Engineering
Simplicity

Junos® OS

FIPS Evaluated Configuration Guide for MX104 Device

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Junos® OS FIPS Evaluated Configuration Guide for MX104 Device
19.1R2

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

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About This Guide

Use this guide to operate MX104 device in Federal Information Processing Standards (FIPS) 140-2 Level 1 environment. FIPS 140-2 defines security levels for hardware and software that perform cryptographic functions.

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CHAPTER

Overview

Understanding Junos OS in FIPS Mode

IN THIS SECTION

Federal Information Processing Standards (FIPS) 140-2 defines security levels for hardware and software that perform cryptographic functions. This Juniper Networks router running the Juniper Networks Junos operating system (Junos OS) in *FIPS mode* comply with the FIPS 140-2 Level 1 standard.

Operating this router in a FIPS 140-2 Level 1 environment requires enabling and configuring FIPS mode on the devices from the Junos OS command-line interface (CLI).

The Crypto Officer enables FIPS mode in Junos OS and sets up keys and passwords for the system and other *FIPS users*.

Supported Platforms and Hardwares

For the features described in this document, the following platform is used to qualify FIPS certification:

- MX104 device with MS-MIC (https://www.juniper.net/us/en/products/routers/mx-series/mx104-universal-routing-platform.html).

About the Cryptographic Boundary on Your Device

FIPS 140-2 compliance requires a defined *cryptographic boundary* around each *cryptographic module* on a device. Junos OS in FIPS mode prevents the cryptographic module from executing any software that is not part of the FIPS-certified distribution, and allows only FIPS-approved cryptographic algorithms to be used. No critical security parameters (CSPs), such as passwords and keys, can cross the cryptographic boundary of the module in unencrypted format.

⚠ **CAUTION**: Virtual Chassis features are not supported in FIPS mode. Do not configure a Virtual Chassis in FIPS mode.

How FIPS Mode Differs from Non-FIPS Mode

Junos OS in FIPS mode differs in the following ways from Junos OS in non-FIPS mode:

- Self-tests of all cryptographic algorithms are performed at startup.
- Self-tests of random number and key generation are performed continuously.
- Weak cryptographic algorithms such as Data Encryption Standard (DES) and MD5 are disabled.
- Weak or unencrypted management connections must not be configured.
- Passwords must be encrypted with strong one-way algorithms that do not permit decryption.
- Administrator passwords must be at least 10 characters long.

Validated Version of Junos OS in FIPS Mode

To determine whether a Junos OS release is NIST-validated, see the compliance page on the Juniper Networks Web site (https://apps.juniper.net/compliance/).

RELATED DOCUMENTATION

Identifying Secure Product Delivery

Understanding FIPS Terminology and Supported Cryptographic Algorithms

IN THIS SECTION

Use the definitions of FIPS terms, and supported algorithms to help you understand Junos OS in FIPS mode.

Terminology

Critical security parameter (CSP) Security-related information—for example, secret and private cryptographic keys and authentication data such as passwords and personal identification numbers (PINs)—whose disclosure or modification can compromise the security of a cryptographic module or the information it protects. For details, see "Understanding the Operational Environment for Junos OS in FIPS Mode" on page 15.

Cryptographic module The set of hardware, software, and firmware that implements approved security functions (including cryptographic algorithms and key generation) and is contained within the cryptographic boundary.

FIPS Federal Information Processing Standards. FIPS 140-2 specifies requirements for security and cryptographic modules. Junos OS in FIPS mode complies with FIPS 140-2 Level 1.

FIPS maintenance role The role the Crypto Officer assumes to perform physical maintenance or logical maintenance services such as hardware or software diagnostics. For FIPS 140-2 compliance, the Crypto Officer zeroizes the Routing Engine on entry to and exit from the FIPS maintenance role to erase all plain-text secret and private keys and unprotected CSPs.

NOTE: The FIPS maintenance role is not supported on Junos OS in FIPS mode.

Hashing A message authentication method that applies a cryptographic technique iteratively to a message of arbitrary length and produces a hash *message digest* or *signature* of fixed length that is appended to the message when sent.

KATs Known answer tests. System self-tests that validate the output of cryptographic algorithms approved for FIPS and test the integrity of some Junos OS modules. For details, see "Understanding FIPS Self-Tests" on page 50.

SSH A protocol that uses strong authentication and encryption for remote access across a nonsecure network. SSH provides remote login, remote program execution, file copy, and other functions. It is intended as a secure replacement for `rlogin`, `rsh`, and `rcp` in a UNIX environment. To secure the information sent over administrative connections, use SSHv2 for CLI configuration. In Junos OS, SSHv2 is enabled by default, and SSHv1, which is not considered secure, is disabled.

Zeroization Erasure of all CSPs and other user-created data on a device before its operation as a FIPS cryptographic module—or in preparation for repurposing the devices for non-FIPS operation. The Crypto Officer can zeroize the system with a CLI operational command.

Supported Cryptographic Algorithms

The following cryptographic algorithms are supported in FIPS mode. Symmetric methods use the same key for encryption and decryption, while asymmetric methods use different keys for encryption and decryption.

AES The Advanced Encryption Standard (AES), defined in FIPS PUB 197. The AES algorithm uses keys of 128, 192, or 256 bits to encrypt and decrypt data in blocks of 128 bits.

ECDH Elliptic Curve Diffie-Hellman. A variant of the Diffie-Hellman key exchange algorithm that uses cryptography based on the algebraic structure of elliptic curves over finite fields. ECDH allows two parties, each having an elliptic curve public-private key pair, to establish a shared secret over an insecure channel. The shared secret can be used either as a key or to derive another key for encrypting subsequent communications using a symmetric key cipher.

ECDSA Elliptic Curve Digital Signature Algorithm. A variant of the Digital Signature Algorithm (DSA) that uses cryptography based on the algebraic structure of elliptic curves over finite fields. The bit size of the elliptic curve determines the difficulty of decrypting the key. The public key believed to be needed for ECDSA is about twice the size of the security level, in bits. ECDSA using the P-256, P-384, and P-521 curves can be configured under OpenSSH.

HMAC Defined as "Keyed-Hashing for Message Authentication" in RFC 2104, HMAC combines hashing algorithms with cryptographic keys for message authentication. For Junos OS in FIPS mode, HMAC uses the iterated cryptographic hash functions SHA-1, SHA-256, and SHA-512 along with a secret key.

SHA-256 and SHA-512 Secure hash algorithms (SHA) belonging to the SHA-2 standard defined in FIPS PUB 180-2. Developed by NIST, SHA-256 produces a 256-bit hash digest, and SHA-512 produces a 512-bit hash digest.

3DES (3des-cbc) Encryption standard based on the original Data Encryption Standard (DES) from the 1970s that used a 56-bit key and was cracked in 1997. The more secure 3DES is DES enhanced with three multiple stages and effective key lengths of about 112 bits. For Junos OS in FIPS mode, 3DES is implemented with cipher block chaining (CBC).

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Identifying Secure Product Delivery

There are several mechanisms provided in the delivery process to ensure that a customer receives a product that has not been tampered with. The customer should perform the following checks upon receipt of a device to verify the integrity of the platform.

- Shipping label—Ensure that the shipping label correctly identifies the correct customer name and address as well as the device.

- Outside packaging—Inspect the outside shipping box and tape. Ensure that the shipping tape has not been cut or otherwise compromised. Ensure that the box has not been cut or damaged to allow access to the device.

- Inside packaging—Inspect the plastic bag and seal. Ensure that the bag is not cut or removed. Ensure that the seal remains intact.

If the customer identifies a problem during the inspection, he or she should immediately contact the supplier. Provide the order number, tracking number, and a description of the identified problem to the supplier.

Additionally, there are several checks that can be performed to ensure that the customer has received a box sent by Juniper Networks and not a different company masquerading as Juniper Networks. The customer should perform the following checks upon receipt of a device to verify the authenticity of the device:

- Verify that the device was ordered using a purchase order. Juniper Networks devices are never shipped without a purchase order.

- When a device is shipped, a shipment notification is sent to the e-mail address provided by the customer when the order is taken. Verify that this e-mail notification was received. Verify that the e-mail contains the following information:

  - Purchase order number

  - Juniper Networks order number used to track the shipment

  - Carrier tracking number used to track the shipment

  - List of items shipped including serial numbers

  - Address and contacts of both the supplier and the customer

- Verify that the shipment was initiated by Juniper Networks. To verify that a shipment was initiated by Juniper Networks, you should perform the following tasks:

  - Compare the carrier tracking number of the Juniper Networks order number listed in the Juniper Networks shipping notification with the tracking number on the package received.

  - Log on to the Juniper Networks online customer support portal at https://support.juniper.net/support/ to view the order status. Compare the carrier tracking number or the Juniper Networks order number listed in the Juniper Networks shipment notification with the tracking number on the package received.

Understanding Management Interfaces

The following management interfaces can be used in the evaluated configuration:

- Local Management Interfaces—The RJ-45 console port on the device is configured as RS-232 data terminal equipment (DTE). You can use the command-line interface (CLI) over this port to configure the device from a terminal.
- Remote Management Protocols—The device can be remotely managed over any Ethernet interface. SSHv2 is the only permitted remote management protocol that can be used in the evaluated configuration. The remote management protocols J-Web and Telnet are not available for use on the device.

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CHAPTER

Configure Administrative Credentials and Privileges

Overview of Associated Password Rules for an Authorized Administrator

The authorized administrator is associated with a defined login class, and the administrator is assigned with all permissions. Data is stored locally for fixed password authentication.

NOTE: Do not use control characters in passwords.

Use the following guidelines and configuration options for passwords and when selecting passwords for authorized administrator accounts. Passwords should be:

- Easy to remember so that users are not tempted to write it down.
- Changed periodically.
- Private and not shared with anyone.
- Contain a minimum of 10 characters. The minimum password length is 10 characters.

```
[ edit ]
administrator@host# set system login password minimum-length 10
```

- Include both alphanumeric and punctuation characters, composed of any combination of upper and lowercase letters, numbers, and special characters such as, “!”, “@”, “#”, “$”, “%”, “^”, “&”, “*”, “(“, and “)”. There should be at least a change in one case, one or more digits, and one or more punctuation marks.
- Contain character sets. Valid character sets include uppercase letters, lowercase letters, numbers, punctuation, and other special characters.

```
[ edit ]
administrator@host# set system login password change-type character-sets
```

- Contain the minimum number of character sets or character set changes. The minimum number of character sets required in plain-text passwords in Junos FIPS is 3.

  ```
  [ edit ]
  administrator@host# set system login password minimum-changes 3
  ```

- The hashing algorithm for user passwords can be either SHA256 or SHA512 (SHA512 is the default hashing algorithm).

  ```
  [ edit ]
  administrator@host# set system login password format sha512
  ```

  NOTE: The device supports ECDSA (P-256, P-384, and P-521) and RSA (2048, 3072, and 4092 modulus bit length) key-types.

  Weak passwords are:

  - Words that might be found in or exist as a permuted form in a system file such as **/etc/passwd**.
  - The hostname of the system (always a first guess).
  - Any words appearing in a dictionary. This includes dictionaries other than English, and words found in works such as Shakespeare, Lewis Carroll, Roget's Thesaurus, and so on. This prohibition includes common words and phrases from sports, sayings, movies, and television shows.
  - Permutations on any of the above. For example, a dictionary word with vowels replaced with digits (for example f00t) or with digits added to the end.
  - Any machine-generated passwords. Algorithms reduce the search space of password-guessing programs and so should not be used.

Strong reusable passwords can be based on letters from a favorite phrase or word, and then concatenated with other, unrelated words, along with additional digits and punctuation.

RELATED DOCUMENTATION

Identifying Secure Product Delivery

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CHAPTER

Configure Roles and Authentication Methods

Understanding Roles and Services for Junos OS

IN THIS SECTION

The Security Administrator is associated with the defined login class "security-admin", which has the necessary permission set to permit the administrator to perform all tasks necessary to manage Junos OS. Administrative users (Security Administrator) must provide unique identification and authentication data before any administrative access to the system is granted.

Security Administrator roles and responsibilities are as follows:

1. Security Administrator can administer locally and remotely.
2. Create, modify, delete administrator accounts, including configuration of authentication failure parameters.
3. Re-enable an Administrator account.
4. Responsible for the configuration and maintenance of cryptographic elements related to the establishment of secure connections to and from the evaluated product.

The Juniper Networks Junos operating system (Junos OS) running in non-FIPS mode allows a wide range of capabilities for users, and authentication is identity-based. In contrast, the FIPS 140-2 standard defines two user roles: Crypto Officer and FIPS user. These roles are defined in terms of Junos OS user capabilities.

All other user types defined for Junos OS in FIPS mode such as read-only and administrative user must fall into one of the two categories: Crypto Officer or FIPS user. For this reason, user authentication in Junos is identity based with role based authorization.

Crypto Officer performs all FIPS-mode-related configuration tasks and issue all statements and commands for Junos OS in FIPS mode. Crypto Officer and FIPS user configurations must follow the guidelines for Junos OS in FIPS mode.

Crypto Officer Role and Responsibilities

The Crypto Officer is the person responsible for enabling, configuring, monitoring, and maintaining Junos OS in FIPS mode on a device. The Crypto Officer securely installs Junos OS on the device, enables FIPS mode, establishes keys and passwords for other users and software modules, and initializes the device before network connection.

BEST PRACTICE: We recommend that the Crypto Officer administer the system in a secure manner by keeping passwords secure and checking audit files.

The permissions that distinguish the Crypto Officer from other FIPS users are `secret`, `security`, `maintenance`, and `control`. Assign the Crypto Officer to a login class that contains all of these permissions.

Among the tasks related to Junos OS in FIPS mode, the Crypto Officer is expected to:

- Set the initial root password. The length of the password should be at least 10 characters.

- Reset user passwords with FIPS-approved algorithms.

- Examine log and audit files for events of interest.

- Erase user-generated files, keys, and data by zeroizing the device.

FIPS User Role and Responsibilities

All FIPS users, including the Crypto Officer, can view the configuration. Only the user assigned as the Crypto Officer can modify the configuration.

The permissions that distinguish Crypto Officers from other FIPS users are secret, security, maintenance, and control. For FIPS compliance, assign the FIPS user to a class that contains none of these permissions.

FIPS user can view status output but cannot reboot or zeroize the device.

What Is Expected of All FIPS Users

All FIPS users, including the Crypto Officer, must observe security guidelines at all times.

All FIPS users must:

- Keep all passwords confidential.
- Store devices and documentation in a secure area.
- Deploy devices in secure areas.
- Check audit files periodically.
- Conform to all other FIPS 140-2 security rules.
- Follow these guidelines:
  - Users are trusted.
  - Users abide by all security guidelines.
  - Users do not deliberately compromise security.
  - Users behave responsibly at all times.

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Understanding the Operational Environment for Junos OS in FIPS Mode

IN THIS SECTION

A Juniper Networks device running the Juniper Networks Junos operating system (Junos OS) in FIPS mode forms a special type of hardware and software operational environment that is different from the environment of a device in non-FIPS mode:

Hardware Environment for Junos OS in FIPS Mode

Junos OS in FIPS mode establishes a cryptographic boundary in the device that no critical security parameters (CSPs) can cross using plain text. Each hardware component of the device that requires a cryptographic boundary for FIPS 140-2 compliance is a separate cryptographic module.

Cryptographic methods are not a substitute for physical security. The hardware must be located in a secure physical environment. Users of all types must not reveal keys or passwords, or allow written records or notes to be seen by unauthorized personnel.

Software Environment for Junos OS in FIPS Mode

A Juniper Networks device running Junos OS in FIPS mode forms a special type of nonmodifiable operational environment. To achieve this environment on the device, the system prevents the execution of any binary file that was not part of the certified Junos OS in FIPS mode distribution. When a device is in FIPS mode, it can run only Junos OS.

The Junos OS in FIPS mode software environment is established after the Crypto Officer successfully enables FIPS mode on a device. The Junos OS image that includes FIPS mode is available on the Juniper Networks website and can be installed on a functioning device.

For FIPS 140-2 compliance, we recommend that you delete all user-created files and data by *zeroizing* the device before enabling FIPS mode.

Enabling FIPS mode disables many of the usual Junos OS protocols and services. In particular, you cannot configure the following services in Junos OS in FIPS mode:

- finger
- ftp
- rlogin
- telnet
- tftp
- xnm-clear-text

Attempts to configure these services, or load configurations with these services configured, result in a configuration syntax error.

You can use only SSH as a remote access service.

All passwords established for users after upgrading to Junos OS in FIPS mode must conform to Junos OS in FIPS mode specifications. Passwords must be between 10 and 20 characters in length and require the use of at least three of the five defined character sets (uppercase and lowercase letters, digits, punctuation marks, and keyboard characters, such as % and &, not included in the other four categories). Attempts to configure passwords that do not conform to these rules result in an error. All passwords and keys used to authenticate peers must be at least 10 characters in length, and in some cases the length must match the digest size.

NOTE: Do not attach the device to a network until the Crypto Officer completes configuration from the local console connection.

For strict compliance, do not examine core and crash dump information on the local console in Junos OS in FIPS mode because some CSPs might be shown in plain text.

Critical Security Parameters

Critical security parameters (CSPs) are security-related information such as cryptographic keys and passwords that can compromise the security of the cryptographic module or the security of the information protected by the module if they are disclosed or modified.

Zeroization of the system erases all traces of CSPs in preparation for operating the deviceor Routing Engine as a cryptographic module.

Table 1 on page 17 lists CSPs on devices running Junos OS.

Table 1: Critical Security Parameters

CSP	Description	Zeroize	Use
SSHv2 private host key	ECDSA / RSA key used to identify the host, generated the first time SSH is configured.	Zeroize command.	Used to identify the host.

Table 1: Critical Security Parameters *(Continued)*

CSP	Description	Zeroize	Use
SSHv2 session keys	Session key used with SSHv2 and as a Diffie-Hellman private key. Encryption: 3DES, AES-128, AES-192, AES-256. MACs: HMAC-SHA-1, HMAC-SHA-2-256, HMAC-SHA2-512. Key exchange: ECDH-sha2-nistp256, ECDH-sha2-nistp384, and ECDH-sha2-nistp521.	Power cycle and terminate session.	Symmetric key used to encrypt data between host and client.
User authentication key	Hash of the user's password: SHA256, SHA512.	Zeroize command.	Used to authenticate a user to the cryptographic module.
Crypto Officer authentication key	Hash of the Crypto Officer's password: SHA256, SHA512.	Zeroize command.	Used to authenticate the Crypto Officer to the cryptographic module.
HMAC DRBG seed	Seed for deterministic randon bit generator (DRBG).	Seed is not stored by the cryptographic module.	Used for seeding DRBG.
HMAC DRBG V value	The value (V) of output block length (outlen) in bits, which is updated each time another outlen bits of output are produced.	Power cycle.	A critical value of the internal state of DRBG.
HMAC DRBG key value	The current value of the outlen-bit key, which is updated at least once each time that the DRBG mechanism generates pseudorandom bits.	Power cycle.	A critical value of the internal state of DRBG.
NDRNG entropy	Used as entropy input string to the HMAC DRBG.	Power cycle.	A critical value of the internal state of DRBG.

In Junos OS in FIPS mode, all CSPs must enter and leave the cryptographic module in encrypted form. Any CSP encrypted with a non-approved algorithm is considered plain text by FIPS.

BEST PRACTICE: For FIPS compliance, configure the router over SSH connections because they

Local passwords are hashed with the SHA256 or SHA512 algorithm. Password recovery is not possible in Junos OS in FIPS mode. Junos OS in FIPS mode cannot boot into single-user mode without the correct root password.

Understanding Password Specifications and Guidelines for Junos OS in FIPS Mode

All passwords established for users by the Crypto Officer must conform to the following Junos OS in FIPS mode requirements. Attempts to configure passwords that do not conform to the following specifications result in an error.

- Length. Passwords must contain between 10 and 20 characters.
- Character set requirements. Passwords must contain at least three of the following five defined character sets:
  - Uppercase letters
  - Lowercase letters
  - Digits
  - Punctuation marks
  - Keyboard characters not included in the other four sets—such as the percent sign (%) and the ampersand (&)
- Authentication requirements. All passwords and keys used to authenticate peers must contain at least 10 characters, and in some cases the number of characters must match the digest size.
- Password encryption. To change the default encryption method (SHA512) include the `format` statement at the `[edit system login password]` hierarchy level.

Guidelines for strong passwords. Strong, reusable passwords can be based on letters from a favorite phrase or word and then concatenated with other unrelated words, along with added digits and punctuation. In general, a strong password is:

- Easy to remember so that users are not tempted to write it down.
- Made up of mixed alphanumeric characters and punctuation. For FIPS compliance include at least one change of case, one or more digits, and one or more punctuation marks.
- Changed periodically.
- Not divulged to anyone.

Characteristics of weak passwords. Do not use the following weak passwords:

- Words that might be found in or exist as a permuted form in a system files such as `/etc/passwd`.
- The hostname of the system (always a first guess).
- Any word or phrase that appears in a dictionary or other well-known source, including dictionaries and thesauruses in languages other than English; works by classical or popular writers; or common words and phrases from sports, sayings, movies or television shows.
- Permutations on any of the above—for example, a dictionary word with letters replaced with digits (`r00t`) or with digits added to the end.
- Any machine-generated password. Algorithms reduce the search space of password-guessing programs and so must not be used.

Downloading Software Packages from Juniper Networks

You can download the Junos OS software package for your device from the Juniper Networks website.

Before you begin to download the software, ensure that you have a Juniper Networks Web account and a valid support contract. To obtain an account, complete the registration form at the Juniper Networks website: https://userregistration.juniper.net/.

To download software packages from Juniper Networks:

1. Using a Web browser, follow the links to the download URL on the Juniper Networks webpage.

   https://support.juniper.net/support/downloads/
2. Log in to the Juniper Networks authentication system using the username (generally your e-mail address) and password supplied by Juniper Networks representatives.
3. Download the software. See Downloading Software.

RELATED DOCUMENTATION

Installation and Upgrade Guide

Installing Software on a Device with Single Routing Engine

You can use this procedure to upgrade Junos OS on device with a single Routing Engine.

To install software upgrades on a device with a single Routing Engine:

1. Download the software package as described in "Downloading Software Packages from Juniper Networks" on page 20.
2. If you have not already done so, connect to the console port on the device from your management device, and log in to the Junos OS CLI.
3. (Optional) Back up the current software configuration to a second storage option. See the *Software Installation and Upgrade Guide* for instructions on performing this task.
4. (Optional) Copy the software package to the device. We recommend that you use FTP to copy the file to the **/var/tmp/** directory.

   This step is optional because Junos OS can also be upgraded when the software image is stored at a remote location. These instructions describe the software upgrade process for both scenarios.
5. Install the new package on the device:

   For RE-MX-104:

   ```
   user@host> request system software add <package>
   ```

   Replace ***package*** with one of the following paths:

   - For a software package in a local directory on the device, use **/var/tmp/*package*.tgz**.

   - For a software package on a remote server, use one of the following paths, replacing variable option *package* with the software package name.

     - **ftp://*hostname*/*pathname*/*package*.tgz**

     - **http://*hostname*/*pathname*/*package*.tgz**

6. Reboot the device to load the installation:

```
user@host> request system reboot
```

7. After the reboot has completed, log in and use the `show version` command to verify that the new version of the software is successfully installed.

```
user@host> show version
Hostname: hostname
Model: mx104
Junos: 19.1R3-S7.2
JUNOS Base OS boot [19.1R3-S7.2]
JUNOS Base OS Software Suite [19.1R3-S7.2]
JUNOS Crypto Software Suite [19.1R3-S7.2]
JUNOS Packet Forwarding Engine Support (TRIO) [19.1R3-S7.2]
JUNOS Web Management [19.1R3-S7.2]
JUNOS Online Documentation [19.1R3-S7.2]
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JUNOS py-base-powerpc [19.1R3-S7.2]
JUNOS py-extensions-powerpc [19.1R3-S7.2]
JUNOS jsd [powerpc-19.1R3-S7.2-jet-1]
JUNOS Kernel Software Suite [19.1R3-S7.2]
JUNOS Routing Software Suite [19.1R3-S7.2]
JUNOS Packet Forwarding Engine FIPS Support [19.1R3-S7.2]
JUNOS FIPS mode utilities [19.1R3-S7.2]
```

RELATED DOCUMENTATION

Software Installation and Upgrade Overview (Junos OS)

Understanding Zeroization to Clear System Data for FIPS Mode

IN THIS SECTION

Zeroization completely erases all configuration information on the Routing Engines, including all plain-text passwords, secrets, and private keys for SSH, local encryption, and local authentication.

Crypto Officer initiates the zeroization process by entering the `request system zeroize` operational command.

⚠ **CAUTION**: Perform system zeroization with care. After the zeroization process is complete, no data is left on the Routing Engine. The device is returned to the factory default state, without any configured users or configuration files.

Zeroization can be time-consuming. Although all configurations are removed in a few seconds, the zeroization process goes on to overwrite all media, which can take considerable time depending on the size of the media.

Why Zeroize?

Your device is not considered a valid FIPS cryptographic module until all critical security parameters (CSPs) have been entered—or reentered—while the device is in FIPS mode.

For FIPS 140-2 compliance, you must zeroize the system to remove sensitive information before disabling FIPS mode on the device.

When to Zeroize?

As Crypto Officer, perform zeroization in the following situations:

- **Before enabling FIPS mode of operation:** To prepare your device for operation as a FIPS cryptographic module, perform zeroization before enabling FIPS mode.
- **Before disabling FIPS mode of operation:** To begin repurposing your device for non-FIPS operation, perform zeroization before disabling FIPS mode on the device.

> **NOTE**: Juniper Networks does not support installing non-FIPS software in a FIPS environment, but doing so might be necessary in certain test environments. Be sure to zeroize the system first.

Zeroizing the System

To zeroize your device, follow the below procedure:

1. Login to the device as Crypto Officer and from CLI, enter

   For RE-MX-104:

```
crypto-officer@host> request system zeroize
warning: System will be rebooted and may not boot without configuration
Erase all data, including configuration and log files? [yes,no] (no) yes
```

2. To initiate the zeroization process, type **yes** at the prompt:

```
Erase all data, including configuration and log files?   [yes, no] (no) yes
warning: ipsec-key-management subsystem not running - not needed by configuration.
warning: zeroizing re0
Dec 16 05:05:03 init: ddos-service (PID 3123) te
Waiting (max 60 seconds) for system process `vnlru' to stop...rminate signal 1done
Waiting (max 60 seconds) for system process `vnlru_mem' to stop...5 sent
Dec 16 done
Waiting (max 60 seconds) for system process `bufdaemon' to stop...05:05:03 init: nfsd-service
(PID 3124) terminate signal 15 sent
Dec 16 05:05:03 init: commit-syncd (PID 3125) terminate signal 15 sent
Dec 16 05:05:03 init: pki-service (PID 3126) terminate signal 15 sent
Dec 16 05:05:03 init: mspd (PID 3127) terminate signal 15 sent
Dec 16 05:05:03 init: mountd-service (PID 3128) terminate signal 15 sent
Dec 16 05:05:03 init: subscriber-management-helper (PID 3129) terdone...
```

The entire operation can take considerable time depending on the size of the media, but all critical security parameters (CSPs) are removed within a few seconds. The physical environment must remain secure until the zeroization process is complete.

Enabling FIPS Mode

When Junos OS is installed on a router and the router is powered on, it is ready to be configured. Initially, you log in as the user root with no password. When you log in as root, your SSH connection is enabled by default.

As Crypto Officer, you must establish a root password conforming to the FIPS password requirements in "Understanding Password Specifications and Guidelines for Junos OS in FIPS Mode" on page 19. When you enable FIPS mode in Junos OS on the device, you cannot configure passwords unless they meet this standard.

Local passwords are encrypted with the secure hash algorithm SHA256 or SHA512. Password recovery is not possible in Junos OS in FIPS mode. Junos OS in FIPS mode cannot boot into single-user mode without the correct root password.

To enable FIPS mode in Junos OS on the device:

1. Zeroize the device to delete all CSPs before entering FIPS mode. Refer to "Understanding Zeroization to Clear System Data for FIPS Mode" on page 23 section for details.
2. After the device comes up in 'Amnesiac mode', login using username `root` and password `""` (blank).

```
FreeBSD/amd64 (Amnesiac) (ttyu0)
login: root

--- JUNOS 19.1R3-S7.2 Kernel 64-bit  JNPR-11.0-20190926.ca2fd68_buil
root@:~ #
```

3. Configure root authentication with password at least 10 characters or more.

```
root> edit
Entering configuration mode
```

```
[edit]
root# set system root-authentication plain-text-password
New password:
Retype new password:
[edit]
root# commit
commit complete
```

4. Load configuration onto device and commit new configuration.
5. Install `fips-mode` package needed for Routing Engine KATS.

```
root@hostname> request system software add jpfe-fips-powerpc-19.1R3-S7.2.tgz
Installing package '/var/tmp/jpfe-fips-powerpc-19.1R3-S7.2.tgz' ...
WARNING: jpfe-fips-powerpc-19.1R3-S7.2.tgz: not a signed package
Verified jpfe-fips-powerpc-19.1R3-S7.2 signed by PackageProductionECP256_2021 method
ECDSA256+SHA256
Mounted jpfe-fips package on /dev/md15...
Verified manifest signed by PackageProductionECP256_2021 method ECDSA256+SHA256
Verified jpfe-fips-powerpc-19.1R3-S7.2 signed by PackageProductionECP256_2021 method
ECDSA256+SHA256
Saving package file in /var/sw/pkg/jpfe-fips-19.1R3-S7.2.tgz ...
Saving state for rollback ...
```

6. Configure chassis boundary fips by setting `set system fips chassis level 1` and `commit`.
7. After deleting and reconfiguring CSPs, commit will go through and device needs reboot to enter FIPS mode.

```
[edit]
root@hostname# commit
Generating RSA key /etc/ssh/fips_ssh_host_key
Generating RSA2 key /etc/ssh/fips_ssh_host_rsa_key
Generating ECDSA key /etc/ssh/fips_ssh_host_ecdsa_key
[edit]
system
reboot is required to transition to FIPS level 1
commit complete
```

8. After rebooting the device, FIPS self-tests will run and device enters FIPS mode.

```
crypto-officer@hostname:fips>
```

RELATED DOCUMENTATION

Understanding Password Specifications and Guidelines for Junos OS in FIPS Mode | 19

Configuring Crypto Officer and FIPS User Identification and Access

IN THIS SECTION

Crypto Officer and FIPS users perform all configuration tasks for Junos OS in FIPS mode and issue all Junos OS in FIPS mode statements and commands. Crypto Officer and FIPS user configurations must follow Junos OS in FIPS mode guidelines.

Configuring Crypto Officer Access

Junos OS in FIPS mode offers a finer granularity of user permissions than those mandated by FIPS 140-2.

For FIPS 140-2 compliance, any FIPS user with the `secret`, `security`, `maintenance`, and `control` permission bits set is a Crypto Officer. In most cases the `super-user` class suffices for the Crypto Officer.

To configure login access for a Crypto Officer:

1. Log in to the device with the root password if you have not already done so, and enter configuration mode:

```
root@hostname> edit
Entering configuration mode
[edit]
root@hostname#
```

2. Name the user `crypto-officer` and assign the Crypto Officer a user ID (for example, `6400`, which must be a unique number associated with the login account in the range of 100 through 64000) and a class (for example, `super-user`). When you assign the class, you assign the permissions—for example, `secret`, `security`, `maintenance`, and `control`.

   For a list of permissions, see Understanding Junos OS Access Privilege Levels.

   ```
   [edit]
   root@hostname# set system login user username uid value class class-name
   ```

   For example:

   ```
   [edit]
   root@hostname# set system login user crypto-officer uid 6400 class super-user
   ```

3. Following the guidelines in "Understanding Password Specifications and Guidelines for Junos OS in FIPS Mode" on page 19, assign the Crypto Officer a plain-text password for login authentication. Set the password by typing a password after the prompts `New password` and `Retype new password`.

   ```
   [edit]
   root@hostname#  set system login user username class class-name authentication (plain-test-
   password | encrypted-password)
   ```

   For example:

   ```
   [edit]
   root@hostname#  set system login user crypto-officer class super-user authentication plain-
   text-password
   ```

4. Optionally, display the configuration:

   ```
   [edit]
   root@hostname#edit system
   [edit system]
   root@hostname#show
   login {
       user crypto-officer {
           uid 6400;
           authentication {
               encrypted-password "<cipher-text>"; ## SECRET-DATA
   ```

```
        }
        class super-user;
    }
}
```

5. If you are finished configuring the device, commit the configuration and exit:

```
[edit]
root@hostname# commit
commit complete
root@hostname# exit
```

Configuring FIPS User Login Access

A `fips-user` is defined as any FIPS user that does not have the `secret`, `security`, `maintenance`, and `control` permission bits set.

As the Crypto Officer you set up FIPS users. FIPS users cannot be granted permissions normally reserved for the Crypto Officer—for example, permission to zeroize the system.

To configure login access for a FIPS user:

1. Log in to the device with your Crypto Officer password if you have not already done so, and enter configuration mode:

```
crypto-officer@hostname:fips> edit
Entering configuration mode
[edit]
crypto-officer@hostname:fips#
```

2. Give the user, a username, and assign the user a user ID (for example, `6401`, which must be a unique number in the range of 1 through 64000) and a class. When you assign the class, you assign the permissions—for example, `clear`, `network`, `resetview`, and `view-configuration`.

```
[edit]
crypto-officer@hostname:fips# set system login user username uid value class class-name
```

For example:

```
[edit]
crypto-officer@hostname:fips# set system login user fips-user1 uid 6401 class read-only
```

3. Following the guidelines in "Understanding Password Specifications and Guidelines for Junos OS in FIPS Mode" on page 19, assign the FIPS user a plain-text password for login authentication. Set the password by typing a password after the prompts `New password` and `Retype new password`.

```
[edit]
crypto-officer@hostname:fips# set system login user username class class-name authentication
(plain-text-password | encrypted-password)
```

For example:

```
[edit]
crypto-officer@hostname:fips# set system login user fips-user1 class read-only authentication
plain-text-password
```

4. Optionally, display the configuration:

```
[edit]
crypto-officer@hostname:fips# edit system
[edit system]
crypto-officer@hostname:fips# show
login {
    user fips-user1 {
        uid 6401;
        authentication {
            encrypted-password "<cipher-text>"; ## SECRET-DATA
        }
        class read-only;
    }
}
```

5. If you are finished configuring the device, commit the configuration and exit:

```
[edit]
crypto-officer@hostname:fips# commit
crypto-officer@hostname:fips#  exit
```

RELATED DOCUMENTATION

Understanding Roles and Services for Junos OS | 13

4

CHAPTER

Configure SSH and Console Connection

Configure SSH on the Evaluated Configuration for FIPS

SSH through remote management interface allowed in the evaluated configuration. This topic describes how to configure SSH through remote management.

The following algorithms that needs to be configured to validate SSH for FIPS.

To configure SSH on the DUT:

1. Specify the permissible SSH host-key algorithms for the system services.

```
[edit]
user@host#set system services ssh hostkey-algorithm ssh-ecdsa
user@host#set system services ssh hostkey-algorithm no-ssh-dss
user@host#set system services ssh hostkey-algorithm ssh-rsa
```

2. Specify the SSH key-exchange for Diffie-Hellman keys for the system services.

```
[edit]
user@host#set system services ssh key-exchange ecdh-sha2-nistp256
user@host#set system services ssh key-exchange ecdh-sha2-nistp384
user@host#set system services ssh key-exchange ecdh-sha2-nistp521
```

3. Specify all the permissible message authentication code algorithms for SSHv2

```
[edit]
user@host#set system services ssh macs hmac-sha1
user@host#set system services ssh macs hmac-sha2-256
user@host#set system services ssh macs hmac-sha2-512
```

4. Specify the ciphers allowed for protocol version 2.

```
[edit]
user@host#set system services ssh ciphers aes128-cbc
user@host#set system services ssh ciphers aes256-cbc
user@host#set system services ssh ciphers aes128-ctr
user@host#set system services ssh ciphers aes256-ctr
```

```
user@host#set system services ssh ciphers aes192-cbc
user@host#set system services ssh ciphers aes192-ctr
```

Supported SSH hostkey algorithm:

```
ssh-ecdsa            Allow generation of ECDSA host-key
ssh-rsa              Allow generation of RSA host-key
```

Supported SSH key-exchange algorithm:

```
ecdh-sha2-nistp256   The EC Diffie-Hellman on nistp256 with SHA2-256
ecdh-sha2-nistp384   The EC Diffie-Hellman on nistp384 with SHA2-384
ecdh-sha2-nistp521   The EC Diffie-Hellman on nistp521 with SHA2-512
```

Supported MAC algorithm:

```
hmac-sha1            Hash-based MAC using Secure Hash Algorithm (SHA1)
hmac-sha2-256        Hash-based MAC using Secure Hash Algorithm (SHA2)
hmac-sha2-512        Hash-based MAC using Secure Hash Algorithm (SHA2)
```

Supported SSH ciphers algorithm:

```
aes128-cbc           128-bit AES with Cipher Block Chaining
aes128-ctr           128-bit AES with Counter Mode
aes192-cbc           192-bit AES with Cipher Block Chaining
aes192-ctr           192-bit AES with Counter Mode
aes256-cbc           256-bit AES with Cipher Block Chaining
aes256-ctr           256-bit AES with Counter Mode
3des-cbc             Triple Data Encryption Standard in Cipher Block Chaining
```

5

CHAPTER

Configure IPsec VPN

Configure IPsec VPN in FIPS mode

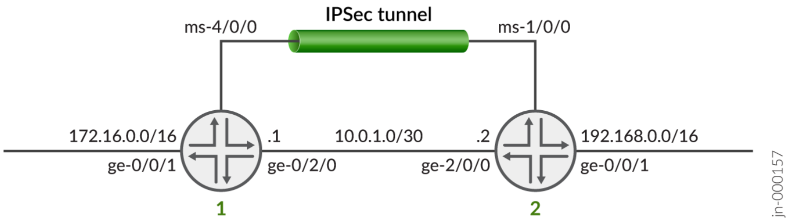
SUMMARY

This section provides configuration commands for configuring IPsec in FIPS mode.

IN THIS SECTION

IPsec tunnel provides device authentication, confidentiality, and integrity of information traversing a public or untrusted network. Figure 1 on page 36 shows the IPsec VPN tunnel topology.

Figure 1: IPsec VPN Tunnel Topology



Configure IPsec VPN Service on Router 1

In this section, you configure Router 1 running Junos OS for IPsec VPN.

1. Configure service set and VPN rules on Router 1.

```
[edit]
crypto-officer@hostname:fips# set services service-set ss1 next-hop-service inside-service-interface ms-4/0/0.1
crypto-officer@hostname:fips# set services service-set ss1 next-hop-service outside-service-interface ms-4/0/0.2
```

```
crypto-officer@hostname:fips# set services service-set ss1 ipsec-vpn-options local-gateway
10.0.1.1
crypto-officer@hostname:fips# set services service-set ss1 ipsec-vpn-rules rule1
crypto-officer@hostname:fips# set services ipsec-vpn rule rule1 term term1 from source-
address 172.16.0.0/16
crypto-officer@hostname:fips# set services ipsec-vpn rule rule1 term term1 from destination-
address 192.168.0.0/16
crypto-officer@hostname:fips# set services ipsec-vpn rule rule1 term term1 then remote-
gateway 10.0.1.2
crypto-officer@hostname:fips# set services ipsec-vpn rule rule1 term term1 then dynamic ike-
policy ike_policy1
crypto-officer@hostname:fips# set services ipsec-vpn rule rule1 term term1 then dynamic ipsec-
policy ipsec_policy1
crypto-officer@hostname:fips# set services ipsec-vpn rule rule1 term term1 then anti-replay-
window-size 4096
crypto-officer@hostname:fips# set services ipsec-vpn rule rule1 match-direction input
crypto-officer@hostname:fips# set services ipsec-vpn ipsec proposal ipsec_proposal1 protocol
esp
crypto-officer@hostname:fips# set services ipsec-vpn ipsec proposal ipsec_proposal1
authentication-algorithm hmac-sha-256-128
crypto-officer@hostname:fips# set services ipsec-vpn ipsec proposal ipsec_proposal1
encryption-algorithm aes-256-cbc
crypto-officer@hostname:fips# set services ipsec-vpn ipsec policy ipsec_policy1 perfect-
forward-secrecy keys group20
crypto-officer@hostname:fips# set services ipsec-vpn ipsec policy ipsec_policy1 proposals
ipsec_proposal1
crypto-officer@hostname:fips# set services ipsec-vpn ike proposal ike_proposal1
authentication-method pre-shared-keys
crypto-officer@hostname:fips# set services ipsec-vpn ike proposal ike_proposal1 dh-group
group20
crypto-officer@hostname:fips# set services ipsec-vpn ike proposal ike_proposal1
authentication-algorithm sha-256
crypto-officer@hostname:fips# set services ipsec-vpn ike proposal ike_proposal1 encryption-
algorithm aes-256-cbc
crypto-officer@hostname:fips# set services ipsec-vpn ike policy ike_policy1 version 2
crypto-officer@hostname:fips# set services ipsec-vpn ike policy ike_policy1 proposals
ike_proposal1
crypto-officer@hostname:fips# set services ipsec-vpn traceoptions file ipsec_1
crypto-officer@hostname:fips# set services ipsec-vpn traceoptions level all
crypto-officer@hostname:fips# set services ipsec-vpn traceoptions flag all
crypto-officer@hostname:fips# set services ipsec-vpn establish-tunnels immediately
crypto-officer@hostname:fips# prompt services ipsec-vpn ike policy ike_policy1 pre-shared-key
ascii-text
```

```
   New ascii-text (secret):
   Retype new ascii-text (secret):
```

NOTE: In FIPS mode, use prompt command for setting pre-shared-key. Type-in pre-shared-key in ASCII format when prompted for secret as below.

```
prompt services ipsec-vpn ike policy ike_policy1 pre-shared-key ascii-text


New ascii-text (secret): xxxxxxxxxxxx
Retype new ascii-text (secret): xxxxxxxxxxxx
```

2. Configure interfaces on Router 1.

```
[edit]
crypto-officer@hostname:fips# set interfaces ms-4/0/0 unit 0 family inet
crypto-officer@hostname:fips# set interfaces ms-4/0/0 unit 1 family inet
crypto-officer@hostname:fips# set iinterfaces ms-4/0/0 unit 1 service-domain inside
crypto-officer@hostname:fips# set interfaces ms-4/0/0 unit 2 family inet
crypto-officer@hostname:fips# set interfaces ms-4/0/0 unit 2 service-domain outside
crypto-officer@hostname:fips# set interfaces xe-0/2/0 unit 0 family inet address 10.0.1.1/30
crypto-officer@hostname:fips# set interfaces lo0 unit 0 family inet address 172.16.0.1/16
```

3. Configure routing options on Router 1.

```
[edit]
crypto-officer@hostname:fips# set routing-options static route 192.168.0.0/16 next-hop
ms-4/0/0.1
```

Configure IPsec VPN Service on Router 2

In this section, you configure Router 2 running Junos OS for IPsec VPN.

1. Configure service set and VPN rules on Router 2.

```
[edit]
crypto-officer@hostname:fips# set services service-set ss1 next-hop-service inside-service-
interface ms-1/0/0.1
crypto-officer@hostname:fips# set services service-set ss1 next-hop-service outside-service-
interface ms-1/0/0.2
crypto-officer@hostname:fips# set services service-set ss1 ipsec-vpn-options local-gateway
10.0.1.2
crypto-officer@hostname:fips# set services service-set ss1 ipsec-vpn-rules rule1
crypto-officer@hostname:fips# set services ipsec-vpn rule rule1 term term1 from source-
address 192.168.0.0/16
crypto-officer@hostname:fips# set services ipsec-vpn rule rule1 term term1 from destination-
address 172.16.0.0/16
crypto-officer@hostname:fips# set services ipsec-vpn rule rule1 term term1 then remote-
gateway 10.0.1.1
crypto-officer@hostname:fips# set services ipsec-vpn rule rule1 term term1 then dynamic ike-
policy ike_policy1
crypto-officer@hostname:fips# set services ipsec-vpn rule rule1 term term1 then dynamic ipsec-
policy ipsec_policy1
crypto-officer@hostname:fips# set services ipsec-vpn rule rule1 term term1 then anti-replay-
window-size 4096
crypto-officer@hostname:fips# set services ipsec-vpn rule rule1 match-direction input
crypto-officer@hostname:fips# set services ipsec-vpn ipsec proposal ipsec_proposal1 protocol
esp
crypto-officer@hostname:fips# set services ipsec-vpn ipsec proposal ipsec_proposal1
authentication-algorithm hmac-sha-256-128
crypto-officer@hostname:fips# set services ipsec-vpn ipsec proposal ipsec_proposal1
encryption-algorithm aes-256-cbc
crypto-officer@hostname:fips# set services ipsec-vpn ipsec policy ipsec_policy1 perfect-
forward-secrecy keys group20
crypto-officer@hostname:fips# set services ipsec-vpn ipsec policy ipsec_policy1 proposals
ipsec_proposal1
crypto-officer@hostname:fips# set services ipsec-vpn ike proposal ike_proposal1
authentication-method pre-shared-keys
crypto-officer@hostname:fips# set services ipsec-vpn ike proposal ike_proposal1 dh-group
group20
crypto-officer@hostname:fips# set services ipsec-vpn ike proposal ike_proposal1
authentication-algorithm sha-256
crypto-officer@hostname:fips# set services ipsec-vpn ike proposal ike_proposal1 encryption-
algorithm aes-256-cbc
crypto-officer@hostname:fips# set services ipsec-vpn ike policy ike_policy1 version 2
```

```
crypto-officer@hostname:fips# set services ipsec-vpn ike policy ike_policy1 proposals
ike_proposal1
crypto-officer@hostname:fips# set services ipsec-vpn traceoptions file ipsec_1
crypto-officer@hostname:fips# set services ipsec-vpn traceoptions level all
crypto-officer@hostname:fips# set services ipsec-vpn traceoptions flag all
crypto-officer@hostname:fips# set services ipsec-vpn establish-tunnels immediately
crypto-officer@hostname:fips# prompt services ipsec-vpn ike policy ike_policy1 pre-shared-key
ascii-text

     New ascii-text (secret):
     Retype new ascii-text (secret):
```

2. Configure interfaces on Router 2.

```
[edit]
crypto-officer@hostname:fips# set interfaces ms-1/0/0 unit 0 family inet
crypto-officer@hostname:fips# set interfaces ms-1/0/0 unit 1 family inet
crypto-officer@hostname:fips# set interfaces ms-1/0/0 unit 1 service-domain inside
crypto-officer@hostname:fips# set interfaces ms-1/0/0 unit 2 family inet
crypto-officer@hostname:fips# set interfaces ms-1/0/0 unit 2 service-domain outside
crypto-officer@hostname:fips# set interfaces ge-2/0/0 unit 0 family inet address 10.0.1.2/30
crypto-officer@hostname:fips# set interfaces lo0 unit 0 family inet address 192.168.0.1/16
```

3. Configure routing options on Router 2.

```
[edit]
crypto-officer@hostname:fips# set routing-options static route 172.16.0.0/16 next-hop
ms-1/0/0.1
```

Verification

IN THIS SECTION

Confirm that the configuration is working properly.

Purpose

Verify that IPsec VPN tunnel is created.

Action

crypto-officer@hostname:fips> **show services ipsec-vpn ike security-associations detail**

```
IKE peer 10.0.1.2
  Role: Initiator, State: Matured
  Initiator cookie: 5d73349e49090ae8, Responder cookie: 40f88e192c6538e1
  Exchange type: IKEv2, Authentication method: Pre-shared-keys
  Local: 10.0.1.1, Remote: 10.0.1.2
  Lifetime: Expires in 3578 seconds
   Algorithms:
   Authentication : hmac-sha256-128
   Encryption : aes256-cbc
   Pseudo random function: hmac-sha256
   Diffie-Hellman group : 20
  Traffic statistics:
   Input bytes : 496
   Output bytes : 496
   Input packets: 2
   Output packets: 2
 Flags: IKE SA created
 IPSec security associations: 2 created, 0 deleted
```

crypto-officer@hostname:fips> **show services ipsec-vpn ipsec security-associations detail**

```
Service set: ss1, IKE Routing-instance: default
  Rule: rule1, Term: term1, Tunnel index: 1
  Local gateway: 10.0.1.1, Remote gateway: 10.0.1.2
  IPSec inside interface: ms-4/0/0.1, Tunnel MTU: 1500
```

```
UDP encapsulate: Disabled, UDP Destination port: 0
Local identity: ipv4_subnet(any:0,[0..7]=172.16.0.0/16)
Remote identity: ipv4_subnet(any:0,[0..7]=192.168.0.0/16)
NATT Detection: Not Detected, NATT keepalive interval: 0

 Direction: inbound, SPI: 3546616983, AUX-SPI: 0
 Mode: tunnel, Type: dynamic, State: Installed
 Protocol: ESP, Authentication: hmac-sha-256-128, Encryption: aes-cbc (256 bits)
 Soft lifetime: Expires in 27960 seconds
 Hard lifetime: Expires in 28766 seconds
 Anti-replay service: Enabled, Replay window size: 4096
 Copy ToS: Enabled
 Copy TTL: Disabled, TTL value: 64

 Direction: outbound, SPI: 4136721180, AUX-SPI: 0
 Mode: tunnel, Type: dynamic, State: Installed
 Protocol: ESP, Authentication: hmac-sha-256-128, Encryption: aes-cbc (256 bits)

 Soft lifetime: Expires in 27960 seconds
 Hard lifetime: Expires in 28766 seconds
 Anti-replay service: Enabled, Replay window size: 4096
 Copy ToS: Enabled
 Copy TTL: Disabled, TTL value: 64
```

6

CHAPTER

Configure Event Logging

Event Logging Overview

The evaluated configuration requires the auditing of configuration changes through the system log.

In addition, Junos OS can:

- Send automated responses to audit events (syslog entry creation).
- Allow authorized managers to examine audit logs.
- Send audit files to external servers.
- Allow authorized managers to return the system to a known state.

The logging for the evaluated configuration must capture the following events:

- Changes to secret key data in the configuration.
- Committed changes.
- Login/logout of users.
- System startup.
- Failure to establish an SSH session.
- Establishment/termination of an SSH session.
- Changes to the (system) time.
- Termination of a remote session by the session locking mechanism.
- Termination of an interactive session.

In addition, Juniper Networks recommends that logging also:

- Capture all changes to the configuration.
- Store logging information remotely.

Configure Event Logging to a Local File

You can configure storing of audit information to a local file with the `syslog` statement. This example stores logs in a file named **Audit-File**:

```
[edit system]
syslog {
    file Audit-File;
}
```

Interpret Event Messages

The following output shows a sample event message.

```
Feb 27 02:33:04  bm-a mgd[6520]: UI_LOGIN_EVENT: User 'security-officer' login, class 'j-super-
user' [6520], ssh-connection '', client-mode 'cli'
Feb 27 02:33:49  bm-a mgd[6520]: UI_DBASE_LOGIN_EVENT: User 'security-officer' entering
configuration mode
Feb 27 02:38:29  bm-a mgd[6520]: UI_CMDLINE_READ_LINE: User 'security-officer', command 'run
show log Audit_log | grep LOGIN
```

Table 2 on page 46 describes the fields for an event message. If the system logging utility cannot determine the value in a particular field, a hyphen (-) appears instead.

Table 2: Fields in Event Messages

Field	Description	Examples

timestamp	Time when the message was generated, in one of two representations:
	• *MMM-DD HH:MM:SS.MS+/-HH:MM*, is the month, day, hour, minute, second and millisecond in local time. The hour and minute that follows the plus sign (+) or minus sign (-) is the offset of the local time zone from Coordinated Universal Time (UTC).
	• *YYYY-MM-DDTHH:MM:SS.MSZ* is the year, month, day, hour, minute, second and millisecond in UTC.
		`Feb 27 02:33:04 is the timestamp expressed as local time in the United States.`
		`2012-02-27T09:17:15.719Z is  2:33 AM UTC on 27 Feb 2012.`

hostname	Name of the host that originally generated the message.	`router1`
process	Name of the Junos OS process that generated the message.	`mgd`
processID	UNIX process ID (PID) of the Junos OS process that generated the message.	`4153`
TAG	Junos OS system log message tag, which uniquely identifies the message.	`UI_DBASE_LOGOUT_EVENT`
username	Username of the user initiating the event.	`“admin”`
message-text	English-language description of the event .	`set: [system radius-server 1.2.3.4 secret]`

Log Changes to Secret Data

The following are examples of audit logs of events that change the secret data. Whenever there is a change in the configuration example, the syslog event should capture the below logs:

```
Jul 24 17:43:28  router1 mgd[4163]: UI_CFG_AUDIT_SET_SECRET: User 'admin' set: [system radius-
server 1.2.3.4 secret]
Jul 24 17:43:28  router1 mgd[4163]: UI_CFG_AUDIT_SET_SECRET: User 'admin' set: [system login
user admin authentication encrypted-password]
Jul 24 17:43:28  router1 mgd[4163]: UI_CFG_AUDIT_SET_SECRET: User 'admin' set: [system login
user admin2 authentication encrypted-password]
```

Everytime a configuration is updated or changed, the syslog should capture these logs:

```
Jul 24 18:29:09  router1 mgd[4163]: UI_CFG_AUDIT_SET_SECRET: User 'admin' replace: [system
radius-server 1.2.3.4 secret]
Jul 24 18:29:09  router1 mgd[4163]: UI_CFG_AUDIT_SET_SECRET: User 'admin' replace: [system login
user admin authentication encrypted-password]
Jul 24 18:29:09  router1 mgd[4163]: UI_CFG_AUDIT_SET_SECRET: User 'admin' replace: [system login
user admin authentication encrypted-password]
```

Login and Logout Events Using SSH

System log messages are generated whenever a user successfully or unsuccessfully attempts SSH access. Logout events are also recorded. For example, the following logs are the result of two failed authentication attempts, then a successful one, and finally a logout:

```
Dec 20 23:17:35  bilbo sshd[16645]: Failed password for op from 172.17.58.45 port 1673 ssh2
Dec 20 23:17:42  bilbo sshd[16645]: Failed password for op from 172.17.58.45 port 1673 ssh2
Dec 20 23:17:53  bilbo sshd[16645]: Accepted password for op from 172.17.58.45 port 1673 ssh2
Dec 20 23:17:53  bilbo mgd[16648]: UI_AUTH_EVENT: Authenticated user 'op' at permission level
                                   'j-operator'
Dec 20 23:17:53  bilbo mgd[16648]: UI_LOGIN_EVENT: User 'op' login, class 'j-operator' [16648]
Dec 20 23:17:56  bilbo mgd[16648]: UI_CMDLINE_READ_LINE: User 'op', command 'quit '
Dec 20 23:17:56  bilbo mgd[16648]: UI_LOGOUT_EVENT: User 'op' logout
```

Logging of Audit Startup

The audit information logged includes startups of Junos OS. This in turn identifies the startup events of the audit system, which cannot be independently disabled or enabled. For example, if Junos OS is restarted, the audit log contains the following information:

```
Dec 20 23:17:35  bilbo syslogd: exiting on signal 14
Dec 20 23:17:35  bilbo syslogd: restart
Dec 20 23:17:35  bilbo syslogd /kernel: Dec 20 23:17:35 init: syslogd (PID 19128) exited with
status=1
Dec 20 23:17:42  bilbo /kernel:
Dec 20 23:17:53  init: syslogd (PID 19200) started
```

7

CHAPTER

Perform Self-Tests on a Device

Understanding FIPS Self-Tests

The cryptographic module enforces security rules to ensure that the Juniper Networks Junos operating system (Junos OS) in FIPS mode meets the security requirements of FIPS 140-2 Level 1. To validate the output of cryptographic algorithms approved for FIPS and test the integrity of some system modules, the device performs the following series of known answer test (KAT) self-tests:

- `kernel_kats`—KAT for kernel cryptographic routines
- `md_kats`—KAT for libmd and libc
- `openssl_kats`—KAT for OpenSSL cryptographic implementation
- `quicksec_kats`—KAT for QuickSec Toolkit cryptographic implementation
- `XLP`—A crypto library (XLP) executes on the MS-MIC and provide cryptographic services for IPsec.

The KAT self-tests are performed automatically at startup. Conditional self-tests are also performed automatically to verify digitally signed software packages, generated random numbers, RSA and ECDSA key pairs, and manually entered keys.

If the KATs are completed successfully, the system log (syslog) file is updated to display the tests that were executed.

If one of the KATs fail, the device panics and reboot continuously. The device can be recovered using USB install.

The `file show /var/log/messages` command displays the system log.

Example: Configure FIPS Self-Tests

IN THIS SECTION

This example shows how to configure FIPS self-tests to run periodically.

Hardware and Software Requirements

- You must have administrative privileges to configure FIPS self-tests.
- The device must be running the evaluated version of Junos OS in FIPS mode software.

Overview

The FIPS self-test consists of the following suites of known answer tests (KATs):

- `kernel_kats`—KAT for kernel cryptographic routines
- `md_kats`—KAT for libmd and libc
- `openssl_kats`—KAT for OpenSSL cryptographic implementation
- `quicksec_kats`—KAT for QuickSec Toolkit cryptographic implementation
- `XLP`—A crypto library (XLP) executes on the MS-MIC and provide cryptographic services for IPsec.

In this example, the FIPS self-test is executed at 9:00 AM in New York City, USA, every Wednesday.

NOTE: Instead of weekly tests, you can configure monthly tests by including the `month` and `day-of-month` statements.

When a KAT self-test fails, a log message is written to the system log messages file with details of the test failure. Then the system panics and reboots.

Configuration

IN THIS SECTION

CLI Quick Configuration

To quickly configure this example, copy the following commands into a text file, remove any line breaks, and then paste the commands into the CLI at the `[edit]` hierarchy level.

```
set system fips self-test periodic start-time 09:00
set system fips self-test periodic day-of-week 3
```

Procedure

Step-by-Step Procedure

To configure the FIPS self-test:

1. Configure the FIPS self-test to execute at 9:00 AM every Wednesday.

   ```
   [edit system fips self-test]
   user@host# set periodic start-time 09:00
   user@host# set periodic day-of-week 3
   ```

2. If you are done configuring the device, commit the configuration.

   ```
   [edit system fips self-test]
   user@host# commit
   ```

Results

From configuration mode, confirm your configuration by issuing the `show system` command. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@host# show system
fips {
    self-test {
        periodic {
            start-time "09:00";
            day-of-week 3;
        }
    }
}
```

Verification

Confirm that the configuration is working properly.

Purpose

Verify that the FIPS self-test is enabled.

Action

Run the FIPS self-test manually by issuing the `request system fips self-test` command.

After issuing the `request system fips self-test` command, the system log file is updated to display the KATs that are executed. To view the system log file, issue the `file show /var/log/messages` command.

`user@host>` **file show /var/log/messages**

```
mgd: Running FIPS Self-tests
mgd: Testing kernel KATS:
mgd:   NIST 800-90 HMAC DRBG Known Answer Test:         Passed
mgd:   DES3-CBC Known Answer Test:                      Passed
mgd:   HMAC-SHA1 Known Answer Test:                     Passed
mgd:   HMAC-SHA2-256 Known Answer Test:                 Passed
mgd:   SHA-2-384 Known Answer Test:                     Passed
mgd:   SHA-2-512 Known Answer Test:                     Passed
```

```
mgd:   AES128-CMAC Known Answer Test:                   Passed
mgd:   AES-CBC Known Answer Test:                       Passed
mgd: Testing MACSec KATS:
mgd:   AES128-CMAC Known Answer Test:                   Passed
mgd:   AES256-CMAC Known Answer Test:                   Passed
mgd:   AES-ECB Known Answer Test:                       Passed
mgd:   AES-KEYWRAP Known Answer Test:                   Passed
mgd: Testing libmd KATS:
mgd:   HMAC-SHA1 Known Answer Test:                     Passed
mgd:   HMAC-SHA2-256 Known Answer Test:                 Passed
mgd:   SHA-2-512 Known Answer Test:                     Passed
mgd: Testing OpenSSL KATS:
mgd:   NIST 800-90 HMAC DRBG Known Answer Test:         Passed
mgd:   FIPS ECDSA Known Answer Test:                    Passed
mgd:   FIPS ECDH Known Answer Test:                     Passed
mgd:   FIPS RSA Known Answer Test:                      Passed
mgd:   DES3-CBC Known Answer Test:                      Passed
mgd:   HMAC-SHA1 Known Answer Test:                     Passed
mgd:   HMAC-SHA2-224 Known Answer Test:                 Passed
mgd:   HMAC-SHA2-256 Known Answer Test:                 Passed
mgd:   HMAC-SHA2-384 Known Answer Test:                 Passed
mgd:   HMAC-SHA2-512 Known Answer Test:                 Passed
mgd:   AES-CBC Known Answer Test:                       Passed
mgd:   AES-GCM Known Answer Test:                       Passed
mgd:   ECDSA-SIGN Known Answer Test:                    Passed
mgd:   KDF-IKE-V1 Known Answer Test:                    Passed
mgd:   KDF-SSH-SHA256 Known Answer Test:                Passed
mgd:   KAS-ECC-EPHEM-UNIFIED-NOKC Known Answer Test:    Passed
mgd:   KAS-FFC-EPHEM-NOKC Known Answer Test:            Passed
mgd: Testing QuickSec 7.0 KATS:
mgd:   NIST 800-90 HMAC DRBG Known Answer Test:         Passed
mgd:   DES3-CBC Known Answer Test:                      Passed
mgd:   HMAC-SHA1 Known Answer Test:                     Passed
mgd:   HMAC-SHA2-224 Known Answer Test:                 Passed
mgd:   HMAC-SHA2-256 Known Answer Test:                 Passed
mgd:   HMAC-SHA2-384 Known Answer Test:                 Passed
mgd:   HMAC-SHA2-512 Known Answer Test:                 Passed
mgd:   AES-CBC Known Answer Test:                       Passed
mgd:   AES-GCM Known Answer Test:                       Passed
mgd:   SSH-RSA-ENC Known Answer Test:                   Passed
mgd:   SSH-RSA-veriexec: no fingerprint for file='/sbin/kats/cannot-exec' fsid=87 fileid=51404
gen=1 uid=0 pid=1363
SIGN Known Answer Test:                  Passed
```

```
mgd:   SSH-ECDSA-SIGN Known Answer Test:                Passed
mgd:   KDF-IKE-V1 Known Answer Test:                    Passed
mgd:   KDF-IKE-V2 Known Answer Test:                    Passed
mgd: Testing QuickSec KATS:
mgd:   NIST 800-90 HMAC DRBG Known Answer Test:         Passed
mgd:   DES3-CBC Known Answer Test:                      Passed
mgd:   HMAC-SHA1 Known Answer Test:                     Passed
mgd:   HMAC-SHA2-224 Known Answer Test:                 Passed
mgd:   HMAC-SHA2-256 Known Answer Test:                 Passed
mgd:   HMAC-SHA2-384 Known Answer Test:                 Passed
mgd:   HMAC-SHA2-512 Known Answer Test:                 Passed
mgd:   AES-CBC Known Answer Test:                       Passed
mgd:   AES-GCM Known Answer Test:                       Passed
mgd:   SSH-RSA-ENC Known Answer Test:                   Passed
mgd:   SSH-RSA-SIGN Known Answer Test:                  Passed
mgd:   KDF-IKE-V1 Known Answer Test:                    Passed
mgd:   KDF-IKE-V2 Known Answer Test:                    Passed
mgd: Testing SSH IPsec KATS:
mgd:   NIST 800-90 HMAC DRBG Known Answer Test:         Passed
mgd:   DES3-CBC Known Answer Test:                      Passed
mgd:   HMAC-SHA1 Known Answer Test:                     Passed
mgd:   HMAC-SHA2-256 Known Answer Test:                 Passed
mgd:   AES-CBC Known Answer Test:                       Passed
mgd:   SSH-RSA-ENC Known Answer Test:                   Passed
mgd:   SSH-RSA-SIGN Known Answer Test:                  Passed
mgd:   KDF-IKE-V1 Known Answer Test:                    Passed
mgd: Testing file integrity:
mgd:   File integrity Known Answer Test:                Passed
mgd: Testing crypto integrity:
mgd:   Crypto integrity Known Answer Test:              Passed
mgd: Expect an exec Authentication error...
mgd: /sbin/kats/run-tests: /sbin/kats/cannot-exec: Authentication error
mgd: FIPS Self-tests Passed
```

8

CHAPTER

Operational Commands

request system zeroize

IN THIS SECTION

Syntax

```
request system zeroize
```

Description

Remove all configuration information on the Routing Engines hypervisor and reset all key values. The command removes all data files, including customized configuration and log files, by unlinking the files from their directories. The command removes all user-created files from the system including all plain-text passwords, secrets, and private keys for SSH, local encryption, and local authentication and IPsec.

This command reboots the device and sets it to the factory default configuration. After the reboot, you cannot access the device through the management Ethernet interface. Log in through the console as root and start the Junos OS CLI by typing cli at the prompt.

Required Privilege Level

maintenance

Sample Output

request system zeroize

```
root@device: fips> request system zeroize
warning: System will be rebooted and may not boot without configuration
Erase all data, including configuration and log files? [yes,no] (no) yes
warning: zeroizing re0
Jul 27 22:25:53 jlaunchd: gkd-re (PID 5264) terminate signal 15 sent
Jul 27 22:25:53 jlaunchd: inet-process (PID 5267) terminate signal 15 sent
Jul 27 22:25:53 jlaunchd: periodic-packet-services (PID 5271) terminate signal 15
sent
Jul 27 22:25:53 jlaunchd: disk-monitoring (PID 5273) terminate signal 15 sent
Jul 27 22:25:53 jlaunchd: neighbor-liveness (PID 5307) terminate signal 15 sent
Jul 27 22:25:53 jlaunchd: event-processing (PID 5209) terminate signal 15 sent
Jul 27 22:25:53 jlaunchd: clksyncd-service (PID 5316) terminate signal 15 sent
Jul 27 22:25:53 jlaunchd: ethernet-link-fault-management (PID 5321) terminate
signal 15 sent
Jul 27 22:25:53 jlaunchd: subscriber-management (PID 5323) terminate signal 15
sent
Jul 27 22:25:53 jlaunchd: shm-rtsdbd (PID 5325) terminate signal 15 sent
Jul 27 22:25:53 jlaunchd: gstatd (PID 5326) terminate signal 15 sent
Jul 27 22:25:53 jlaunchd: rpcbind-service (PID 5330) terminate signal 15 sent
Jul 27 22:25:53 jlaunchd: icmd (PID 5332) terminate signal 15 sent
Jul 27 22:25:53 jlaunchd: pmcd (PID 5333) terminate signal 15 sent
Jul 27 22:25:53 jlaunchd: ftp-inet-process (PID 5334) terminate signal 15 sent
Jul 27 22:25:53 jlaunchd: process-monitor (PID 5338) terminate signal 15 sent
Jul 27 22:25:53 jlaunchd: smg-service-telemetry (PID 5340) terminate signal 15
sent
Jul 27 22:25:53 jlaunchd: application-identification (PID 5341) terminate signal
15 sent
Jul 27 22:25:53 jlaunchd: resource-management (PID 5342) terminate signal 15 sent
Jul 27 22:25:53 jlaunchd: charged (PID 5346) terminate signal 15 sent
Jul 27 22:25:53 jlaunchd: license-service (PID 5351) terminate signal 15 sent
Jul 27 22:25:53 jlaunchd: ntp (PID 6120) terminate signal 15 sent
Jul 27 22:25:53 jlaunchd: gkd-chassis (PID 6121) terminate signal 15 sent
Jul 27 22:25:53 jlaunchd: gkd-lchassis
........
```

Release Information

Command introduced in Junos OS Release 12.2.