



# Red Hat Enterprise Linux 8

## Packaging and distributing software

Packaging software by using the RPM package management system



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## Abstract

Package software into an RPM package by using the RPM package manager. Prepare source code for packaging, package software, and investigate advanced packaging scenarios, such as packaging Python projects or RubyGems into RPM packages.

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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](#).

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5. Click **Create** at the bottom of the dialogue.

# CHAPTER 1. INTRODUCTION TO RPM

The RPM Package Manager (RPM) is a package management system that runs on Red Hat Enterprise Linux (RHEL), CentOS, and Fedora. You can use RPM to distribute, manage, and update software that you create for any of these operating systems.

The RPM package management system has the following advantages over distributing software in conventional archive files:

- RPM manages software in the form of packages that you can install, update, or remove independently of each other, which makes the maintenance of an operating system easier.
- RPM simplifies the distribution of software because RPM packages are standalone binary files, similar to compressed archives. These packages are built for a specific operating system and hardware architecture. RPMs contain files such as compiled executables and libraries that are placed into the appropriate paths on the filesystem when the package is installed.

With RPM, you can perform the following tasks:

- Install, upgrade, and remove packaged software.
- Query detailed information about packaged software.
- Verify the integrity of packaged software.
- Build your own packages from software sources and complete build instructions.
- Digitally sign your packages by using the GNU Privacy Guard (GPG) utility.
- Publish your packages in a YUM repository.

In Red Hat Enterprise Linux, RPM is fully integrated into the higher-level package management software, such as YUM or PackageKit. Although RPM provides its own command-line interface, most users need to interact with RPM only through this software. However, when building RPM packages, you must use the RPM utilities such as **rpmbuild(8)**.

## 1.1. RPM PACKAGES

An RPM package consists of an archive of files and metadata used to install and erase these files. Specifically, the RPM package contains the following parts:

### GPG signature

The GPG signature is used to verify the integrity of the package.

### Header (package metadata)

The RPM package manager uses this metadata to determine package dependencies, where to install files, and other information.

### Payload

The payload is a **cpio** archive that contains files to install to the system.

There are two types of RPM packages. Both types share the file format and tooling, but have different contents and serve different purposes:

- Source RPM (SRPM)

An SRPM contains source code and a **spec** file, which describes how to build the source code into a binary RPM. Optionally, the SRPM can contain patches to source code.

### Binary RPM

A binary RPM contains the binaries built from the sources and patches.

## 1.2. LISTING RPM PACKAGING UTILITIES

In addition to the **rpmbuild(8)** program for building packages, RPM provides other utilities to make the process of creating packages easier. You can find these programs in the **rpmdevtools** package.

### Prerequisites

- The **rpmdevtools** package has been installed:

```
# yum install rpmdevtools
```

### Procedure

- Use one of the following methods to list RPM packaging utilities:
  - To list certain utilities provided by the **rpmdevtools** package and their short descriptions, enter:

```
$ rpm -qi rpmdevtools
```

- To list all utilities, enter:

```
$ rpm -ql rpmdevtools | grep ^/usr/bin
```

### Additional resources

- RPM utilities man pages

## CHAPTER 2. CREATING SOFTWARE FOR RPM PACKAGING

To prepare software for RPM packaging, you must understand what source code is and how to create software.

### 2.1. WHAT IS SOURCE CODE

Source code is human-readable instructions to the computer that describe how to perform a computation. Source code is expressed by using a programming language.

The following versions of the **Hello World** program written in three different programming languages cover major RPM Package Manager use cases:

- **Hello World** written in Bash  
The *bello* project implements **Hello World** in [Bash](#). The implementation contains only the **bello** shell script. The purpose of this program is to output **Hello World** on the command line.

The **bello** file has the following contents:

```
#!/bin/bash

printf "Hello World\n"
```

- **Hello World** written in Python  
The *pello* project implements **Hello World** in [Python](#). The implementation contains only the **pello.py** program. The purpose of the program is to output **Hello World** on the command line.

The **pello.py** file has the following contents:

```
#!/usr/bin/python3

print("Hello World")
```

- **Hello World** written in C  
The *cello* project implements **Hello World** in C. The implementation contains only the **cello.c** and **Makefile** files. The resulting **tar.gz** archive therefore has two files in addition to the **LICENSE** file. The purpose of the program is to output **Hello World** on the command line.

The **cello.c** file has the following contents:

```
#include <stdio.h>

int main(void) {
    printf("Hello World\n");
    return 0;
}
```



#### NOTE

The packaging process is different for each version of the **Hello World** program.

### 2.2. METHODS OF CREATING SOFTWARE

You can convert the human-readable source code into machine code by using one of the following methods:

- Natively compile software.
- Interpret software by using a language interpreter or language virtual machine. You can either raw-interpret or byte-compile software.

### 2.2.1. Natively compiled software

Natively compiled software is software written in a programming language that compiles to machine code with a resulting binary executable file. Natively compiled software is standalone software.



#### NOTE

Natively compiled RPM packages are architecture-specific.

If you compile such software on a computer that uses a 64-bit (x86\_64) AMD or Intel processor, it does not run on a 32-bit (x86) AMD or Intel processor. The resulting package has the architecture specified in its name.

### 2.2.2. Interpreted software

Some programming languages, such as [Bash](#) or [Python](#), do not compile to machine code. Instead, a language interpreter or a language virtual machine executes the programs' source code step-by-step without prior transformations.

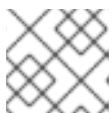


#### NOTE

Software written entirely in interpreted programming languages is not architecture-specific. Therefore, the resulting RPM package has the **noarch** string in its name.

You can either raw-interpret or byte-compile software written in interpreted languages:

- Raw-interpreted software  
You do not need to compile this type of software. Raw-interpreted software is directly executed by the interpreter.
- Byte-compiled software  
You must first compile this type of software into bytecode, which is then executed by the language virtual machine.



#### NOTE

Some byte-compiled languages can be either raw-interpreted or byte-compiled.

Note that the way you build and package software by using RPM is different for these two software types.

## 2.3. BUILDING SOFTWARE FROM SOURCE

During the software building process, the source code is turned into software artifacts that you can package by using RPM.

### 2.3.1. Building software from natively compiled code

You can build software written in a compiled language into an executable by using one of the following methods:

- Manual building
- Automated building

#### 2.3.1.1. Manually building a sample C program

You can use manual building to build software written in a compiled language.

A sample **Hello World** program written in C ( **cello.c** ) has the following contents:

```
#include <stdio.h>

int main(void) {
    printf("Hello World\n");
    return 0;
}
```

#### Procedure

1. Invoke the C compiler from the [GNU Compiler Collection](#) to compile the source code into binary:

```
$ gcc -g -o cello cello.c
```

2. Run the resulting binary **cello**:

```
$ ./cello
Hello World
```

#### 2.3.1.2. Setting up automated building for a sample C program

Large-scale software commonly uses automated building. You can set up automated building by creating the **Makefile** file and then running the [GNU make](#) utility.

#### Procedure

1. Create the **Makefile** file with the following content in the same directory as **cello.c**:

```
cello:
    gcc -g -o cello cello.c
clean:
    rm cello
```

Note that the lines under **cello:** and **clean:** must begin with a tabulation character (tab).

2. Build the software:

```
$ make
make: 'cello' is up to date.
```

3. Because a build is already available in the current directory, enter the **make clean** command, and then enter the **make** command again:

```
$ make clean
rm cello

$ make
gcc -g -o cello cello.c
```

Note that trying to build the program again at this point has no effect because the GNU **make** system detects the existing binary:

```
$ make
make: 'cello' is up to date.
```

4. Run the program:

```
$ ./cello
Hello World
```

### 2.3.2. Interpreting source code

You can convert the source code written in an interpreted programming language into machine code by using one of the following methods:

- Byte-compiling  
The procedure for byte-compiling software varies depending on the following factors:
  - Programming language
  - Language's virtual machine
  - Tools and processes used with that language



#### NOTE

You can byte-compile software written, for example, in [Python](#). Python software intended for distribution is often byte-compiled, but not in the way described in this document. The described procedure aims not to conform to the community standards, but to be simple. For real-world Python guidelines, see [Software Packaging and Distribution](#).

You can also raw-interpret Python source code. However, the byte-compiled version is faster. Therefore, RPM packagers prefer to package the byte-compiled version for distribution to end users.

- Raw-interpreting  
Software written in shell scripting languages, such as [Bash](#), is always executed by raw-interpreting.



### 2.3.2.1. Byte-compiling a sample Python program

By choosing byte-compiling over raw-interpreting of Python source code, you can create faster software.

A sample **Hello World** program written in the [Python](#) programming language (**pello.py**) has the following contents:

```
print("Hello World")
```

#### Procedure

1. Byte-compile the **pello.py** file:

```
$ python -m compileall pello.py
```

2. Verify that a byte-compiled version of the file is created:

```
$ ls __pycache__
pello.cpython-311.pyc
```

Note that the package version in the output might differ depending on which Python version is installed.

3. Run the program in **pello.py**:

```
$ python pello.py
Hello World
```

### 2.3.2.2. Raw-interpreting a sample Bash program

A sample **Hello World** program written in [Bash](#) shell built-in language (**bello**) has the following contents:

```
#!/bin/bash
printf "Hello World\n"
```



#### NOTE

The **shebang** (**#!**) sign at the top of the **bello** file is not part of the programming language source code.

Use the **shebang** to turn a text file into an executable. The system program loader parses the line containing the **shebang** to get a path to the binary executable, which is then used as the programming language interpreter.

#### Procedure

1. Make the file with source code executable:

```
$ chmod +x bello
```

2. Run the created file:

```
█ $.bello  
Hello World
```

## CHAPTER 3. PREPARING SOFTWARE FOR RPM PACKAGING

To prepare a piece of software for packaging with RPM, you can first patch the software, create a LICENSE file for it, and archive it as a tarball.

### 3.1. PATCHING SOFTWARE

When packaging software, you might need to make certain changes to the original source code, such as fixing a bug or changing a configuration file. In RPM packaging, you can instead leave the original source code intact and apply patches on it.

A patch is a piece of text that updates a source code file. The patch has a *diff* format, because it represents the difference between two versions of the text. You can create a patch by using the **diff** utility, and then apply the patch to the source code by using the **patch** utility.



#### NOTE

Software developers often use Version Control Systems such as [Git](#) to manage their code base. Such tools offer their own methods of creating diffs or patching software.

#### 3.1.1. Creating a patch file for a sample C program

You can create a patch from the original source code by using the **diff** utility. For example, to patch a **Hello world** program written in C (**cello.c**), complete the following steps.

##### Prerequisites

- You installed the **diff** utility on your system:

```
# yum install diffutils
```

##### Procedure

- Back up the original source code:

```
$ cp -p cello.c cello.c.orig
```

The **-p** option preserves mode, ownership, and timestamps.

- Modify **cello.c** as needed:

```
#include <stdio.h>

int main(void) {
    printf("Hello World from my very first patch!\n");
    return 0;
}
```

- Generate a patch:

```
$ diff -Naur cello.c.orig cello.c
--- cello.c.orig      2016-05-26 17:21:30.478523360 -0500
+ cello.c            2016-05-27 14:53:20.668588245 -0500
```

```
@@ -1,6 +1,6 @@
#include<stdio.h>

int main(void){
- printf("Hello World!\n");
+ printf("Hello World from my very first patch!\n");
  return 0;
}
\ No newline at end of file
```

Lines that start with **+** replace the lines that start with **-**.



## NOTE

Using the **Naur** options with the **diff** command is recommended because it fits the majority of use cases:

- **-N (--new-file)**  
The **-N** option handles absent files as empty files.
- **-a (--text)**  
The **-a** option treats all files as text. As a result, the **diff** utility does not ignore the files it classified as binaries.
- **-u (-U NUM or --unified[=NUM])**  
The **-u** option returns output in the form of output NUM (default 3) lines of unified context. This is a compact and an easily readable format commonly used in patch files.
- **-r (--recursive)**  
The **-r** option recursively compares any subdirectories that the **diff** utility found.

However, note that in this particular case, only the **-u** option is necessary.

4. Save the patch to a file:

```
$ diff -Naur cello.c.orig cello.c > cello.patch
```

5. Restore the original **cello.c**:

```
$ mv cello.c.orig cello.c
```



## IMPORTANT

You must retain the original **cello.c** because the RPM package manager uses the original file, not the modified one, when building an RPM package. For more information, see [Working with spec files](#).

## Additional resources

- **diff(1)** man page

### 3.1.2. Patching a sample C program

To apply code patches on your software, you can use the **patch** utility.

#### Prerequisites

- You installed the **patch** utility on your system:

```
# yum install patch
```

- You created a patch from the original source code. For instructions, see [Creating a patch file for a sample C program](#).

#### Procedure

The following steps apply a previously created **cello.patch** file on the **cello.c** file.

1. Redirect the patch file to the **patch** command:

```
$ patch < cello.patch
patching file cello.c
```

2. Check that the contents of **cello.c** now reflect the desired change:

```
$ cat cello.c
#include<stdio.h>

int main(void){
    printf("Hello World from my very first patch!\n");
    return 1;
}
```

#### Verification

1. Build the patched **cello.c** program:

```
$ make
gcc -g -o cello cello.c
```

2. Run the built **cello.c** program:

```
$ ./cello
Hello World from my very first patch!
```

## 3.2. CREATING A LICENSE FILE

It is recommended that you distribute your software with a software license.

A software license file informs users of what they can and cannot do with a source code. Having no license for your source code means that you retain all rights to this code and no one can reproduce, distribute, or create derivative works from your source code.

#### Procedure

- Create the **LICENSE** file with the required license statement:

```
$ vim LICENSE
```

### Example 3.1. Example **GPLv3 LICENSE** file text

```
$ cat /tmp/LICENSE
```

This program is free software: you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation, either version 3 of the License, or (at your option) any later version.

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### Additional resources

- [Source code examples](#)

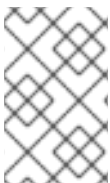
## 3.3. CREATING A SOURCE CODE ARCHIVE FOR DISTRIBUTION

An archive file is a file with the **.tar.gz** or **.tgz** suffix. Putting source code into the archive is a common way to release the software to be later packaged for distribution.

### 3.3.1. Creating a source code archive for a sample Bash program

The *bello* project is a **Hello World** file in [Bash](#).

The following example contains only the **bello** shell script. Therefore, the resulting **tar.gz** archive has only one file in addition to the **LICENSE** file.



#### NOTE

The **patch** file is not distributed in the archive with the program. The RPM package manager applies the patch when the RPM is built. The patch will be placed into the `~/rpmbuild/SOURCES/` directory together with the **tar.gz** archive.

### Prerequisites

- Assume that the **0.1** version of the **bello** program is used.
- You created a **LICENSE** file. For instructions, see [Creating a LICENSE file](#).

### Procedure

1. Move all required files into a single directory:

```
$ mkdir bello-0.1
```

```
$ mv ~/bello bello-0.1/
```

```
$ mv LICENSE bello-0.1/
```

2. Create the archive for distribution:

```
$ tar -cvzf bello-0.1.tar.gz bello-0.1
bello-0.1/
bello-0.1/LICENSE
bello-0.1/bello
```

3. Move the created archive to the `~/rpmbuild/SOURCES/` directory, which is the default directory where the `rpmbuild` command stores the files for building packages:

```
$ mv bello-0.1.tar.gz ~/rpmbuild/SOURCES/
```

### Additional resources

- [Hello World written in bash](#)

### 3.3.2. Creating a source code archive for a sample Python program

The *pello* project is a **Hello World** file in [Python](#).

The following example contains only the **pello.py** program. Therefore, the resulting **tar.gz** archive has only one file in addition to the **LICENSE** file.



#### NOTE

The **patch** file is not distributed in the archive with the program. The RPM package manager applies the patch when the RPM is built. The patch will be placed into the `~/rpmbuild/SOURCES/` directory together with the **tar.gz** archive.

### Prerequisites

- Assume that the **0.1.1** version of the **pello** program is used.
- You created a **LICENSE** file. For instructions, see [Creating a LICENSE file](#).

### Procedure

1. Move all required files into a single directory:

```
$ mkdir pello-0.1.1
```

```
$ mv pello.py pello-0.1.1/
```

```
$ mv LICENSE pello-0.1.1/
```

2. Create the archive for distribution:

```
$ tar -cvzf pello-0.1.1.tar.gz pello-0.1.1/
```

```
pello-0.1.1/LICENSE
pello-0.1.1/pello.py
```

3. Move the created archive to the `~/rpmbuild/SOURCES/` directory, which is the default directory where the `rpmbuild` command stores the files for building packages:

```
$ mv pello-0.1.1.tar.gz ~/rpmbuild/SOURCES/
```

### Additional resources

- [Hello World written in Python](#)

### 3.3.3. Creating a source code archive for a sample C program

The `cello` project is a **Hello World** file in C.

The following example contains only the `cello.c` and the `Makefile` files. Therefore, the resulting `tar.gz` archive has two files in addition to the `LICENSE` file.



#### NOTE

The `patch` file is not distributed in the archive with the program. The RPM package manager applies the patch when the RPM is built. The patch will be placed into the `~/rpmbuild/SOURCES/` directory together with the `tar.gz` archive.

### Prerequisites

- Assume that the **1.0** version of the `cello` program is used.
- You created a `LICENSE` file. For instructions, see [Creating a LICENSE file](#).

### Procedure

1. Move all required files into a single directory:

```
$ mkdir cello-1.0
$ mv cello.c cello-1.0/
$ mv Makefile cello-1.0/
$ mv LICENSE cello-1.0/
```

2. Create the archive for distribution:

```
$ tar -cvzf cello-1.0.tar.gz cello-1.0
cello-1.0/
cello-1.0/Makefile
cello-1.0/cello.c
cello-1.0/LICENSE
```

3. Move the created archive to the `~/rpmbuild/SOURCES/` directory, which is the default directory where the `rpmbuild` command stores the files for building packages:

-



```
█ $ mv cello-1.0.tar.gz ~/rpmbuild/SOURCES/
```

### Additional resources

- [Hello World written in C](#)

## CHAPTER 4. PACKAGING SOFTWARE

In the following sections, learn the basics of the packaging process with the RPM package manager.

### 4.1. SETTING UP RPM PACKAGING WORKSPACE

To build RPM packages, you must first create a special workspace that consists of directories used for different packaging purposes.

#### 4.1.1. Configuring RPM packaging workspace

To configure the RPM packaging workspace, you can set up a directory layout by using the **rpmdev-setuptree** utility.

##### Prerequisites

- You installed the **rpmdevtools** package, which provides utilities for packaging RPMs:

```
# yum install rpmdevtools
```

##### Procedure

- Run the **rpmdev-setuptree** utility:

```
$ rpmdev-setuptree

$ tree ~/rpmbuild/
/home/user/rpmbuild/
|-- BUILD
|-- RPMS
|-- SOURCES
|-- SPECS
`-- SRPMS

5 directories, 0 files
```

##### Additional resources

- [RPM packaging workspace directories](#)

#### 4.1.2. RPM packaging workspace directories

The following are the RPM packaging workspace directories created by using the **rpmdev-setuptree** utility:

Table 4.1. RPM packaging workspace directories

Directory	Purpose
<b>BUILD</b>	Contains build artifacts compiled from the source files from the <b>SOURCES</b> directory.

Directory	Purpose
<b>RPMS</b>	Binary RPMs are created under the <b>RPMS</b> directory in subdirectories for different architectures. For example, in the <b>x86_64</b> or <b>noarch</b> subdirectory.
<b>SOURCES</b>	Contains compressed source code archives and patches. The <b>rpmbuild</b> command then searches for these archives and patches in this directory.
<b>SPECS</b>	Contains <b>spec</b> files created by the packager. These files are then used for building packages.
<b>SRPMS</b>	When you use the <b>rpmbuild</b> command to build an SRPM instead of a binary RPM, the resulting SRPM is created under this directory.

## 4.2. ABOUT SPEC FILES

A **spec** file is a file with instructions that the **rpmbuild** utility uses to build an RPM package. This file provides necessary information to the build system by defining instructions in a series of sections. These sections are defined in the *Preamble* and the *Body* part of the **spec** file:

- The *Preamble* section contains a series of metadata items that are used in the *Body* section.
- The *Body* section represents the main part of the instructions.

### 4.2.1. Preamble items

The following are some of the directives that you can use in the *Preamble* section of the RPM **spec** file.

**Table 4.2.** The *Preamble* section directives

Directive	Definition
<b>Name</b>	A base name of the package that must match the <b>spec</b> file name.
<b>Version</b>	An upstream version number of the software.
<b>Release</b>	The number of times the version of the package was released.  Set the initial value to <b>1%{?dist}</b> and increase it with each new release of the package. Reset to <b>1</b> when a new <b>Version</b> of the software is built.
<b>Summary</b>	A brief one-line summary of the package.

Directive	Definition
<b>License</b>	<p>A license of the software being packaged.</p> <p>The exact format for how to label the <b>License</b> in your <b>spec</b> file varies depending on which RPM-based Linux distribution guidelines you are following, for example, <a href="#">GPLv3+</a>.</p>
<b>URL</b>	A full URL for more information about the software, for example, an upstream project website for the software being packaged.
<b>Source</b>	<p>A path or URL to the compressed archive of the unpatched upstream source code. This link must point to an accessible and reliable storage of the archive, for example, the upstream page, not the packager's local storage.</p> <p>You can apply the <b>Source</b> directive either with or without numbers at the end of the directive name. If there is no number given, the number is assigned to the entry internally. You can also give the numbers explicitly, for example, <b>Source0</b>, <b>Source1</b>, <b>Source2</b>, <b>Source3</b>, and so on.</p>
<b>Patch</b>	<p>A name of the first patch to apply to the source code, if necessary.</p> <p>You can apply the <b>Patch</b> directive either with or without numbers at the end of the directive name. If there is no number given, the number is assigned to the entry internally. You can also give the numbers explicitly, for example, <b>Patch0</b>, <b>Patch1</b>, <b>Patch2</b>, <b>Patch3</b>, and so on.</p> <p>You can apply the patches individually by using the <b>%patch0</b>, <b>%patch1</b>, <b>%patch2</b> macro, and so on. Macros are applied within the <b>%prep</b> directive in the <i>Body</i> section of the RPM <b>spec</b> file. Alternatively, you can use the <b>%autopatch</b> macro that automatically applies all patches in the order they are given in the <b>spec</b> file.</p>
<b>BuildArch</b>	<p>An architecture that the software will be built for.</p> <p>If the software is not architecture-dependent, for example, if you wrote the software entirely in an interpreted programming language, set the value to <b>BuildArch: noarch</b>. If you do not set this value, the software automatically inherits the architecture of the machine on which it is built, for example, <b>x86_64</b>.</p>
<b>BuildRequires</b>	A comma- or whitespace-separated list of packages required to build the program written in a compiled language. There can be multiple entries of <b>BuildRequires</b> , each on its own line in the SPEC file.
<b>Requires</b>	A comma- or whitespace-separated list of packages required by the software to run once installed. There can be multiple entries of <b>Requires</b> , each on its own line in the <b>spec</b> file.

Directive	Definition
<b>ExcludeArch</b>	If a piece of software cannot operate on a specific processor architecture, you can exclude this architecture in the <b>ExcludeArch</b> directive.
<b>Conflicts</b>	A comma- or whitespace-separated list of packages that must not be installed on the system in order for your software to function properly when installed. There can be multiple entries of <b>Conflicts</b> , each on its own line in the <b>spec</b> file.
<b>Obsoletes</b>	The <b>Obsoletes</b> directive changes the way updates work depending on the following factors: <ul style="list-style-type: none"> <li>• If you use the <b>rpm</b> command directly on a command line, it removes all packages that match obsoletes of packages being installed, or the update is performed by an updates or dependency solver.</li> <li>• If you use the updates or dependency resolver (<b>YUM</b>), packages containing matching <b>Obsoletes:</b> are added as updates and replace the matching packages.</li> </ul>
<b>Provides</b>	If you add the <b>Provides</b> directive to the package, this package can be referred to by dependencies other than its name.

The **Name**, **Version**, and **Release** (**NVR**) directives comprise the file name of the RPM package in the **name-version-release** format.

You can display the **NVR** information for a specific package by querying RPM database by using the **rpm** command, for example:

```
# rpm -q bash
bash-4.4.19-7.el8.x86_64
```

Here, **bash** is the package name, **4.4.19** is the version, and **7.el8** is the release. The **x86\_64** marker is the package architecture. Unlike **NVR**, the architecture marker is not under direct control of the RPM packager, but is defined by the **rpmbuild** build environment. The exception to this is the architecture-independent **noarch** package.

## 4.2.2. Body items

The following are the items used in the *Body* section of the RPM **spec** file.

Table 4.3. The Body section items

Directive	Definition
<b>%description</b>	A full description of the software packaged in the RPM. This description can span multiple lines and can be broken into paragraphs.

Directive	Definition
<b>%prep</b>	A command or series of commands to prepare the software for building, for example, for unpacking the archive in the <b>Source</b> directive. The <b>%prep</b> directive can contain a shell script.
<b>%build</b>	A command or series of commands for building the software into machine code (for compiled languages) or bytecode (for some interpreted languages).
<b>%install</b>	<p>A command or series of commands that the <b>rpmbuild</b> utility will use to install the software into the <b>BUILDROOT</b> directory once the software has been built. These commands copy the desired build artifacts from the <b>%_builddir</b> directory, where the build happens, to the <b>%buildroot</b> directory that contains the directory structure with the files to be packaged. This includes copying files from <b>~/rpmbuild/BUILD</b> to <b>~/rpmbuild/BUILDROOT</b> and creating the necessary directories in <b>~/rpmbuild/BUILDROOT</b>.</p> <p>The <b>%install</b> directory is an empty <b>chroot</b> base directory, which resembles the end user's <b>root</b> directory. Here you can create any directories that will contain the installed files. To create such directories, you can use RPM macros without having to hardcode the paths.</p> <p>Note that <b>%install</b> is only run when you create a package, not when you install it. For more information, see <a href="#">Working with spec files</a></p>
<b>%check</b>	A command or series of commands for testing the software, for example, unit tests.
<b>%files</b>	<p>A list of files, provided by the RPM package, to be installed in the user's system and their full path location on the system.</p> <p>During the build, if there are files in the <b>%buildroot</b> directory that are not listed in <b>%files</b>, you will receive a warning about possible unpackaged files.</p> <p>Within the <b>%files</b> section, you can indicate the role of various files by using built-in macros. This is useful for querying the package file manifest metadata by using the <b>rpm</b> command. For example, to indicate that the <b>LICENSE</b> file is a software license file, use the <b>%license</b> macro.</p>
<b>%changelog</b>	A record of changes that happened to the package between different <b>Version</b> or <b>Release</b> builds. These changes include a list of date-stamped entries for each Version-Release of the package. These entries log packaging changes, not software changes, for example, adding a patch or changing the build procedure in the <b>%build</b> section.

### 4.2.3. Advanced items

A **spec** file can contain advanced items, such as [Scriptlets](#) or [Triggers](#).

Scriptlets and Triggers take effect at different points during the installation process on the end user's system, not the build process.

## 4.3. BUILDROOTS

In the context of RPM packaging, **buildroot** is a chroot environment. The build artifacts are placed here by using the same file system hierarchy as the future hierarchy in the end user's system, with **buildroot** acting as the root directory. The placement of build artifacts must comply with the file system hierarchy standard of the end user's system.

The files in **buildroot** are later put into a **cpio** archive, which becomes the main part of the RPM. When RPM is installed on the end user's system, these files are extracted in the **root** directory, preserving the correct hierarchy.



### NOTE

The **rpmbuild** program has its own defaults. Overriding these defaults can cause certain issues. Therefore, avoid defining your own value of the **buildroot** macro. Use the default **%{buildroot}** macro instead.

## 4.4. RPM MACROS

An **rpm macro** is a straight text substitution that can be conditionally assigned based on the optional evaluation of a statement when certain built-in functionality is used. Therefore, RPM can perform text substitutions for you.

For example, you can define *Version* of the packaged software only once in the **%{version}** macro, and use this macro throughout the **spec** file. Every occurrence is automatically substituted by *Version* that you defined in the macro.



### NOTE

If you see an unfamiliar macro, you can evaluate it with the following command:

```
$ rpm --eval %{MACRO}
```

For example, to evaluate the **%{\_bindir}** and **%{\_libexecdir}** macros, enter:

```
$ rpm --eval %{_bindir}
/usr/bin
```

```
$ rpm --eval %{_libexecdir}
/usr/libexec
```

### Additional resources

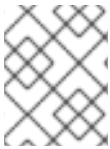
- [More on macros](#)

## 4.5. WORKING WITH SPEC FILES

To package new software, you must create a **spec** file. You can create the **spec** file either of the following ways:

- Write the new **spec** file manually from scratch.

- Use the **rpmdev-newspec** utility. This utility creates an unpopulated **spec** file, where you fill the necessary directives and fields.



## NOTE

Some programmer-focused text editors pre-populate a new **spec** file with their own **spec** template. The **rpmdev-newspec** utility provides an editor-agnostic method.

### 4.5.1. Creating a new spec file for sample Bash, C, and Python programs

You can create a **spec** file for each of the three implementations of the **Hello World!** program by using the **rpmdev-newspec** utility.

#### Prerequisites

- The following **Hello World!** program implementations were placed into the `~/rpmbuild/SOURCES` directory:
  - [bello-0.1.tar.gz](#)
  - [pello-0.1.2.tar.gz](#)
  - [cello-1.0.tar.gz](#) ([cello-output-first-patch.patch](#))

#### Procedure

1. Navigate to the `~/rpmbuild/SPECS` directory:

```
$ cd ~/rpmbuild/SPECS
```

2. Create a **spec** file for each of the three implementations of the **Hello World!** program:

```
$ rpmdev-newspec bello
bello.spec created; type minimal, rpm version >= 4.11.
```

```
$ rpmdev-newspec cello
cello.spec created; type minimal, rpm version >= 4.11.
```

```
$ rpmdev-newspec pello
pello.spec created; type minimal, rpm version >= 4.11.
```

The `~/rpmbuild/SPECS/` directory now contains three **spec** files named **bello.spec**, **cello.spec**, and **pello.spec**.

3. Examine the created files.  
The directives in the files represent those described in [About spec files](#). In the following sections, you will populate particular section in the output files of **rpmdev-newspec**.

### 4.5.2. Modifying an original spec file

The original output **spec** file generated by the **rpmdev-newspec** utility represents a template that you must modify to provide necessary instructions for the **rpmbuild** utility. **rpmbuild** then uses these instructions to build an RPM package.



## Prerequisites

- The unpopulated `~/rpmbuild/SPECS/<name>.spec` **spec** file was created by using the **rpmdev-newspec** utility. For more information, see [Creating a new spec file for sample Bash, C, and Python programs](#).

## Procedure

1. Open the `~/rpmbuild/SPECS/<name>.spec` file provided by the **rpmdev-newspec** utility.
2. Populate the following directives of the **spec** file *Preamble* section:

### Name

**Name** was already specified as an argument to **rpmdev-newspec**.

### Version

Set **Version** to match the upstream release version of the source code.

### Release

**Release** is automatically set to `1%{?dist}`, which is initially **1**.

### Summary

Enter a one-line explanation of the package.

### License

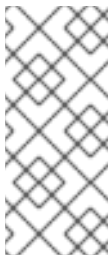
Enter the software license associated with the source code.

### URL

Enter the URL to the upstream software website. For consistency, utilize the `%{name}` RPM macro variable and use the `https://example.com/%{name}` format.

### Source

Enter the URL to the upstream software source code. Link directly to the software version being packaged.



### NOTE

The example URLs in this documentation include hard-coded values that could possibly change in the future. Similarly, the release version can change as well. To simplify these potential future changes, use the `%{name}` and `%{version}` macros. By using these macros, you need to update only one field in the **spec** file.

### BuildRequires

Specify build-time dependencies for the package.

### Requires

Specify run-time dependencies for the package.

### BuildArch

Specify the software architecture.

3. Populate the following directives of the **spec** file *Body* section. You can think of these directives as section headings, because these directives can define multi-line, multi-instruction, or scripted tasks to occur.

### %description

Enter the full description of the software.

### **%prep**

Enter a command or series of commands to prepare software for building.

### **%build**

Enter a command or series of commands for building software.

### **%install**

Enter a command or series of commands that instruct the **rpmbuild** command on how to install the software into the **BUILDROOT** directory.

### **%files**

Specify the list of files, provided by the RPM package, to be installed on your system.

### **%changelog**

Enter the list of dated entries for each **Version-Release** of the package.

Start the first line of the **%changelog** section with an asterisk ( **\*** ) character followed by **Day-of-Week Month Day Year Name Surname <email> - Version-Release**.

For the actual change entry, follow these rules:

- Each change entry can contain multiple items, one for each change.
- Each item starts on a new line.
- Each item begins with a hyphen ( **-** ) character.

You have now written an entire **spec** file for the required program.

### **Additional resources**

- [Preamble items](#)
- [Body items](#)
- [An example spec file for a sample Bash program](#)
- [An example spec file for a sample Python program](#)
- [An example spec file for a sample C program](#)
- [Building RPMs](#)

### **4.5.3. An example spec file for a sample Bash program**

You can use the following example **spec** file for the **bello** program written in bash for your reference.

#### **An example spec file for the **bello** program written in bash**

```
Name:      bello
Version:   0.1
Release:   1%{?dist}
Summary:   Hello World example implemented in bash script

License:   GPLv3+
```

```

URL:      https://www.example.com/{name}
Source0:  https://www.example.com/{name}/releases/{name}-{version}.tar.gz

Requires:  bash

BuildArch: noarch

%description
The long-tail description for our Hello World Example implemented in
bash script.

%prep
%setup -q

%build

%install

mkdir -p %{buildroot}/%{_bindir}

install -m 0755 %{name} %{buildroot}/%{_bindir}/%{name}

%files
%license LICENSE
%{_bindir}/%{name}

%changelog
* Tue May 31 2016 Adam Miller <maxamillion@fedoraproject.org> - 0.1-1
- First bello package
- Example second item in the changelog for version-release 0.1-1

```

- The **BuildRequires** directive, which specifies build-time dependencies for the package, was deleted because there is no building step for **bello**. Bash is a raw interpreted programming language, and the files are just installed to their location on the system.
- The **Requires** directive, which specifies run-time dependencies for the package, includes only **bash**, because the **bello** script requires only the **bash** shell environment to execute.
- The **%build** section, which specifies how to build the software, is blank, because the **bash** script does not need to be built.



#### NOTE

To install **bello**, you must create the destination directory and install the executable **bash** script file there. Therefore, you can use the **install** command in the **%install** section. You can use RPM macros to do this without hardcoding paths.

#### Additional resources

- [What is source code](#)

#### 4.5.4. An example spec file for a sample Python program

You can use the following example **spec** file for the **pello** program written in the Python programming language for your reference.

An example spec file for the `pello` program written in Python

```

Name:      pello
Version:   0.1.1
Release:   1%{?dist}
Summary:   Hello World example implemented in Python

License:   GPLv3+
URL:       https://www.example.com/%{name}
Source0:   https://www.example.com/%{name}/releases/%{name}-%{version}.tar.gz

BuildRequires: python
Requires:   python
Requires:   bash

BuildArch:  noarch

%description
The long-tail description for our Hello World Example implemented in Python.

%prep
%setup -q

%build

python -m compileall %{name}.py

%install

mkdir -p %{buildroot}/%{_bindir}
mkdir -p %{buildroot}/usr/lib/%{name}

cat > %{buildroot}/%{_bindir}/%{name} <<EOF
#!/bin/bash
/usr/bin/python /usr/lib/%{name}/%{name}.pyc
EOF

chmod 0755 %{buildroot}/%{_bindir}/%{name}

install -m 0644 %{name}.py* %{buildroot}/usr/lib/%{name}/

%files
%license LICENSE
%dir /usr/lib/%{name}/
%{_bindir}/%{name}
/usr/lib/%{name}/%{name}.py*

%changelog
* Tue May 31 2016 Adam Miller <maxamillion@fedoraproject.org> - 0.1.1-1
- First pello package

```

- The **Requires** directive, which specifies run-time dependencies for the package, includes two packages:
  - The **python** package required to execute the byte-compiled code at runtime.

- The **bash** package required to execute the small entry-point script.
- The **BuildRequires** directive, which specifies build-time dependencies for the package, includes only the **python** package. The **pello** program requires **python** to perform the byte-compile build process.
- The **%build** section, which specifies how to build the software, creates a byte-compiled version of the script. Note that in real-world packaging, it is usually done automatically, depending on the distribution used.
- The **%install** section corresponds to the fact that you must install the byte-compiled file into a library directory on the system so that it can be accessed.

This example of creating a wrapper script in-line in the **spec** file shows that the **spec** file itself is scriptable. This wrapper script executes the Python byte-compiled code by using the **here document**.

#### Additional resources

- [What is source code](#)

### 4.5.5. An example spec file for a sample C program

You can use the following example **spec** file for the **cello** program that was written in the C programming language for your reference.

#### An example spec file for the **cello** program written in C

```
Name:      cello
Version:   1.0
Release:   1%{?dist}
Summary:   Hello World example implemented in C

License:   GPLv3+
URL:       https://www.example.com/%{name}
Source0:   https://www.example.com/%{name}/releases/%{name}-%{version}.tar.gz

Patch0:    cello-output-first-patch.patch

BuildRequires: gcc
BuildRequires: make

%description
The long-tail description for our Hello World Example implemented in
C.

%prep
%setup -q

%patch0

%build
make %{?_smp_mflags}

%install
%make_install
```

```
%files
%license LICENSE
%{_bindir}/%{name}

%changelog
* Tue May 31 2016 Adam Miller <maxamillion@fedoraproject.org> - 1.0-1
- First cello package
```

- The **BuildRequires** directive, which specifies build-time dependencies for the package, includes the following packages required to perform the compilation build process:
  - **gcc**
  - **make**
- The **Requires** directive, which specifies run-time dependencies for the package, is omitted in this example. All runtime requirements are handled by **rpmbuild**, and the **cello** program does not require anything outside of the core C standard libraries.
- The **%build** section reflects the fact that in this example the **Makefile** file for the **cello** program was written. Therefore, you can use the [GNU make](#) command. However, you must remove the call to **%configure** because you did not provide a configure script.

You can install the **cello** program by using the **%make\_install** macro. This is possible because the **Makefile** file for the **cello** program is available.

#### Additional resources

- [What is source code](#)

## 4.6. BUILDING RPMS

You can build RPM packages by using the **rpmbuild** command. When using this command, a certain directory and file structure is expected, which is the same as the structure that was set up by the **rpmdev-setuptree** utility.

Different use cases and desired outcomes require different combinations of arguments to the **rpmbuild** command. The following are the main use cases:

- Building source RPMs.
- Building binary RPMs:
  - Rebuilding a binary RPM from a source RPM.
  - Building a binary RPM from the **spec** file.

### 4.6.1. Building source RPMs

Building a Source RPM (SRPM) has the following advantages:

- You can preserve the exact source of a certain **Name-Version-Release** of an RPM file that was deployed to an environment. This includes the exact **spec** file, the source code, and all relevant patches. This is useful for tracking and debugging purposes.
- You can build a binary RPM on a different hardware platform or architecture.

## Prerequisites

- You have installed the **rpmbuild** utility on your system:

```
# yum install rpm-build
```

- The following **Hello World!** implementations were placed into the `~/rpmbuild/SOURCES/` directory:
  - [bello-0.1.tar.gz](#)
  - [pello-0.1.2.tar.gz](#)
  - [cello-1.0.tar.gz](#) ( [cello-output-first-patch.patch](#) )
- A **spec** file for the program that you want to package exists.

## Procedure

1. Navigate to the `~/rpmbuild/SPECS/` directive, which contains the created **spec** file:

```
$ cd ~/rpmbuild/SPECS/
```

2. Build the source RPM by entering the **rpmbuild** command with the specified **spec** file:

```
$ rpmbuild -bs <specfile>
```

The **-bs** option stands for the *build source*.

For example, to build source RPMs for the **bello**, **pello**, and **cello** programs, enter:

```
$ rpmbuild -bs bello.spec
Wrote: /home/admilller/rpmbuild/SRPMS/bello-0.1-1.el8.src.rpm

$ rpmbuild -bs pello.spec
Wrote: /home/admilller/rpmbuild/SRPMS/pello-0.1.2-1.el8.src.rpm

$ rpmbuild -bs cello.spec
Wrote: /home/admilller/rpmbuild/SRPMS/cello-1.0-1.el8.src.rpm
```

## Verification steps

- Verify that the **rpmbuild/SRPMS** directory includes the resulting source RPMs. The directory is a part of the structure expected by **rpmbuild**.

## Additional resources

- [Working with spec files](#)
- [Creating a new spec file for sample Bash, C, and Python programs](#)
- [Modifying an original spec file](#)

### 4.6.2. Rebuilding a binary RPM from a source RPM

To rebuild a binary RPM from a source RPM (SRPM), use the **rpmbuild** command with the **--rebuild** option.

The output generated when creating the binary RPM is verbose, which is helpful for debugging. The output varies for different examples and corresponds to their **spec** files.

The resulting binary RPMs are located in the **~/rpmbuild/RPMS/YOURARCH** directory, where **YOURARCH** is your architecture, or in the **~/rpmbuild/RPMS/noarch/** directory, if the package is not architecture-specific.

### Prerequisites

- You have installed the **rpmbuild** utility on your system:

```
# yum install rpm-build
```

### Procedure

1. Navigate to the **~/rpmbuild/SRPMS/** directive, which contains the source RPM:

```
$ cd ~/rpmbuild/SRPMS/
```

2. Rebuild the binary RPM from the source RPM:

```
$ rpmbuild --rebuild <srpm>
```

Replace *srpm* with the name of the source RPM file.

For example, to rebuild **bello**, **pello**, and **cello** from their SRPMs, enter:

```
$ rpmbuild --rebuild bello-0.1-1.el8.src.rpm  
[output truncated]
```

```
$ rpmbuild --rebuild pello-0.1.2-1.el8.src.rpm  
[output truncated]
```

```
$ rpmbuild --rebuild cello-1.0-1.el8.src.rpm  
[output truncated]
```



**NOTE**

Invoking **rpmbuild --rebuild** involves the following processes:

- Installing the contents of the SRPM (the **spec** file and the source code) into the `~/rpmbuild/` directory.
- Building an RPM by using the installed contents.
- Removing the **spec** file and the source code.

You can retain the **spec** file and the source code after building either of the following ways:

- When building the RPM, use the **rpmbuild** command with the **--recompile** option instead of the **--rebuild** option.
- Install SRPMs for **bello**, **pello**, and **cello**:

```
$ rpm -Uvh ~/rpmbuild/SRPMS/bello-0.1-1.el8.src.rpm
Updating / installing...
 1:bello-0.1-1.el8      [100%]
```

```
$ rpm -Uvh ~/rpmbuild/SRPMS/pello-0.1.2-1.el8.src.rpm
Updating / installing...
...1:pello-0.1.2-1.el8      [100%]
```

```
$ rpm -Uvh ~/rpmbuild/SRPMS/cello-1.0-1.el8.src.rpm
Updating / installing...
...1:cello-1.0-1.el8      [100%]
```

### 4.6.3. Building a binary RPM from the spec file

To build a binary RPM from its **spec** file, use the **rpmbuild** command with the **-bb** option.

#### Prerequisites

- You have installed the **rpmbuild** utility on your system:

```
# yum install rpm-build
```

#### Procedure

1. Navigate to the `~/rpmbuild/SPECS/` directive, which contains **spec** files:

```
$ cd ~/rpmbuild/SPECS/
```

2. Build the binary RPM from its **spec**:

```
$ rpmbuild -bb <spec_file>
```

For example, to build **bello**, **pello**, and **cello** binary RPMs from their **spec** files, enter:

```
$ rpmbuild -bb bello.spec
```

```
$ rpmbuild -bb pello.spec
```

```
$ rpmbuild -bb cello.spec
```

## 4.7. CHECKING RPMS FOR SANITY

After creating a package, you might want to check the quality of the package. The main tool for checking package quality is [rpmlint](#).

With the **rpmlint** tool, you can perform the following actions:

- Improve RPM maintainability.
- Enable sanity checking by performing static analysis of the RPM.
- Enable error checking by performing static analysis of the RPM.

You can use **rpmlint** to check binary RPMs, source RPMs (SRPMs), and **spec** files. Therefore, this tool is useful for all stages of packaging.

Note that **rpmlint** has strict guidelines. Therefore, it is sometimes acceptable to skip some of its errors and warnings as shown in the following sections.



### NOTE

In the examples described in the following sections, **rpmlint** is run without any options, which produces a non-verbose output. For detailed explanations of each error or warning, run **rpmlint -i** instead.

### 4.7.1. Checking a sample Bash program for sanity

In the following sections, investigate possible warnings and errors that can occur when checking an RPM for sanity on the example of the **bello spec** file and **bello** binary RPM.

#### 4.7.1.1. Checking the bello spec file for sanity

Inspect the outputs of the following examples to learn how to check a **bello spec** file for sanity.

##### Output of running the rpmlint command on the bello spec file

```
$ rpmlint bello.spec
bello.spec: W: invalid-url Source0: https://www.example.com/bello/releases/bello-0.1.tar.gz HTTP
Error 404: Not Found
0 packages and 1 specfiles checked; 0 errors, 1 warnings.
```

For **bello.spec**, there is only one **invalid-url Source0** warning. This warning means that the URL listed in the **Source0** directive is unreachable. This is expected, because the specified **example.com** URL does not exist. Assuming that this URL will be valid in the future, you can ignore this warning.

##### Output of running the rpmlint command on the bello SRPM

```
$ rpmlint ~/rpmbuild/SRPMs/bello-0.1-1.el8.src.rpm
bello.src: W: invalid-url URL: https://www.example.com/bello HTTP Error 404: Not Found
```

```
bello.src: W: invalid-url Source0: https://www.example.com/bello/releases/bello-0.1.tar.gz HTTP Error
404: Not Found
1 packages and 0 specfiles checked; 0 errors, 2 warnings.
```

For the **bello** SRPM, there is a new **invalid-url URL** warning that means that the URL specified in the **URL** directive is unreachable. Assuming that this URL will be valid in the future, you can ignore this warning.

#### 4.7.1.2. Checking the bello binary RPM for sanity

When checking binary RPMs, the **rpmlint** command checks the following items:

- Documentation
- Manual pages
- Consistent use of the filesystem hierarchy standard

Inspect the outputs of the following example to learn how to check a **bello** binary RPM for sanity.

#### Output of running the rpmlint command on the bello binary RPM

```
$ rpmlint ~/rpmbuild/RPMS/noarch/bello-0.1-1.el8.noarch.rpm
bello.noarch: W: invalid-url URL: https://www.example.com/bello HTTP Error 404: Not Found
bello.noarch: W: no-documentation
bello.noarch: W: no-manual-page-for-binary bello
1 packages and 0 specfiles checked; 0 errors, 3 warnings.
```

The **no-documentation** and **no-manual-page-for-binary** warnings mean that the RPM has no documentation or manual pages, because you did not provide any. Apart from the output warnings, the RPM passed **rpmlint** checks.

### 4.7.2. Checking a sample Python program for sanity

In the following sections, investigate possible warnings and errors that can occur when checking RPM sanity on the example of the **pello spec** file and **pello** binary RPM.

#### 4.7.2.1. Checking the pello spec file for sanity

Inspect the outputs of the following examples to learn how to check a **pello spec** file for sanity.

#### Output of running the rpmlint command on the pello spec file

```
$ rpmlint pello.spec
pello.spec:30: E: hardcoded-library-path in %{buildroot}/usr/lib/%{name}
pello.spec:34: E: hardcoded-library-path in /usr/lib/%{name}/%{name}.pyc
pello.spec:39: E: hardcoded-library-path in %{buildroot}/usr/lib/%{name}/
pello.spec:43: E: hardcoded-library-path in /usr/lib/%{name}/
pello.spec:45: E: hardcoded-library-path in /usr/lib/%{name}/%{name}.py*
pello.spec: W: invalid-url Source0: https://www.example.com/pello/releases/pello-0.1.2.tar.gz HTTP
Error 404: Not Found
0 packages and 1 specfiles checked; 5 errors, 1 warnings.
```

- The **invalid-url Source0** warning means that the URL listed in the **Source0** directive is unreachable. This is expected, because the specified **example.com** URL does not exist. Assuming that this URL will be valid in the future, you can ignore this warning.
- The **hardcoded-library-path** errors suggest using the `%{_libdir}` macro instead of hard-coding the library path. For the sake of this example, you can safely ignore these errors. However, for packages going into production, check all errors carefully.

### Output of running the `rpmlint` command on the SRPM for pello

```
$ rpmlint ~/rpmbuild/SRPMS/pello-0.1.2-1.el8.src.rpm
pello.src: W: invalid-url URL: https://www.example.com/pello HTTP Error 404: Not Found
pello.src:30: E: hardcoded-library-path in %{buildroot}/usr/lib/%{name}
pello.src:34: E: hardcoded-library-path in /usr/lib/%{name}/%{name}.pyc
pello.src:39: E: hardcoded-library-path in %{buildroot}/usr/lib/%{name}/
pello.src:43: E: hardcoded-library-path in /usr/lib/%{name}/
pello.src:45: E: hardcoded-library-path in /usr/lib/%{name}/%{name}.py*
pello.src: W: invalid-url Source0: https://www.example.com/pello/releases/pello-0.1.2.tar.gz HTTP
Error 404: Not Found
1 packages and 0 specfiles checked; 5 errors, 2 warnings.
```

The **invalid-url URL** error means that the URL mentioned in the **URL** directive is unreachable. Assuming that this URL will be valid in the future, you can ignore this warning.

#### 4.7.2.2. Checking the pello binary RPM for sanity

When checking binary RPMs, the `rpmlint` command checks the following items:

- Documentation
- Manual pages
- Consistent use of the Filesystem Hierarchy Standard

Inspect the outputs of the following example to learn how to check a **pello** binary RPM for sanity.

### Output of running the `rpmlint` command on the pello binary RPM

```
$ rpmlint ~/rpmbuild/RPMS/noarch/pello-0.1.2-1.el8.noarch.rpm
pello.noarch: W: invalid-url URL: https://www.example.com/pello HTTP Error 404: Not Found
pello.noarch: W: only-non-binary-in-usr-lib
pello.noarch: W: no-documentation
pello.noarch: E: non-executable-script /usr/lib/pello/pello.py 0644L /usr/bin/env
pello.noarch: W: no-manual-page-for-binary pello
1 packages and 0 specfiles checked; 1 errors, 4 warnings.
```

- The **no-documentation** and **no-manual-page-for-binary** warnings mean that the RPM has no documentation or manual pages because you did not provide any.
- The **only-non-binary-in-usr-lib** warning means that you provided only non-binary artifacts in the `/usr/lib/` directory. This directory is typically used for shared object files, which are binary files. Therefore, `rpmlint` expects at least one or more files in `/usr/lib/` to be binary. This is an example of an `rpmlint` check for compliance with Filesystem Hierarchy Standard. To ensure the correct placement of files, use RPM macros. For the sake of this example, you can safely ignore this warning.

- The **non-executable-script** error means that the `/usr/lib/pello/pello.py` file has no execute permissions. The **rpmlint** tool expects the file to be executable because the file contains the shebang (`#!`). For the purpose of this example, you can leave this file without execute permissions and ignore this error.

Apart from the output warnings and errors, the RPM passed **rpmlint** checks.

### 4.7.3. Checking a sample C program for sanity

In the following sections, investigate possible warnings and errors that can occur when checking RPM sanity on the example of the **cello spec** file and **cello** binary RPM.

#### 4.7.3.1. Checking the cello spec file for sanity

Inspect the outputs of the following examples to learn how to check a **cello spec** file for sanity.

##### Output of running the **rpmlint** command on the **cello spec** file

```
$ rpmlint ~/rpmbuild/SPECS/cello.spec
/home/admiller/rpmbuild/SPECS/cello.spec: W: invalid-url Source0:
https://www.example.com/cello/releases/cello-1.0.tar.gz HTTP Error 404: Not Found
0 packages and 1 specfiles checked; 0 errors, 1 warnings.
```

For **cello.spec**, there is only one **invalid-url Source0** warning. This warning means that the URL listed in the **Source0** directive is unreachable. This is expected because the specified **example.com** URL does not exist. Assuming that this URL will be valid in the future, you can ignore this warning.

##### Output of running the **rpmlint** command on the **cello SRPM**

```
$ rpmlint ~/rpmbuild/SRPMS/cello-1.0-1.el8.src.rpm
cello.src: W: invalid-url URL: https://www.example.com/cello HTTP Error 404: Not Found
cello.src: W: invalid-url Source0: https://www.example.com/cello/releases/cello-1.0.tar.gz HTTP Error
404: Not Found
1 packages and 0 specfiles checked; 0 errors, 2 warnings.
```

For the **cello** SRPM, there is a new **invalid-url URL** warning. This warning means that the URL specified in the **URL** directive is unreachable. Assuming that this URL will be valid in the future, you can ignore this warning.

#### 4.7.3.2. Checking the cello binary RPM for sanity

When checking binary RPMs, the **rpmlint** command checks the following items:

- Documentation
- Manual pages
- Consistent use of the filesystem hierarchy standard

Inspect the outputs of the following example to learn how to check a **cello** binary RPM for sanity.

##### Output of running the **rpmlint** command on the **cello** binary RPM

```
$ rpmlint ~/rpmbuild/RPMS/x86_64/cello-1.0-1.el8.x86_64.rpm
```

```
cello.x86_64: W: invalid-url URL: https://www.example.com/cello HTTP Error 404: Not Found
cello.x86_64: W: no-documentation
cello.x86_64: W: no-manual-page-for-binary cello
1 packages and 0 specfiles checked; 0 errors, 3 warnings.
```

The **no-documentation** and **no-manual-page-for-binary** warnings mean that the RPM has no documentation or manual pages because you did not provide any.

Apart from the output warnings, the RPM passed **rpmlint** checks.

## 4.8. LOGGING RPM ACTIVITY TO SYSLOG

You can log any RPM activity or transaction by using the System Logging protocol (**syslog**).

### Prerequisites

- The **syslog** plug-in is installed on the system:

```
# yum install rpm-plugin-syslog
```



### NOTE

The default location for the **syslog** messages is the **/var/log/messages** file. However, you can configure **syslog** to use another location to store the messages.

### Procedure

- Open the file that you configured to store the **syslog** messages. Alternatively, if you use the default **syslog** configuration, open the **/var/log/messages** file.
- Search for new lines including the **[RPM]** string.

## 4.9. EXTRACTING RPM CONTENT

In some cases, for example, if a package required by RPM is damaged, you might need to extract the content of the package. In such cases, if an RPM installation is still working despite the damage, you can use the **rpm2archive** utility to convert an **.rpm** file to a tar archive to use the content of the package.



### NOTE

If the RPM installation is severely damaged, you can use the **rpm2cpio** utility to convert the RPM package file to a **cpio** archive.

### Procedure

- Convert the RPM file to the tar archive:

```
$ rpm2archive <filename>.rpm
```

The resulting file has the **.tgz** suffix. For example, to create an archive from the **bash** package, enter:

```
■
```

```
$ rpm2archive bash-4.4.19-6.el8.x86_64.rpm  
$ ls bash-4.4.19-6.el8.x86_64.rpm.tgz  
bash-4.4.19-6.el8.x86_64.rpm.tgz
```

## CHAPTER 5. ADVANCED TOPICS

This section covers topics that are beyond the scope of the introductory tutorial but are useful in real-world RPM packaging.

### 5.1. SIGNING RPM PACKAGES

You can sign RPM packages to ensure that no third party can alter their content. To add an additional layer of security, use the HTTPS protocol when downloading the package.

You can sign a package by using the **--addsign** option provided by the **rpm-sign** package.

#### Prerequisites

- You have created a GNU Privacy Guard (GPG) key as described in [Creating a GPG key](#).

#### 5.1.1. Creating a GPG key

Use the following procedure to create a GNU Privacy Guard (GPG) key required for signing packages.

##### Procedure

1. Generate a GPG key pair:

```
# gpg --gen-key
```

2. Check the generated key pair:

```
# gpg --list-keys
```

3. Export the public key:

```
# gpg --export -a '<Key_name>' > RPM-GPG-KEY-pmanager
```

Replace `<Key_name>` with the real key name that you have selected.

4. Import the exported public key into an RPM database:

```
# rpm --import RPM-GPG-KEY-pmanager
```

#### 5.1.2. Configuring RPM to sign a package

To be able to sign an RPM package, you need to specify the **%\_gpg\_name** RPM macro.

The following procedure describes how to configure RPM for signing a package.

##### Procedure

- Define the **%\_gpg\_name** macro in your **\$HOME/.rpmmacros** file as follows:

```
%_gpg_name Key ID
```



Replace *Key ID* with the GNU Privacy Guard (GPG) key ID that you will use to sign a package. A valid GPG key ID value is either a full name or email address of the user who created the key.

### 5.1.3. Adding a signature to an RPM package

The most usual case is when a package is built without a signature. The signature is added just before the release of the package.

To add a signature to an RPM package, use the **--addsign** option provided by the **rpm-sign** package.

#### Procedure

- Add a signature to a package:

```
$ rpm --addsign package-name.rpm
```

Replace *package-name* with the name of an RPM package you want to sign.



#### NOTE

You must enter the password to unlock the secret key for the signature.

## 5.2. MORE ON MACROS

This section covers selected built-in RPM Macros. For an exhaustive list of such macros, see [RPM Documentation](#).

### 5.2.1. Defining your own macros

The following section describes how to create a custom macro.

#### Procedure

- Include the following line in the RPM **spec** file:

```
%global <name>[(opts)] <body>
```

All whitespace surrounding **<body>** is removed. Name may be composed of alphanumeric characters, and the character `_` and must be at least 3 characters in length. Inclusion of the **(opts)** field is optional:

- **Simple** macros do not contain the **(opts)** field. In this case, only recursive macro expansion is performed.
- **Parametrized** macros contain the **(opts)** field. The **opts** string between parentheses is passed to **getopt(3)** for **argc/argv** processing at the beginning of a macro invocation.



## NOTE

Older RPM **spec** files use the **%define <name> <body>** macro pattern instead. The differences between **%define** and **%global** macros are as follows:

- **%define** has local scope. It applies to a specific part of a **spec** file. The body of a **%define** macro is expanded when used.
- **%global** has global scope. It applies to an entire **spec** file. The body of a **%global** macro is expanded at definition time.



## IMPORTANT

Macros are evaluated even if they are commented out or the name of the macro is given into the **%changelog** section of the **spec** file. To comment out a macro, use **%%**. For example: **%%global**.

### Additional resources

- [Macro syntax](#)

## 5.2.2. Using the %setup macro

This section describes how to build packages with source code tarballs using different variants of the **%setup** macro. Note that the macro variants can be combined. The **rpmbuild** output illustrates standard behavior of the **%setup** macro. At the beginning of each phase, the macro outputs **Executing(%...)**, as shown in the below example.

### Example 5.1. Example %setup macro output

```
Executing(%prep): /bin/sh -e /var/tmp/rpm-tmp.DhddsG
```

The shell output is set with **set -x** enabled. To see the content of **/var/tmp/rpm-tmp.DhddsG**, use the **--debug** option because **rpmbuild** deletes temporary files after a successful build. This displays the setup of environment variables followed by for example:

```
cd '/builddir/build/BUILD'
rm -rf 'cello-1.0'
/usr/bin/gzip -dc '/builddir/build/SOURCES/cello-1.0.tar.gz' | /usr/bin/tar -xof -
STATUS=$?
if [ $STATUS -ne 0 ]; then
    exit $STATUS
fi
cd 'cello-1.0'
/usr/bin/chmod -Rf a+rX,u+w,g-w,o-w .
```

The **%setup** macro:

- Ensures that we are working in the correct directory.
- Removes residues of previous builds.
- Unpacks the source tarball.

- Sets up some default privileges.

### 5.2.2.1. Using the `%setup -q` macro

The `-q` option limits the verbosity of the `%setup` macro. Only `tar -xof` is executed instead of `tar -xvvoF`. Use this option as the first option.

### 5.2.2.2. Using the `%setup -n` macro

The `-n` option is used to specify the name of the directory from expanded tarball.

This is used in cases when the directory from expanded tarball has a different name from what is expected (`%{name}-%{version}`), which can lead to an error of the `%setup` macro.

For example, if the package name is `cello`, but the source code is archived in `hello-1.0.tgz` and contains the `hello/` directory, the `spec` file content needs to be as follows:

```
Name: cello
Source0: https://example.com/%{name}/release/hello-%{version}.tar.gz
...
%prep
%setup -n hello
```

### 5.2.2.3. Using the `%setup -c` macro

The `-c` option is used if the source code tarball does not contain any subdirectories and after unpacking, files from an archive fills the current directory.

The `-c` option then creates the directory and steps into the archive expansion as shown below:

```
/usr/bin/mkdir -p cello-1.0
cd 'cello-1.0'
```

The directory is not changed after archive expansion.

### 5.2.2.4. Using the `%setup -D` and `%setup -T` macros

The `-D` option disables deleting of source code directory, and is particularly useful if the `%setup` macro is used several times. With the `-D` option, the following lines are not used:

```
rm -rf 'cello-1.0'
```

The `-T` option disables expansion of the source code tarball by removing the following line from the script:

```
/usr/bin/gzip -dc 'builddir/build/SOURCES/cello-1.0.tar.gz' | /usr/bin/tar -xvvoF -
```

### 5.2.2.5. Using the `%setup -a` and `%setup -b` macros

The `-a` and `-b` options expand specific sources:

- The `-b` option stands for **before**. This option expands specific sources before entering the working directory.

- The **-a** option stands for **after**. This option expands those sources after entering. Their arguments are source numbers from the **spec** file preamble.

In the following example, the **cello-1.0.tar.gz** archive contains an empty **examples** directory. The examples are shipped in a separate **examples.tar.gz** tarball and they expand into the directory of the same name. In this case, use **-a 1** if you want to expand **Source1** after entering the working directory:

```
Source0: https://example.com/%{name}/release/%{name}-%{version}.tar.gz
Source1: examples.tar.gz
...
%prep
%setup -a 1
```

In the following example, examples are provided in a separate **cello-1.0-examples.tar.gz** tarball, which expands into **cello-1.0/examples**. In this case, use **-b 1** to expand **Source1** before entering the working directory:

```
Source0: https://example.com/%{name}/release/%{name}-%{version}.tar.gz
Source1: %{name}-%{version}-examples.tar.gz
...
%prep
%setup -b 1
```

### 5.2.3. Common RPM macros in the %files section

The following table lists advanced RPM Macros that are needed in the **%files** section of a **spec** file.

**Table 5.1. Advanced RPM Macros in the %files section**

Macro	Definition
%license	The <b>%license</b> macro identifies the file listed as a <b>LICENSE</b> file and it will be installed and labeled as such by RPM. Example: <b>%license LICENSE</b> .
%doc	The <b>%doc</b> macro identifies a file listed as documentation and it will be installed and labeled as such by RPM. The %doc macro is used for documentation about the packaged software and also for code examples and various accompanying items. If code examples are included, care must be taken to remove executable mode from the file. Example: <b>%doc README</b>
%dir	The <b>%dir</b> macro ensures that the path is a directory owned by this RPM. This is important so that the RPM file manifest accurately knows what directories to clean up on uninstall. Example: <b>%dir %{_libdir}/%{name}</b>
%config(noreplace)	The <b>%config(noreplace)</b> macro ensures that the following file is a configuration file and therefore should not be overwritten (or replaced) on a package install or update if the file has been modified from the original installation checksum. If there is a change, the file will be created with <b>.rpmnew</b> appended to the end of the filename upon upgrade or install so that the pre-existing or modified file on the target system is not modified. Example: <b>%config(noreplace) %{_sysconfdir}/%{name}/%{name}.conf</b>

## 5.2.4. Displaying the built-in macros

Red Hat Enterprise Linux provides multiple built-in RPM macros.

### Procedure

1. To display all built-in RPM macros, run:

```
rpm --showrc
```

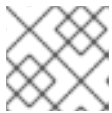


#### NOTE

The output is quite sizeable. To narrow the result, use the command above with the **grep** command.

2. To find information about the RPMs macros for your system's version of RPM, run:

```
rpm -ql rpm
```



#### NOTE

RPM macros are the files titled **macros** in the output directory structure.

## 5.2.5. RPM distribution macros

Different distributions provide different sets of recommended RPM macros based on the language implementation of the software being packaged or the specific guidelines of the distribution.

The sets of recommended RPM macros are often provided as RPM packages, ready to be installed with the **yum** package manager.

Once installed, the macro files can be found in the **/usr/lib/rpm/macros.d/** directory.

### Procedure

- To display the raw RPM macro definitions, run:

```
rpm --showrc
```

The above output displays the raw RPM macro definitions.

- To determine what a macro does and how it can be helpful when packaging RPMs, run the **rpm -eval** command with the name of the macro used as its argument:

```
rpm --eval %[_MACRO]
```

### Additional resources

- **rpm** man page

## 5.2.6. Creating custom macros

You can override the distribution macros in the `~/rpmmacros` file with your custom macros. Any changes that you make affect every build on your machine.



### WARNING

Defining any new macros in the `~/rpmmacros` file is not recommended. Such macros would not be present on other machines, where users may want to try to rebuild your package.

## Procedure

- To override a macro, run:

```
%_topdir /opt/some/working/directory/rpmbuild
```

You can create the directory from the example above, including all subdirectories through the `rpmdev-setuptree` utility. The value of this macro is by default `~/rpmbuild`.

```
%_smp_mflags -l3
```

The macro above is often used to pass to Makefile, for example `make %{?_smp_mflags}`, and to set a number of concurrent processes during the build phase. By default, it is set to `-jX`, where `X` is a number of cores. If you alter the number of cores, you can speed up or slow down a build of packages.

## 5.3. EPOCH, SCRIPTLETS AND TRIGGERS

This section covers **Epoch**, **Scriptlets**, and **Triggers**, which represent advanced directives for RPM `spec` files.

All these directives influence not only the `spec` file, but also the end machine on which the resulting RPM is installed.

### 5.3.1. The Epoch directive

The **Epoch** directive enables to define weighted dependencies based on version numbers.

If this directive is not listed in the RPM `spec` file, the **Epoch** directive is not set at all. This is contrary to common belief that not setting **Epoch** results in an **Epoch** of 0. However, the `yum` utility treats an unset **Epoch** as the same as an **Epoch** of 0 for the purposes of depsolving.

However, listing **Epoch** in a `spec` file is usually omitted because in majority of cases introducing an **Epoch** value skews the expected RPM behavior when comparing versions of packages.

#### Example 5.2. Using Epoch

If you install the `foobar` package with **Epoch: 1** and **Version: 1.0**, and someone else packages `foobar` with **Version: 2.0** but without the **Epoch** directive, the new version will never be considered an update. The reason being that the **Epoch** version is preferred over the traditional **Name-Version-Release** marker that signifies versioning for RPM Packages.

Using of **Epoch** is thus quite rare. However, **Epoch** is typically used to resolve an upgrade ordering issue. The issue can appear as a side effect of upstream change in software version number schemes or versions incorporating alphabetical characters that cannot always be compared reliably based on encoding.

### 5.3.2. Scriptlets directives

**Scriptlets** are a series of RPM directives that are executed before or after packages are installed or deleted.

Use **Scriptlets** only for tasks that cannot be done at build time or in an start up script.

A set of common **Scriptlet** directives exists. They are similar to the **spec** file section headers, such as **%build** or **%install**. They are defined by multi-line segments of code, which are often written as a standard POSIX shell script. However, they can also be written in other programming languages that RPM for the target machine's distribution accepts. RPM Documentation includes an exhaustive list of available languages.

The following table includes **Scriptlet** directives listed in their execution order. Note that a package containing the scripts is installed between the **%pre** and **%post** directive, and it is uninstalled between the **%preun** and **%postun** directive.

Table 5.2. Scriptlet directives

Directive	Definition
<b>%pretrans</b>	Scriptlet that is executed just before installing or removing any package.
<b>%pre</b>	Scriptlet that is executed just before installing the package on the target system.
<b>%post</b>	Scriptlet that is executed just after the package was installed on the target system.
<b>%preun</b>	Scriptlet that is executed just before uninstalling the package from the target system.
<b>%postun</b>	Scriptlet that is executed just after the package was uninstalled from the target system.
<b>%posttrans</b>	Scriptlet that is executed at the end of the transaction.

### 5.3.3. Turning off a scriptlet execution

The following procedure describes how to turn off the execution of any scriptlet using the **rpm** command together with the **--no\_scriptlet\_name\_** option.

#### Procedure

- For example, to turn off the execution of the **%pretrans** scriptlets, run:

```
# rpm --noprotrans
```

You can also use the **-- noscripts** option, which is equivalent to all of the following:

- **--nopre**
- **--nopost**
- **--nopreun**
- **--nopostun**
- **--nopretrans**
- **--noposttrans**

#### Additional resources

- **rpm(8)** man page.

### 5.3.4. Scriptlets macros

The **Scriptlets** directives also work with RPM macros.

The following example shows the use of `systemd` scriptlet macro, which ensures that `systemd` is notified about a new unit file.

```
$ rpm --showrc | grep systemd
-14: __transaction_systemd_inhibit    %{__plugindir}/systemd_inhibit.so
-14: _journalcatalogdir /usr/lib/systemd/catalog
-14: _presetdir /usr/lib/systemd/system-preset
-14: _unitdir /usr/lib/systemd/system
-14: _userunitdir /usr/lib/systemd/user
/usr/lib/systemd/systemd-binfmt %{?*} >/dev/null 2>&1 || :
/usr/lib/systemd/systemd-sysctl %{?*} >/dev/null 2>&1 || :
-14: systemd_post
-14: systemd_postun
-14: systemd_postun_with_restart
-14: systemd_preun
-14: systemd_requires
Requires(post): systemd
Requires(preun): systemd
Requires(postun): systemd
-14: systemd_user_post %systemd_post --user --global %{?*}
-14: systemd_user_postun %{}
-14: systemd_user_postun_with_restart %{}
-14: systemd_user_preun
systemd-sysusers %{?*} >/dev/null 2>&1 || :
echo %{?*} | systemd-sysusers - >/dev/null 2>&1 || :
systemd-tmpfiles --create %{?*} >/dev/null 2>&1 || :

$ rpm --eval %{systemd_post}

if [ $1 -eq 1 ] ; then
    # Initial installation
    systemctl preset >/dev/null 2>&1 || :
fi

$ rpm --eval %{systemd_postun}
```



```
systemctl daemon-reload >/dev/null 2>&1 || :

$ rpm --eval %{systemd_preun}

if [ $1 -eq 0 ] ; then
    # Package removal, not upgrade
    systemctl --no-reload disable > /dev/null 2>&1 || :
    systemctl stop > /dev/null 2>&1 || :
fi
```

### 5.3.5. The Triggers directives

**Triggers** are RPM directives which provide a method for interaction during package installation and uninstallation.



#### WARNING

**Triggers** may be executed at an unexpected time, for example on update of the containing package. **Triggers** are difficult to debug, therefore they need to be implemented in a robust way so that they do not break anything when executed unexpectedly. For these reasons, Red Hat recommends to minimize the use of **Triggers**.

The order of execution on a single package upgrade and the details for each existing **Triggers** are listed below:

```
all-%pretrans
...
any-%triggerprein (%triggerprein from other packages set off by new install)
new-%triggerprein
new-%pre    for new version of package being installed
...        (all new files are installed)
new-%post   for new version of package being installed

any-%triggerin (%triggerin from other packages set off by new install)
new-%triggerin
old-%triggerun
any-%triggerun (%triggerun from other packages set off by old uninstall)

old-%preun   for old version of package being removed
...         (all old files are removed)
old-%postun  for old version of package being removed

old-%triggerpostun
any-%triggerpostun (%triggerpostun from other packages set off by old un
install)
...
all-%posttrans
```

The above items are found in the `/usr/share/doc/rpm-4.*/triggers` file.

### 5.3.6. Using non-shell scripts in a spec file

The **-p** scriptlet option in a **spec** file enables the user to invoke a specific interpreter instead of the default shell scripts interpreter (**-p /bin/sh**).

The following procedure describes how to create a script, which prints out a message after installation of the **pello.py** program:

#### Procedure

1. Open the **pello.spec** file.
2. Find the following line:

```
install -m 0644 %{name}.py* %{buildroot}/usr/lib/%{name}/
```

3. Under the above line, insert:

```
%post -p /usr/bin/python3
print("This is {} code".format("python"))
```

4. Build your package as described in [Building RPMs](#).
5. Install your package:

```
# yum install /home/<username>/rpmbuild/RPMS/noarch/pello-0.1.2-1.el8.noarch.rpm
```

6. Check the output message after the installation:

```
Installing      : pello-0.1.2-1.el8.noarch           1/1
Running scriptlet: pello-0.1.2-1.el8.noarch         1/1
This is python code
```

#### NOTE

To use a Python 3 script, include the following line under **install -m** in a **spec** file:

```
%post -p /usr/bin/python3
```

To use a Lua script, include the following line under **install -m** in a SPEC file:

```
%post -p <lua>
```

This way, you can specify any interpreter in a **spec** file.

## 5.4. RPM CONDITIONALS

RPM Conditionals enable conditional inclusion of various sections of the **spec** file.

Conditional inclusions usually deal with:

- Architecture-specific sections

- Operating system-specific sections
- Compatibility issues between various versions of operating systems
- Existence and definition of macros

### 5.4.1. RPM conditionals syntax

RPM conditionals use the following syntax:

If *expression* is true, then do some action:

```
%if expression
...
%endif
```

If *expression* is true, then do some action, in other case, do another action:

```
%if expression
...
%else
...
%endif
```

### 5.4.2. The %if conditionals

The following examples shows the usage of **%if** RPM conditionals.

#### Example 5.3. Using the %if conditional to handle compatibility between Red Hat Enterprise Linux 8 and other operating systems

```
%if 0%{?rhel} == 8
sed -i '/AS_FUNCTION_DESCRIBE/ s/^/#/' configure.in
sed -i '/AS_FUNCTION_DESCRIBE/ s/^/#/' acinclude.m4
%endif
```

This conditional handles compatibility between RHEL 8 and other operating systems in terms of support of the `AS_FUNCTION_DESCRIBE` macro. If the package is built for RHEL, the **%rhel** macro is defined, and it is expanded to RHEL version. If its value is 8, meaning the package is built for RHEL 8, then the references to `AS_FUNCTION_DESCRIBE`, which is not supported by RHEL 8, are deleted from autoconfig scripts.

#### Example 5.4. Using the %if conditional to handle definition of macros

```
%define ruby_archive %{name}-%{ruby_version}
%if 0%{?milestone:1}%{?revision:1} != 0
%define ruby_archive %{ruby_archive}-%{?milestone}%{?!milestone:%{?revision:r%{revision}}}
%endif
```

This conditional handles definition of macros. If the **%milestone** or the **%revision** macros are set, the **%ruby\_archive** macro, which defines the name of the upstream tarball, is redefined.

### 5.4.3. Specialized variants of %if conditionals

The **%ifarch** conditional, **%ifnarch** conditional and **%ifos** conditional are specialized variants of the **%if** conditionals. These variants are commonly used, hence they have their own macros.

#### The %ifarch conditional

The **%ifarch** conditional is used to begin a block of the **spec** file that is architecture-specific. It is followed by one or more architecture specifiers, each separated by commas or whitespace.

##### Example 5.5. An example use of the %ifarch conditional

```
%ifarch i386 sparc
...
%endif
```

All the contents of the **spec** file between **%ifarch** and **%endif** are processed only on the 32-bit AMD and Intel architectures or Sun SPARC-based systems.

#### The %ifnarch conditional

The **%ifnarch** conditional has a reverse logic than **%ifarch** conditional.

##### Example 5.6. An example use of the %ifnarch conditional

```
%ifnarch alpha
...
%endif
```

All the contents of the **spec** file between **%ifnarch** and **%endif** are processed only if not done on a Digital Alpha/AXP-based system.

#### The %ifos conditional

The **%ifos** conditional is used to control processing based on the operating system of the build. It can be followed by one or more operating system names.

##### Example 5.7. An example use of the %ifos conditional

```
%ifos linux
...
%endif
```

All the contents of the **spec** file between **%ifos** and **%endif** are processed only if the build was done on a Linux system.

## 5.5. PACKAGING PYTHON 3 RPMS

Most Python projects use Setuptools for packaging, and define package information in the **setup.py** file. For more information about Setuptools packaging, see the [Setuptools documentation](#).

You can also package your Python project into an RPM package, which provides the following advantages compared to Setuptools packaging:

- Specification of dependencies of a package on other RPMs (even non-Python)
- Cryptographic signing  
With cryptographic signing, content of RPM packages can be verified, integrated, and tested with the rest of the operating system.

### 5.5.1. The spec file description for a Python package

A **spec** file contains instructions that the **rpmbuild** utility uses to build an RPM. The instructions are included in a series of sections. A **spec** file has two main parts in which the sections are defined:

- Preamble (contains a series of metadata items that are used in the Body)
- Body (contains the main part of the instructions)

An RPM SPEC file for Python projects has some specifics compared to non-Python RPM SPEC files. Most notably, a name of any RPM package of a Python library must always include the prefix determining the version, for example, **python3** for Python 3.6, **python38** for Python 3.8, **python39** for Python 3.9, **python3.11** for Python 3.11, or **python3.12** for Python 3.12.

Other specifics are shown in the following **spec** file **example for the python3-detox package**. For description of such specifics, see the notes below the example.

```
%global modname detox 1
Name:      python3-detox 2
Version:   0.12
Release:   4%{?dist}
Summary:   Distributing activities of the tox tool
License:   MIT
URL:       https://pypi.io/project/detox
Source0:   https://pypi.io/packages/source/d/%{modname}/%{modname}-%{version}.tar.gz
```

```
BuildArch: noarch
```

```
BuildRequires: python36-devel 3
BuildRequires: python3-setuptools
BuildRequires: python3-rpm-macros
BuildRequires: python3-six
BuildRequires: python3-tox
BuildRequires: python3-py
BuildRequires: python3-eventlet
```

```
%?python_enable_dependency_generator 4
```

```
%description
```

Detox is the distributed version of the tox python testing tool. It makes efficient use of multiple CPUs by running all possible activities in parallel.

Detox has the same options and configuration that tox has, so after installation you can run it in the same way and with the same options that you use for tox.

```

$ detox

%prep
%autosetup -n %{modname}-%{version}

%build
%py3_build

%install
%py3_install

%check
%{__python3} setup.py test

%files -n python3-%{modname}
%doc CHANGELOG
%license LICENSE
%{_bindir}/detox
%{python3_sitelib}/%{modname}/
%{python3_sitelib}/%{modname}-%{version}*

%changelog
...

```

- 1 The **modname** macro contains the name of the Python project. In this example it is **detox**.
- 2 When packaging a Python project into RPM, the **python3** prefix always needs to be added to the original name of the project. The original name here is **detox** and the **name of the RPM** is **python3-detox**.
- 3 **BuildRequires** specifies what packages are required to build and test this package. In **BuildRequires**, always include items providing tools necessary for building Python packages: **python36-devel** and **python3-setuptools**. The **python36-rpm-macros** package is required so that files with **/usr/bin/python3** interpreter directives are automatically changed to **/usr/bin/python3.6**.
- 4 Every Python package requires some other packages to work correctly. Such packages need to be specified in the **spec** file as well. To specify the **dependencies**, you can use the **%python\_enable\_dependency\_generator** macro to automatically use dependencies defined in the **setup.py** file. If a package has dependencies that are not specified using **Setuptools**, specify them within additional **Requires** directives.
- 5 The **%py3\_build** and **%py3\_install** macros run the **setup.py build** and **setup.py install** commands, respectively, with additional arguments to specify installation locations, the interpreter to use, and other details.
- 6 The **check** section provides a macro that runs the correct version of Python. The **%{\_\_python3}** macro contains a path for the Python 3 interpreter, for example **/usr/bin/python3**. We recommend to always use the macro rather than a literal path.

### 5.5.2. Common macros for Python 3 RPMs

In a **spec** file, always use the macros that are described in the following **Macros for Python 3 RPMs** table rather than hardcoding their values.

In macro names, always use **python3** or **python2** instead of unversioned **python**. Configure the particular Python 3 version in the **BuildRequires** section of the SPEC file to **python36-rpm-macros**, **python38-rpm-macros**, **python39-rpm-macros**, **python3.11-rpm-macros**, or **python3.12-rpm-macros**.

Table 5.3. Macros for Python 3 RPMs

Macro	Normal Definition	Description
<code>%{__python3}</code>	<code>/usr/bin/python3</code>	Python 3 interpreter
<code>%{python3_version}</code>	3.6	The full version of the Python 3 interpreter.
<code>%{python3_sitelib}</code>	<code>/usr/lib/python3.6/site-packages</code>	Where pure-Python modules are installed.
<code>%{python3_sitelib64}</code>	<code>/usr/lib64/python3.6/site-packages</code>	Where modules containing architecture-specific extensions are installed.
<code>%py3_build</code>		Runs the <b>setup.py build</b> command with arguments suitable for a system package.
<code>%py3_install</code>		Runs the <b>setup.py install</b> command with arguments suitable for a system package.

### 5.5.3. Automatic provides for Python RPMs

When packaging a Python project, make sure that the following directories are included in the resulting RPM if these directories are present:

- **.dist-info**
- **.egg-info**
- **.egg-link**

From these directories, the RPM build process automatically generates virtual **pythonX.Ydist** provides, for example, **python3.6dist(detox)**. These virtual provides are used by packages that are specified by the `%python_enable_dependency_generator` macro.

## 5.6. HANDLING INTERPRETER DIRECTIVES IN PYTHON SCRIPTS

In Red Hat Enterprise Linux 8, executable Python scripts are expected to use interpreter directives (also known as hashbangs or shebangs) that explicitly specify at a minimum the major Python version. For example:

```
#!/usr/bin/python3
#!/usr/bin/python3.6
```

```
#!/usr/bin/python3.8
#!/usr/bin/python3.9
#!/usr/bin/python3.11
#!/usr/bin/python3.12
#!/usr/bin/python2
```

The `/usr/lib/rpm/redhat/brp-mangle-shebangs` buildroot policy (BRP) script is run automatically when building any RPM package, and attempts to correct interpreter directives in all executable files.

The BRP script generates errors when encountering a Python script with an ambiguous interpreter directive, such as:

```
#!/usr/bin/python
```

or

```
#!/usr/bin/env python
```

### 5.6.1. Modifying interpreter directives in Python scripts

Modify interpreter directives in the Python scripts that cause the build errors at RPM build time.

#### Prerequisites

- Some of the interpreter directives in your Python scripts cause a build error.

#### Procedure

To modify interpreter directives, complete one of the following tasks:

- Apply the `pathfix.py` script from the `platform-python-devel` package:

```
# pathfix.py -pn -i %(__python3) PATH ...
```

Note that multiple ***PATHs*** can be specified. If a ***PATH*** is a directory, `pathfix.py` recursively scans for any Python scripts matching the pattern `^[a-zA-Z0-9_]+\.[py]$`, not only those with an ambiguous interpreter directive. Add this command to the `%prep` section or at the end of the `%install` section.

- Modify the packaged Python scripts so that they conform to the expected format. For this purpose, `pathfix.py` can be used outside the RPM build process, too. When running `pathfix.py` outside an RPM build, replace `%(__python3)` from the example above with a path for the interpreter directive, such as `/usr/bin/python3`.

If the packaged Python scripts require a version other than Python 3.6, adjust the preceding commands to include the required version.

### 5.6.2. Changing `/usr/bin/python3` interpreter directives in your custom packages

By default, interpreter directives in the form of `/usr/bin/python3` are replaced with interpreter directives pointing to Python from the `platform-python` package, which is used for system tools with Red Hat Enterprise Linux. You can change the `/usr/bin/python3` interpreter directives in your custom packages to point to a specific version of Python that you have installed from the AppStream repository.



## Procedure

- To build your package for a specific version of Python, add the ***python\*-rpm-macros*** subpackage of the respective **python** package to the **BuildRequires** section of the **spec** file. For example, for Python 3.6, include the following line:

```
BuildRequires: python36-rpm-macros
```

As a result, the `/usr/bin/python3` interpreter directives in your custom package are automatically converted to `/usr/bin/python3.6`.



### NOTE

To prevent the BRP script from checking and modifying interpreter directives, use the following RPM directive:

```
%undefine __brp_mangle_shebangs
```

## 5.7. RUBYGEMS PACKAGES

This section explains what RubyGems packages are, and how to re-package them into RPM.

### 5.7.1. What RubyGems are

Ruby is a dynamic, interpreted, reflective, object-oriented, general-purpose programming language.

Programs written in Ruby are typically packaged using the RubyGems project, which provides a specific Ruby packaging format.

Packages created by RubyGems are called gems, and they can be re-packaged into RPM as well.



### NOTE

This documentation refers to terms related to the RubyGems concept with the **gem** prefix, for example `.gemspec` is used for the **gem specification**, and terms related to RPM are unqualified.

### 5.7.2. How RubyGems relate to RPM

RubyGems represent Ruby's own packaging format. However, RubyGems contain metadata similar to those needed by RPM, which enables the conversion from RubyGems to RPM.

According to [Ruby Packaging Guidelines](#), it is possible to re-package RubyGems packages into RPM in this way:

- Such RPMs fit with the rest of the distribution.
- End users are able to satisfy dependencies of a gem by installing the appropriate RPM-packaged gem.

RubyGems use similar terminology as RPM, such as **spec** files, package names, dependencies and other items.

To fit into the rest of RHEL RPM distribution, packages created by RubyGems must follow the conventions listed below:

- Names of gems must follow this pattern:

```
rubygem-%{gem_name}
```

- To implement a shebang line, the following string must be used:

```
#!/usr/bin/ruby
```

### 5.7.3. Creating RPM packages from RubyGems packages

To create a source RPM for a RubyGems package, the following files are needed:

- A gem file
- An RPM **spec** file

The following sections describe how to create RPM packages from packages created by RubyGems.

#### 5.7.3.1. RubyGems spec file conventions

A RubyGems **spec** file must meet the following conventions:

- Contain a definition of **%{gem\_name}**, which is the name from the gem's specification.
- The source of the package must be the full URL to the released gem archive; the version of the package must be the gem's version.
- Contain the **BuildRequires**: a directive defined as follows to be able to pull in the macros needed to build.

```
BuildRequires:rubygems-devel
```

- Not contain any RubyGems **Requires** or **Provides**, because those are autogenerated.
- Not contain the **BuildRequires**: directive defined as follows, unless you want to explicitly specify Ruby version compatibility:

```
Requires: ruby(release)
```

The automatically generated dependency on RubyGems (**Requires: ruby(rubygems)**) is sufficient.

#### 5.7.3.2. RubyGems macros

The following table lists macros useful for packages created by RubyGems. These macros are provided by the **rubygems-devel** packages.

Table 5.4. RubyGems' macros

Macro name	Extended path	Usage
<code>{gem_dir}</code>	<code>/usr/share/gems</code>	Top directory for the gem structure.
<code>{gem_instdir}</code>	<code>{gem_dir}/gems/{gem_name}-{version}</code>	Directory with the actual content of the gem.
<code>{gem_libdir}</code>	<code>{gem_instdir}/lib</code>	The library directory of the gem.
<code>{gem_cache}</code>	<code>{gem_dir}/cache/{gem_name}-{version}.gem</code>	The cached gem.
<code>{gem_spec}</code>	<code>{gem_dir}/specifications/{gem_name}-{version}.gemspec</code>	The gem specification file.
<code>{gem_docdir}</code>	<code>{gem_dir}/doc/{gem_name}-{version}</code>	The RDoc documentation of the gem.
<code>{gem_extdir_mri}</code>	<code>{libdir}/gems/ruby/{gem_name}-{version}</code>	The directory for gem extension.

### 5.7.3.3. RubyGems spec file example

Example **spec** file for building gems together with an explanation of its particular sections follows.

#### An example RubyGems spec file

```
%prep
%setup -q -n {gem_name}-{version}

# Modify the gemspec if necessary
# Also apply patches to code if necessary
%patch0 -p1

%build
# Create the gem as gem install only works on a gem file
gem build ../{gem_name}-{version}.gemspec

# %%gem_install compiles any C extensions and installs the gem into ../%%gem_dir
# by default, so that we can move it into the buildroot in %%install
%gem_install
```

```

%install
mkdir -p %{buildroot}%{gem_dir}
cp -a ./%{gem_dir}/* %{buildroot}%{gem_dir}/

# If there were programs installed:
mkdir -p %{buildroot}%{_bindir}
cp -a ./%{_bindir}/* %{buildroot}%{_bindir}

# If there are C extensions, copy them to the extdir.
mkdir -p %{buildroot}%{gem_extdir_mri}
cp -a ./%{gem_extdir_mri}/{gem.build_complete,*.so} %{buildroot}%{gem_extdir_mri}/

```

The following table explains the specifics of particular items in a RubyGems **spec** file:

**Table 5.5. RubyGems' spec directives specifics**

Directive	RubyGems specifics
%prep	RPM can directly unpack gem archives, so you can run the <b>gem unpack</b> command to extract the source from the gem. The <b>%setup -n %{gem_name}-%{version}</b> macro provides the directory into which the gem has been unpacked. At the same directory level, the <b>%{gem_name}-%{version}.gemspec</b> file is automatically created, which can be used to rebuild the gem later, to modify the <b>.gemspec</b> , or to apply patches to the code.
%build	<p>This directive includes commands or series of commands for building the software into machine code. The <b>%gem_install</b> macro operates only on gem archives, and the gem is recreated with the next gem build. The gem file that is created is then used by <b>%gem_install</b> to build and install the code into the temporary directory, which is <b>./%{gem_dir}</b> by default. The <b>%gem_install</b> macro both builds and installs the code in one step. Before being installed, the built sources are placed into a temporary directory that is created automatically.</p> <p>The <b>%gem_install</b> macro accepts two additional options: <b>-n &lt;gem_file&gt;</b>, which allows to override gem used for installation, and <b>-d &lt;install_dir&gt;</b>, which might override the gem installation destination; using this option is not recommended.</p> <p>The <b>%gem_install</b> macro must not be used to install into the <b>%{buildroot}</b>.</p>
%install	The installation is performed into the <b>%{buildroot}</b> hierarchy. You can create the directories that you need and then copy what was installed in the temporary directories into the <b>%{buildroot}</b> hierarchy. If this gem creates shared objects, they are moved into the architecture-specific <b>%{gem_extdir_mri}</b> path.

#### Additional resources

- [Ruby Packaging Guidelines](#)

#### 5.7.3.4. Converting RubyGems packages to RPM spec files with gem2rpm

The **gem2rpm** utility converts RubyGems packages to RPM **spec** files.

The following sections describe how to:

- Install the **gem2rpm** utility
- Display all **gem2rpm** options
- Use **gem2rpm** to convert RubyGems packages to RPM **spec** files
- Edit **gem2rpm** templates

#### 5.7.3.4.1. Installing gem2rpm

The following procedure describes how to install the **gem2rpm** utility.

##### Procedure

- To install **gem2rpm** from [RubyGems.org](http://RubyGems.org), run:

```
$ gem install gem2rpm
```

#### 5.7.3.4.2. Displaying all options of gem2rpm

The following procedure describes how to display all options of the **gem2rpm** utility.

##### Procedure

- To see all options of **gem2rpm**, run:

```
$ gem2rpm --help
```

#### 5.7.3.4.3. Using gem2rpm to convert RubyGems packages to RPM spec files

The following procedure describes how to use the **gem2rpm** utility to convert RubyGems packages to RPM **spec** files.

##### Procedure

- Download a gem in its latest version, and generate the RPM **spec** file for this gem:

```
$ gem2rpm --fetch <gem_name> > <gem_name>.spec
```

The described procedure creates an RPM **spec** file based on the information provided in the gem's metadata. However, the gem misses some important information that is usually provided in RPMs, such as the license and the changelog. The generated **spec** file thus needs to be edited.

#### 5.7.3.4.4. gem2rpm templates

The **gem2rpm** template is a standard Embedded Ruby (ERB) file, which includes variables listed in the following table.

Table 5.6. Variables in the **gem2rpm** template

Variable	Explanation
package	The <b>Gem::Package</b> variable for the gem.
spec	The <b>Gem::Specification</b> variable for the gem (the same as format.spec).
config	The <b>Gem2Rpm::Configuration</b> variable that can redefine default macros or rules used in spec template helpers.
runtime_dependencies	The <b>Gem2Rpm::RpmDependencyList</b> variable providing a list of package runtime dependencies.
development_dependencies	The <b>Gem2Rpm::RpmDependencyList</b> variable providing a list of package development dependencies.
tests	The <b>Gem2Rpm::TestSuite</b> variable providing a list of test frameworks allowing their execution.
files	The <b>Gem2Rpm::RpmFileList</b> variable providing an unfiltered list of files in a package.
main_files	The <b>Gem2Rpm::RpmFileList</b> variable providing a list of files suitable for the main package.
doc_files	The <b>Gem2Rpm::RpmFileList</b> variable providing a list of files suitable for the <b>-doc</b> subpackage.
format	The <b>Gem::Format</b> variable for the gem. Note that this variable is now deprecated.

#### 5.7.3.4.5. Listing available gem2rpm templates

Use the following procedure describes to list all available **gem2rpm** templates.

##### Procedure

- To see all available templates, run:

```
$ gem2rpm --templates
```

#### 5.7.3.4.6. Editing gem2rpm templates

You can edit the template from which the RPM **spec** file is generated instead of editing the generated **spec** file.

Use the following procedure to edit the **gem2rpm** templates.

##### Procedure

1. Save the default template:

```
$ gem2rpm -T > rubygem-<gem_name>.spec.template
```

2. Edit the template as needed.
3. Generate the **spec** file by using the edited template:

```
$ gem2rpm -t rubygem-<gem_name>.spec.template <gem_name>-<latest_version.gem
> <gem_name>-GEM.spec
```

You can now build an RPM package by using the edited template as described in [Building RPMs](#).

## 5.8. HOW TO HANDLE RPM PACKAGES WITH PERLS SCRIPTS

Since RHEL 8, the Perl programming language is not included in the default buildroot. Therefore, the RPM packages that include Perl scripts must explicitly indicate the dependency on Perl using the **BuildRequires:** directive in RPM **spec** file.

### 5.8.1. Common Perl-related dependencies

The most frequently occurring Perl-related build dependencies used in **BuildRequires:** are :

- **perl-generators**  
Automatically generates run-time **Requires** and **Provides** for installed Perl files. When you install a Perl script or a Perl module, you must include a build dependency on this package.
- **perl-interpreter**  
The Perl interpreter must be listed as a build dependency if it is called in any way, either explicitly via the **perl** package or the **%\_\_perl** macro, or as a part of your package's build system.
- **perl-devel**  
Provides Perl header files. If building architecture-specific code which links to the **libperl.so** library, such as an XS Perl module, you must include **BuildRequires: perl-devel**.

### 5.8.2. Using a specific Perl module

If a specific Perl module is required at build time, use the following procedure:

#### Procedure

- Apply the following syntax in your RPM **spec** file:

```
BuildRequires: perl(MODULE)
```



#### NOTE

Apply this syntax to Perl core modules as well, because they can move in and out of the **perl** package over time.

### 5.8.3. Limiting a package to a specific Perl version

To limit your package to a specific Perl version, follow this procedure:

## Procedure

- Use the **perl(:VERSION)** dependency with the desired version constraint in your RPM **spec** file: For example, to limit a package to Perl version 5.22 and later, use:

```
BuildRequires: perl(:VERSION) >= 5.22
```



### WARNING

Do not use a comparison against the version of the **perl** package because it includes an epoch number.

## 5.8.4. Ensuring that a package uses the correct Perl interpreter

Red Hat provides multiple Perl interpreters, which are not fully compatible. Therefore, any package that delivers a Perl module must use at run time the same Perl interpreter that was used at build time.

To ensure this, follow the procedure below:

## Procedure

- Include versioned **MODULE\_COMPAT Requires** in RPM **spec** file for any package that delivers a Perl module:

```
Requires: perl(:MODULE_COMPAT_$(eval `perl -V:version`; echo $version))
```



## CHAPTER 6. NEW FEATURES IN RHEL 8

This section documents the most notable changes in RPM packaging between Red Hat Enterprise Linux 7 and 8.

### 6.1. SUPPORT FOR WEAK DEPENDENCIES

**Weak dependencies** are variants of the **Requires** directive. These variants are matched against virtual **Provides** and package names using **Epoch-Version-Release** range comparisons.

**Weak dependencies** have two strengths (**weak** and **hint**) and two directions (**forward** and **backward**), as summarized in the following table.



#### NOTE

The **forward** direction is analogous to **Requires**:. The **backward** has no analog in the previous dependency system.

Table 6.1. Possible combinations of Weak dependencies' strengths and directions

Strength/Direction	Forward	Backward
Weak	Recommends:	Supplements:
Hint	Suggests:	Enhances:

The main advantages of the **Weak dependencies** policy are:

- It allows smaller minimal installations while keeping the default installation feature rich.
- Packages can specify preferences for specific providers while maintaining the flexibility of virtual provides.

#### 6.1.1. Introduction to Weak dependencies

By default, **Weak dependencies** are treated similarly to regular **Requires**:. Matching packages are included in the **YUM** transaction. If adding the package leads to an error, **YUM** by default ignores the dependency. Hence, users can exclude packages that would be added by **Weak dependencies** or remove them later.

#### Conditions of use

You can use **Weak dependencies** only if the package still functions without the dependency.



#### NOTE

It is acceptable to create packages with very limited functionality without adding any of its weak requirements.

#### Use cases

Use **Weak dependencies** especially where it is possible to minimize the installation for reasonable use cases, such as building virtual machines or containers that have a single purpose and do not require the full feature set of the package.

Typical use cases for **Weak dependencies** are:

- Documentation
  - Documentation viewers if missing them is handled gracefully
- Examples
- Plug-ins or add-ons
  - Support for file formats
  - Support for protocols

### 6.1.2. The Hints strength

**Hints** are by default ignored by **YUM**. They can be used by GUI tools to offer add-on packages that are not installed by default but can be useful in combination with the installed packages.

Do not use **Hints** for the requirements of the main use cases of a package. Include such requirements in the strong or **Weak dependencies** instead.

#### Package Preference

**YUM** uses **Weak dependencies** and **Hints** to decide which package to use if there is a choice between multiple equally valid packages. Packages that are pointed at by dependencies from installed or to be installed packages are preferred.

Note, the normal rules of dependency resolution are not influenced by this feature. For example, **Weak dependencies** cannot enforce an older version of a package to be chosen.

If there are multiple providers for a dependency, the requiring package can add a **Suggests:** to provide a hint to the dependency resolver about which option is preferred.

**Enhances:** is only used when the main package and other providers agree that adding the hint to the required package is for some reason the cleaner solution.

#### Example 6.1. Using Hints to prefer one package over another

Package A: Requires: mysql

Package mariadb: Provides: mysql

Package community-mysql: Provides: mysql

If you want to prefer the **mariadb** package over the **community-mysql** package → use:

Suggests: mariadb to Package A.

### 6.1.3. Forward and Backward dependencies

**Forward dependencies** are, similarly to **Requires**, evaluated for packages that are being installed. The best of the matching packages are also installed.

In general, prefer **Forward dependencies**. Add the dependency to the package when getting the other package added to the system.

For **Backward dependencies**, the packages containing the dependency are installed if a matching package is installed as well.

**Backward dependencies** are mainly designed for third party vendors who can attach their plug-ins, add-ons, or extensions to distribution or other third party packages.

## 6.2. SUPPORT FOR BOOLEAN DEPENDENCIES

Starting with version 4.13, RPM is able to process boolean expressions in the following dependencies:

- **Requires**
- **Recommends**
- **Suggests**
- **Supplements**
- **Enhances**
- **Conflicts**

The following sections describe [boolean dependencies syntax](#), provides a list of [boolean operators](#), and explains [boolean dependencies nesting](#) as well as [boolean dependencies semantics](#).

### 6.2.1. Boolean dependencies syntax

Boolean expressions are always enclosed with parenthesis.

They are build out of normal dependencies:

- Name only or name
- Comparison
- Version description

### 6.2.2. Boolean operators

RPM 4.13 introduced the following boolean operators:

**Table 6.2. Boolean operators introduced with RPM 4.13**

Boolean operator	Description	Example use
<b>and</b>	Requires all operands to be fulfilled for the term to be true.	Conflicts: (pkgA and pkgB)

Boolean operator	Description	Example use
<b>or</b>	Requires one of the operands to be fulfilled for the term to be true.	Requires: (pkgA >= 3.2 or pkgB)
<b>if</b>	Requires the first operand to be fulfilled if the second is. (reverse implication)	Recommends: (myPkg-langCZ if langsupportCZ)
<b>if else</b>	Same as the <b>if</b> operator, plus requires the third operand to be fulfilled if the second is not.	Requires: myPkg-backend-mariaDB if mariaDB else sqlite

RPM 4.14 introduced the following additional boolean operators:

**Table 6.3. Boolean operators introduced with RPM 4.14**

Boolean operator	Description	Example use
<b>with</b>	Requires all operands to be fulfilled by the same package for the term to be true.	Requires: (pkgA-foo with pkgA-bar)
<b>without</b>	Requires a single package that satisfies the first operand but not the second. (set subtraction)	Requires: (pkgA-foo without pkgA-bar)
<b>unless</b>	Requires the first operand to be fulfilled if the second is not. (reverse negative implication)	Conflicts: (myPkg-driverA unless driverB)
<b>unless else</b>	Same as the <b>unless</b> operator, plus requires the third operand to be fulfilled if the second is.	Conflicts: (myPkg-backend-SDL1 unless myPkg-backend-SDL2 else SDL2)



### IMPORTANT

The **if** operator cannot be used in the same context with the **or** operator, and the **unless** operator cannot be used in the same context with **and**.

## 6.2.3. Nesting

Operands themselves can be used as boolean expressions, as shown in the below examples.

Note that in such case, operands also need to be surrounded by parenthesis. You can chain the **and** and **or** operators together repeating the same operator with only one set of surrounding parenthesis.

### Example 6.2. Example use of operands applied as boolean expressions

Requires: (pkgA or pkgB or pkgC)

Requires: (pkgA or (pkgB and pkgC))

Supplements: (foo and (lang-support-cz or lang-support-all))

Requires: (pkgA with capB) or (pkgB without capA)

Supplements: ((driverA and driverA-tools) unless driverB)

Recommends: myPkg-langCZ and (font1-langCZ or font2-langCZ) if langsupportCZ

### 6.2.4. Semantics

Using **Boolean dependencies** does not change the semantic of regular dependencies.

If **Boolean dependencies** are used, checking for one match all names are checked and the boolean value of there being a match is then aggregated over the Boolean operators.



#### IMPORTANT

For all dependencies with the exception of **Conflicts:**, the result has to be **True** to not prevent an install. For **Conflicts:**, the result has to be **False** to not prevent an install.



#### WARNING

**Provides** are not dependencies and cannot contain boolean expressions.

### 6.2.5. Understanding the output of the if operator

The **if** operator is also returning a boolean value, which is usually close to what the intuitive understanding is. However, the below examples show that in some cases intuitive understanding of **if** can be misleading.

#### Example 6.3. Misleading outputs of the if operator

This statement is true if pkgB is not installed. However, if this statement is used where the default result is false, things become complicated:

Requires: (pkgA if pkgB)

This statement is a conflict unless pkgB is installed and pkgA is not:

Conflicts: (pkgA if pkgB)

So you might rather want to use:

Conflicts: (pkgA and pkgB)

The same is true if the **if** operator is nested in **or** terms:

Requires: ((pkgA if pkgB) or pkgC or pkg)

This also makes the whole term true, because the **if** term is true if pkgB is not installed. If pkgA only helps if pkgB is installed, use **and** instead:

Requires: ((pkgA and pkgB) or pkgC or pkg)

## 6.3. SUPPORT FOR FILE TRIGGERS

**File triggers** are a kind of [RPM scriptlets](#),

which are defined in a **spec** file of a package.

Similar to **Triggers**, they are declared in one package but executed when another package that contains the matching files is installed or removed.

A common use of **File triggers** is to update registries or caches. In such use case, the package containing or managing the registry or cache should contain also one or more **File triggers**. Including **File triggers** saves time compared to the situation when the package controls updating itself.

### 6.3.1. File triggers syntax

**File triggers** have the following syntax:

```
%file_trigger_tag [FILE_TRIGGER_OPTIONS] — PATHPREFIX...
body_of_script
```

Where:

**file\_trigger\_tag** defines a type of file trigger. Allowed types are:

- **filetriggerin**
- **filetriggerun**
- **filetriggerpostun**
- **transfiletriggerin**
- **transfiletriggerun**
- **transfiletriggerpostun**

**FILE\_TRIGGER\_OPTIONS** have the same purpose as RPM scriptlets options, except for the **-P** option.

The priority of a trigger is defined by a number. The bigger number, the sooner the file trigger script is executed. Triggers with priority greater than 100000 are executed before standard scriptlets, and the other triggers are executed after standard scriptlets. The default priority is set to 1000000.

Every file trigger of each type must contain one or more path prefixes and scripts.

### 6.3.2. Examples of File triggers syntax

The following example shows the **File triggers** syntax:

```
%filetriggerin — /lib, /lib64, /usr/lib, /usr/lib64
/usr/sbin/ldconfig
```

This file trigger executes **/usr/bin/ldconfig** directly after the installation of a package that contains a file having a path starting with **/usr/lib** or **/lib**. The file trigger is executed just once even if the package includes multiple files with the path starting with **/usr/lib** or **/lib**. However, all file names starting with **/usr/lib** or **/lib** are passed to standard input of trigger script so that you can filter inside of your script as shown below:

```
%filetriggerin — /lib, /lib64, /usr/lib, /usr/lib64
grep "foo" && /usr/sbin/ldconfig
```

This file trigger executes **/usr/bin/ldconfig** for each package containing files starting with **/usr/lib** and containing **foo** at the same time. Note that the prefix-matched files include all types of files including regular files, directories, symlinks and others.

### 6.3.3. File triggers types

**File triggers** have two main types:

- [File triggers executed once per package](#)
- [File triggers executed once per transaction](#)

**File triggers** are further divided based on the time of execution as follows:

- Before or after installation or erasure of a package
- Before or after a transaction

#### 6.3.3.1. Executed once per package File triggers

**File triggers** executed once per package are:

- `%filetriggerin`
- `%filetriggerun`
- `%filetriggerpostun`

##### **%filetriggerin**

This file trigger is executed after installation of a package if this package contains one or more files that match the prefix of this trigger. It is also executed after installation of a package that contains this file trigger and there is one or more files matching the prefix of this file trigger in the **rpmdb** database.

##### **%filetriggerun**

This file trigger is executed before uninstallation of a package if this package contains one or more files that match the prefix of this trigger. It is also executed before uninstallation of a package that contains this file trigger and there is one or more files matching the prefix of this file trigger in **rpmdb**.

### %filetriggerpostun

This file trigger is executed after uninstallation of a package if this package contains one or more files that match the prefix of this trigger.

### 6.3.3.2. Executed once per transaction File triggers

**File triggers** executed once per transaction are:

- %transfiletriggerin
- %transfiletriggerun
- %transfiletriggerpostun

#### %transfiletriggerin

This file trigger is executed once after a transaction for all installed packages that contain one or more files that match the prefix of this trigger. It is also executed after a transaction if there was a package containing this file trigger in that transaction and there is one or more files matching the prefix of this trigger in **rpmdb**.

#### %transfiletriggerun

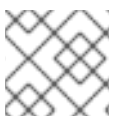
This file trigger is executed once before a transaction for all packages that meet the following conditions:

- The package will be uninstalled in this transaction
- The package contains one or more files that match the prefix of this trigger

It is also executed before a transaction if there is a package containing this file trigger in that transaction and there is one or more files matching the prefix of this trigger in **rpmdb**.

#### %transfiletriggerpostun

This file trigger is executed once after a transaction for all uninstalled packages that contain one or more file that matches the prefix of this trigger.



#### NOTE

The list of triggering files is not available in this trigger type.

Therefore, if you install or uninstall multiple packages that contain libraries, the `ldconfig` cache is updated at the end of the whole transaction. This significantly improves the performance compared to RHEL 7 where the cache was updated for each package separately. Also the scriptlets which called `ldconfig` in `%post` and `%postun` in **spec** file of every package are no longer needed.

### 6.3.4. Example use of File triggers in glibc

The following example shows a real-world usage of **File triggers** within the **glibc** package.

In RHEL 8, **File triggers** are implemented in **glibc** to call the **ldconfig** command at the end of an installation or uninstallation transaction.

This is ensured by including the following scriptlets in the **glibc's** SPEC file:

```
%transfiletriggerin common -P 2000000 – /lib /usr/lib /lib64 /usr/lib64
/sbin/ldconfig
```



```
%end
%transfiletriggerpostun common -P 2000000 -- /lib /usr/lib /lib64 /usr/lib64
/sbin/ldconfig
%end
```

Therefore, if you install or uninstall multiple packages, the **ldconfig** cache is updated for all installed libraries after the whole transaction is finished. Consequently, it is no longer necessary to include the scriptlets calling **ldconfig** in RPM **spec** files of individual packages. This improves the performance compared to RHEL 7, where the cache was updated for each package separately.

## 6.4. STRICTER SPEC PARSER

The SPEC parser has now some changes incorporated. Hence, it can identify new issues that were previously ignored.

## 6.5. SUPPORT FOR FILES ABOVE 4 GB

On Red Hat Enterprise Linux 8, **RPM** can use 64-bit variables and tags, which enables operating on files and packages bigger than 4 GB.

### 6.5.1. 64-bit RPM tags

Several RPM tags exist in both 64-bit versions and previous 32-bit versions. Note that the 64-bit versions have the **LONG** string in front of their name.

**Table 6.4. RPM tags available in both 32-bit and 64-bit versions**

32-bit variant tag name	62-bit variant tag name	Tag description
RPMTAG_SIGSIZE	RPMTAG_LONGSIGSIZE	Header and compressed payload size.
RPMTAG_ARCHIVESIZE	RPMTAG_LONGARCHIVESIZE	Uncompressed payload size.
RPMTAG_FILESIZE	RPMTAG_LONGFILESIZES	Array of file sizes.
RPMTAG_SIZE	RPMTAG_LONGSIZE	Sum of all file sizes.

### 6.5.2. Using 64-bit tags on command line

The **LONG** extensions are always enabled on the command line. If you previously used scripts containing the **rpm -q --qf** command, you can add **long** to the name of such tags:

```
rpm -qp --qf "[%{filenames} %{longfilesizes}\n"]
```

## 6.6. OTHER FEATURES

Other new features related to RPM packaging in Red Hat Enterprise Linux 8 are:

- Simplified signature checking output in non-verbose mode

- Support for the enforced payload verification
- Support for the enforcing signature checking mode
- Additions and deprecations in macros

### Additional resources

See the following references to various topics related to RPMs, RPM packaging, and RPM building. Some of these are advanced and extend the introductory material included in this documentation.

[Red Hat Software Collections Overview](#) - The Red Hat Software Collections offering provides continuously updated development tools in latest stable versions.

[Red Hat Software Collections](#) - The Packaging Guide provides an explanation of Software Collections and details how to build and package them. Developers and system administrators with basic understanding of software packaging with RPM can use this Guide to get started with Software Collections.

[Mock](#) - Mock provides a community-supported package building solution for various architectures and different Fedora or RHEL versions than has the build host.

[RPM Documentation](#) - The official RPM documentation.

[Fedora Packaging Guidelines](#) - The official packaging guidelines for Fedora, useful for all RPM-based distributions.