

# Windup User Guide

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## Introduction

This guide is for engineers, consultants, and others who plan to use Windup to migrate Java applications or other components.

## What is Windup?

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## Overview

Windup is an extensible and customizable rule-based tool that helps simplify migration of Java applications.

Running from a [Forge](#) environment, Windup examines application artifacts, including project source directories and applications archives, then produces an HTML report highlighting areas that need changes. Windup can be used to migrate Java applications from previous versions of *Red Hat JBoss Enterprise Application Platform* or from other containers, such as *Oracle WebLogic Server* or *IBM® WebSphere® Application Server*.

## How Does Windup Simplify Migration?

Windup looks for common resources and highlights technologies and known “trouble spots” when migrating applications. The goal is to provide a high level view into the technologies used by the application and provide a detailed report organizations can use to estimate, document, and migrate enterprise applications to Java EE and JBoss EAP.

## Features of Windup

|                          |  |
|--------------------------|--|
| <b>Shared Data Model</b> | <p>Windup creates a shared data model graph that provides the following benefits.</p> <ul style="list-style-type: none"><li>• It enables complex rule interaction, allowing rules to pass findings to other rules.</li><li>• It enables 3rd-party plug-ins to interact with other plug-ins, rules and reports.</li><li>• The findings in data graph model can be searched and queried during rule execution and used for reporting purposes.</li></ul>   |
| <b>Extensibility</b>     | <p>Windup can be extended by developers, users, and 3rd-party software.</p> <ul style="list-style-type: none"><li>• It provides a plug-in API to inject other applications into Windup.</li><li>• It enables 3rd-parties to create simple POJO plug-ins that can interact with the data graph.</li><li>• Means we don't have to invent everything. Users with domain knowledge can implement their own rules.</li></ul>  |
| <b>Better Rules</b>      | <p>Windup provides more powerful and complex rules.</p> <ul style="list-style-type: none"><li>• XML-based rules are simple to write and easy to implement.</li><li>• Java-based rule add-ons are based on <a href="#">OCPsoft Rewrite</a> and provide greater flexibility and power creating when rules.</li><li>• Rules can now be nested to handle more complex situations. This means you can nest simple statements rather than use complex XPATH or REGEX expressions. *Rules can be linked using and/or statements</li></ul> |

|                         |  |
|-------------------------|--|
| <b>Automation</b>       | <p>Windup has the ability to automate some of the migration processes.</p> <ul style="list-style-type: none"><li>• Windup is integrated with Forge 2, meaning it can generate projects, libraries, and configuration files.</li><li>• Rules can create Forge inputs and put them into the data graph.</li><li>• During the automation phase, the data graph inputs can be processed to generate a new project.</li></ul> |
| <b>Work Estimation</b>  | <p>Estimates for the <i>level of effort</i> are based on the skills required and the classification of migration work needed. <i>Level of effort</i> is represented as <i>story points</i> in the Windup reports and are described in more detail here: <a href="#">Rule Story Points</a>.</p>   |
| <b>Better Reporting</b> | <p>Windup reports are now targeted for specific audiences.</p> <ul style="list-style-type: none"><li>• IT Management - Applications are ranked by cost of migration.</li><li>• Project Management - Reports detail the type of work and estimation of effort to complete the tasks.</li><li>• Developers - An Eclipse plug-in provides hints and suggested code changes within the IDE.</li></ul>                        |

## About Windup Rules

Windup is a rule-based migration tool that analyzes the APIs, technologies, and architectures used by the applications you plan to migrate. In fact, the Windup tool executes its own core set of rules through all phases of the migration process. It uses rules to extract files from archives, decompile files, scan and classify file types, analyze XML and other file content, analyze the application code, and build the reports.

Windup builds a data model based on the rule execution results and stores

component data and relationships in a graph database, which can then be queried and updated as needed by the migration rules and for reporting purposes.

Windup rules use the following familiar rule pattern:

```
when(condition)
  perform(action)
otherwise(action)
```

Windup provides comprehensive set of standard migration rules out-of-the-box. Because applications may contain custom libraries or components, Windup allows you to write your own rules to identify use of components or software that may not be covered by the existing ruleset. If you plan to write your own custom rules, see the *Windup Rule Development Guide* for detailed instructions.

## System Requirements

### Software

- Java Platform, Enterprise Edition 7
- Windup is tested on Linux, Mac OS X, and Windows. Other Operating Systems with Java 7 support should work equally well.

### Hardware

The following memory and disk space requirements are the minimum needed to run Windup. If your application is very large or you need to evaluate multiple applications, you may want to increase these values to improve performance. For tips on how to optimize performance, see [Optimize Windup Performance](#).

- A minimum of 4 GB RAM. For better performance, a 4-core processor with 8 GB RAM is recommended. This allows 3 - 4 GB RAM for use by the JVM.
- A minimum of 4 GB of free disk space. A fast disk, especially a Solid State Drive (SSD), will improve performance.

## About the WINDUP\_HOME Variable

This documentation uses the **WINDUP\_HOME** *replaceable* value to denote the path to the Windup distribution. When you encounter this value in the documentation, be

sure to replace it with the actual path to your Windup installation.

- If you download and install the latest distribution of Windup from the JBoss Nexus repository, WINDUP\_HOME refers to the windup-distribution-2.2.0-Final folder extracted from the downloaded ZIP file.
  - If you build Windup from GitHub source, WINDUP\_HOME refers to the windup-distribution-2.2.0-Final folder extracted from the Windup source dist/target/windup-distribution-2.2.0-Final.zip file.
- 

## Get Started

### Install Windup

1. If you installed previous versions of Windup, delete the `${user.home}/.windup/` directory. Otherwise you may see errors like the following when you execute Windup.

```
Command: windup-migrate-app was not found
```

2. Download the latest [Windup ZIP distribution](#).
3. Extract the ZIP file in to a directory of your choice.

### Execute Windup

#### Prerequisites

Before you begin, you must gather the following information.

1. The fully qualified path of the application archive or folder you plan to migrate.
2. The fully qualified path to a folder that will contain the resulting report information.
  - If you do not specify a folder, Windup creates one for you at the same level as the application.
  - If you specify a folder and it does not exist, it is created by Windup.
  - If you specify a folder and it does exist, you see the following:

- In batch mode, you must specify `--overwrite` or you see the following error.

```
***ERROR*** Files exist in /home/username/OUTPUT_REPORT_DIRECTORY, but --  
overwrite not specified. Aborting!
```

- In interactive mode, you see the following prompt and can choose whether to overwrite the directory.

```
Overwrite all contents of <OUTPUT_DIRECTORY> (anything already in the  
directory will be deleted)? [y/N]
```

Choose "y" if you want Windup to delete and recreate the directory. If you are confident you want to overwrite the output directory, you can specify `--overwrite` on the command line to automatically delete and recreate the directory.

#### WARNING

Be careful not to specify a report output directory that contains important information!

3. You must also provide a list of the application packages to be evaluated.
  - In most cases, you are interested only in evaluating the custom application class packages and not the standard Java EE or 3rd party packages. For example, if the *MyCustomApp* application uses the package `com.mycustomapp`, you provide that package using the `--packages` argument on the command line. It is not necessary to provide the standard Java EE packages, like `java.util` or `javax.ejb`.
  - While you can provide package names for standard Java EE 3rd party software like `org.apache`, it is usually best not to include them as they should not impact the migration effort.
  - If you omit the `--packages` argument, every package in the application is scanned, resulting in very slow performance. It is best to provide the argument with one or more packages.
4. For information about the use of `WINDUP_HOME` in the instructions below, see [About the WINDUP\\_HOME Variable](#).

## Run Windup in Batch Mode

This is the quickest way to run Windup.

1. Open a terminal and navigate to the WINDUP\_HOME directory.
2. Type the following command to run Windup in batch mode:

```
For Linux:      $ WINDUP_HOME/bin/windup --input INPUT_ARCHIVE --output  
OUTPUT_REPORT --packages PACKAGE_1 PACKAGE_2 PACKAGE_N  
For Windows:   > WINDUP_HOME\bin\windup.bat --input INPUT_ARCHIVE --output  
OUTPUT_REPORT --packages PACKAGE_1 PACKAGE_2 PACKAGE_N
```

3. This command can take arbitrary options processed by different add-ons. The list of options in the core Windup distribution can be found in the [Javadoc](#). Most commonly used command line arguments are:

### **--input INPUT\_ARCHIVE\_OR\_FOLDER**

This is the fully qualified application archive or source path.

### **--output OUTPUT\_REPORT\_DIRECTORY (optional)**

The fully qualified path to the folder that will contain the the report information produced by Windup. If omitted, the report will be generated in a **INPUT\_ARCHIVE\_OR\_FOLDER.report** folder. If the output directory exists, you will see the error described above and must specify the `--overwrite` argument. This forces Windup to delete and recreate the folder, so be careful not to specify an output directory that contains important information!

### **--source (optional)**

One or more source technologies, platforms, or frameworks to migrate from.

### **--target (optional)**

One or more source technologies, platforms, or frameworks to migrate to.

### **--overwrite (optional)**

Specify this optional argument only if you are certain you want to force Windup to delete the existing **OUTPUT\_REPORT\_DIRECTORY** folder. The default value is `false`.

### **--userRulesDirectory (optional)**

Points to a directory to load XML rules from. (Search pattern: \*.windup.groovy)

and \*.windup.xml)

**--packages PACKAGE\_1, PACKAGE\_2, PACKAGE\_N (optional)**

This is a comma-delimited list of the packages to be evaluated by Windup.

**--excludePackages PACKAGE\_1, PACKAGE\_2, PACKAGE\_N (optional)**

This is a comma-delimited list of the packages to be excluded by Windup.

**--source-mode true (optional)**

This argument is optional and is only required if the application to be evaluated contains source files rather than compiled binaries. The default value is `false`.

4. To evaluate an application archive, use the following syntax:

```
WINDUP_HOME/bin/windup --input INPUT_ARCHIVE_OR_FOLDER --output  
OUTPUT_REPORT_DIRECTORY --packages PACKAGE_1 PACKAGE_2 PACKAGE_N
```

To run Windup against application source code, you must add the `--sourceMode true` argument:

```
WINDUP_HOME/bin/windup --sourceMode true --source SOURCE_TECHNOLOGY --target  
TARGET_TECHNOLOGY --input INPUT_ARCHIVE_OR_FOLDER --output  
OUTPUT_REPORT_DIRECTORY --packages PACKAGE_1 PACKAGE_2 PACKAGE_N
```

See [Windup Command Examples](#) below for concrete examples of commands that use source code directories and archives located in the Windup GitHub repository.

5. You should see the following result upon completion of the command:

```
**SUCCESS** Windup report created: PATH_TO_REPORTS/index.html  
Access it at this URL:  
file:///home/username/PATH_TO_REPORTS/index.html
```

**WARNING**

Depending on the size of the application and the hardware Windup is running on, this command can take a very long time. For tips on how to improve performance, see [Optimize Windup Performance](#).



6. Open the `OUTPUT_REPORT_DIRECTORY/index.html` file in a browser to access the report. The following subdirectories in the `OUTPUT_REPORT_DIRECTORY` contain the supporting information for the report:

```
OUTPUT_REPORT_DIRECTORY/  
  graph/  
  renderedGraph/  
  reports/  
  stats/  
  index.html
```

7. For details on how to evaluate the report data, see [Review the Report](#).

### Windup Help for Batch Mode

To see the complete list of available arguments for the `windup` command, execute the following command in the terminal:

```
WINDUP_HOME/bin/windup --help
```

### Start Windup in Interactive Mode

Windup can also be run in interactive mode. This mode offers tab completion, which is useful if you need assistance with valid argument values, for example, valid `--source` or `--target` technologies.

1. Open a terminal and navigate to the `WINDUP_HOME/bin` directory
2. Type the following command to start Windup:

```
For Linux:    WINDUP_HOME/bin $ ./windup  
For Windows:  C:\WINDUP_HOME\bin> windup
```

3. You are presented with the following prompt.

```
Using Windup at WINDUP_HOME
```

```
  _      _      _  
 | |      / ( )  _  _  / / _  _  _  
 | | / / / / / _ \ \ _  / / / / _ \  
 | / / / / / / / / / / / / / / / /  
 | _ / | _ / _ / / _ \ _ , _ \ _ , _ / . _ /  
      / _ /
```

```
JBoss Windup, version [ 2.2.0.Final ] - JBoss, by Red Hat, Inc. [
http://windup.jboss.org ]
```

```
[windup-distribution-2.2.0.Final]$
```

4. The command to run Windup is `windup-migrate-app`. It uses the same arguments as batch mode. If you are unsure of valid argument values, hit the `tab` a few times to see what is available.
5. To evaluate an application archive, use the following syntax:

```
windup-migrate-app --input INPUT_ARCHIVE_OR_FOLDER --output
OUTPUT_REPORT_DIRECTORY -source SOURCE_TECHNOLOGY --target TARGET_TECHNOLOGY --
packages PACKAGE_1 PACKAGE_2 PACKAGE_N
```

To run Windup against application source code, you must add the `--sourceMode true` argument:

```
windup-migrate-app --sourceMode true --input INPUT_ARCHIVE_OR_FOLDER --output
OUTPUT_REPORT_DIRECTORY -source SOURCE_TECHNOLOGY --target TARGET_TECHNOLOGY --
packages PACKAGE_1 PACKAGE_2 PACKAGE_N
```

6. You should see the following result upon completion of the command:

```
***SUCCESS*** Windup execution successful!
```

#### WARNING

Depending on the size of the application and the hardware Windup is running on, this command can take a very long time. For tips on how to improve performance, see [Optimize Windup Performance](#).

7. To exit Windup, type:

```
exit
```

8. Review the report as described for batch mode.

Windup Help for Interactive Mode

To see the complete list of available arguments for the `windup-migrate-app` command, execute the following command at the Windup prompt:

```
man windup-migrate-app
```

## Windup Command Examples

The following batch mode examples report against applications located in the Windup source [test-files](#) directory. The same arguments can be used to run the commands interactively in Windup using the `windup-migrate-app` command.

### Source Code Example

The following command runs against the [seam-booking-5.2](#) application source code. It evaluates all `org.jboss.seam` packages and creates a folder named 'seam-booking-report' in the `/home/username/windup-reports/` directory to contain the reporting output.

```
WINDUP_HOME/bin/windup --sourceMode true --input /home/username/windup-source/test-files/seam-booking-5.2/ --output /home/username/windup-reports/seam-booking-report --source eap4,eap5 --target eap6 --packages org.jboss.seam
```

### Archive Example

The following command runs against the [jee-example-app-1.0.0.ear](#) EAR archive. It evaluates all `com.acme` and `org.apache` packages and creates a folder named 'jee-example-app-1.0.0.ear-report' in the `/home/username/windup-reports/` directory to contain the reporting output.

```
WINDUP_HOME/bin/windup --input /home/username/windup-source/test-files/jee-example-app-1.0.0.ear/ --output /home/username/windup-reports/jee-example-app-1.0.0.ear-report --source eap4,eap5 --target eap6 --packages com.acme org.apache
```

## Windup Quickstart Examples

For more concrete examples, see the Windup quickstarts located on GitHub here: <https://github.com/windup/windup-quickstarts>. If you prefer, you can download the [latest release](#) ZIP or TAR distribution of the quickstarts.

The quickstarts provide examples of Java-based and XML-based rules you can run

and test using Windup. The README instructions provide a step-by-step guide to run the quickstart example. You can also look through the code examples and use them as a starting point for creating your own rules.

## Review the Report

### About the Report

When you execute Windup, the report is generated in the `OUTPUT_REPORT_DIRECTORY` you specify for the `--output` argument in the command line. This output directory contains the following files and subdirectories:

- `index.html` : This is the landing page for the report.
- `archives/` : Contains the archives extracted from the application
- `graph/` : Contains binary graph database files
- `reports/` : This directory contains the generated HTML report files
- `stats/` : Contains Windup performance statistics

The examples below use the [test-files/jee-example-app-1.0.0.ear](#) located in the Windup GitHub source repository for input and specify the `com.acme` and `org.apache` package name prefixes to scan. For example:

```
windup-migrate-app --input /home/username/windup-source/test-files/jee-example-app-1.0.0.ear/ --output /home/username/windup-reports/jee-example-app-1.0.0.ear-report --packages com.acme org.apache
```

### Open the Report

Use your favorite browser to open the `index.html` file located in the output report directory. You should see something like the following:

#### ***Windup Report: Overview***



## Overview / Profiled by Windup

| Name   | Technology   | Effort          |
|--|--|-----------------|
| <a href="#">JEE Example App (org.windup.example:jee-example-app:1.0.0)</a> | <a href="#">Web XML 2.4</a> <a href="#">Properties</a> <a href="#">Manifest</a> <a href="#">EJB XML 2.1</a> <a href="#">Decompiled Java File</a> | 34 Story Points |

[All Rules](#) | [Windup FreeMarker Methods](#)

This page lists the applications that were processed along with the technologies that were encountered.

Click on the link under the **Name** column to view the Windup application report page.

### Report Sections

#### Application Report Page

The first section of the application report page summarizes the migration effort. It displays the following information both graphically and in list form by application artifact for each file that is analyzed.

- The file name
- The file type
- A list of issues, if any, that were found in the file
- The estimated total *Story Points* to migrate the file. A *Story Point* is a term commonly used in Scrum Agile software development methodology to estimate the level of effort needed to implement a feature or change. It does not necessarily translate to man-hours, but the value should be consistent across tasks. For more information about *Story Points*, see [Rule Story Points](#).

#### NOTE

The estimated Story Points change as new rules are added to Windup. The values here may not match what you see when you test this application.

In the following Windup Application Report example, the migration of the **JEE Example App** EAR is assigned a total of 34 story points. A pie chart shows the breakdown of story points by package. This is followed by a section for each of the archives contained in the EAR. It provides the total of the story points assigned to the archive and lists the files contained in archive along with the warnings and story point assigned to each file.

Windup Report: Application Report

OverviewUnclassified FilesEJB Report

Application Report / JEE Example App (org.windup.example:jee-example-app:1.0.0)

ALL APPLICATIONS / OVERVIEW

34

Story Points

weblogic.common.\* - 8

weblogic.j11n.\* - 4

weblogic.application.\* - 3

java.management.\* - 3

java.management.\* - 3

jee-example-app-1.0.0.ear

5

Story Points

OrganizationVersionLink

UnknownJEE Example App (org.windup.example:jee-example-app:1.0.0)

Description

| Name   | Technology | Issues | Estimated Story Points |
|--|------------|--------|------------------------|
| LogEventLog-jee.xml  |            |        | 1                      |
| META-INF/MANIFEST.MF   | Unknown    |        | 0                      |
| META-INF/application.xml   |            |        | 1                      |
| META-INF/weblogic-application.xml                                |            |        | 3                      |
| META-INF/resources/org.windup.example/jee-example-app.properties | Properties |        | 0                      |

jee-example-app-1.0.0.ear/jee-example-services.jar

23

Story Points

weblogic.common.\* - 8

weblogic.j11n.\* - 2

weblogic.application.\* - 3

java.management.\* - 3

java.management.\* - 2

weblogic.j11n.\* - 2

OrganizationVersionLink

UnknownJEE Example EJB Services (org.windup.example:jee-example-services:1.0.0)

Description

| Name  | Technology        | Issues  | Estimated Story Points |
|---|-------------------|---|------------------------|
| META-INF/MANIFEST.MF  | Unknown           |   | 0                      |
| META-INF/ejbjar.xml   | EJB 3.0 (EJB 3.1) |   | 0                      |
| META-INF/weblogic-ejbjar.xml  |                   |   | 3                      |
| META-INF/resources/org.windup.example/jee-example-services.properties | Properties        |   | 0                      |
| com.acme.xml.listener.ArudWebLifecycleListener                        | Decoded Archive   | Warnings: 6 items <ul style="list-style-type: none"><li>Constructing type 'java.management.ObjectName\$Builder\$Builder'</li><li>Constructing type 'java.management.ObjectName\$Builder\$Builder'</li><li>Constructing type 'java.management.ObjectName\$Builder\$Builder'</li><li>Import of 'weblogic.application.ApplicationLifecycleListener'</li><li>Import of 'weblogic.application.ApplicationLifecycleListener'</li><li>Import of 'weblogic.application.ApplicationLifecycleEvent'</li></ul> | 16                     |

Archive Analysis Sections

Each archive summary begins with a total of the story points assigned to its

migration, followed by a table detailing the changes required for each file in the archive. The report contains the following columns.

### **Name**

The name of the file being analyzed

### **Technology**

The type of file being analyzed. For example:

- Java Source
- Decompiled Java File
- Manifest
- Properties
- EJB XML
- Spring XML
- Web XML
- Hibernate Cfg
- Hibernate Mapping

### **Issues**

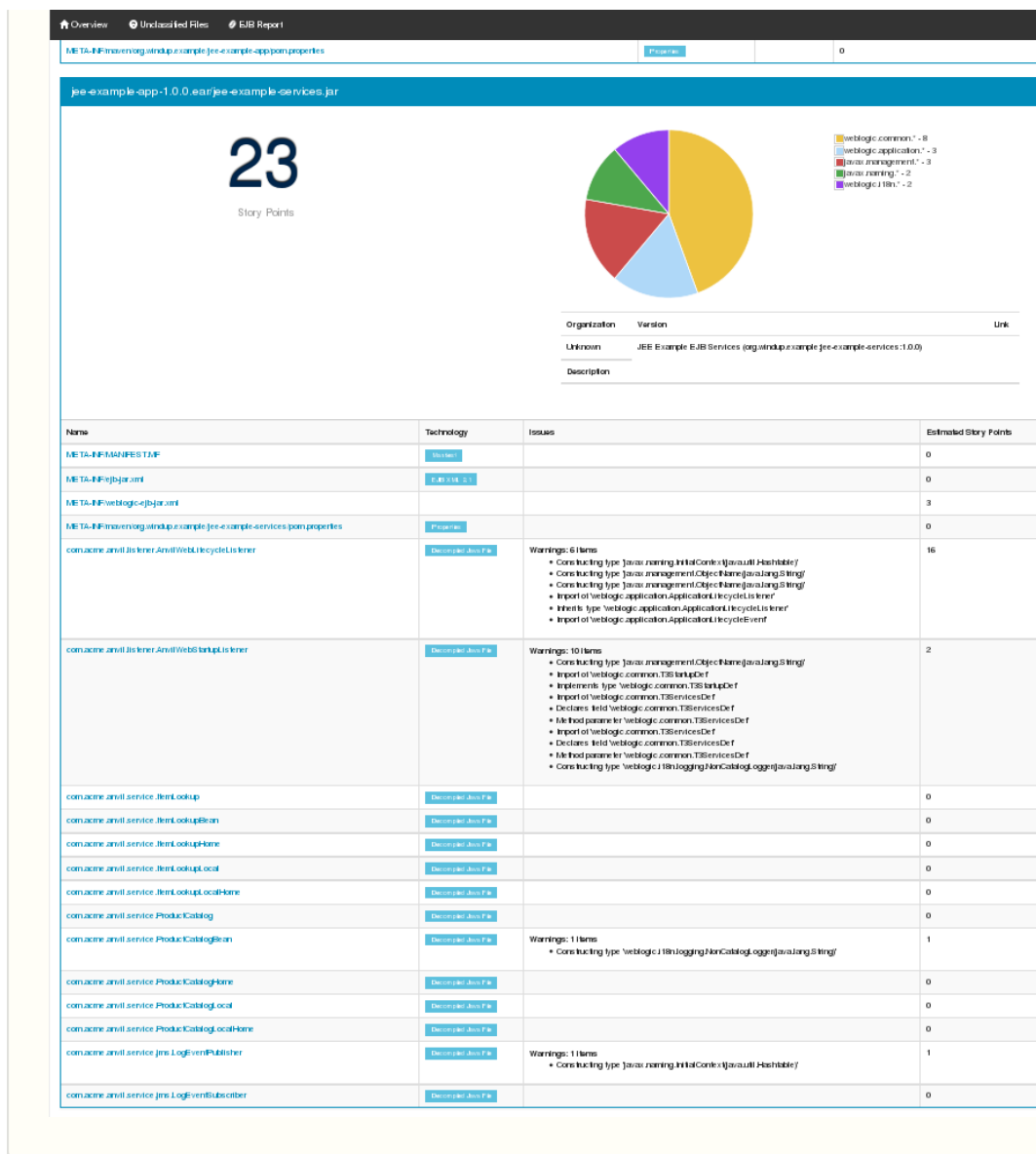
Warnings about areas of code that need review or changes.

### **Estimated Story Points**

Level of effort required for migrating the file.

The following is an example of the archive analysis summary section of a Windup Report. The following is an the analysis of the `WINDUP_SOURCE/test-files/jee-example-app-1.0.0.ear/jee-example-services.jar`.

***Windup Report: Application Report (jee-example-app-1.0.0.ear/jee-example-services.jar)***



## File Analysis Pages

The analysis of the `jee-example-services.jar` lists the files in the JAR and the warnings and story points assigned to each one. Notice the `com.acme.anvil.listener.AnvilWebLifecycleListener` file, at the time of this test, has 6 warnings and is assigned 16 story points. Click on the file to see the detail.

- The **Information** section provides a summary of the story points and notes that the file was decompiled by Windup.
- This is followed by the file source code listing. Warnings appear in the file at the point where migration is required.

In this example, warnings appear at the import of `weblogic.application.ApplicationLifecycleEvent` and report that the class is



proprietary to WebLogic and must be removed.

## Windup Report: Source Report - Part 1

[Overview](#) [Unclassified Files](#) [EJB Report](#)

Source Report/ `jee-example-app-1.0.0.ear/jee-example-services.jar/com/acme/anvil/listener`  
`/AnvilWebLifecycleListener.java`

ALL APPLICATIONS / JEE-EXAMPLE-APP (ORG.WINDUP.EXAMPLES:JEE-EXAMPLE-APP1.0.0) / ANVILWEBLIFECYCLELISTENER.JAVA

Information

- Estimated Story Points: 16
- [Decompiled Java File](#)
- WebLogic `ApplicationLifecycleListener`, proprietary class, must be migrated.
  - Migrate Oracle WebLogic Server `ApplicationLifecycleListener` Code to Red Hat JBoss Enterprise Application Platform 6
  - Master the JBoss Tutorial: EJB 3.1 Tutorial
  - Caucho.com Tutorial: `ServletContextListener`, `@WebListener` tutorial
  - Rose India Tutorial: `ServletContextListener`, `@WebListener` tutorial

```
01. package com.acme.anvil.listener;
02.
03. import javax.management.ObjectName;
04. import com.acme.anvil.management.AnvilInvokeBeanImpl;
05. import javax.naming.NamingException;
06. import javax.naming.Context;
07. import java.util.Hashtable;
08. import javax.naming.InitialContext;
09. import java.util.Properties;
10. import javax.management.MBeanServer;
11. import weblogic.application.ApplicationLifecycleEvent;
12. import org.apache.log4j.Logger;
13. import weblogic.application.ApplicationLifecycleListener;
14.
15. public class AnvilWebLifecycleListener extends ApplicationLifecycleListener{
```

Import of 'weblogic.application.ApplicationLifecycleEvent'

This class is proprietary to WebLogic, remove.

Import of 'weblogic.application.ApplicationLifecycleListener'

This class is proprietary to WebLogic, remove.

Inherits type 'weblogic.application.ApplicationLifecycleListener'

Use a `javax.servlet.ServletContextListener` with `@javax.annotation.servlet.WebListener`, or EJB 3.1 `@javax.ejb.Startup` `@javax.ejb.Singleton` service bean.

- Migrate Oracle WebLogic Server `ApplicationLifecycleListener` Code to Red Hat JBoss Enterprise Application Platform 6

Later in the code, warnings appear for the creation of the `InitialContext` and for the object name when registering and unregistering an MBeans

## Windup Report: Source Report - Part 2

```
35. }
36. private MBeanServer getMBeanServer() throws NamingException{
37.     final Properties environment=new Properties();
38.     ((Hashtable<String,String>)environment).put("java.naming.factory.initial","weblogic.jndi.WLInitialContextFactory");
39.     ((Hashtable<String,String>)environment).put("java.naming.provider.url","t3://localhost:7001");
40.     final Context context=new InitialContext(environment);
41.     final MBeanServer server=(MBeanServer)context.lookup("java.comp/jmx/runtime");
42.     return server;
43. }
44. private void registerMBean(){
45.     AnvilWebLifecycleListener.LOG.info((Object)"Registering MBeans.");
46.     try{
47.         final MBeanServer server=this.getMBeanServer();
48.         server.registerMBean(new AnvilInvokeBeanImpl(),new ObjectName("com.acme.Name=anvil,Type=com.acme.anvil.management.AnvilInvokeBeanApplicationLifecycleListener"));
49.         AnvilWebLifecycleListener.LOG.info((Object)"Registered MBean[com.acme.Name=anvil,Type=com.acme.anvil.management.AnvilInvokeBeanApplicationLifecycleListener]");
50.     }
51.     catch(Exception e){
52.         AnvilWebLifecycleListener.LOG.error((Object)"Exception while registering MBean[com.acme.Name=anvil,Type=com.acme.anvil.management.AnvilInvokeBeanApplicationLifecycleListener]");
53.     }
54. }
55. private void unregisterMBean(){
56.     AnvilWebLifecycleListener.LOG.info((Object)"Unregistering MBeans.");
57.     try{
58.         final MBeanServer server=this.getMBeanServer();
59.         server.unregisterMBean(new ObjectName("com.acme.Name=anvil,Type=com.acme.anvil.management.AnvilInvokeBeanApplicationLifecycleListener"));
60.         AnvilWebLifecycleListener.LOG.info((Object)"Unregistered MBean[com.acme.Name=anvil,Type=com.acme.anvil.management.AnvilInvokeBeanApplicationLifecycleListener]");
61.     }
```

## Additional Reports

Explore the Windup `OUTPUT_REPORT_DIRECTORY/reports` folder to find additional reporting information.

## Rule Provider Execution Report

The `OUTPUT_REPORT_DIRECTORY/reports/windup_ruleproviders.html` page provides the list of rule providers that executed when running the Windup migration command against the application.

### *Windup Report: Rule Provider Report*

All Applications

# Rule Provider Executions

Phase: DependentPhase

Phase: InitializationPhase

IgnoredArchivesConfigLoadingRuleProvider

Phase: InitializationPhase

| Rule  | Statistics   | Executed? | Failed? | Failure Cause |
|---|--|-----------|---------|---------------|
| <pre> addRule()     .perform(org.jboss.windup.rules.apps.java.archives.config         .IgnoredArchivesConfigLoadingRuleProvider\$1@38a13fd8     )     withId("GeneratedID_IgnoredArchivesConfigLoadingRuleProvider_1") </pre> | Vertices Created: 0<br>Edges Created: 0<br>Vertices Removed: 0<br>Edges Removed: 0 | yes       | no      |               |

ArchiveIdentificationConfigLoadingRuleProvider

Phase: InitializationPhase

| Rule   | Statistics   | Executed? | Failed? | Failure Cause |
|--|--|-----------|---------|---------------|
| <pre> addRule()     .perform(org.jboss.windup.rules.apps.java.archives.config         .ArchiveIdentificationConfigLoadingRuleProvider\$1@729c304     )     withId("GeneratedID_ArchiveIdentificationConfigLoadingRuleProvider_1") </pre> | Vertices Created: 0<br>Edges Created: 0<br>Vertices Removed: 0<br>Edges Removed: 0 | yes       | no      |               |

CopyJavaConfigToGraphRuleProvider

Phase: InitializationPhase

| Rule   | Statistics   | Executed? | Failed? | Failure Cause |
|--|--|-----------|---------|---------------|
| <pre> addRule()     .perform(org.jboss.windup.rules.apps.java.config         .CopyJavaConfigToGraphRuleProvider\$1@3d097c85     )     withId("GeneratedID_CopyJavaConfigToGraphRuleProvider_1") </pre> | Vertices Created: 11<br>Edges Created: 10<br>Vertices Removed: 0<br>Edges Removed: 0 | yes       | no      |               |

GatherIgnoredFileNamesRuleProvider

Phase: InitializationPhase

| Rule  | Statistics   | Executed? | Failed? | Failure Cause |
|---|--|-----------|---------|---------------|
| <pre> addRule()     .when(Query.find(org.jboss.windup.graph.model.WindupConfigurationModel).as(default)     )     .perform(Iteration.over(?).perform(Gather all the information about ignored files.)     )     withId("GeneratedID_GatherIgnoredFileNamesRuleProvider_1") </pre> | Vertices Created: 0<br>Edges Created: 0<br>Vertices Removed: 0<br>Edges Removed: 0 | yes       | no      |               |

Phase: DiscoveryPhase

DiscoverFilesAndTypesRuleProvider

Phase: DiscoveryPhase

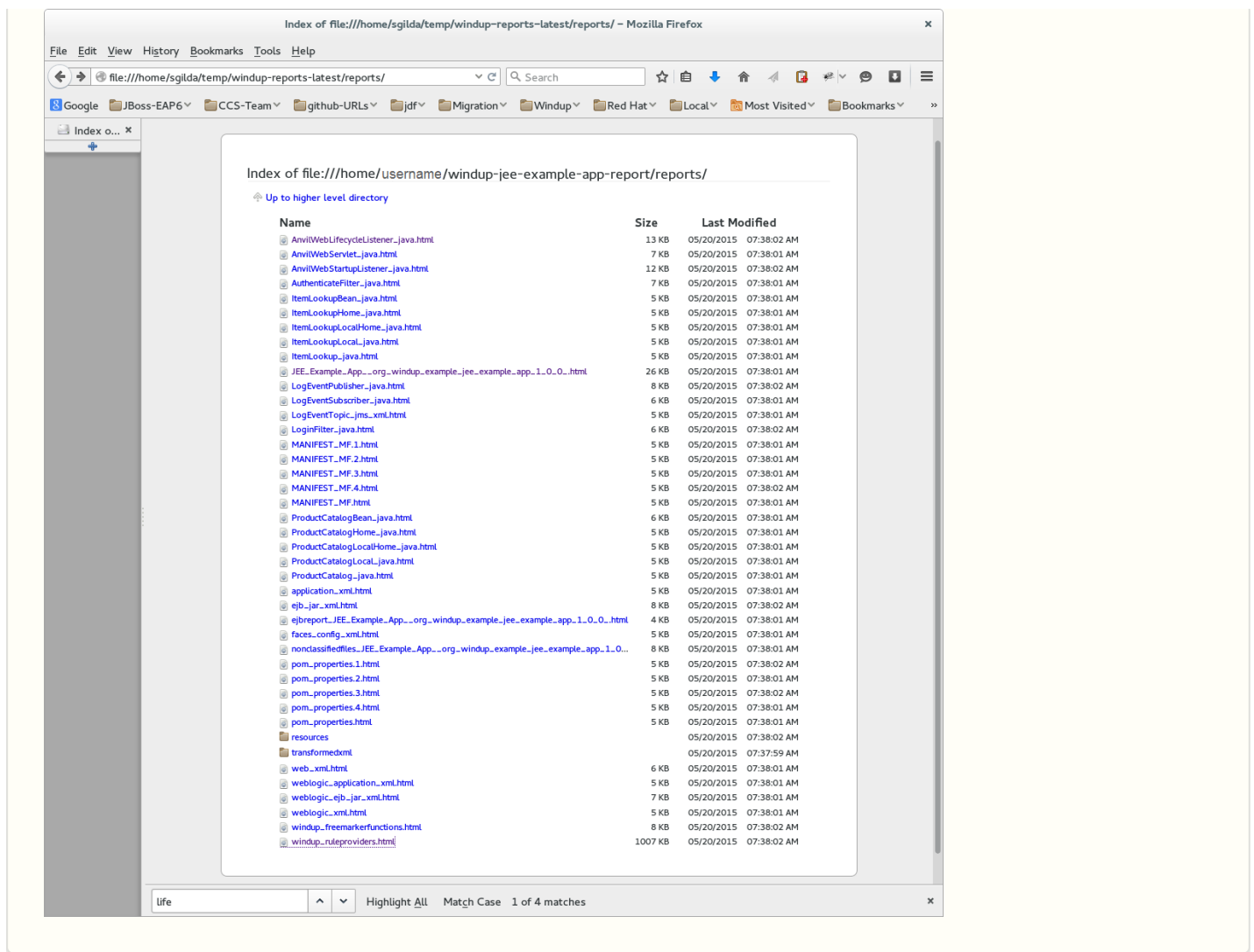
## Rule Provider Execution Report

The `OUTPUT_REPORT_DIRECTORY/reports/windup_ruleproviders.html` page provides the list of rule providers that executed when running the Windup migration command against the application.

## Individual File Analysis Reports

You can directly access the the file analysis report pages described above by browsing for them by name in the `OUTPUT_REPORT_DIRECTORY/reports/` directory. Because the same common file names can exist in multiple archives, for example "manifest.mf" or "web.xml", Windup adds a unique numeric suffix to each report file name.

### *Windup Report: Report Directory List*



## Additional Resources

### Review the Windup Quickstarts

The Windup quickstarts provide working examples of how to create custom Java-based rule add-ons and XML rules. You can use them as a starting point for creating your own custom rules.

You can download a ZIP file of the latest released version of the quickstarts. Or, if you prefer to play around with the source code, you can fork and clone the windup-quickstarts project repository.

### Download the Latest Quickstart ZIP

To download the latest quickstart ZIP file, browse to:

<https://github.com/windup/windup-quickstarts/releases>

Click on the most recent release to download the ZIP to your local file system.

## Fork and Clone the Quickstart GitHub Project

If you don't have the GitHub client (`git`), download it from: <http://git-scm.com/>

1. Click the `Fork` link on the [Windup quickstart](#) GitHub page to create the project in your own Git. The forked GitHub repository URL created by the fork should look like this: [https://github.com/YOUR\\_USER\\_NAME/windup-quickstarts.git](https://github.com/YOUR_USER_NAME/windup-quickstarts.git)
2. Clone your Windup quickstart repository to your local file system:

```
git clone https://github.com/YOUR_USER_NAME/windup-quickstarts.git
```

3. This creates and populates a `windup-quickstarts` directory on your local file system. Navigate to the newly created directory, for example

```
cd windup-quickstarts/
```

4. If you want to be able to retrieve the latest code updates, add the remote `upstream` repository so you can fetch any changes to the original forked repository.

```
git remote add upstream https://github.com/windup/windup-quickstarts.git
```

5. To get the latest files from the `upstream` repository.

```
git reset --hard upstream/master
```

## Get Involved

### How can you help?

To help us make Windup cover most application constructs and server configurations, including yours, you can help with any of the following items. Many require only a few minutes of your time!

- Send an email to [windup-users@lists.jboss.org](mailto:windup-users@lists.jboss.org) and let us know what should

Windup migration rules cover.

- Provide example applications to test migration rules.
- Identify application components and problem areas that may be difficult to migrate.
  - Write a short description of these problem migration areas.
  - Write a brief overview describing how to solve the problem migration areas.
- [Try Windup](#) on your application. Be sure to [report any issues](#) you encounter.
- You can contribute to the Windup rules repository.
  - Write a Windup rule to identify or automate a migration process.
  - Create a test for the new rule.
  - Fork the `windup-rulesets` Github repository and put the rule therein.
  - Details are provided in the [Windup Rules Development Guide](#).
- You can also contribute to the project source code.
  - Create a core rule.
  - Improve Windup performance or efficiency.
  - See the [Windup Core Development Guide](#) for information about how to configure your environment and set up the project.

Any level of involvement is greatly appreciated!

Important links

See the [list of links to Windup resources](#)

Important Links

- Windup wiki: <https://github.com/windup/windup/wiki>
- Windup documentation (generated from the Wiki documentation at the link above):
  - [Windup User Guide](#)
  - [Windup Rules Development Guide](#)

- [Windup Core Development Guide](#)
- [Windup Javadoc](#)
- Windup forums: <https://community.jboss.org/en/windup>
  - Windup 0.x legacy forums: <https://developer.jboss.org/en/windup>
- Windup issue tracker: <https://issues.jboss.org/browse/WINDUP>
- Windup users mailing List: [windup-users@lists.jboss.org](mailto:windup-users@lists.jboss.org)
- Windup developers mailing list: [windup-dev@lists.jboss.org](mailto:windup-dev@lists.jboss.org)
- Windup commits mailing list: [windup-commits@lists.jboss.org](mailto:windup-commits@lists.jboss.org)
- Windup on Twitter: [@JBossWindup](#)
- Windup IRC channel: Server FreeNode ( `irc.freenode.net` ), channel `#windup` .
  - Windup IRC Chat transcripts: <http://bit.ly/windup-transcripts>
  - Windup meeting IRC Chat transcripts: transcripts: <http://bit.ly/windup-meetings>

## Known Windup Issues

Windup known issues are tracked here: [Open Windup issues](#)

## Report Issues with Windup

Windup uses JIRA as its issue tracking system. If you encounter an issue executing Windup, please file a JIRA Issue.

### Create a JIRA Account

If you do not yet have a JIRA account, create one using the following procedure.

1. Open a browser to the following URL:  
<https://issues.jboss.org/secure/Dashboard.jspa>
2. Click the *Sign Up* link in the top right side of the page.
3. Enter your email address and click the `Confirm address` button.
4. Follow the instructions sent to your email address.

### Create a JIRA Issue

1. Open a browser to the following URL:  
<https://issues.jboss.org/secure/CreateIssue!default.jspx>.
    - If you have not yet logged in, click the *Log In* link at the top right side of the page.
    - Enter your credentials and click the **LOGIN** button.
    - You are then redirected back to the **Create Issue** page.
  2. Choose the following options and click the **Next** button.
    - **Project:** *Windup*
    - **Issue Type:** *Bug*
  3. On the next screen complete the following fields:
    - **Summary:** Enter a brief description of the problem or issue.
    - **Environment:** Provide the details of your operating system, version of Java, and any other pertinent information.
    - **Description:** Provide a detailed description of the issue. Be sure to include logs and exceptions traces.
  4. Click the **Create** button to create the JIRA issue.
  5. If the application or archive causing the issue does not contain sensitive information and you are comfortable sharing it with the Windup development team, attach it to the issue by choosing **More → Attach Files**. You are provided with an option to restrict visibility to JBoss employees.
- 

## Appendix

### Glossary of Terms Used in Windup

#### Rules Terms

##### **Rule**

A piece of code that performs a single unit of work during the migration process. Depending on the complexity of the rule, it may or may not include configuration data. Extensive configuration information may be externalized into external



configuration, for example, a custom XML file. The following is an example of a Java-based rule added to the `JDKConfig` `RuleProvider` class.

```
.addRule()

.when(JavaClass.references("java.lang.ClassLoader$").at(TypeReferenceLocation.TYPE))
    .perform(Classification.as("Java Classloader, must be migrated."))
    .with(Link.to("Red Hat Customer Portal: How to get resources via the ClassLoader
in a JavaEE application in JBoss EAP",
"https://access.redhat.com/knowledge/solutions/239033"))
    .withEffort(1))
```

## RuleProvider

An implementation of `OCPSoft ConfigurationProvider` class specifically for Windup. It provides Rule instances and the relevant `RuleProviderMetadata` for those Java-based and XML-based Rule instances.

## Ruleset

A ruleset is a group of one or more `RuleProviders` that targets a specific area of migration, for example, `Spring → Java EE 6` or `WebLogic → JBoss EAP`. A ruleset is packaged as a JAR and contains additional information needed for the migration, such as operations, conditions, report templates, static files, metadata, and relationships to other rulesets. The following Windup projects are rulesets.

- `rules-java-ee`
- `rules-xml`

## Rules Metadata

Information about whether a particular ruleset applies to a given situation. The metadata can include the source and target platform and frameworks.

## Rules Pipeline

A collection of rules that feed information into the knowledge graph.

## Reporting Terms

### Level of effort

The effort required to complete the migration task. *Level of effort* is represented as

*story points* in the Windup reports.

## Story Point

A term commonly used in Scrum Agile software development methodology to estimate the *level of effort* needed to implement a feature or change. It does not necessarily translate to man-hours, but the value should be consistent across tasks. *Story points* and *level of effort* are described in more detail here: [Rule Story Points](#).

## Rule Story Points

### What are Story Points?

*Story Points* are an abstract metric commonly used in Scrum Agile software development methodology to estimate the *level of effort* needed to implement a feature or change. They are based on a [modified Fibonacci sequence](#).

In a similar manner, Windup uses *story points* to express the *level of effort* needed to migrate particular application constructs, and in a sum, the application as a whole. It does not necessarily translate to man-hours, but the value should be consistent across tasks.

### How Story Points are Estimated in Rules

Estimating the *level of effort* for the *story points* for a rule can be tricky. The following are the general guidelines Windup uses when estimating the *level of effort* required for a rule.

| Level of Effort | Story Points | Description  |
|-----------------|--------------|--|
| Trivial         | 1            | The migration is a trivial change or a simple library swap with no or minimal API changes. |
| Complex         | 3            | The changes required for the migration task are complex, but have a documented solution.   |

| Level of Effort | Story Points | Description  |
|-----------------|--------------|--|
| Redesign        | 5            | The migration task requires a redesign or a complete library change, with significant API changes. |
| Rearchitecture  | 7            | The migration requires a complete rearchitecture of the component or subsystem.                    |
| Unknown         | 13           | The migration solution is not known and may need a complete rewrite.                               |

### Task Severity

In addition to the *level of effort*, migration tasks can be assigned a *severity* that indicates whether the task must be completed or can be postponed.

#### Mandatory

The task must be completed for a successful migration. If the changes are not made, the resulting application will not build or run successfully. Examples include replacement of proprietary APIs that are not supported in the target platform.

#### Optional

If the migration task is not completed, the application will work, but the results may not be the optimal. If the change is not made at the time of migration, it is recommended to put it on the schedule soon after migration is completed. An example of this would be the upgrade of EJB 2.x code to EJB 3.

## Optimize Windup Performance

### Overview

Windup performance depends on a number of factors, including hardware

configuration, the number and types of files in the application, the size and number of applications to be evaluated, and whether the application contains source or compiled code. For example, a file that is larger than 10 MB may need a lot of time to process.

In general, Windup spends about 40% of the time decompiling classes, 40% of the time executing rules, and the remainder of the time processing other tasks and generating reports. This section describes what you can do to improve the performance of Windup.

## Tips to Optimize Performance

### Application and Command Line Suggestions

Try these suggestions first before upgrading hardware.

- If possible, execute Windup against the source code instead of the archives. This eliminates the need to decompile additional JARs and archives.
- Specify the `--target` platform on the `windup-migrate-app` command line to limit the execution of rules to only those that apply to this target platform.
- Be sure to specify a comma-delimited list of the packages to be evaluated by Windup using the `--packages` argument on the `windup-migrate-app` command line. If you omit this argument, Windup will decompile everything, which has a big impact on performance.
- Specify the `--excludePackages` and `--excludeTags` where possible to exclude them from processing.
- Add additional proprietary packages that should not be processed to the `ignore/proprietary.package-ignore.txt` file in the Windup distribution directory. Windup can still find the references to the packages in the application source code, but avoids the need to decompile and analyze the proprietary classes.

## Hardware Upgrade Suggestions

If the steps above do not improve performance, you may need to upgrade your hardware.

- Very large applications that require decompilation have large memory requirements. 8 GB RAM is recommended. This allows 3 - 4 GB RAM for use by the JVM.
- An upgrade from a single or dual-core to a 4-core CPU processor provides better performance.
- Disk space and fragmentation can impact performance. A fast disk, especially a Solid State Drive (SSD), with greater than 4 GB of defragmented disk space should improve performance.

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