JDBC.

Obtaining the Sample Plugin

The sources for the database plugin sample are available from the *download package* in the `kettle-sdk-database-plugin` folder. Before you can build and deploy your plugin, supply the path to a local PDI installation. You can find the path in the `kettle-dir` property in `kettle-sdk-database-plugin/build/build.properties`.

Building and Deploying From the Command Line

The sample Database plugin is built using *Apache Ant*. You can build and deploy the database plugin from the command line, by invoking the Ant install target command from the build directory.

```
kettle-sdk-database-plugin $ cd build
build $ ant install
```

The install target compiles the source, creates a `jar` file for the resulting class, puts together a plugin folder, and finally copies the plugin into the `plugins/databases` directory of your local PDI installation. It also copies the `csvjdbc.jar` file to `libext/JDBC`, which provides the actual JDBC driver. Remember to adjust the `kettle-dir` property in `build.properties` so that the Ant process knows where to copy the plugin.

Building and Deploying From Eclipse

You may prefer to import the plugin into Eclipse.

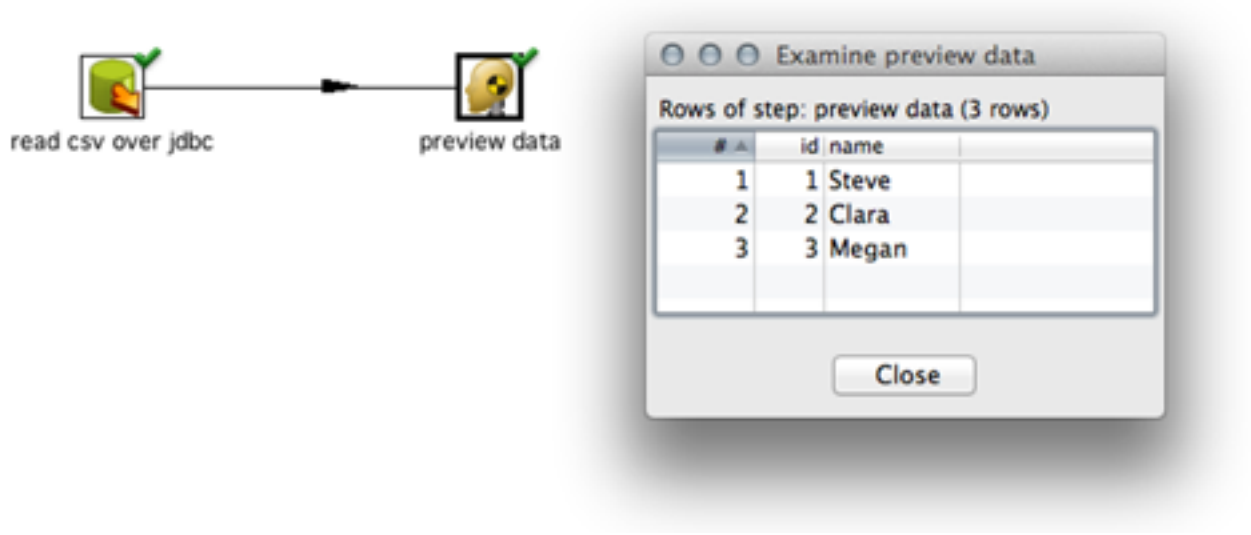
1. From the menu, select **File** > **Import** > **Existing Projects Into Worksapace**.
2. Browse to the `kettle-sdk-database-plugin` folder and choose the project to be imported.

This is how you build and install the plugin.

1. Open the Ant view in Eclipse by selecting **Window** > **Show View** from the main menu and select **Ant**.

   You may have to browse other views in case you have not used the Ant view before.
2. Adjust the `kettle-dir` property in `build.properties` so the Ant process can know where to copy the plugin.
3. Drag the file `build/build.xml` from your project into the Ant view and execute the install target by double-clicking it.
4. After the plugin has been deployed, restart Spoon.

The plugin appears in the **Transform** panel.



Exploring Existing Database Implementations

PDI sources are invaluable when seeking example implementations of databases. Each of the PDI core databases is located in the `org.pentaho.di.core.database` package found in the `src-db` folder.

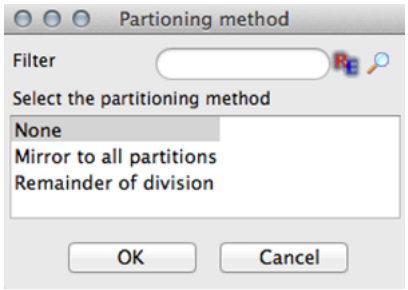
For example, here are the classes that define behavior for some major database systems.

Database	DatabaseInterface Class
MySQL	`org.pentaho.di.core.database.MySQLDatabaseMeta`
Oracle	`org.pentaho.di.core.database.OracleDatabaseMeta`
PostgreSQL	`org.pentaho.di.core.database.PostgreSQLDatabaseMeta`

When implementing a database plugin for a new database system, we recommended starting from an existing database class that already shares characteristics with the new database system.

Creating Partioner Plugins

PDI uses partitioner plugins for its partitioning feature. Each partitioner plugin implements a specific partitioning method.



For most applications, the Remainder of Division partitioner works well. On the rare occasion that an application would benefit from an additional partitioning method, this section explains how to implement them.

This section explains the architecture and programming concepts for creating your own partitioner plugin. We recommended you open and refer to the *sample Partitioner plugin sources* while following these instructions. A complete explanation of the feature, including sample transformations is available here *http://type-exit.org/adventures-with-open-source-bi/2011/09/partitioning-in-kettle/*.

A partitioner plugin integrates with PDI by implementing two distinct Java interfaces. Each interface represents a set of responsibilities performed by a PDI partitioner. Each of the interfaces has a base class that implements the bulk of the interface in order to simplify plugin development.

Package	Interface	Base Class	Main Responsibilities
`org.pentaho.di.trans`	`Partitioner`	`BasePartitioner`	• Maintain partitioner settings • Serialize partitioner enumerations • Provide access to dialog class • Assign rows to partitions during runtime
`org.pentaho.di.ui.trans.step`	`StepDialogInterface`	`BaseStepDialog`	• Partitioner settings dialog

Implementing the Partitioner Interface

Java Interface	*`org.pentaho.di.trans.Partitioner`*
Base class	*`org.pentaho.di.trans.BasePartitioner`*

`Partitioner` is the main Java interface that a plugin implements.

Keep Track of Partitioner Settings

The implementing class keeps track of partitioner settings using private fields with corresponding `get` and `set` methods. The `dialog` class implementing `PartionerDialogInterface` is using these methods to copy the user supplied configuration in and out of the dialog.

`public Object clone()`

This method is called when a step containing partitioning configuration is duplicated in Spoon. It needs to return a deep copy of this partitioner object. It is essential that the implementing class creates proper deep copies if the configuration is stored in modifiable objects, such as lists or custom helper objects. The copy is created by calling `super.clone()` and deep-copying any fields the partitioner may have declared.

`public Partitioner getInstance()`

This method is required to return a new instance of the partitioner class, with the plugin id and plugin description inherited from the instance upon which this method is called.

Serialize Partitioner Settings

The plugin serializes its settings to both XML and a PDI repository.

`public String getXML()`

This method is called by PDI whenever the plugin needs to serialize its settings to XML. It is called when saving a transformation in Spoon. The method returns an XML string containing the serialized settings. The string contains a series of XML tags, one tag per setting. The helper class `org.pentaho.di.core.xml.XMLHandler` constructs the XML string.

`public void loadXML()`

This method is called by PDI whenever a plugin reads its settings from XML. The XML node containing the plugin settings is passed in as an argument. Again, the helper class `org.pentaho.di.core.xml.XMLHandler` is used to read the settings from the XML node.

`public void saveRep()`

This method is called by PDI whenever a plugin saves its settings to a PDI repository. The repository object passed in as the first argument provides a convenient set of methods for serializing settings. The transformation id and step id passed in are used as identifiers when calling the repository serialization methods.

`public void readRep()`

This method is called by PDI whenever a plugin needs to read its configuration from a PDI repository. The step id given in the arguments should be used as the identifier when using the repositories serialization methods.

When developing plugins, make sure the serialization code is in synch with the settings available from the partitioner plugin dialog. When testing a partitioned step in Spoon, PDI internally saves and loads a copy of the transformation before it is executed.

Provide the Name of the Dialog Class

PDI needs to know which class will take care of the settings dialog for the plugin. The interface method `getDialogClassName()` must return the name of the class implementing the `StepDialogInterface` for the partitioner.

Partition Incoming Rows During Runtime

The class implementing `Partitioner` executes the actual logic that distributes the rows to available partitions.

`public int getPartition()`

This method is called with the row structure and the actual row as arguments. It returns the partition to which this row is sent. The total number of partitions is available in the inherited field `nrPartitions` and the return value is between zero (0) and `nrPartitions` minus 1.

Implementing the Partitioner Settings Dialog Box

Java Interface	*`org.pentaho.di.trans.step.StepDialogInterface`*
Base class	*`org.pentaho.di.ui.trans.step.BaseStepDialog`*

`StepDialogInterface` is the Java interface that implements the settings dialog of a partitioner plugin.

Maintain the Dialog for Partitioner Settings

The `dialog` class is responsible for constructing and opening the settings dialog for the partitioner. When you open the partitioning settings in Spoon, the system instantiates the `dialog` class passing in a `StepPartitioningMeta` object. Retrieve the `Partitioner` object by calling `getPartitioner()` and call the `open()` method on the dialog. *SWT* is the native windowing environment of Spoon and the framework used for implementing dialogs.

`public String open()`

This method returns only after the dialog has been confirmed or cancelled. The method must conform to these rules.

- If the dialog is confirmed
  - The `Partition` object must be updated to reflect the new settings
  - If you changed any settings, the `StepPartitioningMeta` object Changed flag must be set to `true`
  - `open()` returns the name of the step to which the partitioning is applied—use the `stepname` field inherited from `BaseStepDialog`
- If the dialog is cancelled
  - The `Partition` object must not be changed
  - The `StepPartitioningMeta` object Changed flag must be set to the value it had at the time the dialog opened
  - `open()` must return `null`

The `StepPartitioningMeta` object has an internal Changed flag that is accessible using `hasChanged()` and `setChanged()`. Spoon decides whether the transformation has unsaved changes based on the Changed flag, so it is important for the dialog to set the flag appropriately.

The *sample Partitioner plugin project* has an implementation of the dialog class that is consistent with the these rules and is a good basis for creating your own dialogs.

Deploying Partitioner Plugins

A PDI partitioner plugin consists of a folder with a `jar` file containing the plugin class.

In order for PDI to recognize a partitioner plugin, the implementation class needs to provide basic descriptive information about itself. To do that, the plugin annotates the class implementing `Partitioner` with Java annotations to provide this information. The annotation to use is *`org.pentaho.di.core.annotations.PartitionerPlugin`*.

Supply these annotation attributes:

Attribute	Description
`id`	A globally unique ID for the plugin
	A short label for the plugin
`description`	A longer description for the plugin
`i18nPackageName`	If the `i18nPackageName` attribute is supplied in the annotation attributes, the values of name and description are interpreted as *`i18n`* keys. The keys may be supplied in the extended form `i18n:<packagename>` key to specify a package that is different from the default package given in the `i18nPackageName` attribute.

Once a plugin folder with the `jar` file is ready, place the plugin folder in a specific location for PDI to find.

Deploying to Spoon or Carte

To deploy the plugin, copy the plugin folder into the following location:

`design-tools/data-integration/plugins/steps`

After restarting Spoon, the new partitioning method is available.

Deploying to Data Integration Server

If you are running data integration server, copy the plugin folder into the following location:

`server/data-integration-server/pentaho-solutions/system/kettle/plugins/steps`

After restarting the data integration server, the plugin is available to the server.

Deploying to BA Server

If you plan to execute PDI transformations on BA-server, copy the plugin folder into the following location:

`server/biserver-ee/pentaho-solutions/system/kettle/plugins/steps`

After restarting the BA server, the plugin is available to the server.

Sample Partitioner Plugin

The sample Partitioner plugin project is designed to show a minimal functional implementation of a partitioner plugin that you can use as a basis to develop your own custom plugins.

The sample Partitioner plugin distributes rows to partitions based on the value of a string field, or more precisely the string length. The sample shows a partitioner executing on five partitions, assigning longer strings to higher partition numbers.

Obtaining the Sample Plugin

The sources for the partitioner plugin sample are available from the *download package* in the `kettle-sdk-partitioner-plugin` folder. Before you can build and deploy your plugin, supply the path to a local PDI installation. You can find the path in the `kettle-dir` property in `/kettle-sdk-partitioner-plugin/build/build.properties`.

Building and Deploying From the Command Line

The sample Partitioner plugin is built using *Apache Ant*. You can build and deploy the partitioner plugin from the command line by invoking the Ant install target command from the build directory.

```
kettle-sdk-partitioner-plugin $ cd build
build $ ant install
```

The install target compiles the sources, creates `jar` files for the resulting classes, puts together a plugin folder, and finally copies it into the `plugins/steps` directory of your local PDI installation. Adjust the `kettle-dir` property in `build.properties` so the Ant process knows where to copy the plugin.

Building and Deploying From Eclipse

You may prefer to import the plugin into Eclipse.

1. From the menu, select **File** > **Import** > **Existing Projects Into Worksapace**.
2. Browse to the `kettle-sdk-partitioner-plugin` folder and choose the project to be imported.

This is how you build and install the plugin.

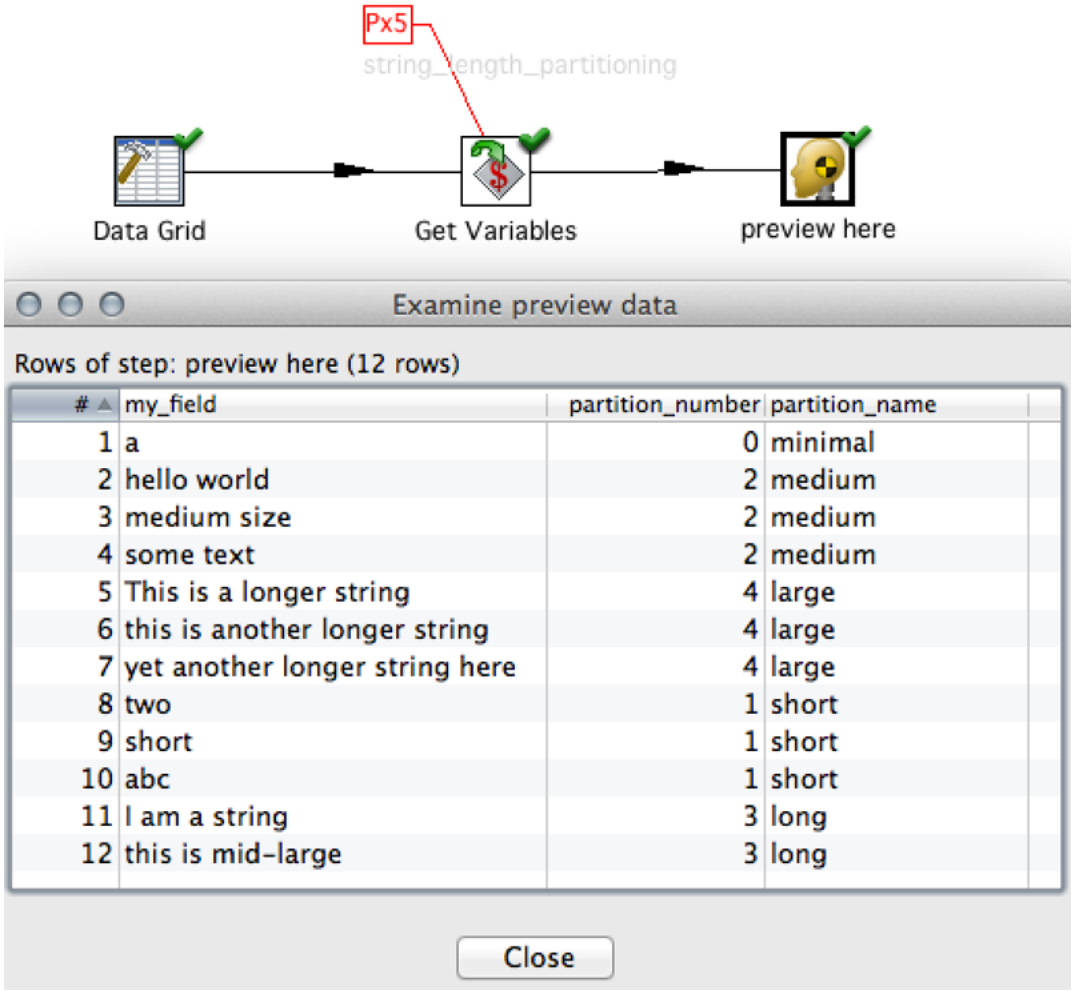
1. Open the Ant view in Eclipse by selecting **Window** > **Show View** from the main menu and select **Ant**.

   You may have to browse other views in case you have not used the Ant view before.
2. Adjust the `kettle-dir` property in `build.properties` so the Ant process can know where to copy the plugin.
3. Drag the file `build/build.xml` from your project into the Ant view and execute the install target by double-clicking it.
4. After the plugin has been deployed, restart Spoon.

The new partitioning method is available.

Testing the Plugin

The sample Partitioner plugin project comes with a demo transformation in `demo_transform/partitioning_demo.ktr` to test the plugin.



Exploring Existing Partitioners

PDI sources are useful if you want to investigate the implementation of the standard modulo partitioner. The main class is available in the `org.pentaho.di.trans.ModPartitioner` package found in the `src` folder. The corresponding

`dialog` class in located in `org.pentaho.di.ui.trans.dialog.ModPartitionerDialog` package found in the `src-ui` folder.

Debugging Plugins

A good way to debug PDI plugins is to deploy the plugin, launch Spoon, and connect the debugger to the Spoon JVM. This section explains how to debug a plugin in Eclipse.

1. Prepare Spoon for debugging.
   a) Start the Spoon JVM, allowing debug sessions and passing these arguments to the Spoon JVM.

   ```
   -Xdebug -Xnoagent -Djava.compiler=NONE -
   Xrunjdwp:transport=dt_socket,server=y,suspend=n,address=1044
   ```

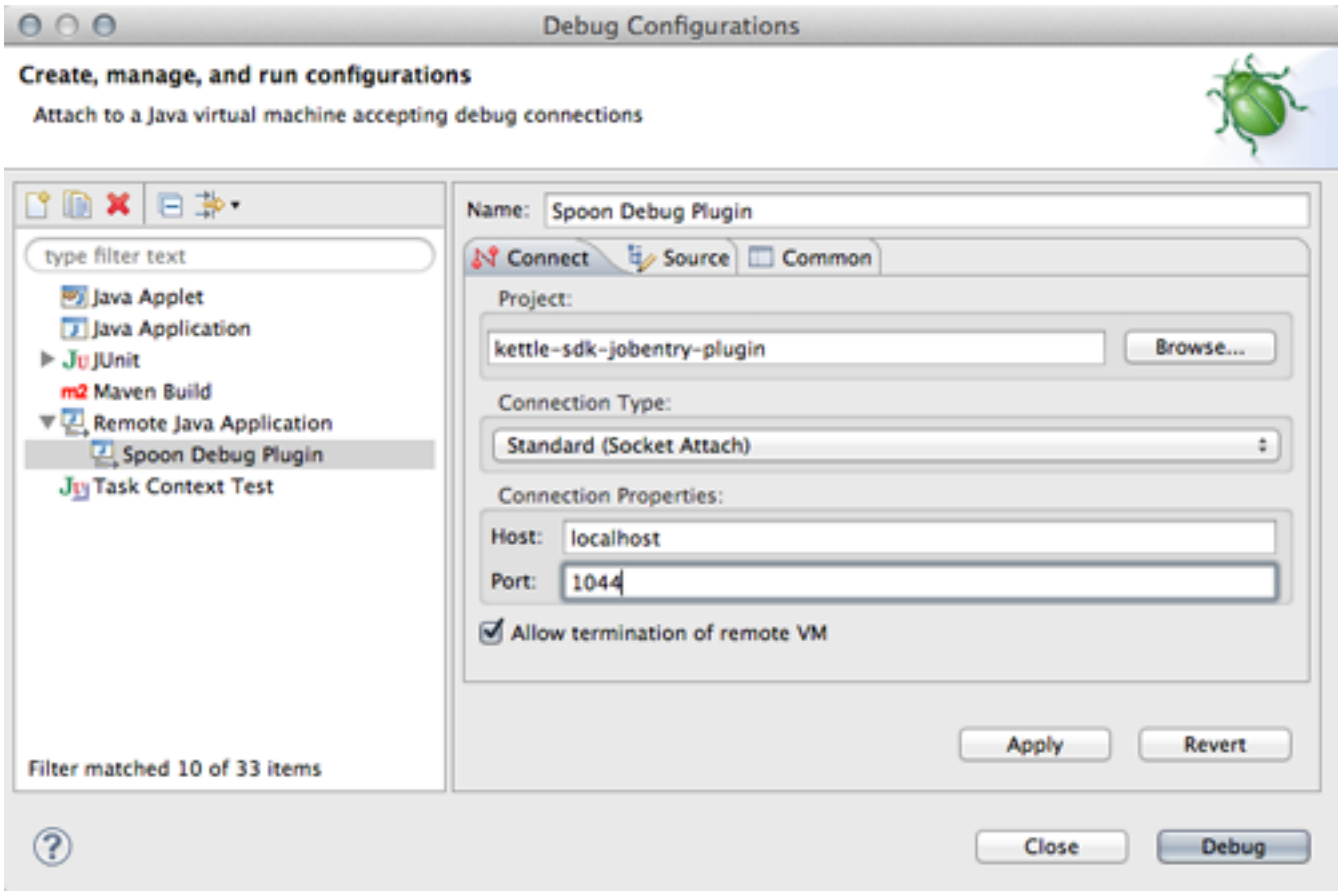
   The address argument can be any free port on your machine. This example uses port 1044.

   If you are using `Spoon.bat` or `spoon.sh` to launch Spoon, create a copy of the file and edit it to include the debugging parameters to the Java options near the bottom of the file. If you are using a Mac app, add the JVM parameters to

   `VMOptions key of "Data Integration 64-bit.app/Contents/Info.plist"` or `"Data Integration 32-bit.app/Contents/Info.plist"` respectively.

   When you start Spoon, debuggers connect on port 1044.
2. Launch a debug session.
   a) Ensure that Spoon is set up for debugging and running with the plugin deployed.
   b) Connect the Eclipse debugger by creating a debug configuration for your plugin project. From the **Run/Debug Configurations** menu, create a new configuration for **Remote Java Application**.
   c) Select your project, making sure the port matches the port configured in step 1.
   d) Decide whether you want to be able to kill the Spoon JVM from the debugger, then click **Apply** and **Debug**.

   The debugger opens, stops at the breakpoints you set, and in-line editing of the plugin source is enabled.

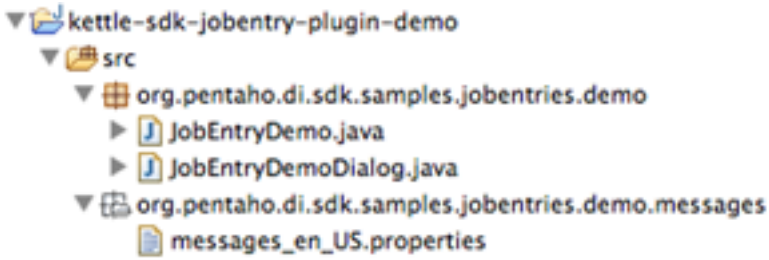


Localization

Message Bundles

PDI uses property files for internationalization. Property files reside in the `messages` sub-package in the plugin `jar` file. Each property file is specific to a locale. Property files contain translations for message keys that are used in the source code. A `messages` sub-package containing locale-specific translations is called a message bundle.

Consider the package layout of the sample job entry plugin project. It contains the Java class in the package `org.pentaho.di.sdk.samples.jobentries.demo`package, and there is a message bundle containing the localized strings for the en_United States.



Additional property files can be added using the naming pattern `messages_<locale>.properties`. PDI core steps and job entries usually come with several localizations. See the shell job entry messages package for an example of more complete `i18n`: *http://source.pentaho.org/svnkettleroot/Kettle/tags/4.3.0-stable/src/org/pentaho/di/job/entries/shell/messages/*.

Resolving Localized Strings

The key to resolving localized strings is to use the `getString()` methods of *`org.pentaho.di.i18n.BaseMessages`*. PDI follows conventions when using this class, which enables easy integration with the *PDI translator tool*.

All PDI plugin classes that use localization declare a private static `Class<?> PKG` field, and assign a class that lives one package-level above the message bundle package. This is often the main class of the plugin.

With the `PKG` field defined, the plugin then resolves its localized strings with a call to `BaseMessages.getString(PKG, "localization key", ... optional_parameters)`. The first argument helps PDI finding the correct message bundle, the second argument is the key to localize, and the optional parameters are injected into the localized string following the Java *Message Format* conventions.

Common Localization Strings

Some strings are commonly used,and have been pulled together into a common message bundle in *`org.pentaho.di.i18n.messages`*. Whenever `BaseMessages` cannot find the key in the specified message bundle, PDI looks for the key in the common message bundle.

Example

For an example, check the sampe *Job Entry plugin project*, which uses this technique for localized string resolution in its dialog class.

Embedding Pentaho Data Integration

To integrate PDI transformations and jobs into your applications, embed PDI objects directly into your application code. The instructions in this section address common embedding scenarios.

You can get the accompanying sample project from the `kettle-sdk-embedding-samples` folder of the *sample code* package. The sample project is bundled with a minimal set of dependencies. In a real-world implementation, projects require the complete set of PDI dependencies that includes all `.jar` files form `data-integration/lib` and `data-integration/libext` folders.

Running Transformations

If you want to run a PDI transformation from Java code in a stand-alone application, take a look at this sample class, `org.pentaho.di.sdk.samples.embedding.RunningTransformations`. It sets the parameters and executes the transformation in `etl/parametrized_transformation.ktr`. The transform can be run from the `.ktr` file using `runTransformationFromFileSystem()` or from a PDI repository using `runTransfomrationFromRepository()`.

1. Always make the first call to `KettleEnvironment.init()` whenever you are working with the PDI APIs.
2. Prepare the transformation.

   The definition of a PDI transformation is represented by a *`TransMeta`* object. You can load this object from a `.ktr` file, a PDI repository, or you can *generate it dynamically*. To query the declared parameters of the transformation definition use `listParameters()`, or to query the assigned values use `setParameterValue()`.
3. Execute the transformation.

   An executable *`Trans`* object is derived from the *`TransMeta`* object that is passed to the constructor. The *`Trans`* object starts and then executes asynchronously. To ensure that all steps of the *`Trans`* object have completed, call *`waitUntilFinished()`*.
4. Evaluate the transformation outcome.

   After the *`Trans`* object completes, you can access the result using *`getResult()`*. The *`Result`* object can be queried for success by evaluating *`getNrErrors()`*. This method returns zero (0) on success and a non-zero value when there are errors. To get more information, retrieve the transformation *log lines*.

Running Jobs

If you want to run a PDI job from Java code in a stand-alone application, take a look at this sample class, `org.pentaho.di.sdk.samples.embedding.RunningJobs`. It sets the parameters and executes the job in `etl/parametrized_job.kjb`. The job can be run from the `.kjb` file using `runJobFromFileSystem()` or from a repository using `runJobFromRepository()`.

1. Always make the first call to `KettleEnvironment.init()` whenever you are working with the PDI APIs..
2. Prepare the job.

   The definition of a PDI job is represented by a *`JobMeta`* object. You can load this object from a `.ktr` file, a PDI repository, or you can *generate it dynamically*. To query the declared parameters of the job definition use *`listParameters()`* or to query the assigned values use *`setParameterValue()`*.
3. Execute the job.

   An executable *`Job`* object is derived from the *`JobMeta`* object that is passed in to the constructor. The *`Job`* object starts, and then executes in a separate thread. To ensure that each part of the *`Job`* object completes before going on to the next, call *`waitUntilFinished()`*.
4. Evaluate the job outcome.

   After the *`Job`* completes, you can access the result using *`getResult()`*. The *`Result`* object can be queried for success using *`getResult()`*. This method returns `true` on success and `false` on failure. To get more information, retrieve the job *log lines*.

Building Transformations Dynamically

To enable your application to respond quickly to changing conditions, you can build transformations dynamically. The example class, `org.pentaho.di.sdk.samples.embedding.GeneratingTransformations`, shows you how. It generates a transformation definition and saves it to a `.ktr` file.

1. Always make the first call to `KettleEnvironment.init()` whenever you are working with the PDI APIs.
2. Create and configure a transformation definition object.

   A transformation definition is represented by a *`TransMeta`* object. Create this object using the default constructor. The transformation definition includes the *name*, *the declared parameters*, and the required *database connections*.
3. Populate the *`TransMeta`* object with steps.

   The data flow of a transformation is defined by steps that are connected by hops.

   a) Create the step by instantiating its class directly and configure it using its `get` and `set` methods. Transformation steps reside in sub-packages of `org.pentaho.di.trans.steps`. For example, to use the **Get File Names** job entry, create an instance of *`org.pentaho.di.trans.steps.getfilenames.GetFileNamesMeta`* and use its `get` and `set` methods to configure it.

   b) Obtain the step id string. Each PDI step has an id that can be retrieved from the PDI *plugin registry*. A simple way to retrieve the step id is to call *`PluginRegistry.getInstance().getPluginId(StepPluginType.class, theStepMetaObject)`*.

   c) Create an instance of `org.pentaho.di.trans.step.StepMeta`, passing the step id string, the name, and the configured step object to the constructor. An instance of `StepMeta` encapsulates the step properties, as well as controls the placement of the step on the Spoon canvas and connections to hops. Once the `StepMeta` object has been created, call *`setDrawn(true)`* and *`setLocation(x,y)`* to make sure the step appears correctly on the Spoon canvas. Finally, add the step to the transformation, by calling *`addStep()`* on the transformation definition object.

   d) Once steps have been added to the transformation definition, they need to be connected by hops. To create a hop, create an instance of *`org.pentaho.di.trans.TransHopMeta`*, passing in the From and To steps as arguments to the constructor. Add the hop to the transformation definition by calling *`addTransHop()`*.

After all steps have been added and connected by hops, the transformation definition object can be serialized to a `.ktr` file by calling `getXML()` and opening it in Spoon for inspection. The sample class `org.pentaho.di.sdk.samples.embedding.GeneratingTransformations` generates this transformation.

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Building Jobs Dynamically

To enable your application to respond quickly to changing conditions, you can build jobs dynamically. The example class, `org.pentaho.di.sdk.samples.embedding.GeneratingJobs`, shows you how. It generates a transformation definition and saves it to a `.kjb` file.

1. Always make the first call to `KettleEnvironment.init()` whenever you are working with the PDI APIs.
2. Create and configure a job definition object.

   A job definition is represented by a *`JobMeta`* object. Create this object using the default constructor. The job definition includes the *name*, the *declared parameters*, and the required *database connections*.

3. Populate the `JobMeta` object with job entries.

   The control flow of a job is defined by job entries that are connected by hops.

   a) Create the job entry by instantiating its class directly and configure it using its `get` and `set` methods. The job entries reside in sub-packages of `org.pentaho.di.job.entries`. For example, use the **File Exists** job entry, create an instance of *`org.pentaho.di.job.entries.fileexists.JobEntryFileExists`*, and use *`setFilename()`* to configure it.

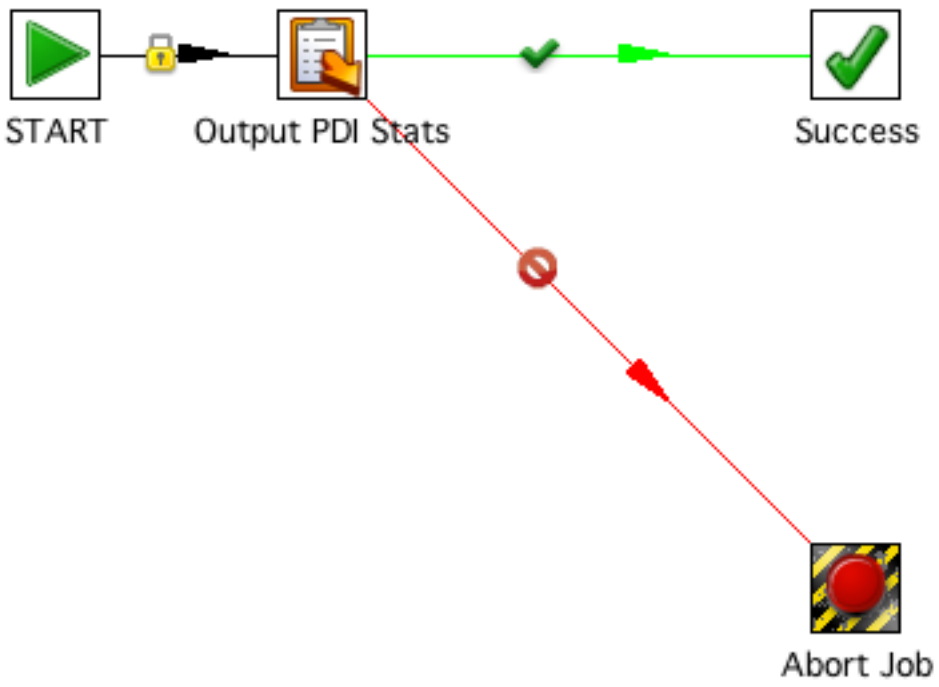
      The **Start** job entry is implemented by `org.pentaho.di.job.entries.special.JobEntrySpecial`.

   b) Create an instance of *`org.pentaho.di.job.entry.JobEntryCopy`* by passing the job entry created in the previous step to the constructor. An instance of `JobEntryCopy` encapsulates the properties of a job entry, as well as controls the placement of the job entry on the Spoon canvas and connections to hops. Once created, call *`setDrawn(true)`* and *`setLocation(x,y)`* to make sure the job entry appears correctly on the Spoon canvas. Finally, add the job entry to the job by calling *`addJobEntry()`* on the job definition object.

      It is possible to place the same job entry in several places on the canvas by creating multiple instances of `JobEntryCopy` and passing in the same job entry instance.

   c) Once job entries have been added to the job definition, they need to be connected by hops. To create a hop, create an instance of *`org.pentaho.di.job.JobHopMeta`*, passing in the From and To job entries as arguments to the constructor. Configure the hop consistently. Configure it as a green or red hop by calling *`setConditional()`* and *`setEvaluation(true/false)`*. If it is an unconditional hop, call *`setUnconditional()`*. Add the hop to the job definition by calling *`addJobHop()`*.

After all job entries have been added and connected by hops, the job definition object can be serialized to a `.kjb` file by calling *`getXML()`*, and opened in Spoon for inspection. The sample class `org.pentaho.di.sdk.samples.embedding.GeneratingJobs` generates this job.



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Obtaining Logging Information

When you need more information about how transformations and jobs execute, you can view PDI log lines and text.

PDI collects log lines in a central place. The class *`org.pentaho.di.core.logging.CentralLogStore`* manages all log lines and provides methods for retrieving the log text for to a specified entity. To retrieve log text or log lines, supply the log channel id generated by PDI during runtime. You can obtain the log channel id by calling

`getLogChannelId()`, which is part of *`LoggingObjectInterface`*. Jobs, transformations, job entries, and transformation steps all implement this interface.

For example, assuming the job variable is an instance of a running or completed job, this is how you retrieve its log lines:

```
Log4jBufferAppender appender = CentralLogStore.getAppender();
String logText = appender.getBuffer(job.getLogChannelId(), false).toString();
```

The main methods in these sample classes, `org.pentaho.di.sdk.samples.embedding.RunningJobs` and `org.pentaho.di.sdk.samples.embedding.RunningTransformations`, retrieve log information from the executed job or transformation.

Exposing a Transformation or Job as a Web Service

Running a PDI job or transformation as part of a web-service is implemented by writing a servlet that maps incoming parameters for a *transformation* or *job entry* and executes them as part of the request cycle.

Alternatively, you can use Carte or the Data Integration server directly by building a transformation that writes its output to the HTTP response of the Carte server. This is achieved by using the **Pass Output to Servlet** feature of the Text output, XML output, JSON output, or scripting steps. For an example, run the sample transformation, `/data-integration/samples/transformations/Servlet Data Example.ktr`, on Carte.