

# Juniper Extension Toolkit Developer Guide

Published  
2023-06-14

Juniper Networks, Inc.  
1133 Innovation Way  
Sunnyvale, California 94089  
USA  
408-745-2000  
[www.juniper.net](http://www.juniper.net)

Juniper Networks, the Juniper Networks logo, Juniper, and Junos are registered trademarks of Juniper Networks, Inc. in the United States and other countries. All other trademarks, service marks, registered marks, or registered service marks are the property of their respective owners.

Juniper Networks assumes no responsibility for any inaccuracies in this document. Juniper Networks reserves the right to change, modify, transfer, or otherwise revise this publication without notice.

*Juniper Extension Toolkit Developer Guide*  
Copyright © 2023 Juniper Networks, Inc. All rights reserved.

The information in this document is current as of the date on the title page.

## YEAR 2000 NOTICE

Juniper Networks hardware and software products are Year 2000 compliant. Junos OS has no known time-related limitations through the year 2038. However, the NTP application is known to have some difficulty in the year 2036.

## END USER LICENSE AGREEMENT

The Juniper Networks product that is the subject of this technical documentation consists of (or is intended for use with) Juniper Networks software. Use of such software is subject to the terms and conditions of the End User License Agreement ("EULA") posted at <https://support.juniper.net/support/eula/>. By downloading, installing or using such software, you agree to the terms and conditions of that EULA.

# Table of Contents

About This Guide | vi

1

## Getting Started

JET Overview | 2

Set Up the JET VM | 4

Overview | 5

Install the JET Software Bundle | 5

Set Up Your Virtual Machine Environment | 7

Download the JET IDL | 7

Prepare to Compile the Proto Definition Files in Python | 8

2

## Application Development

Develop Off-Device JET Applications | 12

Overview | 12

Develop and Package Your Application | 13

Prepare to Deploy Your Application | 14

Example: Python JET Application | 17

Develop On-Device JET Applications | 24

Overview | 24

Develop Unsigned JET Applications | 26

Develop Signed JET Applications | 26

Compile 64-Bit Applications | 29

Example: Develop a Signed C Package | 29

Example: Develop a Signed Python Package Without C Dependencies | 33

Example: Develop a Signed Python Package With C Dependencies | 37

Package JET Applications | 41

## Debug JET Applications | 48

Debugging Tips | 48

How to Invoke the Debugger During Install | 49

Issue: Cannot Connect to jsd | 50

3

## Additional Resources

Additional Resources | 52

4

## Configuration Statements

application (Extensions) | 55

cert-file (Scripts) | 57

extensions | 59

extension-service (System Extensions) | 62

extension-service (System Services gRPC) | 64

file (JET) | 67

grpc | 69

interface-notification (programmable-rpd) | 71

max-connections | 73

notification (System Services) | 75

programmable-rpd | 77

providers | 80

purge-timeout (programmable-rpd) | 81

refresh (JET) | 84

refresh-from (JET) | 86

request-response | 88

rib-service (programmable-rpd) | 90

routing-instance (JET Scripts) | 92

source (JET Scripts) | 93

start (Scripts) | 95

stats-aggregation-interval (programmable-rpd) | 98

stats-sampling-interval (programmable-rpd) | 99

traceoptions (Extensions) | 101

traceoptions (Services) | 104

traceoptions (programmable-rpd) | 107

## 5

### Operational Commands

request extension-service (start | stop) | 112

request extension-service restart-daemonize-app | 113

show extension-service request-response clients | 115

show extension-service request-response servers | 118

show extension-service status | 120

show programmable-rpd clients | 123

# About This Guide

Use this guide to develop, deploy, use, and debug Juniper Extension Toolkit (JET) applications that are developed on Junos OS or Junos OS Evolved and third-party applications. For information about JET APIs, see the [Juniper Extension Toolkit API Guide](#).

# 1

CHAPTER

## Getting Started

---

[JET Overview](#) | 2

[Set Up the JET VM](#) | 4

---

# JET Overview

## IN THIS SECTION

- [Benefits of JET | 2](#)
- [JET Architecture | 2](#)
- [JET and gRPC | 4](#)

Juniper Extension Toolkit (JET), an evolution of the Junos SDK, provides a modern, programmatic interface for developers of third-party applications on Junos devices. It focuses on providing a standards-based interface to the Juniper Networks Junos operating system (Junos OS) and Junos OS Evolved for customizing management and control plane functionality.

JET also includes a toolchain along with libraries and other tools to enable developers to write on-device JET applications.

## Benefits of JET

- Provides APIs to interact with any Junos device.
- Supports API development in multiple languages.
- Provides tools to develop applications that run on Junos devices.
- Uses an event notification method that enables JET applications to respond to selected system events.

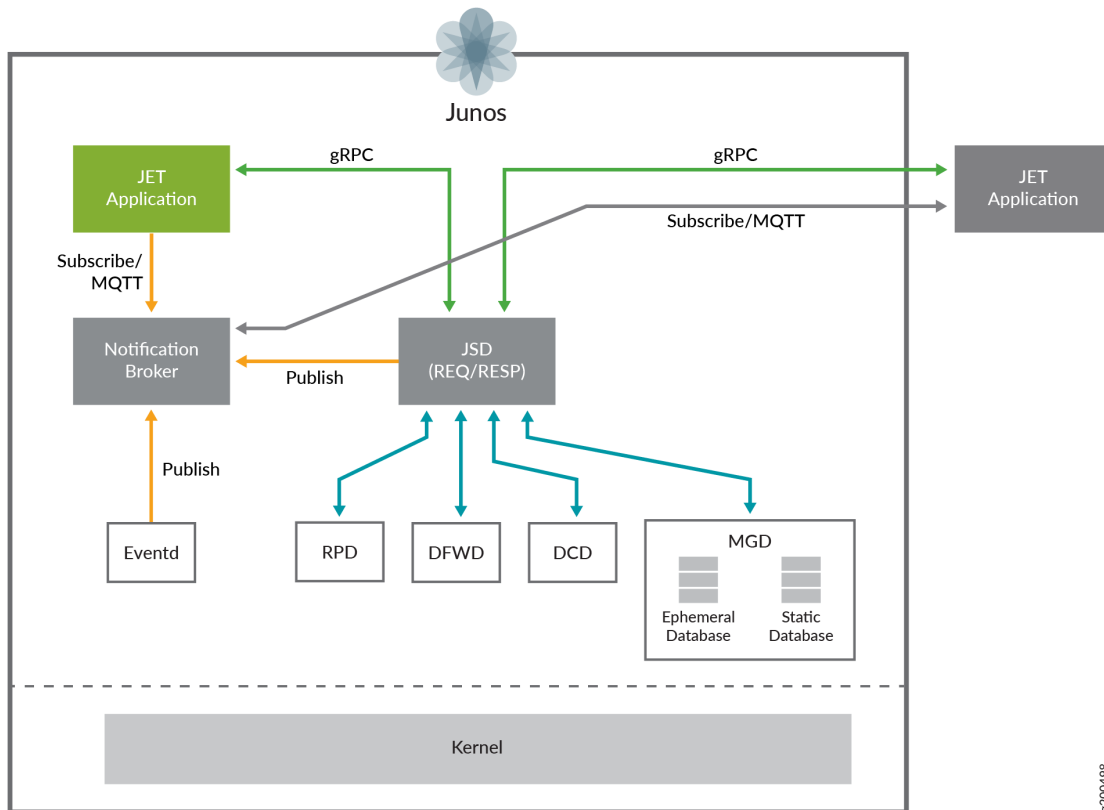
## JET Architecture

JET is a framework that enables developers to create applications that extend the functionality of Junos OS and Junos OS Evolved. For example, a JET application might extend the Junos CLI by adding a new operational command to show application-specific states. JET applications can run on Junos devices or on another device in your operating environment and connect over the network to a Junos device.



JET applications interact with Junos OS and Junos OS Evolved through request-response and notification services over standards based transport channels. [Figure 1 on page 3](#) illustrates the request-response and notification services.

**Figure 1: JET Request-Response and Notification Services**



[Table 1 on page 4](#) describes the request-response and notification services.

**Table 1: JET Applications Interact with Junos OS Through Services**

Service	Description
Request-response—An application can issue a request and wait for the response from Junos OS.	<p>JET services process (jsd), which runs on Junos OS, provides the request-response service. When jsd receives a request (by default on TCP port 32767), it creates a new session to service the JET application. The session remains alive as long as the client and server are both up and communicating with each other. Over the lifetime of a session, jsd can execute any number of APIs. jsd can support a maximum of 8 active client sessions and execute APIs from these sessions in parallel.</p> <p><b>NOTE:</b> For secure communications with jsd, use RSA certificates, specifically TLSv1.2 (minimum).</p>
Notifications—An application can receive asynchronous notifications of events happening on Junos OS.	<p>JET provides a publish-subscribe based messaging protocol and a notification broker. JET applications can register with the notification broker and inform the broker about the topics of interest to receive messages. The broker is responsible for distributing messages to the interested clients based on the topic of the message. Junos OS processes publishing the events (such as eventd) connect to the broker as a publisher and publish the events.</p> <p>JET utilizes Message Queue Telemetry Transport (MQTT) protocol (see <a href="https://mqtt.org/">https://mqtt.org/</a>) method to implement the notification service.</p>

## JET and gRPC

JET supports the gRPC framework for remote procedure calls (RPCs). JET uses gRPC for cross-language services as a mechanism to enable request-response service. gRPC also provides a mechanism to define APIs that are programming language agnostic. For more information, see <https://www.grpc.io/>.

# Set Up the JET VM

## IN THIS SECTION

● Overview | 5

- Install the JET Software Bundle | 5
- Set Up Your Virtual Machine Environment | 7
- Download the JET IDL | 7
- Prepare to Compile the Proto Definition Files in Python | 8

## Overview

Install the JET bundle on an external device before developing or running JET applications. The JET bundle includes the JET toolchain, plug-ins, and other tools and libraries that are required for developing on-device or off-device applications. Once you install the JET toolchain on your external device, the device functions as your JET virtual machine (VM).

If you are developing an application with a dependency on C or C++ modules or developing a signed application, you must use the JET VM for JET application development.

Follow these instructions to download the following packages on your external device:

- JET software bundle: This contains the JET sandbox and toolchain file.

In the `junos-jet-XX.YRZ.S.tar.gz` package name:

- XX is the main release number of the product, for example, 21.
- Y is the minor release number of the product, for example, 2.
- R is the type of software release, for example, R for FRS or maintenance release.
- Z is the build number of the product, for example, 1, indicating the FRS rather than a maintenance release.
- S is the spin number of the product, for example, 13.
- JET client IDL library: This contains the protobuf definition files for the JET APIs. You can also view them on the [JET GitHub repository](#).

## Install the JET Software Bundle

Install JET on an external device that will function as your JET VM. This task walks you through how to install JET on a device running Ubuntu.

1. Download the JET software bundle onto your external device from the [Juniper Networks downloads website](#). In this example, we downloaded the software bundle for JET Release 21.4R2.
2. Open a Terminal, Command, or similar window on your device. Confirm the file downloaded.

```
user@jet-vm:~$ cd ~/Downloads
user@jet-vm:~/Downloads$ ls
junos-jet-21.4R2.10.tar.gz
```

3. Extract the file.

```
user@jet-vm:~/Downloads$ tar -zxf junos-jet-21.4R2.10.tar.gz
```

4. View the contents of the extracted file.

```
user@jet-vm:~/Downloads$ ls
junos-jet-21.4R2.10  junos-jet-21.4R2.10.tar.gz
user@jet-vm:~/Downloads$ cd junos-jet-21.4R2.10/
user@jet-vm:~/Downloads/junos-jet-21.4R2.10$ ls
init_linux_prereqs.sh  junos-jet-sb-21.4R2.10-signed.tgz  README
install                junos-jet-toolchain-21.4R2.10-signed.tgz
```

5. Install the package. Use the `./install` command if you are logged in as the root user. If you are logged in as a different user, use the `sudo ./install` command. If using the `sudo ./install` command, you are prompted to enter the password for your account.

The output in this example has been snipped for length.

```
user@jet-vm:~/Downloads/junos-jet-21.4R2.10$ sudo ./install
[sudo] password for user:
Installing jot utility
Reading package lists... Done
Building dependency tree
[...]
Installation of JET SB successful.
[...]
Installation of JET Toolchain successful.
Installation of junos-jet-sb and junos-jet-toolchain completed
```

The JET sandbox and toolchain are installed on your device. This device now functions as your JET VM.

## Set Up Your Virtual Machine Environment

To set the PATH variable and prepare the JET VM:

1. Open a Terminal window in the JET VM.
2. Add the absolute path to the `/junos-jet-XX.YRZ.S.tar.gz/bin` directory to the PATH variable in `.bashrc`.

```
user@jet-vm:~$ echo 'PATH=$PATH:/usr/local/junos-jet/18.3R1/junos-jet-XX.YRZ.S.tar.gz'>> ~/.bashrc
```

3. Run the following command to display the JET `XX.YRZ.S.tar.gz` path in the output:

```
user@jet-vm:~$ source ~/.bashrc
```

4. Run the `env` command to ensure the PATH variable contains the directory path you just added.

```
user@jet-vm:~$ env

PATH=/usr/lib/lightdm/lightdm:/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin: /bin:/usr/games:/usr/local/junos-jet/18.3R1/junos-jet-XX.YRZ.S.tar.gz/bin
```

You are ready to develop applications in the JET VM.

## Download the JET IDL

1. Download the IDL file onto your device from the [Juniper Networks downloads website](#).
2. Make a directory on your device to store the proto definition files.

```
user@jet-vm:~$ mkdir jet
user@jet-vm:~$ cd jet
user@jet-vm:~/jet$ mkdir proto
```

3. Confirm the IDL file downloaded.

```
user@jet-vm:~/jet$ cd ../Downloads
user@jet-vm:~/Downloads$ ls
jet-idl-21.4R2.10.tar.gz  junos-jet-21.4R2.10  junos-jet-21.4R2.10.tar.gz
```

4. Unzip the IDL file into the directory you created.

```
user@jet-vm:~/Downloads$ tar -xzf jet-idl-21.4R2.10.tar.gz -C ../jet/proto/
```

5. Confirm the file unzipped properly.

```
user@jet-vm:~/Downloads$ cd ../jet/proto
user@jet-vm:~/jet/proto$ ls
1 2 README
```

6. You can view the most recent JET API proto definition files in the folder called 2.

```
user@jet-vm:~/jet/proto$ cd 2
user@jet-vm:~/jet/proto/2$ ls
jnx_authentication_service.proto  jnx_routing_base_service.proto
jnx_common_addr_types.proto       jnx_routing_base_types.proto
jnx_common_base_types.proto       jnx_routing_bgp_service.proto
jnx_firewall_service.proto        jnx_routing_flexible_tunnel_profile.proto
jnx_interfaces_service.proto      jnx_routing_flexible_tunnel_service.proto
jnx_management_service.proto      jnx_routing_interface_service.proto
jnx_registration_service.proto    jnx_routing_rib_service.proto
```

You have downloaded the IDL file successfully. It is ready to use.

## Prepare to Compile the Proto Definition Files in Python

If you are using Python, you need to install certain gRPC tools before you can compile the proto definition files in Python. These steps are also described on the [Quick Start page on the gRPC site](#).

1. (Optional) Activate a virtual environment.

```
user@jet-vm:~/PycharmProjects/jetTest$ source venv/bin/activate
(venv) user@jet-vm:~/PycharmProjects/jetTest$
```

2. Check you have the desired versions of Python and Pip installed. If you do not have them installed, install them now.

```
(venv) user@jet-vm:~/PycharmProjects/jetTest$ python --version
Python 3.8.10
(venv) user@jet-vm:~/PycharmProjects/jetTest$ python -m pip --version
pip 22.2.2 from /home/user/PycharmProjects/jetTest/venv/lib/python3.8/site-packages/pip
(pytho 3.8)
```

3. Install gRPC if it is not already installed.

```
(venv) user@jet-vm:~/PycharmProjects/jetTest$ python -m pip install grpcio
Collecting grpcio
  Downloading grpcio-1.48.1-cp38-cp38-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (4.6 MB)
    ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 4.6/4.6 MB 6.1 MB/s eta 0:00:00
Collecting six>=1.5.2
  Using cached six-1.16.0-py2.py3-none-any.whl (11 kB)
Installing collected packages: six, grpcio
Successfully installed grpcio-1.48.1 six-1.16.0
```

If gRPC is already installed, you will see this message:

```
(venv) user@jet-vm:~$ python -m pip install grpcio
Requirement already satisfied: grpcio in ./PycharmProjects/jetTest/venv/lib/python3.8/site-
packages (1.48.1)
```

4. Install gRPC tools if it is not already installed.

```
(venv) user@jet-vm:~/PycharmProjects/jetTest$ python -m pip install grpcio-tools
Collecting grpcio-tools
  Downloading grpcio_tools-1.48.1-cp38-cp38-manylinux_2_17_x86_64.manylinux2014_x86_64.whl
  (2.4 MB)
    ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 2.4/2.4 MB 10.6 MB/s eta 0:00:00
Requirement already satisfied: setuptools in ./venv/lib/python3.8/site-packages (from grpcio-
tools) (60.2.0)
```

```
Collecting protobuf<4.0dev,>=3.12.0
  Using cached protobuf-3.20.1-cp38-cp38-manylinux_2_5_x86_64.manylinux1_x86_64.whl (1.0 MB)
Requirement already satisfied: grpcio>=1.48.1 in ./venv/lib/python3.8/site-packages (from
grpcio-tools) (1.48.1)
Requirement already satisfied: six>=1.5.2 in ./venv/lib/python3.8/site-packages (from
grpcio>=1.48.1->grpcio-tools) (1.16.0)
Installing collected packages: protobuf, grpcio-tools
Successfully installed grpcio-tools-1.48.1 protobuf-3.20.1
```

You are ready to compile the IDL files you need to develop your application.



# 2

CHAPTER

## Application Development

---

Develop Off-Device JET Applications | 12

Develop On-Device JET Applications | 24

Package JET Applications | 41

Debug JET Applications | 48

---

# Develop Off-Device JET Applications

## IN THIS SECTION

- [Overview | 12](#)
- [Develop and Package Your Application | 13](#)
- [Prepare to Deploy Your Application | 14](#)
- [Example: Python JET Application | 17](#)

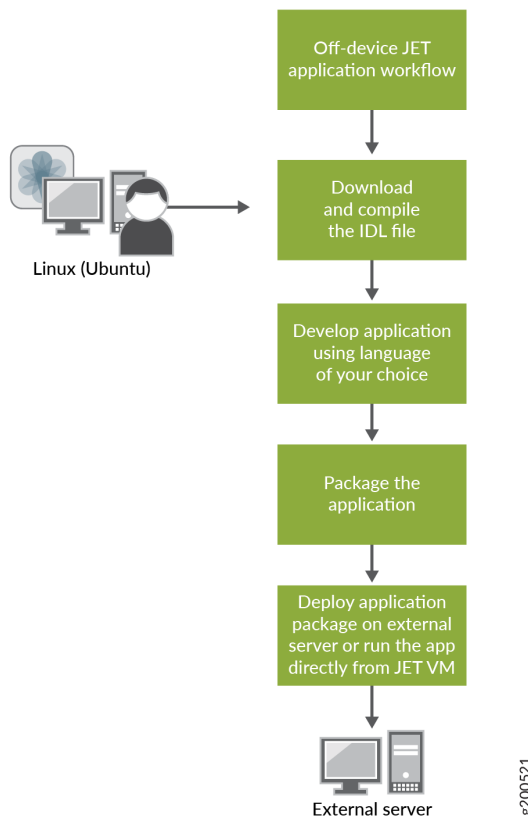
## Overview

You can use JET to develop applications that run off-device. This allows you to leverage the benefits of JET on all devices on your network. For ease of development, you can write off-device JET applications in the language of your choice. To develop an off-device application:

1. Download and compile the IDL file.
2. Develop the application using the language of your choice.
3. Package the application.
4. Deploy the application package on an external server or run the application directly from the JET VM.

[Figure 2 on page 13](#) shows the off-device application development workflow.

Figure 2: Off-Device JET Application Workflow



## Develop and Package Your Application

Before developing your application, make sure you have already followed the instructions in ["Set Up the JET VM" on page 4](#) to set up the JET VM and download the IDL file.

1. Compile the proto definition files that you plan to use in the language of your choice.

In this example, we are using Python. We compile the files for the management, authentication, and common base types APIs.

```

user@jet-vm:~/jet$ python -m grpc_tools.protoc -I./proto/2 --python_out=. --grpc_python_out=.
proto/2/jnx_management_service.proto
user@jet-vm:~/jet$ python -m grpc_tools.protoc -I./proto/2 --python_out=. --grpc_python_out=.
proto/2/jnx_authentication_service.proto
user@jet-vm:~/jet$ python -m grpc_tools.protoc -I./proto/2 --python_out=. --grpc_python_out=.

```

```

proto/2/jnx_common_base_types.proto
user@jet-vm:~/jet$ ls -lrt
total 48
drwxrwxr-x 4 user user 4096 Sep  1 15:34 proto
-rw-rw-r-- 1 user user 13969 Sep  1 16:02 jnx_management_service_pb2.py
-rw-rw-r-- 1 user user 8342 Sep  1 16:02 jnx_management_service_pb2_grpc.py
-rw-rw-r-- 1 user user 2472 Sep  1 16:04 jnx_authentication_service_pb2.py
-rw-rw-r-- 1 user user 3086 Sep  1 16:04 jnx_authentication_service_pb2_grpc.py
-rw-rw-r-- 1 user user 3971 Sep  1 16:04 jnx_common_base_types_pb2.py
-rw-rw-r-- 1 user user 159 Sep  1 16:04 jnx_common_base_types_pb2_grpc.py

```

You have compiled Python and gRPC modules for each specified API.

## 2. Develop the application using the language of your choice.

If you are developing an application with a dependency on C or C++ modules or developing a signed application, you must use the JET VM for JET application development.

**NOTE:** Starting in Junos OS Release 21.1R1 and Junos OS Evolved Release 22.3R1, Python 2.7 is no longer supported. Use Python 3 instead.

You can write the application using a stub after a client side stub is generated. For more information on generating the gRPC client side stubs, writing the application using the stub, and generating code from an IDL file in the language of your choice, see <https://www.grpc.io/docs/>.

## 3. Package the application using JSON. See "Package JET Applications" on page 41 for more information.

## SEE ALSO

[Understanding Python Automation Scripts for Devices Running Junos OS](#)

[IPv6 Support in Python Automation Scripts](#)

# Prepare to Deploy Your Application

## IN THIS SECTION

- [Configure JET Interaction with Junos OS](#) | 15

Run your application on an external server or directly from the JET VM. Before you deploy your application on an external server, you need to configure JET interaction with Junos OS.

## Configure JET Interaction with Junos OS

To run an off-device application, you need to enable the [request-response](#) configuration on Junos OS or Junos OS Evolved. When using the request-response service, the client application issues a request and synchronously waits for the response from the Junos server. Use this section to configure the JET service process (jsd) for the request-response service to run in Secure Sockets Layer (SSL) mode. This provides increased security and enables SSL-based API connections.

**NOTE:** Currently, JET supports Transport Layer Security (TLS) version 1.2 for certificate exchange and supports multiple encryption algorithms, but does not support mutual authentication. This means that clients can authenticate the server, but the server can not authenticate clients using SSL/TLS certificates. For client authentication, use the `LoginCheck()` procedure from the authentication service API.

1. Enable jsd to use SSL by adding and configuring the certificate name locally. The certificate must be an RSA certificate. ECDSA and DSA SSL certificates are not supported.

This method is same as other SSL-based services in Junos OS like `xnm-ssl`. Keep track of the certificate name entry you specify during certificate generation. You will use it for the `HOST_OVERRIDE` option in the example Python application in the next section. In this example, the certificate name is `router`.

```
user@jet-vm:~ jet$ openssl genrsa -aes256 -out router.key.orig 2048
user@jet-vm:~ jet$ openssl req -new -key router.key.orig -out router.csr
user@jet-vm:~ jet$ openssl rsa -in router.key.orig -out router.key
user@jet-vm:~ jet$ openssl x509 -req -days 365 -in router.csr -signkey router.key -out
router.crt
user@jet-vm:~ jet$ cat router.crt router.key > router.pem
```

**NOTE:** If a certificate is updated with the same identifier, the changes will not be reflected for jsd. You need to either configure the certificate with a new identifier in the jsd hierarchy or perform a jsd restart to reflect the changes made.

2. Copy the SSL certificate **.pem** file to the Junos device.

```
user@device% scp pem-file-name device-name:/var/tmp
```

For example:

```
user@device% scp router.pem device:/var/tmp
```

3. Load the certificate into the keychain on the Junos device. For example, if the local name of the SSL certificate is **sslcert**:

```
[edit]  
user@device# set security certificates local sslcert load-key-file /var/tmp/router.pem
```

4. Enable support for SSL for the loaded certificate.

```
[edit system services extension-service request-response grpc]  
user@device# set ssl local-certificate cert-name
```

For example:

```
[edit system services extension-service request-response grpc]  
user@device# set ssl local-certificate sslcert
```

5. (Optional) Specify the specific IP address or port that will use SSL. SSL makes that address or port a secure channel.

```
[edit system services extension-service request-response grpc]  
user@device# set ssl address address  
user@device# set ssl port port-number
```

If you set the address to 0.0.0.0, the device uses SSL on all ports. For example, to enable support for SSL on the gRPC endpoint on all ports and the default TCP port 51051:

```
[edit system services extension-service request-response grpc]
user@device# set ssl address 0.0.0.0
user@device# set ssl port 51051
```

6. Specify the maximum number of simultaneous connections for request-response that can be attached to jsd. The higher the number, the higher the impact on the client's performance.

```
[edit system services extension-service request-response grpc]
user@device# set max-connections 8
```

You have configured jsd for request-response service to run in SSL mode. You are ready to deploy your JET off-device application.

7. Specify the scripts to use.

```
[edit]
user@device# set system scripts language python3
```

**NOTE:** Starting in Junos OS Release 21.1R1 and Junos OS Evolved Release 22.3R1, Python 2.7 is no longer supported and the `set system scripts language python` statement is deprecated. Use the `set system scripts language python3` statement instead.

## Example: Python JET Application

### IN THIS SECTION

- Junos OS Release 18.4R1 and Later | 18
- Before Junos OS Release 18.4R1 | 21

Use this example to develop an off-device JET application written in Python. You can follow the same guidance for other languages that are supported by gRPC. This Python JET application runs the command `get-system-uptime-information` in XML format.

In this example, the `HOST_OVERRIDE` option uses the certificate name that you specified during the certificate generation. See ["Prepare to Deploy Your Application" on page 14](#).

**NOTE:** Juniper Networks supports both of the following forms for denoting XML opening and closing tags: `<xml-tag/>` and `<xml-tag></xml-tag>`.

## Junos OS Release 18.4R1 and Later

Use the example Python application shown in this section as a guide if you are using Junos OS Release 18.4R1 or later.

If you are writing your application using Python 3, include the `PASS` keyword in the Exception block of the script.

```
except Exception as tx:
    pass
```

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

# A simple Python client to run XML OP command 'get-system-uptime-information'

# Environment
# Python 2.7.12
# grpcio (1.12.0)
# grpcio-tools (1.12.0)

# Following files should be available in current working directory
# jnx_authentication_service_pb2_grpc.py
# jnx_authentication_service_pb2.py
# jnx_management_service_pb2_grpc.py
# jnx_management_service_pb2.py

import argparse
import grpc
import os
```



```

import stat

import jnx_authentication_service_pb2
import jnx_authentication_service_pb2_grpc
import jnx_management_service_pb2
import jnx_management_service_pb2_grpc
import jnx_common_base_types_pb2

_HOST_OVERRIDE = 'router'

def Main():
    try:
        parser = argparse.ArgumentParser()

        parser.add_argument('-d', '--device', help='Input hostname',
                            required=True)
        parser.add_argument('-t', '--timeout', help='Input time_out value',
                            required=True, type=int)
        parser.add_argument('-u', '--user', help='Input username',
                            required=True)
        parser.add_argument('-pw', '--password', help='Input password',
                            required=True)

        args = parser.parse_args()

        #Establish grpc channel to jet router
        creds = grpc.ssl_channel_credentials(open('/tmp/router.pem').read(),
                                             None, None)
        channel = grpc.secure_channel(args.device + ":32767", creds,
                                      options=(('grpc.ssl_target_name_override', _HOST_OVERRIDE),))

        #create stub for authentication services
        stub = jnx_authentication_service_pb2_grpc.AuthenticationStub(channel)
        #Authenticate
        login_request = jnx_authentication_service_pb2.LoginRequest(
            username=args.user, password=args.password, client_id="SampleApp")
        login_response = stub.Login(login_request, args.timeout)
        #Check if authentication is successful
        if login_response.status.code == jnx_common_base_types_pb2.SUCCESS:
            print "[INFO] Connected to gRPC Server"
        else:
            print "[ERROR] gRPC Server Connection failed:"
    
```

```

        print login_response.status.message

    #Create stub for management services
    stub = jnx_management_service_pb2_grpc.ManagementStub(channel)
    print "[INFO] Connected to management service"
    for i in range(1):
        #Provide API request details
        op_xml_command = "<get-system-uptime-information></get-system-uptime-information>"
        op = jnx_management_service_pb2.OpCommandGetRequest(
            xml_command=op_xml_command, out_format=2)
        # Invoke API
        op_response = stub.OpCommandGet(op, args.timeout)
        # Check API response like status and output
        for resp in op_response:
            if resp.status.code == jnx_common_base_types_pb2.SUCCESS:
                print "[INFO] Invoked OpCommandGetRequest succeeded"
                print "[INFO] Return output in CLI format = "
                print resp.data
            else:
                print "[ERROR] Invoked OpCommandGetRequest failed"
                print "[ERROR] " + resp.status.message

    except Exception as ex:
        print ex

if __name__ == '__main__':
    Main()

```

```

user@jet-vm:~ jet$ python mgd_api_new_doc_example_ssl.py -d JUNOS_DEVICE -t TIMEOUT -u USER -pw
PASSWORD

```

```

[INFO] Connected to gRPC Server
[INFO] Connected to management service
[INFO] Invoked OpCommandGetRequest succeeded
[INFO] Return output in CLI format =

```

```

Current time: 2018-11-08 09:36:40 PST
Time Source: NTP CLOCK
System booted: 2018-10-09 17:02:56 PDT (4w1d 17:33 ago)

```

```

Protocols started: 2018-10-09 17:05:09 PDT (4w1d 17:31 ago)
Last configured: 2018-11-08 09:30:28 PST (00:06:12 ago) by root
9:36AM up 29 days, 17:34, 2 users, load averages: 1.05, 0.77, 0.57

```

## Before Junos OS Release 18.4R1

Use the example Python application in this section as a guide if you are using Junos OS releases prior to 18.4R1.

```

#!/usr/bin/env python

# A simple Python client to run XML OP command 'get-system-uptime-information'

# Environment
# Python 2.7.12
# grpcio (1.12.0)
# grpcio-tools (1.12.0)

# Following files should be available in current working directory
# authentication_service_pb2_grpc.py
# authentication_service_pb2.py
# management_service_pb2_grpc.py
# management_service_pb2.py

import argparse
import grpc

import authentication_service_pb2
import authentication_service_pb2_grpc
import management_service_pb2
import management_service_pb2_grpc

_HOST_OVERRIDE = 'router'

def Main():
    try:
        parser = argparse.ArgumentParser()

        parser.add_argument('-d', '-device', help='Input hostname',
                            required=True)
        parser.add_argument('-t', '-timeout', help='Input time_out value',

```

```

        required=True,type=int)
    parser.add_argument('-u', '-user', help='Input username',
        required=True)
    parser.add_argument('-pw', '-password', help='Input password',
        required=True)

    args = parser.parse_args()

    #Establish grpc channel to jet router
    creds = grpc.ssl_channel_credentials(open('/tmp/router.pem').read(),
                                         None, None)
    channel = grpc.secure_channel(args.device + ":51051", creds,
        options= (('grpc.ssl_target_name_override', _HOST_OVERRIDE),))

    #create stub for authentication services
    stub = authentication_service_pb2_grpc.LoginStub(channel)
    #Authenticate
    login_request = authentication_service_pb2.LoginRequest(
        user_name=args.user, password=args.password, client_id="SampleApp")
    login_response = stub.LoginCheck(login_request, args.timeout)

    #Check if authentication is successful
    if login_response.result == True:
        print "[INFO] Connected to gRPC Server:"
        print login_response.result
    else:
        print "[ERROR] gRPC Server Connection failed!!!"
        print login_response.result

    #Create stub for management services
    stub = management_service_pb2_grpc.ManagementRpcApiStub(channel)
    print "[INFO] Connected to JSD and created handle to mgd services"

    for i in range(1):
        #Provide API request details
        op_xml_command = "<get-system-uptime-information>" \
            "</get-system-uptime-information>"
        op = management_service_pb2.ExecuteOpCommandRequest(
            xml_command=op_xml_command, out_format=2, request_id=1000)
        # Invoke API
        result = stub.ExecuteOpCommand(op, 100)
        # Check API response like status and output
        for i in result:

```

```

        print "[INFO] Invoked ExecuteOpCommand API return code = "
        print i.status
        print "[INFO] Return output in CLI format = "
        print i.data
    except Exception as ex:
        print ex

if __name__ == '__main__':
    Main()

```

```

user@jet-vm:~ jet$ python mgd_api_doc_example_ssl.py -d JUNOS_DEVICE -t TIMEOUT_VAL -u USER -pw
PASSWORD

```

```

[INFO] Connected to gRPC Server:
True
[INFO] Connected to JSD and created handle to mgd services
[INFO] Invoked ExecuteOpCommand API return code =
0
[INFO] Return output in CLI format =
Current time: 2018-09-04 11:24:36 PDT
Time Source: NTP CLOCK
System booted: 2018-08-31 10:58:22 PDT (4d 00:26 ago)
Protocols started: 2018-08-31 11:00:52 PDT (4d 00:23 ago)
Last configured: 2018-08-31 14:21:32 PDT (3d 21:03 ago) by root
11:24AM up 4 days, 26 mins, 0 users, load averages: 1.20, 1.27, 1.10

```

## RELATED DOCUMENTATION

[Debug JET Applications](#) | 48

# Develop On-Device JET Applications

## IN THIS SECTION

- [Overview | 24](#)
- [Develop Unsigned JET Applications | 26](#)
- [Develop Signed JET Applications | 26](#)
- [Compile 64-Bit Applications | 29](#)
- [Example: Develop a Signed C Package | 29](#)
- [Example: Develop a Signed Python Package Without C Dependencies | 33](#)
- [Example: Develop a Signed Python Package With C Dependencies | 37](#)

## Overview

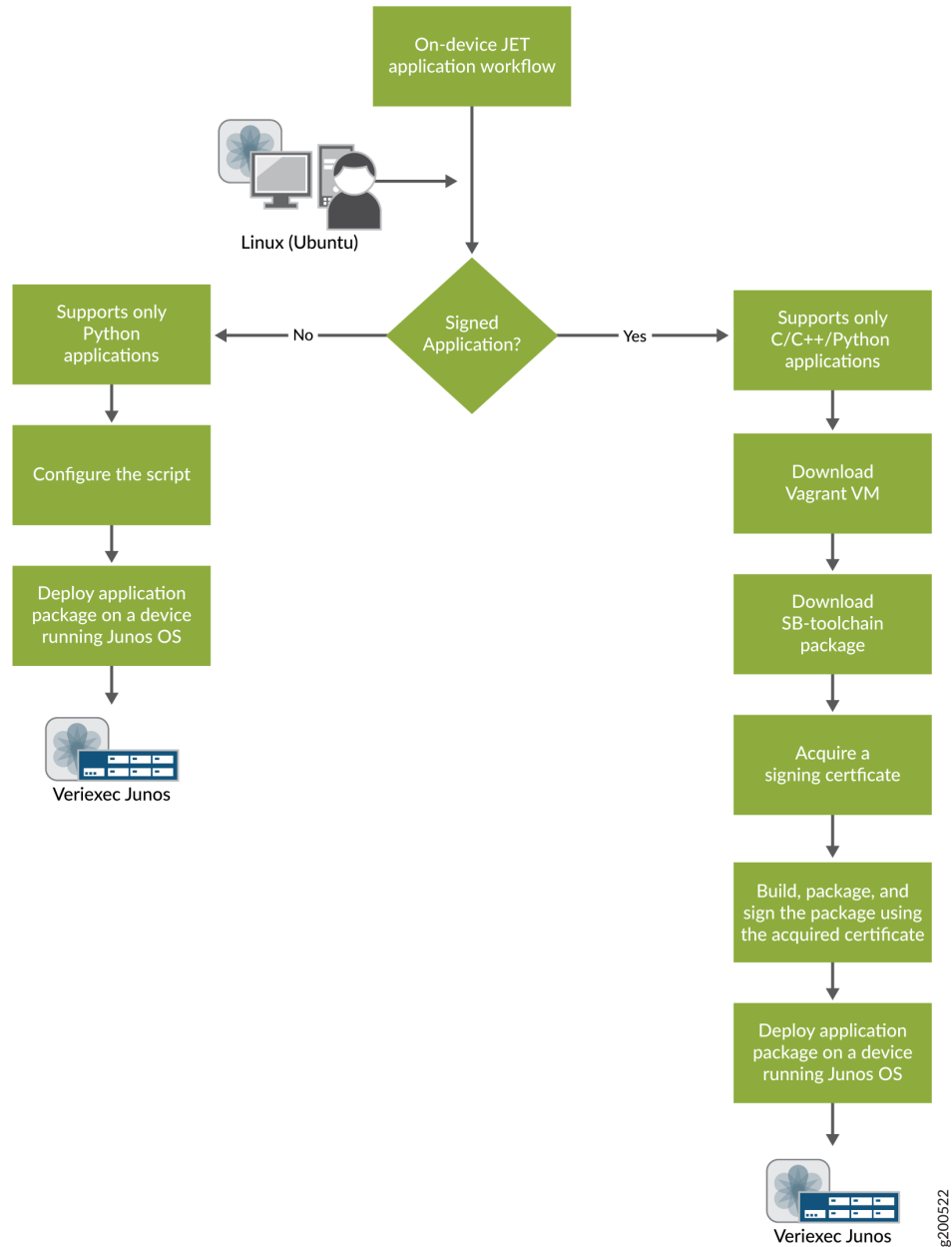
JET applications written in C, C++, and Python languages can run on-device. You can develop the applications in the downloaded JET VM and then deploy these applications on the device running Junos OS. You can sign on-device JET applications to show that they can be trusted.

**NOTE:** The Python 2.7 end-of-life and end-of-support date is January 1, 2020. The official upgrade path for Python 2.7 is to Python 3. As support for Python 3 is added to devices running Junos OS for the different types of on-device scripts, we recommend that you migrate supported script types from Python 2 to Python 3.

Starting in Junos OS Release 21.1R1 and Junos OS Evolved Release 22.3R1, Python 2.7 is no longer supported and the `set system scripts language python` statement is deprecated. Use the `set system scripts language python3` statement instead.

[Figure 3 on page 25](#) shows the application development workflow for unsigned and signed on-device JET applications.

Figure 3: On-Device JET Application Workflow



## SEE ALSO

[Understanding Python Automation Scripts for Devices Running Junos OS](#)

[IPv6 Support in Python Automation Scripts](#)

## Develop Unsigned JET Applications

Unsigned JET applications can only be written in Python.

To develop an unsigned JET application:

1. (Optional) Download and set up the JET VM. See ["Set Up the JET VM" on page 4](#).
2. Develop your application in Python.
3. Package your application. See ["Package JET Applications" on page 41](#).
4. Configure the `language` statement on the Junos device. For example, to use Python 3 to run a JET script that supports Python 3:

```
[edit]
user@device# set system scripts language python3
```

See [Understanding Python Automation Scripts for Devices Running Junos OS](#) for more information.

5. Run the application on a device running on Junos OS.

## Develop Signed JET Applications

### IN THIS SECTION

- [Request a Signing Certificate | 27](#)

You can develop signed applications in C, C++, or Python.

To develop a signed application:

1. Download the packages you need and set up the JET VM. See ["Set Up the JET VM" on page 4](#).
2. Request a signing certificate. See ["Request a Signing Certificate" on page 27](#).
3. Develop the application.



4. Configure the license if your application is written in C or C++. This step is optional for applications written in Python. See [Configuring the JET Application and its License on a Device Running Junos OS](#) for details.
5. Build the package and sign the package using the acquired certificate.
6. Deploy the application on a device running Junos OS.

## Request a Signing Certificate

To develop and distribute JET applications, you must install a package signing certificate on the JET VM by executing the certificate request script. This script assists you in creating a signing key and a certificate request for use with JET.



**CAUTION:** Never share the signing key with anyone, including Juniper Networks. The key enables anyone to sign applications that your router will trust. Therefore, treat the key with the same level of security as the root password for the routers. Once you obtain your signing key, save it in a file outside of the VM.

The certificate request script asks for the following information:

- City, state, and country.
- Your organization and unit. The organization should not be vague. There cannot be any hyphens ("-").
- Certificate type: Specify whether the certificate is commercial or private. Non-Juniper entities must use commercial. Private certificates are only assigned when the organization is Juniper.
- Provider prefix: This is the unique provider name assigned by Juniper to each JET partner.
- User string: This is an additional specification of your choosing. It could be a string specifying the development team or project name. The user string can consist of a lowercase letter followed by one or more lowercase letters or numbers (for example, teamjet2).
- Deployment scope: The deployment scope is the string assigned by Juniper to differentiate multiple certificates for the same JET partner. This defines the validity period for the generated certificate. The scope can be commercial or evaluation. If none is assigned to you, leave it empty.
- Index number: This number is known as a certificate generations number. It will be 1 for your initial certificate. When a certificate expires and when you request a new one, this number will be incremented.
- Email address: The email address for the certificate contact will be embedded into the certificate. We recommend using the email address of a department or unit in your organization. We recommend that you do not use a personal email address.

To create a signed application, request certificates and copy them as explained in the following procedure. This procedure is optional if you want to create an unsigned application.

To manually request a certificate:

1. Create the `/usr/local/junos-jet/certs` directory if it does not already exist on your device.
2. In a VM terminal, run the `jet-certificate-request` command.
3. The script leads you through a series of questions. Answer the questions and press Enter after each answer. See the requirements for each answer listed above.
4. Based on your answers, the script generates two files in the `/usr/local/junos-jet/certs` directory: `certname_key.pem` and `certname_req.pem`. The `certname` is the name of the certificate.

The certificate name must follow the format ORGANIZATION-USER-TYPE-NUMBER. All four parameters are mandatory or else you will see the following error:

```
ERROR: CN has invalid format; regex: ^([a-z0-9]+)-([a-z0-9]+)-(commercial|private)-([1-9]
[0-9]*)$
    Expected format: ORGANIZATION-USER-TYPE-NUMBER
      organization: [a-z0-9]+
        Must be "juniper" for type is "private"
      user:    [a-z0-9]+
      type:   commercial|private
      number: [1-9][0-9]*
```

5. Save the `certname_key.pem` file outside the VM. This is your signing key. Ensure that no one outside of your development organization has access to it. Never share the signing key with anyone, including Juniper Networks.

The key enables anyone to sign applications that your router will trust. Therefore, treat the key with the same level of security as the root password for the routers.

6. Send the `certname_req.pem` file to JET Certificate Processing at <mailto:jet-cert@juniper.net>. This file contains your certificate request. The requestor should be authorized to request signing certificates on behalf of their organization. JET Certificate Processing will immediately send your certificate to you.
7. When you receive your certificate, save it as `certname` and copy it to the `/usr/local/junos-jet/certs` directory.
8. Verify the certificate and the signing key are available in the `/usr/local/junos-jet/certs` directory.

## Compile 64-Bit Applications

JET supports 64-bit applications for Junos OS with FreeBSD and Junos OS with upgraded FreeBSD. When you are ready to package your application, use the following commands to compile 64-bit applications for use with the AMD64 or ARM64 64-bit processor architecture.

To compile the application for use with AMD64 and Junos OS with FreeBSD:

1. Check you have the GCC toolchain, which should be included in the JET package.
2. Use the command `mk-amd64 application name` to build the application package.

To compile the application for use with AMD64 and Junos OS with upgraded FreeBSD:

1. Check you have the Clang toolchain, which should be included in the JET package.
2. Use the command `mk-amd64,bsd application name` to build the application package.

To compile the application for use with ARM64 and Junos OS with upgraded FreeBSD:

1. Check you have the Clang toolchain, which should be included in the JET package.
2. Use the command `mk-arm64,bsd application name` to build the application package.

## Example: Develop a Signed C Package

After you have set up the JET VM and acquired a signing certification, you are ready to create the development sandbox in the VM and start developing your signed, on-device application. Use this example to create C applications echoclient and echoserver.

1. Check out the sandbox. A sandbox is a build tree with a little environment file called `.sandbox-env` at the top that is used by a wrapper script `mk` to ensure the build environment is properly conditioned.

```
user@jet-vm:~$ mksb -n capp echoclient /home/user/capp_server/src/echoclient.json
```

**NOTE:** The echo client is a demo application. In the `bin/` directory, all the necessary configuration and build related files are available within the sandbox along with source file for the echo client.

2. Build an echo client package.

```
user@jet-vm:/home/user/capp/src$ mk-i386,bsdxc echoclient
```

**NOTE:** Starting in Junos OS Release 20.2R1, if you will be running your JET application on a ACX710 device, you can use the Clang toolchain for ARM-based compilation of JET applications written in C, Python, or Ruby. Use the command `mk-arm,bsdxc` instead of `mk-i386,bsdxc` to use the Clang toolchain to compile your application.

3. Copy the echo client package onto the device running on Junos OS.

```
user@jet-vm:/home/user/capp/src$ scp /home/user/capp/junos-jet-sb-obj//ship/echoclient-x86-32-20180829.065039_user.tgz root@device:/var/tmp
```

4. Enter configuration mode on the Junos device.

```
root@device:~ # cli
```

5. Install the echo client package.

```
root@device> request system software add /var/tmp/echoclient-x86-32-20180829.065039_user.tgz
```

```
Verified echoclient-x86-32-20180829.065039_user signed by junosmanageability-dev-beta-1
method RSA2048+SHA1
```

Confirm it was installed successfully.

```
root@device> show version
```

```
Hostname: device
```

```
Model: mx480
```

```
Junos: 18.4-20180627_dev_common.1
```

```
JUNOS OS Kernel 32-bit [20180621.191151_fbsd-builder_stable_11]
```

```
...
```

```
...
```

```
JET app echoclient [20180829.065039_user]
```

6. Check out the echo server sandbox.

```
user@jet-vm:/home/user$ mksb -n capp_server echoserver /home/user/capp_server/src/
echoclient.json
```

7. Build the echo server package.

```
user@jet-vm:/home/user/capp_server/src$ mk-i386,bsdxc echoserver
```

8. Copy the echo server package to the Junos VM.

```
user@jet-vm:/home/user/capp_server/src$ scp /home/user/capp_server/junos-jet-sb-obj//ship/
echoserver-x86-32-20180829.065703_user.tgz root@device:/var/tmp/
```

9. Add the echo server package to the Junos device.

```
root@device> request system software add /var/tmp/echoserver-x86-32-20180829.065703_user.tgz

Verified echoserver-x86-32-20180829.065703_user signed by junosmanageability-dev-beta-1
method RSA2048+SHA1
```

10. Check that the packages were added successfully.

```
root@device> show version

Hostname: device
Model: mx480
Junos: 18.4-20180627_dev_common.1
JUNOS OS Kernel 32-bit [20180621.191151_fbsd-builder_stable_11]
JUNOS OS libs [20180621.191151_fbsd-builder_stable_11]
.....
JET app echoserver [20180829.065703_user]
JET app echoclient [20180829.065039_user]
```

11. Configure the echo server's provider's ID, license type, and deployment scope on the Junos device. Use the same provider license that you used to package it.

```
root@device# set system extensions providers 12345 license-type juniper deployment-scope
commercial
```

For more information, see [Configuring the JET Application and its License on a Device Running Junos OS](#).

12. Configure the echo server on the Junos device.

```
root@device# set system extensions extension-service application file echoserverd
[edit]
root@device# commit
commit complete
[edit]
root@device# exit
root@device> request extension-service start echoserverd
```

```
Extension-service application 'echoserverd' started with pid: 12345
```

13. Configure the echo client's provider's ID, license type, and deployment scope on the Junos device. Use the same provider license that you used to package it.

```
root@device# set system extensions providers 56789 license-type juniper deployment-scope
commercial
```

14. Configure the echo client application on the Junos device.

```
root@device# set system extensions extension-service application file echoclientd arguments
"127.0.0.1 Testmessage"
[edit]
root@device# commit
commit complete
[edit]
root@device# exit
```

15. Run the echo client application.

```
root@device> request extension-service start echoclientd
```

```
Extension-service application 'echoclientd' started with pid: 56789
-- server reply:Testmessage
-- Testmessage
```

## Example: Develop a Signed Python Package Without C Dependencies

After you have set up the JET VM and acquired a signing certification, you are ready to create the development sandbox in the VM and start developing your signed, on-device application. Use this example to develop a signed Python package without C dependencies.

1. In the VM, go to the **/home/user** directory.
2. Create a sandbox by using the `mksb` command, where `SamplePyApp` is the name of the sandbox. A sandbox is a build tree with a little environment file called `.sandbox-env` at the top that is used by a wrapper script `mk` to ensure the build environment is properly conditioned.

```
user@jet-vm:~$ mksb -n SamplePyApp
% mksb -n SamplePyApp
```

3. Create subdirectories in the sandbox.

First, use the `workon` command to go into your sandbox. The `workon` command takes you directly to the **\$SB/src** directory and sets the sandbox correctly.

```
user@jet-vm:/home/user$ workon SamplePyApp
```

Alternatively, you can `cd` to the **src** directory of your sandbox.

Next, create subdirectories for application code in **\$SB/src/python**, **\$SB/src/lib**, or **\$SB/src/bin**, based on whether you need Python, library, or bin (executable) files.

```
user@jet-vm:/home/user/pyapp/src/python$ mkdir SamplePyApp
```

4. Develop the code.

```
user@jet-vm:$ /home/user/pyapp/src/python/SamplePyApp$ ls cmdline_args.py.
```

If you are writing your application using Python 3, include the `PASS` keyword in the Exception block of the script.

```
except Exception as tx:
    pass
```

5. Write an application JSON file to package the application.

```
SamplePyApp.json
{
  "app-name" : "SamplePyApp",
  "app-path" : "python/SamplePyApp",
  "language" : "python",
  "main-scripts" : ["cmdline_args.py"],
  "app-type" : "standalone",
  "sign" : "yes",
  "os-type" : "bsd11",
  "target-arch" : "i386",
  "description" : "Simple Python App"
}
```

See "[Package JET Applications](#)" on page 41 for more information.

6. Add the path to `jet-pkg-gen.py` to your `.bashrc` file.

```
user@jet-vm:/home/user$ echo 'PATH=$PATH:/usr/local/junos-jet/18.2R1.9/junos-jet-sb/src/junos/
host-utils/scripts' >> ~/.bashrc
user@jet-vm:/home/user/pyapp/src$ source ~/.bashrc
```

7. Autogenerate the appropriate makefiles by running the `jet-pkg-gen.py` command. The `jet-pkg-gen.py` command takes two options:

- The `-i` option is followed by the path and filename of the JSON file.
- The `-p` option is followed by the path to the `src` directory of the sandbox.

For example, if the sandbox name is `SamplePyApp`:

```
user@jet-vm:~/SamplePyApp/src$ jet-pkg-gen.py -I /home/user/pyapp/src/SamplePyApp.json -p /
home/user/pyapp/src
```



**NOTE:** The autogenerated application makefile will be correct in most cases. If there are any external library dependencies, adjust the makefile accordingly.

8. Build the entire package.

First, return to the **src** directory (**\$SB/src**). Next, run the `mk-i386 SamplePyApp` command, where *SamplePyApp* is the "app-name" from the JSON file in Step 5.

```
user@jet-vm:/home/user/pyapp/src$ mk-i386,bsdix SamplePyApp
```

**NOTE:** Starting in Junos OS Release 20.2R1, if you will be running your JET application on a ACX710 device, you can use the Clang toolchain for ARM-based compilation of JET applications written in C, Python, or Ruby. Use the command `mk-arm,bsdix` instead of `mk-i386,bsdix` to use the Clang toolchain to compile your application.

9. Copy the package onto a device running Junos OS.

```
user@jet-vm:/home/user/pyapp/src$ scp ../junos-jet-sb-obj/ship/SamplePyApp-  
x86-32-20180828.231545_user.tgz root@device:/var/tmp/
```

Now configure the Junos device and install the package.

1. Enter configuration mode.

```
root@device> configure  
Entering configuration mode  
[edit]  
root@device#
```

2. Configure the application's provider's ID, license type, and deployment scope on the Junos device, if necessary. Use the same provider license that you used to package it.

```
root@device# set system extensions providers 12345 license-type juniper deployment-scope  
commercial
```

For more information, see [Configuring the JET Application and its License on a Device Running Junos OS](#).

3. Exit to operational mode and install the copied package on the Junos device.

```
root@device# exit
root@device> request system software add /var/tmp/SamplePyApp-x86-32-20180828.231545_user.tgz
```

**NOTE:** This step will fail if `providers` is not configured.

4. Verify the package was installed successfully.

```
root@device> show version

Hostname: device
Model: mx480
...
...
JET app SamplePyApp [20180828.231545_user]
```

5. Enter configuration mode.

```
root@device> configure
Entering configuration mode
[edit]
root@device#
```

6. Configure the command-line arguments through the Junos OS CLI. If a Python JET script is available in the `/var/db/scripts/jet/` directory on a device running Junos OS, you can configure command-line arguments for the file and supply the arguments from the Junos CLI.

Here are the arguments in the application.

```
import argparse

def main():
    parser = argparse.ArgumentParser(description='This is a demo script.')

    parser.add_argument('-arg1', required=True)
    parser.add_argument('-arg2', required=True)
```

```
args = parser.parse_args()

print args.arg1
print args.arg2

if __name__ == '__main__':
    main()
```

Configure the command-line arguments in the CLI. In this example, the script filename is `cmdline_args.py`.

```
root@device# set system extensions extension-service application file cmdline_args.py
arguments "-arg1 jet -arg2 application"
```

7. Commit the configuration and exit to operational mode.

```
root@device# commit
root@device# exit
```

8. Run the application.

```
root@device> request extension-service start cmdline_args.py

Extension-service application 'cmdline_args.py' started with PID: 12345
jet
application
```

## Example: Develop a Signed Python Package With C Dependencies

After you have set up the JET VM and acquired a signing certification, you are ready to create the development sandbox in the VM and start developing your signed, on-device application. Use this example to develop a signed Python package with C dependencies.

1. Check out the sandbox.

```
user@jet-vm:/user/jet-trial-apps/signed-python-with-c-dep$ mksb -n PyAppC
```

2. Create an application directory in the Python subdirectory.

```
user@jet-vm:/user/jet-trial-apps/signed-python-with-c-dep/PyAppC/src/python$ mkdir pyappc
```

3. A bitarray is an example of a relatively simple Python module with a C dependency. Download and extract the bitarray from <https://pypi.org/project/bitarray/> into the Python application directory.

```
user@jet-vm:/user/jet-trial-apps/signed-python-with-c-dep/PyAppC/src/python/pyappc$ ls
bitarray

_bitarray.c  __init__.py
```

This is an example of a simple Python application that uses a bitarray module:

```
user@jet-vm:/user/jet-trial-apps/signed-python-with-c-dep/PyAppC/src/python/pyappc$ cat
bitarray_app.py
from bitarray import bitarray

a = bitarray()
a.append(True)
a.extend([False, True, False])
print a
```

If you are writing your application using Python 3, include the PASS keyword in the Exception block of the script.

```
except Exception as tx:
    pass
```

4. Create the JSON configuration file that references the external source files. See "[Package JET Applications](#)" on [page 41](#) for more information.

```
user@jet-vm:/user/jet-trial-apps/signed-python-with-c-dep/PyAppC/src$ cat pyappc.json

{
  "app-name" : "PyAppC",
  "app-path" : "python/pyappc",
  "language" : "python",
  "main-scripts" : ["bitarray_app.py"],
  "app-type" : "standalone",
```

```

    "sign" : "yes",
    "os-type" : "bsd11",
    "target-arch" : "i386",
    "description" : "Simple Python App with C dependencies",

    "srcs" : {
        "python/pyappc/bitarray" : ["__init__.py"]
    },
    "extn-srcs" : {
        "python/pyappc/bitarray" : ["_bitarray.c"]
    }
}

```

```

user@jet-vm:/user/jet-trial-apps/signed-python-with-c-dep/PyAppC/src$ jet-pkg-gen.py -I /
user/jet-trial-apps/signed-python-with-c-dep/PyAppC/src/pyappc.json -p /user/jet-trial-apps/
signed-python-with-c-dep/PyAppC/src

```

5. Run the following command to create the necessary makefiles and the manifest file that locates the files on the Junos device when the package is installed.

```

/user/jet-trial-apps/signed-python-with-c-dep/PyAppC/src/pkgs/PyAppC/contents.manifest

user@jet-vm:/user/jet-trial-apps/signed-python-with-c-dep/PyAppC/src$ cat ./pkgs/PyAppC/
contents.manifest.orig

/set package_id=31 role=Provider_Daemon
%TOPDIR%/python/pyappc/bitarray_app.py store=%INSTALLDIR%/bitarray_app.py mode=555
program_id=1
%TOPDIR%/python/pyappc/bitarray/__init__.py store=%PYTHON_MOD_INSTALLDIR%/PyAppC/bitarray/
__init__.py mode=555 program_id=1
%TOPDIR%/python/pyappc/_bitarray.so store=%PYTHON_MOD_INSTALLDIR%/PyAppC/_bitarray.so
mode=555 program_id=1

```

6. To locate the bitarray module on a Junos device, add the **/PyAppC/** path for the **\_\_init\_\_.py** file and the **bitarray/** directory path for the **\_bitarray.so** file.

```

user@jet-vm:/user/jet-trial-apps/signed-python-with-c-dep/PyAppC/src$ cat ./pkgs/PyAppC/
contents.manifest

/set package_id=31 role=Provider_Daemon
%TOPDIR%/python/pyappc/bitarray_app.py store=%INSTALLDIR%/bitarray_app.py mode=555
program_id=1

```

```
%TOPDIR%/python/pyappc/bitarray/__init__.py store=%PYTHON_MOD_INSTALLDIR%/bitarray/
__init__.py mode=555 program_id=1
%TOPDIR%/python/pyappc/_bitarray.so store=%PYTHON_MOD_INSTALLDIR%/bitarray/_bitarray.so
mode=555 program_id=1
```

7. Build and package the application.

```
user@jet-vm:/user/jet-trial-apps/signed-python-with-c-dep/PyAppC/src$ mk-i386,bsd PyAppC
```

**NOTE:** Starting in Junos OS Release 20.2R1, if you will be running your JET application on a ACX710 device, you can use the Clang toolchain for ARM-based compilation of JET applications written in C, Python, or Ruby. Use the command `mk-arm,bsd` instead of `mk-i386,bsd` to use the Clang toolchain to compile your application.

8. Copy the built package onto the device running Junos OS.

```
user@jet-vm:/user/jet-trial-apps/signed-python-with-c-dep/PyAppC/src$ scp /user/jet-trial-
apps/signed-python-with-c-dep/PyAppC/junos-jet-sb-obj/ship/
PyAppC-x86-32-20180829.211252_user.tgz root@device:/var/tmp/
```

9. Configure the application's provider's ID, license type, and deployment scope on the Junos device, if necessary. Use the same provider license that you used to package it.

```
root@device# set system extensions providers 12345 license-type juniper deployment-scope
commercial
```

For more information, see [Configuring the JET Application and its License on a Device Running Junos OS](#).

10. Install the package on the device running Junos OS.

```
root@device> request system software add PyAppC-x86-32-20180830.031354_user.tgz
```

Once the package is installed successfully, the dependent Python module and the C shared library are installed on the device in the standard Python module path as specified in the manifest file.

```
root@device:/opt/lib/python2.7/site-packages # ls bitarray/__init__.py _bitarray.so
```

11. Add the application in configuration mode.

```
root@device# set system extensions extension-service application file bitarray_app.py
[edit]
root@device# commit
commit complete
```

12. Run the application

```
root@device> request extension-service start bitarray_app.py

Extension-service application 'bitarray_app.py' started with PID: 12345
bitarray('1010')
```

Release History Table

Release	Description
20.2R1	Starting in Junos OS Release 20.2R1, if you will be running your JET application on a ACX710 device, you can use the Clang toolchain for ARM-based compilation of JET applications written in C, Python, or Ruby.

# Package JET Applications

IN THIS SECTION

- [Main Section Attributes | 42](#)
- [Source Attributes | 45](#)
- [Dependent Libraries | 46](#)
- [Dependent Python Modules | 47](#)

After application development is complete, write the JavaScript Object Notation (JSON) file describing the content to build and package the application before deploying it on the device. JSON is a lightweight

data-interchange format. It is easy for humans to read and write, and also easy for machines to parse and generate. For more details, see <https://www.json.org>.

JSON files consist of a collection of attributes are included inside a set of curly braces. Attributes use two structures:

- A collection of key-value pairs.
- An ordered list of values.

Read further to learn about each of the attributes contained in the JSON format for application packaging.

## Main Section Attributes

The top block of the JSON file is the main section of the file. It consists of mandatory and optional attributes.

### Mandatory Attributes

Table 2 on page 43 describes the mandatory attributes that all JSON files for application packaging must have in the main section. The following is an example of a simple application JSON file containing only the mandatory attributes:

```
{
  "app-name": "testcapp",
  "app-path": "bin/test-c-app",
  "language": "c",
  "app-type": "standalone",
  "sign": "yes",
  "os-type": "bsd10",
  "target-arch": "i386",
  "description": "C Test Application",
  "srcs": {
    "bin/test-c-app": ["test_app.c"]
  }
}
```



Table 2: Mandatory Attributes in the JSON File Main Section

Attribute	Description	Example Values
"app-name"	Specify the name of the application.	"sample_pyapp"
"app-path"	Specify the path to the application's implementation directory. All paths should be relative to sandbox src.	"python/sample_pyapp"
"language"	Specify the language used for developing the application.	"python", "c", "c++"
"main-scripts"	This is a list attributes. Specify the filename or filenames of the main script or scripts that run on the device (do not specify the module here). The main script files will be deployed under the <code>/var/db/scripts/jet</code> path on the device.	["foo.py", "bar.py"]
"app-type"	Specify whether an application is to be a standalone program or a daemon.	"standalone" or "daemon"
"sign"	Indicate whether the application is to be signed or unsigned.	"yes" or "no"
"os-type"	Specify whether the application is to be deployed on legacy Junos OS (bsd6) or Junos OS with upgraded FreeBSD (bsd10).	"bsd6", bsd10, or "bsd11"
"target-arch"	Specify the target architecture on which the application is to be deployed.	"i386", "powerpc", "octeon", "xlr", or "arm"
"description"	Write a brief (one-line) description about the application. This will be displayed in the <code>show version</code> operational command output.	"Simple Python test app"

## Optional Attributes

Table 3 on page 44 describes the optional attributes you can include in the main section of the JSON file for application packaging. The following is an example main section with mandatory and optional attributes:

```
{
  "app-name": "sample_pyapp",
  "app-path": "python/sample_pyapp",
  "language": "python",
  "main-scripts": ["foo.py", "bar.py"],
  "app-type": "standalone",
  "sign": "no",
  "os-type": "bsd6",
  "target-arch": "i386",
  "description": "Simple Python test app",
  "c-compiler-flags": "-DFOO -DBAR",
  "c++-compiler-flags": "-DAPP_CHECK -DSOMETHING_ON",
  "linker-flags": "-lstdc++ -lfoo" }
```

**Table 3: Optional Attributes in the JSON File Main Section**

Attribute	Description	Example Values
"c-compiler-flags"	Specify the list of C compiler flags, if any. Compilation flags can be defined for the main section, dependent libraries (dep-libs), or dependent Python modules (dep-py-modules).	"flag1 flag2 flag3"
"c++-compiler-flags"	Specify the list of C++ compiler flags, if any. Compilation flags can be defined for the main section, dependent libraries (dep-libs), or dependent Python modules (dep-py-modules).	"flag1 flag2 flag3"

**Table 3: Optional Attributes in the JSON File Main Section (Continued)**

Attribute	Description	Example Values
"linker-flags"	Specify the list of linker flags, if any. Use these flags to specify additional libraries to link to or additional link-specific flags that are required during linking. You can define linker-specific flags either in the main section or in the dep-py-modules section.	" <i>flag1 flag2 flag3</i> "

## Source Attributes

[Table 4 on page 46](#) shows two source attributes you can use to specify source files for the application package. The following is an example Python application with additional module files to be deployed, along with the main script file:

```
{
  "app-name": "sample_pyapp",
  "app-path": "python/sample_pyapp",
  "language": "python",
  "main-scripts": ["foo.py", "bar.py"],
  "app-type": "standalone",
  "sign": "no",
  "os-type": "bsd6",
  "target-arch": "i386",
  "description": "Simple Python test app",

  "srcs": {
    "python/sample_pyapp": ["a.py", "b.py"],
    "python/sample_pyapp/temp": ["temp1.py", "temp2.py"]
  },

  "extn-srcs": {
    "python/sample_pyapp": ["foo.c", "bar.c"],
    "python/sample_pyapp/temp": ["1.cpp", "2.cpp"]
  }
}
```

**Table 4: Source Attributes You Can Use in a JSON File**

Attribute	Description	Example Values
"srcs"	Specify the list of additional source files. For Python applications, these source files are the additional module files. For C or C++ applications, these source files are the source files to be compiled to generate <b>lib/binary</b> . Each entry should be a key-value pair, where the key is the path of the source files and the value is an array of source filenames.	<pre>"srcs": {   "python/sample_pyapp": ["a.py", "b.py"],   "python/sample_pyapp/temp": ["temp1.py",     "temp2.py"] }</pre>
"extn-srcs"	This section is applicable only for Python. Specify the list of C or C++ module files to be compiled. Each entry should be a key-value pair, where the key is the path of the source files and the value is an array of source filenames.	<pre>"extn-srcs": {   "python/sample_pyapp": ["foo.c", "bar.c"],   "python/sample_pyapp/temp": ["1.cpp",     "2.cpp"] }</pre>

## Dependent Libraries

You must compile any dependent libraries available in the dependent libraries (dep-libs) section. The library generated from this JSON code is packaged with the application. The dep-libs section is an array of multiple library dependencies, each composed of the following key-name pairs:

- "lib-name" is the name of the library.
- "lib-path" is the path of the library source code in the development sandbox.
- "srcs" is a key-value pair in which the path is the key and its value is a list of source files.

The following is an example of a dep-libs attribute:

```
"dep-libs": [
  {
```

```

    "lib-name": "xyz",
    "lib-path": "lib/xyz",
    "srcs": {
        "lib/xyz": ["foo.c", "bar.c"]
    }
}
]

```

## Dependent Python Modules

The dependent Python modules (`dep-py-modules`) attribute is used only for Python applications. This attribute contains any dependent Python modules that need to be compiled and packaged with the application. The `dep-py-modules` attribute is an array in which you can specify multiple Python module dependencies. Each dependency is composed of the following objects:

- `"py-module-name"` is the name of the Python module.
- `"py-module-path"` is the path of the Python module source code in the development sandbox.
- `"srcs"` is a key-value pair in which the path is the key and its value is a list of source files.
- `"extn-srcs"` is a key-value pair in which the path is the key and its value is a list of Python extension source files.

The following is an example of a `dep-py-modules` attribute:

```

"dep-py-modules": [
    {
        "py-module-name": "module_a",
        "py-module-path": "python/module_a",
        "srcs": {
            "python/module_a": ["foo.py", "bar.py"]
        },
        "extn-srcs": {
            "python/module_a": ["foo.c", "bar.c"],
            "python/module_a/sub_mod": ["lmn.cpp"]
        }
    }
]

```

## RELATED DOCUMENTATION

[Develop Off-Device JET Applications | 12](#)

[Develop On-Device JET Applications | 24](#)

# Debug JET Applications

## IN THIS SECTION

- [Debugging Tips | 48](#)
- [How to Invoke the Debugger During Install | 49](#)
- [Issue: Cannot Connect to jsd | 50](#)

Use this topic to debug JET applications.

## Debugging Tips

- For debugging applications on a device running Junos OS, you can configure the trace file option with the `edit system services extension-service traceoptions` statement. You need to enable this statement on the Junos OS device before writing the sample applications.
- The Junos service process (jsd) is supported only on the Routing Engine running in primary mode. It is not supported on the backup Routing Engine.
- To eliminate any firewall issues, use an on-device application to test.
- For notification applications, verify that your client IP source address (the address from which the connection is established) is added to the list of allowed clients in the jsd notification configuration.

- Ensure that the maximum number of notification connections does not exceed the number configured on the device. Use the following command to see the clients:

```
netstat -a | grep 1883
```

## How to Invoke the Debugger During Install

For non-daemonized applications that run on the router, you can invoke the debugger at the same time that you install the application. To load your application along with the debugger:

1. Use the Junos OS CLI to invoke the debugger and install the application at the same time.

```
user@device> request extension-service start invoke-debugger cli application-name.py
```

```
Extension-service application 'application-name.py' started with pid: 12345
```

2. Enter help to display a list of the supported commands.

```
(Pdb) help
```

```
Documented commands (type help <topic>):
```

```
=====
```

```
EOF    bt      cont    enable  jump  pp      run    unt
a      c      continue exit    l     q      s      until
alias  cl      d      h      list  quit   step   up
args   clear   debug  help   n     r      tbreak w
b      commands disable ignore next  restart u      whatis
break  condition down    j      p     return unalias where
```

```
Miscellaneous help topics:
```

```
=====
```

```
exec  pdb
```

```
Undocumented commands:
```

```
=====
```

```
retval  rv
```

3. Use the debugger commands as needed by typing **help <topic>**.

## Issue: Cannot Connect to jsd

Use this procedure if your application cannot connect to jsd.

1. Check whether jsd is up and running on the Junos OS device using the following command:

```
ps aux | grep jsd
```

2. If jsd is not up, restart jsd. Choose from the following options:

- gracefully—Gracefully restart the process.
- immediately—Immediately restart (SIGKILL) the process.
- soft—Soft reset (SIGHUP) the process.
- |—Pipe through a command.

```
user@device# restart jsd <gracefully | immediately | soft>
```

3. If jsd is up, verify the configuration is present on the device using the following command:

```
user@device# show system services extension-service
```

You should see the configuration in the output. If you do not, redo the configuration.

4. If the configuration is present, verify jsd is listening on configured port 51051:

```
netstat -a | grep 51051
```

You should see a matching entry.

5. If you do not see a matching entry, restart jsd.

```
user@device# restart jsd <gracefully | immediately | soft>
```

### RELATED DOCUMENTATION

[Develop Off-Device JET Applications | 12](#)

[Develop On-Device JET Applications | 24](#)



# 3

CHAPTER

## Additional Resources

---

[Additional Resources](#) | 52

---

## Additional Resources

- [Expert Advice: Junos Extension Toolkit \(JET\)](#)
- [FAQ: Learning About JET Part 1—Python on Junos OS](#)
- [FAQ: Learning About JET Part 2—JavaScript Object Notation \(JSON\)](#)
- [FAQ: Learning About JET Part 3—JET APIs](#)
- [FAQ: Learning About JET Part 4—Fast Programmatic Configuration](#)

# 4

CHAPTER

## Configuration Statements

---

[application \(Extensions\) | 55](#)

[cert-file \(Scripts\) | 57](#)

[extensions | 59](#)

[extension-service \(System Extensions\) | 62](#)

[extension-service \(System Services gRPC\) | 64](#)

[file \(JET\) | 67](#)

[grpc | 69](#)

[interface-notification \(programmable-rpd\) | 71](#)

[max-connections | 73](#)

[notification \(System Services\) | 75](#)

[programmable-rpd | 77](#)

[providers | 80](#)

[purge-timeout \(programmable-rpd\) | 81](#)

[refresh \(JET\) | 84](#)

[refresh-from \(JET\) | 86](#)

[request-response | 88](#)

[rib-service \(programmable-rpd\) | 90](#)

[routing-instance \(JET Scripts\) | 92](#)

[source \(JET Scripts\) | 93](#)

[start \(Scripts\) | 95](#)

[stats-aggregation-interval \(programmable-rpd\)](#) | 98

[stats-sampling-interval \(programmable-rpd\)](#) | 99

[traceoptions \(Extensions\)](#) | 101

[traceoptions \(Services\)](#) | 104

[traceoptions \(programmable-rpd\)](#) | 107

---

# application (Extensions)

## IN THIS SECTION

- [Syntax | 55](#)
- [Hierarchy Level | 56](#)
- [Description | 56](#)
- [Required Privilege Level | 56](#)
- [Release Information | 57](#)

## Syntax

```
application {  
  file script-name {  
    arguments arguments;  
    cert-file path;  
    checksum hash-algorithm hash-value;  
    daemonize;  
    interpreter (bash | python | python3);  
    refresh;  
    refresh-from;  
    respawn-on-normal-exit;  
    routing-instance;  
    source;  
    start {  
      start-options {  
        mem-factor percentage;  
      }  
    }  
    traceoptions {  
      file <filename> <files number> <match regex> <size size> <world-readable | no-world-readable>;  
      flag flag;  
      no-remote-trace;  
    }  
  }  
}
```

```

    username username;
}
max-datasize max-datasize;
start {
    start-options {
        mem-factor percentage;
    }
}
traceoptions {
    file <filename> <files number> <size size> <world-readable | no-world-readable>;
    flag flag;
    no-remote-trace;
}
}

```

## Hierarchy Level

```
[edit system extensions extension-service]
```

## Description

Configure the Junos OS extension service application.

**NOTE:** Global traceoptions for daemonized applications do not take effect if the daemonized application and global traceoptions are committed separately.

The remaining statements are explained separately. See [CLI Explorer](#).

## Required Privilege Level

maintenance—To view or add this statement in the configuration.

## Release Information

Statement introduced in Junos OS Release 16.1.

### RELATED DOCUMENTATION

| [extension-service \(System Extensions\)](#) | [62](#)

## cert-file (Scripts)

### IN THIS SECTION

- [Syntax](#) | [57](#)
- [Hierarchy Level](#) | [57](#)
- [Description](#) | [58](#)
- [Default](#) | [58](#)
- [Options](#) | [58](#)
- [Required Privilege Level](#) | [58](#)
- [Release Information](#) | [59](#)

## Syntax

```
cert-file path;
```

## Hierarchy Level

```
[edit event-options event-script file filename],  
[edit system extensions extension-service application file filename],
```

```
[edit system scripts commit file filename],  
[edit system scripts op file filename],  
[edit system scripts snmp file filename]
```

## Description

Specify the certificate file (Root CA or self-signed) that the device uses to validate the server's certificate when you refresh a local script from an HTTPS server.

When you issue the `set refresh` or `set refresh-from` configuration mode command to refresh a single script or all scripts of a given type from an HTTPS server, the device uses the certificate configured for each script to validate the server's certificate and ensure the server is authentic. If certificate validation is successful, the device refreshes the script.

**NOTE:** We do not recommend refreshing scripts from an HTTPS server when the device is unable to authenticate the server because malicious users could compromise the integrity of a script.

## Default

If you do not configure the `cert-file` statement for a script and you attempt to refresh the script from an HTTPS server, the device issues an error that `cert-file` is mandatory for HTTPS communication.

## Options

***path*** Absolute path to the certificate (Root CA or self-signed) in Privacy-Enhanced Mail (PEM) format that is used to validate the certificate of the server from which you refresh the script.

## Required Privilege Level

system—To view this statement in the configuration.



system-control—To add this statement to the configuration.

## Release Information

Statement introduced in Junos OS Release 21.2R1.

### RELATED DOCUMENTATION

*Configure and Use a Master Source Location for a Script*

## extensions

### IN THIS SECTION

- [Syntax | 59](#)
- [Hierarchy Level | 61](#)
- [Description | 61](#)
- [Required Privilege Level | 61](#)
- [Release Information | 61](#)

## Syntax

```
extensions {  
  extension-service {  
    application {  
      file script-name {  
        arguments arguments;  
        cert-file path;  
        checksum hash-algorithm hash-value;  
        daemonize;  
      }  
    }  
  }  
}
```

```

        refresh;
        refresh-from;
        routing-instance;
        source;
        start {
            start-options {
                mem-factor percentage;
            }
        }
        traceoptions {
            file <filename> <files number> <match regex> <size size> <world-readable |
no-world-readable>;
            flag flag;
            no-remote-trace;
        }
        username username;
    }
    max-datasize max-datasize;
    start {
        start-options {
            mem-factor percentage;
        }
    }
    traceoptions {

        file <filename> <files number> <size size> <world-readable | no-world-readable>;
        flag flag;
        no-remote-trace;
    }
}
}
providers {
    provider-id {
        license-type license deployment-scope [ deployments ];
    }
}
}
}

```

## Hierarchy Level

```
[edit system]
```

## Description

Configure extensions to Junos OS.

You must configure the [providers](#) statement to enable application packages developed using the Junos SDK to be deployed and run on the router.

You must configure the [extension-service](#) statement to enable application packages developed using the Juniper Extension Toolkit (JET) to be deployed and run on the device.

The remaining statements are explained separately. See [CLI Explorer](#).

**NOTE:** This configuration is optional in Junos OS Evolved. You can run JET applications directly using a Python interpreter instead of configuring and invoking them in the CLI.

## Required Privilege Level

admin—To view this statement in the configuration.

admin-control—To add this statement to the configuration.

## Release Information

Statement introduced in Junos OS Release 9.0.

`extension-service` option introduced in Junos OS Release 16.1.

# extension-service (System Extensions)

## IN THIS SECTION

- [Syntax | 62](#)
- [Hierarchy Level | 63](#)
- [Description | 63](#)
- [Required Privilege Level | 63](#)
- [Release Information | 63](#)

## Syntax

```
extension-service {  
  application {  
    file script-name {  
      arguments arguments;  
      cert-file path;  
      checksum (md5 | sha-256 | sha1) hash;  
      daemonize;  
      refresh;  
      refresh-from;  
      respawn-on-normal-exit;  
      routing-instance  
      source;  
      start {  
        start-options {  
          mem-factor percentage;  
        }  
      }  
      traceoptions {  
        file <filename> <files number> <size size> <world-readable | no-world-readable>;  
        flag flag;  
        no-remote-trace;  
      }  
      username username;
```

```

    }
    max-datasize max-datasize;
    start {
        start-options {
            mem-factor percentage;
        }
    }
    traceoptions {
        file <filename> <files number> <size size> <world-readable | no-world-readable>;
        flag flag;
        no-remote-trace;
    }
}

```

## Hierarchy Level

[edit system extensions]

## Description

Enable Junos OS extension services.

The remaining statements are explained separately. See [CLI Explorer](#).

## Required Privilege Level

maintenance—To view or add this statement in the configuration.

## Release Information

Statement introduced in Junos OS Release 16.1.

respawn-on-normal-exit option introduced in Junos OS Releases 17.3R3 and 18.1R1.

## RELATED DOCUMENTATION

[extensions](#) | 59

# extension-service (System Services gRPC)

## IN THIS SECTION

- [Junos OS Syntax](#) | 64
- [Junos OS Evolved Syntax](#) | 65
- [Hierarchy Level](#) | 66
- [Description](#) | 66
- [Required Privilege Level](#) | 66
- [Release Information](#) | 66

## Junos OS Syntax

```
extension-service {  
  request-response {  
    grpc {  
      max-connections max-connections;  
      routing-instance routing-instance;  
      ssl {  
        address ip-address;  
        hot-reloading;  
        local-certificate local-certificate;  
        mutual-authentication {  
          certificate-authority certificate-authority-profile-name;  
          client-certificate-request (no-certificate | request-certificate | request-  
certificate-and-verify | require-certificate | require-certificate-and-verify);
```

```

        }
        port port;
    }
}
notification {
    allow-clients {
        address ip-address;
    }
    broker-socket-send-buffer-size broker-socket-send-buffer-size;
    max-connections max-connections;
    port port;
}
traceoptions {
    file <filename> <files number> <match regex> <size size> <world-readable | no-world-
readable>;
    flag flag;
    level <error>;
    no-remote-trace;
}
}

```

## Junos OS Evolved Syntax

```

extension-service {
    request-response {
        grpc {
            max-connections max-connections;
            routing-instance routing-instance;
            ssl {
                address ip-address;
                hot-reloading;
                local-certificate local-certificate;
                mutual-authentication {
                    certificate-authority certificate-authority-profile-name;
                    client-certificate-request (no-certificate | request-certificate | request-
certificate-and-verify | require-certificate | require-certificate-and-verify);
                }
            }
            port port;
        }
    }
}

```

```

        use-pki;
    }
}
}
traceoptions {
    file <filename> <files number> <match regex> <size size> <world-readable | no-world-
readable>;
    flag flag;
    no-remote-trace;
}
}

```

## Hierarchy Level

```
[edit system services]
```

## Description

Enable Junos OS extension services.

The remaining statements are explained separately. See [CLI Explorer](#).

## Required Privilege Level

system—To view this statement in the configuration.

system-control—To add this statement to the configuration.

## Release Information

Statement introduced in Junos OS Release 16.1.

*grpc* option introduced in Junos OS Release 16.2.



# file (JET)

## IN THIS SECTION

- [Syntax | 67](#)
- [Hierarchy Level | 68](#)
- [Description | 68](#)
- [Options | 68](#)
- [Required Privilege Level | 69](#)
- [Release Information | 69](#)

## Syntax

```
file filename {
    arguments arguments;
    cert-file path;
    checksum hash-algorithm hash-value;
    daemonize;
    interpreter (bash | python | python3);
    optional;
    refresh;
    refresh-from;
    respawn-on-normal-exit;
    routing-instance;
    source;
    start {
        start-options {
            mem-factor percentage;
        }
    }
    traceoptions {
        file <filename> <files number> <match regex> <size size> <world-readable | no-world-
readable>;
        flag flag;
        no-remote-trace;
    }
}
```

```

    }
    username username;
}

```

## Hierarchy Level

```
[edit system extensions extension-service application]
```

## Description

For files in the [edit system extensions extension-service *application*] hierarchy level, specify the configuration for each file in the extension-service application.

## Options

<b>arguments</b> <i>arguments</i>	Specify the command-line arguments called by a JET application. A program can take any number of command-line arguments. Enter the arguments in the way the application expects. Developer must supply this information.
<b>daemonize</b>	Specify the file as daemonized. An application runs as a daemonized process in the background. An application configured to run as a daemonized process is automatically triggered upon commit. A non-daemonized application must be triggered manually from the command-line client.
<b>filename</b>	Local filename of the script file.
<b>interpreter</b> (bash   python   python3)	Specify whether a device running Junos OS Evolved should run a daemonized on-device JET application using Bash, Python, or Python 3.
<b>optional</b>	Allow the operating system to commit the configuration even if the file is not available at the <b>/var/db/scripts/jet</b> file path.
<b>respawn-on-normal-exit</b>	Automatically restart a daemonized JET application written in Python after you exit the application normally, such as when you upgrade the JET application. If this option is

not configured, and if the application normally exits, it will not restart automatically. This option can only be used with Python JET applications that have been configured to run as a daemonized process using the `daemonize` option.

**username** Specify the name of the user under whose privileges the extension service will execute.  
**username** This user name is configured at the `[edit system login]` hierarchy level. If you do not associate a user name with an extension-service application, the application is executed as user `nobody`.

- **Default:** `nobody`

The remaining statements are explained separately. See [CLI Explorer](#).

## Required Privilege Level

`maintenance`—To view or add this statement in the configuration.

## Release Information

Statement introduced in Junos OS Release 16.1.

`refresh`, `refresh-from`, `respawn-on-normal-exit`, `routing-instance`, and `source` options added in Junos OS Release 18.1R1.

`interpreter` option added in Junos OS Evolved Release 20.3R1.

`optional` option added in Junos OS and Junos OS Evolved Release 23.2R1.

# grpc

## IN THIS SECTION

- [Syntax | 70](#)
- [Hierarchy Level | 70](#)

- Description | 70
- Options | 71
- Required Privilege Level | 71
- Release Information | 71

## Syntax

```
grpc {
  max-connections max-connections;
  routing-instance routing-instance;
  ssl {
    address ip-address;
    hot-reloading;
    local-certificate local-certificate;
    mutual-authentication {
      certificate-authority certificate-authority-profile-name;
      client-certificate-request (no-certificate | request-certificate | request-
certificate-and-verify | require-certificate | require-certificate-and-verify);
    }
    port port;
    use-pki;
  }
}
```

## Hierarchy Level

```
[edit system services extension-service request-response]
```

## Description

Configure the type of connections the gRPC service accepts for API applications.

## Options

`routing-instance` *routing-instance*                      Name of routing instance for grpc.

The remaining statements are explained separately. See [CLI Explorer](#).

## Required Privilege Level

system—To view this statement in the configuration.

system-control—To add this statement to the configuration.

## Release Information

Statement introduced in Junos OS Release 16.2.

### RELATED DOCUMENTATION

| [request-response](#) | **88**

# interface-notification (programmable-rpd)

### IN THIS SECTION

- [Syntax](#) | **72**
- [Hierarchy Level](#) | **72**
- [Description](#) | **72**
- [Default](#) | **72**
- [Options](#) | **72**
- [Required Privilege Level](#) | **73**

## Syntax

```
interface-notification name;
```

## Hierarchy Level

```
[edit logical-systems name routing-instances name routing-options programmable-rpd client id],  
[edit logical-systems name routing-options programmable-rpd client id],  
[edit routing-instances name routing-options programmable-rpd client id],  
[edit routing-options programmable-rpd client id]
```

## Description

Restrict interface event notifications from the programmable routing protocol process (prpd) to specified JET clients and interfaces. The prpd provides public APIs to program routing systems, making it possible for users to directly access the APIs to customize, create, and modify behavior of their network.

## Default

By default, no restrictions are imposed and JET clients are notified of all interfaces.

## Options

<i>name</i>	Interface name.
-------------	-----------------

## Required Privilege Level

routing

## Release Information

Statement introduced in Junos OS Release 17.4R1.

### RELATED DOCUMENTATION

[show programmable-rpd clients](#) | 123

[traceoptions \(programmable-rpd\)](#) | 107

[purge-timeout \(programmable-rpd\)](#) | 81

# max-connections

### IN THIS SECTION

- [Syntax](#) | 74
- [Hierarchy Level](#) | 74
- [Description](#) | 74
- [Options \(Junos OS\)](#) | 74
- [Options \(Junos OS Evolved\)](#) | 74
- [Required Privilege Level](#) | 75
- [Release Information](#) | 75

## Syntax

```
max-connections max-connections;
```

## Hierarchy Level

```
[edit system services extension-service request-response grpc]
```

## Description

Number of simultaneous connections for request-response that can be attached to jsd. The higher the number, the higher the impact on clients performance.

## Options (Junos OS)

- **Range:** 1 through 8
- **Default:** 8

## Options (Junos OS Evolved)

Junos OS Evolved Release 22.2R1 and later:

- **Range:** 1 through 300

Releases before Junos OS Evolved Release 22.2R1:

- **Range:** 1 through 30



## Required Privilege Level

system—To view this statement in the configuration.

system-control—To add this statement to the configuration.

## Release Information

Statement introduced in Junos OS Release 16.1.

# notification (System Services)

### IN THIS SECTION

- [Syntax | 75](#)
- [Hierarchy Level | 76](#)
- [Description | 76](#)
- [Options | 76](#)
- [Required Privilege Level | 77](#)
- [Release Information | 77](#)

## Syntax

```
notification {  
  allow-clients {  
    address ip-address;  
  }  
  broker-socket-send-buffer-size broker-socket-send-buffer-size;  
  max-connections max-connections;
```

```
port port;  
}
```

## Hierarchy Level

```
[edit system services extension-service]
```

## Description

Enable notification services for applications.

## Options

<code>allow-clients address</code> <i>ip-address</i>	Specify IPv4 or IPv6 addresses (prefix length optional) or host names of clients that are allowed to request notifications from the application. You can specify a set of values using square brackets ([ ]). If this option is not configured, the client cannot subscribe to notifications.
<code>broker-socket-send-buffer-size</code> <i>broker-socket-send-buffer-size</i>	Socket send buffer size for the broker to publish the messages
<code>max-connections</code> <i>max-connections</i>	Specify the maximum number of clients that can connect to the application. <ul style="list-style-type: none"> <li>• <b>Range:</b> 1 through 20</li> <li>• <b>Default:</b> 20</li> </ul>
<code>port</code> <i>port</i>	Specify the number of the port to accept incoming connections. <ul style="list-style-type: none"> <li>• <b>Range:</b> 1 through 65535</li> <li>• <b>Default:</b> 1883</li> </ul>

## Required Privilege Level

system—To view this statement in the configuration.

system-control—To add this statement to the configuration.

## Release Information

Statement introduced in Junos OS Release 16.1.

### RELATED DOCUMENTATION

| [grpc](#) | [69](#)

# programmable-rpd

### IN THIS SECTION

- [Syntax \(Junos OS\) | 77](#)
- [Syntax \(Junos OS Evolved\) | 78](#)
- [Hierarchy Level | 78](#)
- [Description | 79](#)
- [Required Privilege Level | 79](#)
- [Release Information | 79](#)

## Syntax (Junos OS)

```
programmable-rpd {  
  client name {  
    interface-notification name;
```

```

}
purge-timeout (never | timeout);
rib-service {
    dynamic-next-hop-interface (disable | enable);
}
traceoptions {
    file filename <files files> <size size> <(world-readable | no-world-readable)>;
    flag name;
}
}

```

## Syntax (Junos OS Evolved)

```

programmable-rpd {
    client name {
        interface-notification name;
    }
    purge-timeout (never | timeout);
    rib-service {
        dynamic-next-hop-interface (disable);
    }
    stats-aggregation-interval seconds;
    stats-sampling-interval seconds;
    traceoptions {
        file filename <files files> <size size> <(world-readable | no-world-readable)>;
        flag name;
    }
}

```

## Hierarchy Level

```

[edit logical-systems name routing-instances name routing-options],
[edit logical-systems name routing-options],
[edit logical-systems name tenants name routing-instances name routing-options],
[edit routing-instances name routing-options],

```

```
[edit routing-options],  
[edit tenants name routing-instances name routing-options]
```

## Description

Configure the programmable routing protocol process (prpd). The prpd provides public APIs to program routing systems, making it possible for users to directly access the APIs to customize, create, and modify behavior of their network.

## Required Privilege Level

routing—To view this statement in the configuration.

routing-control—To add this statement to the configuration.

## Release Information

Statement introduced in Junos OS Release 16.2.

stats-aggregation-interval and stats-sampling-interval statements introduced in Junos OS Evolved Release 22.2R1.

## RELATED DOCUMENTATION

[show programmable-rpd clients](#) | 123

# providers

## IN THIS SECTION

- [Syntax | 80](#)
- [Hierarchy Level | 80](#)
- [Description | 80](#)
- [Options | 81](#)
- [Required Privilege Level | 81](#)
- [Release Information | 81](#)

## Syntax

```
providers {  
    provider-id {  
        license-type license deployment-scope [ deployments ];  
    }  
}
```

## Hierarchy Level

[edit system [extensions](#)]

## Description

Activate the certificate of the provider of the application and enable the PIC for loading of the application.

## Options

- provider-id*** Provider ID for the application package. The provider ID identifies the provider of the application to the system. The provider ID must be activated on the device to allow the application to be deployed on the device and run.
- license-type*** Configure the license type and the scope of application deployment.
- license*** Type of license. Obtain correct value from the application's provider.
- deployment*** Scope of application deployment. You can configure a set of deployments. Obtain correct value from the application's provider.

## Required Privilege Level

admin—To view this statement in the configuration.

admin-control—To add this statement to the configuration.

## Release Information

Statement introduced in Junos OS Release 9.0.

license-type option introduced in Junos OS Release 10.2.

# purge-timeout (programmable-rpd)

### IN THIS SECTION

- [Syntax | 82](#)
- [Hierarchy Level | 82](#)
- [Description | 82](#)

- Options | 82
- Required Privilege Level | 83
- Release Information | 83

## Syntax

```
purge-timeout {  
    never;  
    timeout <seconds>;  
}
```

## Hierarchy Level

[edit [programmable-rpd](#)]

## Description

Set the time, in seconds, after which a disconnected client times out. Upon disconnect, the client state remains available but no operations occur. If the disconnected client reconnects before the set time has elapsed, the states are restored on the router. If it does not, all client operations are reverted and the programmable routing protocol process (prpd) server notifies any other modules of the disconnect so they can purge any other client operations.

## Options

<b>never</b>	When this option is configured, the purge timeout is infinite for the BGP route service. Client-added routes never time out. The prpd-client-added routes are not deleted when the
--------------	--



client disconnects and does not reconnect back. The routes are deleted only when the client explicitly deletes the routes. If routing is restarted, then the client-added routes are lost.

**timeout**  
*seconds* (Optional) After this time, in seconds, disconnected clients time out on the prpd server and the routes added by the client are purged.

- **Default:** 120
- **Range (Junos OS Releases 18.4R1 and later):** 1 through 604,800 (7 days)
- **Range (Before Junos OS Releases 18.4R1):** 1 through 1000

## Required Privilege Level

routing and trace—To view this statement in the configuration.

routing-control and trace-control—To add this statement to the configuration.

## Release Information

Statement introduced in Junos OS Release 16.2.

*never* option introduced in Junos OS Release 18.4R1.

### RELATED DOCUMENTATION

[traceoptions \(programmable-rpd\) | 107](#)

[show programmable-rpd clients | 123](#)

*show route*

# refresh (JET)

## IN THIS SECTION

- [Syntax | 84](#)
- [Hierarchy Level | 84](#)
- [Description | 84](#)
- [Required Privilege Level | 85](#)
- [Release Information | 85](#)

## Syntax

```
refresh;
```

## Hierarchy Level

```
[edit system extensions extension-service application file filename]
```

## Description

Overwrite the local copy of all enabled commit scripts or a single enabled commit script with the copy located at the source URL, as specified in the [source](#) statement at the same hierarchy level. If the [load-scripts-from-flash](#) statement is configured, the device refreshes the scripts on the flash drive instead of the hard disk.

The update operation occurs as soon as you issue the `set refresh` configuration mode command. Issuing the `set refresh` command does not add the `refresh` statement to the configuration. Thus the command behaves like an operational mode command by executing an operation, instead of adding a statement to the configuration.

Before you refresh a local script from an HTTPS server, you must first configure the `cert-file` statement for that script in supported releases. Specify the absolute path to the certificate (Root CA or self-signed) that the device will use to validate the server's certificate during the refresh operation.

**NOTE:** On the QFabric system, commit scripts are stored in the `/pbdata/mgd_shared/partition-ip/var/db/scripts/commit/` directory on the Director device.

As of Junos OS Release 18.1R1, you can specify which routing instance the update is done through. To specify the routing instance to use for updating commit scripts, configure the routing instance in two places in the CLI:

```
user@host# set system routing-instances routing-instance-name description description
user@host# set system extensions extension-service application file filename routing-instance
routing-instance-name
```

If you enable the non-default management instance and use `mgmt_junos` for *routing-instance-name*, you can configure scripts to update using the dedicated management instance `mgmt_junos`.

## Required Privilege Level

maintenance—To execute this statement in configuration mode.

## Release Information

Statement introduced in Junos OS Release 18.1R1.

### RELATED DOCUMENTATION

[refresh-from \(JET\) | 86](#)

[Configuring and Using a Master Source Location for a Script](#)

[Example: Configuring and Refreshing from the Master Source for a Script](#)

[Management Interface in a Non-Default Instance](#)

# refresh-from (JET)

## IN THIS SECTION

- [Syntax | 86](#)
- [Hierarchy Level | 86](#)
- [Description | 86](#)
- [Options | 87](#)
- [Required Privilege Level | 87](#)
- [Release Information | 87](#)

## Syntax

```
refresh-from url;
```

## Hierarchy Level

```
[edit system extensions extension-service application file filename]
```

## Description

Overwrite the local copy of all enabled commit scripts or a single enabled commit script with the copy located at the specified URL. If the `load-scripts-from-flash` statement is configured, the device refreshes the scripts on the flash drive instead of the hard disk.

The update operation occurs as soon as you issue the `set refresh-from url` configuration mode command. Issuing the `set refresh-from` command does not add the `refresh-from` statement to the configuration. Thus the command behaves like an operational mode command by executing an operation, instead of adding a statement to the configuration.

Before you refresh a local script from an HTTPS server, you must first configure the `cert-file` statement for that script in supported releases. Specify the absolute path to the certificate (Root CA or self-signed) that the device will use to validate the server's certificate during the refresh operation.

**NOTE:** This statement is not supported on the QFabric system.

As of Junos OS Release 18.1R1, you can specify which routing instance the update is done through. To specify the routing instance to use for updating op scripts, configure the routing instance in two places in the CLI:

```
user@host# set system routing-instances routing-instance-name description description
user@host# set system extensions extension-service application file filename routing-instance
routing-instance-name
```

If you enable the non-default management instance and use `mgmt_junos` for *routing-instance-name*, you can configure scripts to update using the dedicated management instance `mgmt_junos`.

## Options

**url** The source specified as a HTTPS URL, HTTP URL, FTP URL, or secure copy (scp)-style remote file specification.

## Required Privilege Level

maintenance—To execute this statement in configuration mode.

## Release Information

Statement introduced in Junos OS Release 18.1R1.

## RELATED DOCUMENTATION

[Using an Alternate Source Location for a Script](#)

[refresh \(JET\) | 84](#)

[source \(JET Scripts\) | 93](#)

[routing-instance \(JET Scripts\) | 92](#)

# request-response

## IN THIS SECTION

- [Syntax | 88](#)
- [Hierarchy Level | 89](#)
- [Description | 89](#)
- [Required Privilege Level | 89](#)
- [Release Information | 89](#)

## Syntax

```
request-response {
  grpc {
    max-connections max-connections;
    routing-instance routing-instance;
    ssl {
      address ip-address;
      hot-reloading;
      local-certificate local-certificate;
      mutual-authentication {
        certificate-authority certificate-authority-profile-name;
        client-certificate-request (no-certificate | request-certificate | request-
certificate-and-verify | require-certificate | require-certificate-and-verify);
      }
      port port;
    }
  }
}
```

```

        use-pki;
    }
}

```

## Hierarchy Level

```
[edit system services extension-service]
```

## Description

Allow request-response API execution.

Statements are explained separately.

## Required Privilege Level

system—To view this statement in the configuration.

system-control—To add this statement to the configuration.

## Release Information

Statement introduced in Junos OS Release 16.1.

grpc option introduced in Junos OS Release 16.2.

# rib-service (programmable-rpd)

## IN THIS SECTION

- [Syntax | 90](#)
- [Hierarchy Level | 90](#)
- [Description | 90](#)
- [Options | 91](#)
- [Required Privilege Level | 91](#)
- [Release Information | 91](#)

## Syntax

```
rib-service {  
    dynamic-next-hop-interface (enable | disable);  
}
```

## Hierarchy Level

```
[edit routing-options programmable-rpd]
```

## Description

Configure programmable routing protocol process (prpd) options that apply only to the RIB Service API.



## Options

### dynamic-next-hop-interface (enable | disable)

Disable or enable dynamic next-hop interface binding. When enabled, programmed RIB routes react to Up, Down, Add, and Delete events for direct next-hop interfaces. When all next-hop interfaces are unconfigured or down, the route is hidden and becomes inactive. When a next-hop interface is configured or comes up, the route becomes visible and active. This prevents dropped traffic and keeps inactive routes from being propagated through the network.

This feature applies to all routes programmed using the rib\_service JET API where an interface is configured as a direct next-hop, including interfaces that are part of a flexible tunnel. It also applies to tunnels configured with the flexible\_tunnel\_service JET API. Indirect next-hops are resolved by the RPD resolver normally.

Changes to the configuration of this statement only affect routes programmed using Junos OS Release 20.2R1 or later.

- **Default:** This option is enabled by default starting in Junos OS Release 20.2R1. In earlier releases, dynamic next-hop interface binding is disabled by default.

## Required Privilege Level

routing

## Release Information

Statement introduced in Junos OS Release 20.2R1.

### RELATED DOCUMENTATION

*Understanding Programmable Flexible VXLAN Tunnels*

[show programmable-rpd clients](#) | 123

[traceoptions \(programmable-rpd\)](#) | 107

# routing-instance (JET Scripts)

## IN THIS SECTION

- [Syntax | 92](#)
- [Hierarchy Level | 92](#)
- [Description | 92](#)
- [Options | 93](#)
- [Required Privilege Level | 93](#)
- [Release Information | 93](#)

## Syntax

```
routing-instance routing-instance-name;
```

## Hierarchy Level

```
[edit system extensions extension-service application file filename]
```

## Description

Configure the routing instance you want to use to update Automation scripts. To use a management instance, configure the `management-instance` statement along with the `routing-instance` statement, thus enabling JET scripts to use the non-default management routing instance `mgmt_junos` when refreshing the scripts.

## Options

*routing-instance-name* Name of the routing instance. For the management instance, use `mgmt_junos`. Otherwise, you can specify any routing instance name.

**NOTE:** You must also define the routing instance under the `[edit routing-instances]` hierarchy level.

## Required Privilege Level

system—To view this statement in the configuration.

system-control—To add this statement to the configuration.

## Release Information

Statement introduced in Junos OS Release 18.1R1.

### RELATED DOCUMENTATION

[management-instance](#)

[Management Interface in a Non-Default Instance](#)

## source (JET Scripts)

### IN THIS SECTION

● [Syntax](#) | 94

● [Hierarchy Level](#) | 94

- Description | 94
- Options | 94
- Required Privilege Level | 95
- Release Information | 95

## Syntax

```
source url;
```

## Hierarchy Level

```
[edit system extensions extension-service application file filename]
```

## Description

Specify the location of the master source file for a JET script. When you issue the `set refresh` configuration mode command at the same hierarchy level, the local copy of the script is overwritten by the version stored at the specified URL. If the `load-scripts-from-flash` statement is configured, the device refreshes the scripts on the flash drive instead of the hard disk.

**NOTE:** JET scripts are stored in the `/var/db/scripts/jet` directory.

## Options

***url*** Master source file for a JET script specified as an HTTPS URL, HTTP URL, FTP URL, or scp-style remote file specification.

If you specify an HTTPS URL, you must also configure the `cert-file` statement at the same hierarchy level. Specify the path to the certificate (Root CA or self-signed) that the device will use to validate the server's certificate when you refresh the script.

## Required Privilege Level

maintenance—To view or add this statement in the configuration.

## Release Information

Statement introduced in Junos OS Release 18.1R1.

### RELATED DOCUMENTATION

[Configuring and Using a Master Source Location for a Script](#)

[Example: Configuring and Refreshing from the Master Source for a Script](#)

# start (Scripts)

## IN THIS SECTION

- [Syntax | 96](#)
- [Hierarchy Level | 96](#)
- [Description | 96](#)
- [Default | 96](#)
- [Options | 97](#)
- [Required Privilege Level | 97](#)
- [Release Information | 97](#)

## Syntax

```
start {  
    start-options {  
        mem-factor percentage;  
    }  
}
```

## Hierarchy Level

```
[edit event-options event-script],  
[edit event-options event-script file filename],  
[edit system extensions extension-service application],  
[edit system extensions extension-service application file filename],  
[edit system scripts op],  
[edit system scripts op file filename],  
[edit system scripts snmp],  
[edit system scripts snmp file filename]
```

## Description

Configure options to control script execution.

**NOTE:** Junos devices do not enforce script start options for remote op scripts, which are executed using the `op url` command. Script start options are enforced only for local op scripts.

## Default

If you do not configure start options for an individual script or script type, the device does not perform any system resource checks before executing a script.

## Options

### **mem-factor percentage**

System memory usage threshold, specified as a percentage, above which a script does not execute.

You can configure the statement for op, event, SNMP, and Juniper Extension Toolkit (JET) scripts. You can apply the statement to an individual script or to all scripts of a given script type. If you define different thresholds for the script type and an individual script of the same type, the configuration for the individual script takes precedence.

If a device prevents the execution of a script, the cscript process records system log messages in the log file. The CLI does not issue any warning or error that the script was halted.

- Range: 1 through 100

**NOTE:** For JET applications, the `mem-factor` and `daemonize` statements are mutually exclusive.

## Required Privilege Level

maintenance—To view or add this statement in the configuration.

## Release Information

Statement introduced in Junos OS Release 22.4R1.

Statement introduced in Junos OS Evolved Release 23.1R1.

### RELATED DOCUMENTATION

*Configure Script Start Options*

# stats-aggregation-interval (programmable-rpd)

## IN THIS SECTION

- [Syntax | 98](#)
- [Hierarchy Level | 98](#)
- [Description | 98](#)
- [Options | 99](#)
- [Required Privilege Level | 99](#)
- [Release Information | 99](#)

## Syntax

```
stats-aggregation-interval seconds;
```

## Hierarchy Level

```
[edit routing-options programmable-rpd]
```

## Description

Configure the aggregation window for programmable routing protocol process (prpd) statistics.

If the OpenConfig telemetry collector is receiving periodic streaming every 1 minute, then we recommend that you configure a 60-second stats-aggregation-interval in order for the collector to not lose any data. This is because, after every aggregation period, the previous data is reset.



## Options

- seconds* Statistics aggregation time in seconds.
- **Range:** 60 through 3600 seconds
  - **Default:** 60 seconds

## Required Privilege Level

routing

## Release Information

Statement introduced in Junos OS Evolved Release 22.2R1.

### RELATED DOCUMENTATION

| [show programmable-rpd clients](#) | 123

# stats-sampling-interval (programmable-rpd)

### IN THIS SECTION

- [Syntax](#) | 100
- [Hierarchy Level](#) | 100
- [Description](#) | 100
- [Options](#) | 100
- [Required Privilege Level](#) | 100
- [Release Information](#) | 100

## Syntax

```
stats-sampling-interval seconds;
```

## Hierarchy Level

```
[edit routing-options programmable-rpd]
```

## Description

Configure the sampling interval at which to collect programmable routing protocol process (prpd) statistics.

## Options

- |                |  |
|----------------|--|
| <i>seconds</i> | Interval in seconds.   |
|                | <ul style="list-style-type: none"><li>• <b>Range:</b> 30 through 3600 seconds</li><li>• <b>Default:</b> 30 seconds</li></ul> |

## Required Privilege Level

routing

## Release Information

Statement introduced in Junos OS Evolved Release 22.2R1.

## RELATED DOCUMENTATION

[show programmable-rpd clients](#) | [123](#)

## traceoptions (Extensions)

### IN THIS SECTION

- [Syntax](#) | [101](#)
- [Hierarchy Level](#) | [101](#)
- [Description](#) | [102](#)
- [Options](#) | [102](#)
- [Required Privilege Level](#) | [103](#)
- [Release Information](#) | [103](#)

### Syntax

```
traceoptions {  
    file <filename> <files number> <match regex> <size size> <world-readable | no-world-readable>;  
    flag flag;  
    no-remote-trace;  
}
```

### Hierarchy Level

```
[edit system extensions extension-service application],  
[edit system extensions extension-service application file script-name]
```

## Description

Trace options for extension-service applications. You can set the `traceoptions` statement for the application level or for the file *script-name* level or for both. If the `traceoptions` statement is set for both the application and file *script-name* levels, the latter will have a higher priority.

**NOTE:** Global traceoptions for daemonized applications do not take effect if the daemonized application and global traceoptions are committed separately

## Options

file	Indicate trace file information.
<i>filename</i>	Name of the file to receive the tracing operation output. Enclose the name in quotation marks. Traceoption output files are located in the <code>/var/log/</code> directory.
files <i>number</i>	(Optional) Specify maximum number of trace files. <ul style="list-style-type: none"><li>• <b>Range:</b> 2 through 1000</li><li>• <b>Default:</b> 3</li></ul>
size <i>size</i>	(Optional) Specify the maximum size of each trace file. When a trace file named <i>trace-file</i> reaches its maximum size, it is renamed <i>trace-file.0</i> . The traceoption output continues in a second trace file named <i>trace-file.1</i> . When <i>trace-file.1</i> reaches its maximum size, output continues in a third file named <i>trace-file.2</i> , and so on. When the maximum number of trace files is reached, the oldest trace file is overwritten. <ul style="list-style-type: none"><li>• <b>Range:</b> 10240 through 1073741824</li><li>• <b>Default:</b> 128k</li></ul>
world-readable   no-world-readable	(Optional). Grant all users permission to read log files, or restrict the permission only to the root user and users who have Junos OS maintenance permission.
flag <i>flag</i>	Specify the tracing operation to perform. To specify more than one tracing operation, include multiple <code>flag</code> statements:

<code>all</code>	Trace all operations.
<code>config</code>	Trace important events.
<code>general</code>	Trace script input data.
<code>grpc</code>	Trace grpc server events.
<code>notification</code>	Trace notification events.
<code>routing-socket</code>	Trace routing socket calls.
<code>timeouts</code>	Trace timeouts.
<code>timer</code>	Trace internal timer events.

`no-remote-trace` Disable remote tracing. This option is valid only when [system tracing] is configured.

## Required Privilege Level

`trace`—To view this statement in the configuration.

`trace-control`—To add this statement to the configuration.

## Release Information

Statement introduced in Junos OS Release 16.1.

### RELATED DOCUMENTATION

[application \(Extensions\)](#) | 55

# traceoptions (Services)

## IN THIS SECTION

- [Syntax | 104](#)
- [Hierarchy Level | 104](#)
- [Description | 104](#)
- [Options | 105](#)
- [Required Privilege Level | 106](#)
- [Release Information | 106](#)

## Syntax

```
traceoptions {  
    file <filename> <files number> <match regex> <size size> <world-readable | no-world-readable>;  
    flag flag;  
    level <error>;  
    no-remote-trace;  
}
```

## Hierarchy Level

```
[edit system services extension-service]
```

## Description

Define tracing operations for the JET service process (jsd).

## Options

<b>file</b>	Indicate trace file information.
<b><i>filename</i></b>	Name of the file to receive the tracing operation output. Enclose the name in quotation marks. Traceoption output files are located in the <b>/var/log/</b> directory.
<b>files <i>number</i></b>	(Optional) Specify the maximum number of trace files. <ul style="list-style-type: none"> <li>• <b>Range:</b> 2 through 1000</li> <li>• <b>Default:</b> 10</li> </ul>
<b>match <i>regex</i></b>	Specify the regular expression for lines to be logged.
<b>size <i>size</i></b>	(Optional) Specify the maximum size of each trace file. When a trace file named <i>trace-file</i> reaches its maximum size, it is renamed <i>trace-file.0</i> . The traceoption output continues in a second trace file named <i>trace-file.1</i> . When <i>trace-file.1</i> reaches its maximum size, output continues in a third file named <i>trace-file.2</i> , and so on. When the maximum number of trace files is reached, the oldest trace file is overwritten. <ul style="list-style-type: none"> <li>• <b>Range:</b> 10,240 through 1,073,741,824 bytes</li> <li>• <b>Default:</b> 1000k</li> </ul>
<b>world-readable   no-world- readable</b>	(Optional). Grant all users permission to read log files, or restrict the permission only to the root user and users who have Junos OS maintenance permission.
<b>flag <i>flag</i></b>	Specify the tracing operation to perform. To specify more than one tracing operation, include multiple flag statements: <ul style="list-style-type: none"> <li>• <b>all</b>—Trace everything.</li> <li>• <b>config</b>—Trace configuration events.</li> <li>• <b>general</b>—Trace general events.</li> <li>• <b>grpc</b>—Trace grpc server events.</li> <li>• <b>libgrpc-debug</b>—(Junos OS Release 19.3R1 only) Trace all lib grpc-related events.</li> </ul>

- `libgrpc-errors`—(Junos OS Release 19.3R1 only) Trace lib grpc errors.
- `libgrpc-info`—(Junos OS Release 19.3R1 only) Trace lib grpc info and errors.
- `notification`—Trace notification events.
- `routing-socket`—Trace routing socket calls
- `timeouts`—Trace timeouts.
- `timer`—Trace internal timer events.

**NOTE:** The libgrpc trace flags are only supported in Junos OS Release 19.3R1. They allow you to see events from the grpc libraries in the jsd trace log. Within the grpc core there are multiple libraries (for example, iomgr, compression, and profiling).

**level** Set the trace log verbosity. Use the `error` option to only show error events.

**NOTE:** This `error` option does not apply to the libgrpc trace flags.

**no-remote-trace** Disable remote tracing.

## Required Privilege Level

`trace`—To view this statement in the configuration.

`trace-control`—To add this statement to the configuration.

## Release Information

Statement introduced in Junos OS Release 16.1.

`level` option introduced in Junos OS Release 20.2R1.

Trace flag options `libgrpc-debug`, `libgrpc-errors`, and `libgrpc-info` are supported in Junos OS Release 19.3R1 only.



# traceoptions (programmable-rpd)

## IN THIS SECTION

- [Syntax | 107](#)
- [Hierarchy Level | 107](#)
- [Description | 107](#)
- [Default | 108](#)
- [Options | 108](#)
- [Required Privilege Level | 109](#)
- [Release Information | 109](#)

## Syntax

```
traceoptions {  
    file filename <files number> <size size> <world-readable | no-world-readable>;  
    flag flag <disable>;  
}
```

## Hierarchy Level

```
[edit routing-options programmable-rpd]
```

## Description

Starts logging traces related to the programmable routing protocol process (prpd). Use the traceoptions statement, along with related show commands, to help debug client-server interactions, identify the

flow of control, and detect errors, get client-level information and statistics. You can filter traces according to the flag(s) you have enabled.

## Default

If you do not include this statement, no tracing operations are performed.

## Options

<code>file</code> <i>filename</i>	Name of the file to receive the output of the tracing operation. Enclose the name within quotation marks. All files are placed in the directory <code>/var/log</code> .
<code>files</code> <i>number</i>	<p>(Optional) Maximum number of trace files. When a trace file named <i>trace-file</i> reaches its maximum size, it is renamed <i>trace-file.0</i>, then <i>trace-file.1</i>, and so on, until the maximum number of trace files is reached. Then, the oldest trace file is overwritten. Note that if you specify a maximum number of files, you also must specify a maximum file size with the <code>size</code> option.</p> <ul style="list-style-type: none"> <li>• <b>Range:</b> 2 through 1000 files</li> <li>• <b>Default:</b> 10 files</li> </ul>
<code>no-world-readable</code>	(Optional) Prevent any user from reading the log file.
<code>size</code> <i>size</i>	<p>(Optional) Maximum size of each trace file, in kilobytes (KB), megabytes (MB), or gigabytes (GB). When a trace file named <i>trace-file</i> reaches this size, it is renamed <i>trace-file.0</i>. When the <i>trace-file</i> again reaches its maximum size, <i>trace-file.0</i> is renamed <i>trace-file.1</i> and <i>trace-file</i> is renamed <i>trace-file.0</i>. This renaming scheme continues until the maximum number of trace files is reached. Then, the oldest trace file is overwritten.</p> <p>Note that if you specify a maximum file size, you also must specify a maximum number of trace files with the <code>files</code> option.</p> <ul style="list-style-type: none"> <li>• <b>Syntax:</b> <i>kb</i> to specify KB, <i>mb</i> to specify MB, or <i>gb</i> to specify GB</li> <li>• <b>Range:</b> 1024 to 4,294,967,295 bytes</li> <li>• <b>Default:</b> 128 KB</li> </ul>
<code>world-readable</code>	(Optional) Allow any user to read the log file.

- flag *flag*** Specifies the tracing operation to perform. To specify more than one tracing operation, include multiple **flag** statements. The options are:
- **all**—All tracing operations.
  - **client**—Client events.
  - **general**—All normal operations and routing table changes (a combination of the **normal** and **route trace** operations).
  - **japi**—JAPI-related changes.
  - **normal**—All normal operations.
  - **policy**—Routing policy operations and actions.
  - **route**—Routing table changes.
  - **routing-interface**—Routing interface changes.
  - **state**—State transitions.
  - **task**—Interface transactions and processing.
  - **te-path-compute**—Traffic engineering path computation changes.
  - **timer**—Timer usage.

## Required Privilege Level

**routing and trace**—To view this statement in the configuration.

**routing-control and trace-control**—To add this statement to the configuration.

## Release Information

Statement introduced in Junos OS Release 16.2.

### RELATED DOCUMENTATION

[purge-timeout \(programmable-rpd\)](#) | 81

[show programmable-rpd clients](#) | 123

---

*show route*

# 5

CHAPTER

## Operational Commands

---

`request extension-service (start | stop)` | 112

`request extension-service restart-daemonize-app` | 113

`show extension-service request-response clients` | 115

`show extension-service request-response servers` | 118

`show extension-service status` | 120

`show programmable-rpd clients` | 123

---

# request extension-service (start | stop)

## IN THIS SECTION

- [Syntax | 112](#)
- [Description | 112](#)
- [Options | 112](#)
- [Required Privilege Level | 113](#)
- [Output Fields | 113](#)
- [Sample Output | 113](#)
- [Release Information | 113](#)

## Syntax

```
request extension-service (start | stop) application-name  
<invoke-debugger cli>
```

## Description

Start or stop a JET application running on a device running Junos OS.

## Options

- |                            |   |
|----------------------------|---|
| <i>application-name</i>    | Name of application to be started or stopped.                     |
| <i>invoke-debugger cli</i> | (Optional) Starts the extension service process in debugger mode. |

## Required Privilege Level

maintenance

## Output Fields

When you enter this command, you are provided feedback on the status of your request.

## Sample Output

command-name

```
user@device> request extension-service start cmdline_args.py
Extension-service application 'cmdline_args.py' started with pid: 99418
```

## Release Information

Command introduced in Junos OS Release 16.1.

# request extension-service restart-daemonize-app

### IN THIS SECTION

- [Syntax | 114](#)
- [Description | 114](#)
- [Options | 114](#)
- [Required Privilege Level | 114](#)
- [Output Fields | 114](#)

## Syntax

```
request extension-service restart-daemonize-app application-name
```

## Description

Restart a daemonized application running on a Junos device.

A daemonized application runs as a process in the background. An application configured to run as a daemonized process is automatically triggered upon commit. Restarting the application can assist you with debugging and troubleshooting.

## Options

<i>application-name</i>	Name of application to be restarted.
-------------------------	--------------------------------------

## Required Privilege Level

maintenance

## Output Fields

When you enter this command, you are provided feedback on the status of your request.



## Release Information

Command introduced in Junos OS and Junos OS Evolved Release 23.2R1.

# show extension-service request-response clients

### IN THIS SECTION

- [Syntax | 115](#)
- [Description | 115](#)
- [Options | 115](#)
- [Required Privilege Level | 116](#)
- [Output Fields | 116](#)
- [Sample Output | 117](#)
- [Release Information | 118](#)

## Syntax

```
show extension-service request-response clients (detail | brief)
```

## Description

Display the status of the request-response clients connected to the device.

## Options

*client-id*      The client identifier.

- brief** (Default) Display a summary of the information.
- detail** Display detailed information.

## Required Privilege Level

view

## Output Fields

Table 5 on page 116 lists the output fields for the `show extension-service request-response clients` command.

**Table 5: show extension-service request-response clients Output Fields**

Field Name	Field Description
Client ID	Client identifier.
Socket Address	Address of the socket.
Client Type	Type of the client.
Client Login Time	The most recent login time of the remote procedure call (gRPC) client. This is when the authentication request was received for the channel.
Channel Count	The number of channels.
User Name	The user name for which the session was authenticated in a gRPC session. If authentication is not required, this field displays as “No User.” This helps you identify which users have requested programmable operations.

## Sample Output

### show extension-service request-response clients

```
user@device> show extension-service request-response clients
```

Client ID	Socket Address	Client Type	Client Login Time
Channel Count			
ipv6::ffff:10.209.0.224:45888	ipv6::ffff:10.209.0.224:45888	gRPC	2020-02-24 04:08:11
UTC 1			
unix::20	unix::20	gRPC	2020-02-23 15:23:47
UTC 1			

### show extension-service request-response clients detail

```
user@device> show extension-service request-response clients detail
```

Channel information:

Client ID: ipv6::ffff:10.209.0.224:45888  
 Socket Address: ipv6::ffff:10.209.0.224:45888  
 Client Type: gRPC  
 Client Login Time : 2020-02-24 04:08:11 UTC  
 Channel Count: 1

Channel target: unix:/var/run/japi\_mgd-api  
 Channel status: GRPC\_CHANNEL\_READY  
 User Name: root

Channel information:

Client ID: unix::20  
 Socket Address: unix::20  
 Client Type: gRPC  
 Client Login Time : 2020-02-23 15:23:47 UTC  
 Channel Count: 1

Channel target: unix:/var/run/japi\_na-grpcd  
 Channel status: GRPC\_CHANNEL\_READY  
 User Name: No User

## Release Information

Command introduced in Junos OS.

Client Login Time and User Name output fields introduced in Junos OS Release 20.4R1 for PTX5000.

# show extension-service request-response servers

### IN THIS SECTION

- [Syntax | 118](#)
- [Description | 118](#)
- [Required Privilege Level | 118](#)
- [Output Fields | 119](#)
- [Sample Output | 119](#)
- [Release Information | 119](#)

## Syntax

```
show extension-service request-response servers
```

## Description

Display the status of the request-response servers connected to the device.

## Required Privilege Level

view

## Output Fields

Table 6 on page 119 lists the output fields for the `show extension-service request-response servers` command.

**Table 6: show extension-service request-response servers Output Fields**

Field Name	Field Description
Max connections	The maximum number of simultaneous connections for request-response that can be attached to jsd.
Address	The address of the server.
Status	The status of the server.

## Sample Output

### `show extension-service request-response servers`

```
user@device> show extension-service request-response servers
gRPC server information:
  Max connections: 5, Skip-authentication: Disabled

  Address: unix:/var/run/japi_jsd
  Status: Up, Type: Clear-text
```

## Release Information

Command introduced in Junos OS.

# show extension-service status

## IN THIS SECTION

- [Syntax | 120](#)
- [Description | 120](#)
- [Options | 120](#)
- [Required Privilege Level | 121](#)
- [Output Fields | 121](#)
- [Sample Output | 121](#)
- [Release Information | 122](#)

## Syntax

```
show extension-service status (application-name | all)
```

## Description

Display the status of all JET applications.

**NOTE:** The `show extension-service status` operational command is limited to use with Python applications only.

## Options

*application-name*      Display information for a single application.

**all** Display information for all JET applications running on the system.

### Required Privilege Level

view

### Output Fields

[Table 7 on page 121](#) lists the output fields for the `show extension-service status` command.

**Table 7: show extension-service status Output Fields**

Field Name	Field Description
Name	Name of the application.
Arguments	Arguments passed to the application.
Process-id	Process ID.
Stack-Segment-Size	Size of the stack segment memory.
Data-Segment-Size	Size of the data segment memory.

### Sample Output

**show extension-service status**

```
user@host> show extension-service status application-one
Extension service application details:
Name : application-one
```

```
Arguments: -arg1 foo -arg2 goo  
Process-id: 52592  
Stack-Segment-Size: 16777216B  
Data-Segment-Size: 134217728B
```

### **show extension-service status all**

```
user@host> show extension-service status all  
Extension service application details:  
Name : application-name1  
Arguments: -arg1 foo -arg2 goo  
Process-id: 54834  
Stack-Segment-Size: 16777216B  
Data-Segment-Size: 134217728B  
Name : application-name2  
Arguments: -arg1 foo -arg2 goo  
Process-id: 55011  
Stack-Segment-Size: 16777216B  
Data-Segment-Size: 134217728B
```

### **show extension-service status all (when no applications are active)**

```
user@host> show extension-service status all  
warning: No active extension-services
```

## **Release Information**

Command introduced in Junos OS Release 16.1.



# show programmable-rpd clients

## IN THIS SECTION

- [Syntax | 123](#)
- [Description | 123](#)
- [Required Privilege Level | 123](#)
- [Sample Output | 124](#)
- [Release Information | 124](#)

## Syntax

```
show programmable-rpd clients
```

## Description

Lists clients connected to the programmable routing protocol process (prpd) server. The prpd provides public APIs to program routing systems, making it possible for users to directly access the APIs to customize, create and modify behavior of their network.

The command output shows client specific details and statistics such as client ID, protocol and corresponding gateway handle, purge timer, the client up/down status, the route-summary of the number of routes installed, the per-route-table breakup of the route count and, if the client is disconnected, the time remaining before the client state is purged. If the client has not registered any protocol, the gateway handle is 0.

## Required Privilege Level

view

## Sample Output

**show programmable-rpd clients**

```
user@host> show programmable-rpd clients
RPD global purge timeout: 120
RPD Server connected client details:
ClientIdentifier  PurgeTimer  Status  Timeout  Protocol  Gateway
3                150        Up      117      BGP-Static  578
2                75         Up      117      NoGwProtocol 0
1                120        Down    117      BGP-Static  577
```

## Release Information

Command introduced in Junos OS Release 16.2.

### RELATED DOCUMENTATION

[purge-timeout \(programmable-rpd\) | 81](#)

*show route*