OpenJDK 11

Using jlink to customize Java runtime environment
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Abstract

OpenJDK 11 is a Red Hat offering on the Red Hat Enterprise Linux platform. The Using jlink to customize Java runtime images guide provides an overview of Jlink, and explains how to create and use customize Java runtime image using jlink.
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MAKING OPEN SOURCE MORE INCLUSIVE

Red Hat is committed to replacing problematic language in our code, documentation, and web properties. We are beginning with these four terms: master, slave, blacklist, and whitelist. Because of the enormity of this endeavor, these changes will be implemented gradually over several upcoming releases. For more details, see our CTO Chris Wright’s message.
PROVIDING FEEDBACK ON RED HAT DOCUMENTATION

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- You are logged in to the Red Hat Customer Portal.
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**Procedure**

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   **NOTE**

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4. Enter your feedback in the text box and click **Submit**. A documentation issue is created.

5. To view the issue, click the issue tracker link in the feedback view.
CHAPTER 1. OVERVIEW OF JLINK

Jlink is a Java command line tool that is used to generate a custom Java runtime environment (JRE). You can use your customized JRE to run Java applications.

Using jlink, you can create a custom runtime environment that only includes the relevant class file.
You can create a custom Java runtime environment (JRE) from a non-modular application using the `jlink` tool.

Prerequisites

- Install OpenJDK 11.

**NOTE**

It is always recommended to use the portable tarball as a basis of jlink’ed runtime.

Procedure

1. Create a simple Hello World application using Logger class.
   a. You have the base OpenJDK 11 available in the `jdk-11` folder:

   ```bash
   $ ls jdk-11
   bin  conf  demo  include  jmods  legal  lib  man  NEWS  release
   $ ./jdk-11/bin/java -version
   openjdk version "11.0.10" 2021-01-19 LTS
   OpenJDK Runtime Environment 18.9 (build 11.0.10+9-LTS)
   OpenJDK 64-Bit Server VM 18.9 (build 11.0.10+9-LTS, mixed mode)
   
   b. Create a directory for your application:

   ```bash
   $ mkdir -p hello-example/sample
   ```

   c. Create `hello-example/sample/HelloWorld.java` file with the following content:

   ```java
   package sample;
   import java.util.logging.Logger;
   public class HelloWorld {
   private static final Logger LOG = Logger.getLogger(HelloWorld.class.getName());
   public static void main(String[] args) {
   LOG.info("Hello World!");
   }
   }
   ```

   d. Compile your application:

   ```bash
   $ ./jdk-11/bin/javac -d . $(find hello-example -name ".java")
   ```

   e. Run your application **without** a custom JRE:

   ```bash
   $ ./jdk-11/bin/java sample.HelloWorld
   Mar 09, 2021 10:48:59 AM sample.HelloWorld main
   INFO: Hello World!
   ```
In this case, the base OpenJDK takes 311 MB to run a single class.

f. (Optional) You can inspect the OpenJDK and see many non-required modules for your application:

```bash
$ du -sh jdk-11/
313M jdk-11/

$ ./jdk-11/bin/java --list-modules
```

```bash
java.base@11.0.10
java.compiler@11.0.10
java.datatransfer@11.0.10
java.desktop@11.0.10
java.instrument@11.0.10
java.logging@11.0.10
java.management@11.0.10
java.management.rmi@11.0.10
java.naming@11.0.10
java.net.http@11.0.10
java.prefs@11.0.10
java.rmi@11.0.10
java.scripting@11.0.10
java.se@11.0.10
java.security.jgss@11.0.10
java.security.sasl@11.0.10
java.smartcardio@11.0.10
java.sql@11.0.10
java.sql.rowset@11.0.10
java.transaction.xa@11.0.10
java.xml@11.0.10
java.xml.crypto@11.0.10
jdk.accessibility@11.0.10
jdk.aot@11.0.10
jdk.attach@11.0.10
jdk.charset@11.0.10
jdk.compiler@11.0.10
jdk.crypto.cryptoki@11.0.10
jdk.crypto.ec@11.0.10
jdk.dynalink@11.0.10
jdk.editpad@11.0.10
jdk.hotspot.agent@11.0.10
jdk.httpserver@11.0.10
jdk.internal.ed@11.0.10
jdk.internal.jvmstat@11.0.10
jdk.internal.le@11.0.10
jdk.internal.opt@11.0.10
jdk.internal.vm.ci@11.0.10
jdk.internal.vm.compiler@11.0.10
jdk.internal.vm.compiler.management@11.0.10
jdk.jar@11.0.10
jdk.javac@11.0.10
jdk.jcmd@11.0.10
jdk.jconsole@11.0.10
jdk.jdeps@11.0.10
jdk.jdi@11.0.10
```
Sample **Hello World** application has very few dependencies. You can use jlink to create custom runtime images for your application. These images help you run your application with only required OpenJDK dependencies.

2. Determine module dependencies of your application using `jdeps` command:

   ```bash
   $ ./jdk-11/bin/jdeps -s ./sample/HelloWorld.class
   HelloWorld.class -> java.base
   HelloWorld.class -> java.logging
   ```

3. Build a custom Java runtime image for your application:

   ```bash
   $ ./jdk-11/bin/jlink --add-modules java.base,java.logging --output custom-runtime
   $ du -sh custom-runtime
   50M custom-runtime/
   $ ./custom-runtime/bin/java --list-modules
   java.base@11.0.10
   java.logging@11.0.10
   ```

   **NOTE**

   The size of your custom java runtime image is being reduced to 50M runtime image from 313M runtime image.

4. You can verify the reduced runtime of your application:
$ ./custom-runtime/bin/java sample.HelloWorld
Jan 14, 2021 12:13:26 PM HelloWorld main
INFO: Hello World!

The generated JRE with your sample application does not have any other dependencies.

You can distribute your application together with your custom runtime for deployment.

**NOTE**

Rebuild the custom java runtime images for your application with every security update of your base OpenJDK.
CHAPTER 3. CREATING A CUSTOM JAVA RUNTIME ENVIRONMENT FOR MODULAR APPLICATIONS

You can create a custom Java runtime environment from a modular application using the `jlink` tool.

Prerequisites

- Install OpenJDK 11.

**NOTE**

It is always recommended to use the portable tarball as a basis of Jlink’ed runtime.

Procedure

1. Create a simple Hello World application using Logger class.
   
   a. You have the base OpenJDK 11 available in the `jdk-11` folder:

   ```bash
   $ ls jdk-11
   bin  conf  demo  include  jmods  legal  lib  man  NEWS  release
   $ ./jdk-11/bin/java -version
   openjdk version "11.0.10" 2021-01-19 LTS
   OpenJDK Runtime Environment 18.9 (build 11.0.10+9-LTS)
   OpenJDK 64-Bit Server VM 18.9 (build 11.0.10+9-LTS, mixed mode)
   ```

   b. Create a directory for your application:

   ```bash
   $ mkdir -p hello-example/sample
   ```

   c. Create `hello-example/sample/HelloWorld.java` file with the following content:

   ```java
   package sample;
   import java.util.logging.Logger;
   public class HelloWorld {
   private static final Logger LOG = Logger.getLogger(HelloWorld.class.getName());
   public static void main(String[] args) {
   LOG.info("Hello World!");
   }
   }
   ```

   d. Create `hello-example/module-info.java` file with the following content:

   ```java
   module sample
   {
   requires java.logging;
   }
   ```

   e. Compile your application:
 CHAPTER 3. CREATING A CUSTOM JAVA RUNTIME ENVIRONMENT FOR MODULAR APPLICATIONS

f. Run your application **without** a custom JRE:

```
$ ./jdk-11/bin/java -cp example sample.HelloWorld
Mar 09, 2021 10:48:59 AM sample.HelloWorld main
INFO: Hello World!
```

In this case, the base OpenJDK takes 311 MB to run a single class.

g. (Optional) You can inspect the OpenJDK and see many non-required modules for your application:

```
$ du -sh jdk-11/
313M jdk-11/
```

```
$ ./jdk-11/bin/java --list-modules
java.base@11.0.10
java.compiler@11.0.10
java.datatransfer@11.0.10
java.desktop@11.0.10
java.instrument@11.0.10
java.logging@11.0.10
java.management@11.0.10
java.management.rmi@11.0.10
java.naming@11.0.10
java.net.http@11.0.10
java.prefs@11.0.10
java.rmi@11.0.10
java.scripting@11.0.10
java.se@11.0.10
java.security.jgss@11.0.10
java.security.sasl@11.0.10
java.smartcardio@11.0.10
java.sql@11.0.10
java.sql.rowset@11.0.10
java.transaction.xa@11.0.10
java.xml@11.0.10
java.xml.crypto@11.0.10
jdk.accessibility@11.0.10
jdk.aot@11.0.10
jdk.attach@11.0.10
jdk.charsetsets@11.0.10
jdk.compiler@11.0.10
jdk.crypto.cryptoki@11.0.10
jdk.crypto.ec@11.0.10
jdk.dynalink@11.0.10
jdk.editpad@11.0.10
jdk.hotspot.agent@11.0.10
jdk.httpserver@11.0.10
jdk.internal.ed@11.0.10
jdk.internal.jvmstat@11.0.10
jdk.internal.le@11.0.10
jdk.internal.opt@11.0.10
jdk.internal.vm.ci@11.0.10
```
Sample **Hello World** application has very few dependencies. You can use jlink to create custom runtime images for your application. These images help you run your application with only required OpenJDK dependencies.

2. Create your application module:

```bash
$ mkdir sample-module
$ ./jdk-11/bin/jmod create --class-path example/ --main-class sample.HelloWorld --module-version 1.0.0 -p example sample-module/hello.jmod
```

3. Create a custom JRE with the required modules and a custom application launcher for your application.

```bash
$ ./jdk-11/bin/jlink --launcher hello=sample/sample.HelloWorld --module-path sample-module --add-modules sample --output custom-runtime
```

4. List the modules of the produced custom JRE.
Observe that only a fraction of the original OpenJDK remains.

```bash
$ du -sh custom-runtime
50M custom-runtime/
```
5. Launch the application using the `hello` launcher.

    $ ./custom-runtime/bin/hello
    Jan 14, 2021 12:13:26 PM HelloWorld main
    INFO: Hello World!

The generated JRE with your sample application does not have any other dependencies other than `java.base`, `java.logging`, and `sample` module.

You can distribute your application bundled with the custom runtime in `custom-runtime`. It includes your application.

**NOTE**

Rebuild the custom java runtime images for your application with every security update of your base OpenJDK.