

# JUNOS-FIPS 9.3 OS Cryptographic Module

## Security Policy

### For the RE-850-1536 with the M7i and M10i Routers

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## 1. Module Overview

The JUNOS-FIPS 9.3 OS Cryptographic Module executes on a multiple-chip embedded routing engine with Juniper Networks M Series routers; M7i and M10i. The validated version of JUNOS-FIPS 9.3 OS is 9.3R2.8; the image is `junos-juniper-9.3R2.8-fips.tgz`. See Table 1 below for hardware platform specifics. JUNOS-FIPS 9.3 OS is a release of the JUNOS operating system, the first routing operating system designed specifically for the Internet. JUNOS Software is currently deployed in the largest and fastest-growing networks worldwide. A full suite of industrial-strength routing protocols, a flexible policy language, and a leading MPLS implementation efficiently scale to large numbers of network interfaces and routes.

JUNOS-FIPS 9.3 OS meets the requirements of the FIPS Publication 140-2. JUNOS-FIPS 9.3 OS is a firmware-only module designed to operate on Routing Engine (RE) hardware, which is equivalent to PC hardware. The cryptographic module's operational environment is a limited operational environment. The module's cryptographic boundary is the firmware installed on the RE-850-1536 card. The firmware module was tested on the following hardware:

Table 1. JUNOS-FIPS 9.3 OS Series/Platform/RE

Series	Platform	Routing Engine
<b>M Series</b>	M7i	RE-850-1536 - 850MHz processor with 1.5GB of memory
	M10i	RE-850-1536 - 850MHz processor with 1.5GB of memory

Figure 1. Diagram of the Cryptographic Module

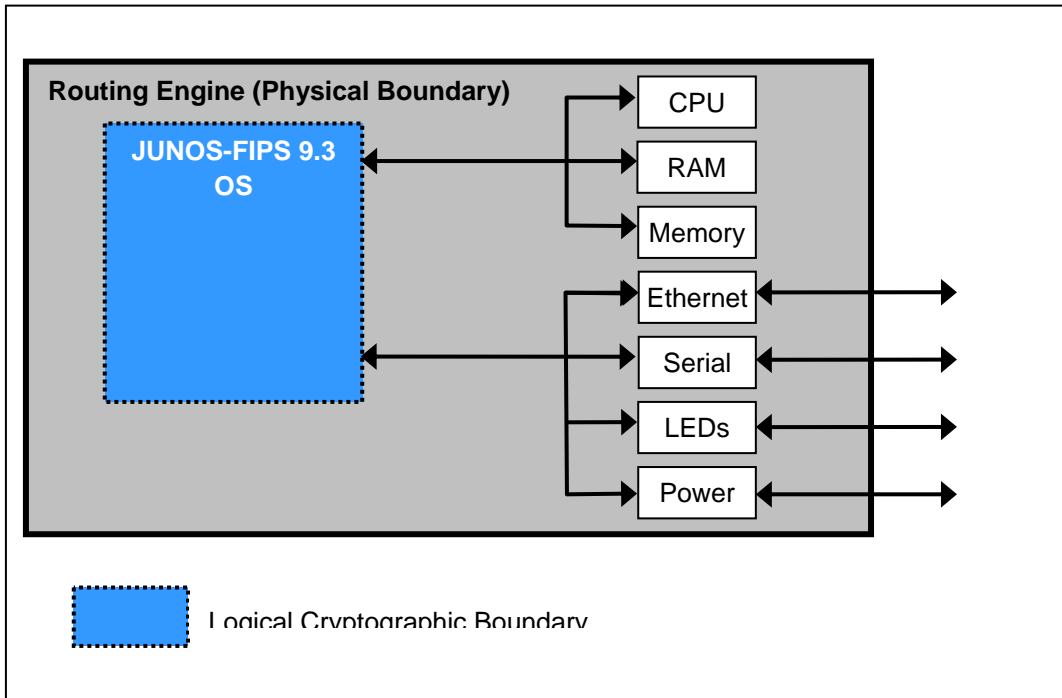
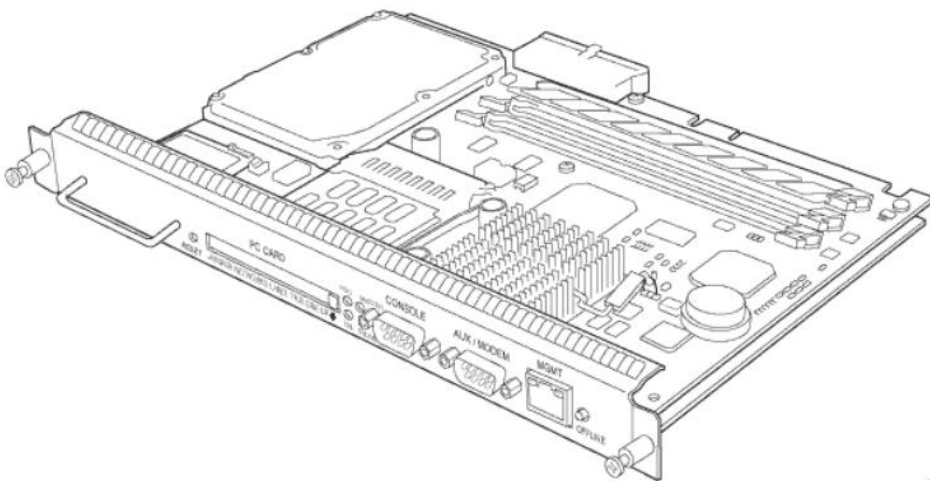


Figure 2 Image of RE-850-1536



## 2. Security Level

The cryptographic module, which is a multiple-chip embedded embodiment, meets the overall requirements applicable to Level 1 security of FIPS 140-2.

Table 2. Security Level

Security Requirements Section	Level
<b>Cryptographic Module Specification</b>	1
<b>Module Ports and Interfaces</b>	1
<b>Roles, Services and Authentication</b>	2
<b>Finite State Model</b>	1
<b>Physical Security</b>	1
<b>Operational Environment</b>	N/A
<b>Cryptographic Key Management</b>	1
<b>EMI/EMC</b>	1
<b>Self-Tests</b>	1
<b>Design Assurance</b>	3
<b>Mitigation of Other Attacks</b>	N/A

## 3. Modes of Operation

### Approved Mode of Operation

The cryptographic module supports FIPS-Approved algorithms as follows:

- AES 128, 192, 256 for encryption/decryption
- ECDSA with Curve P-192 for digital signature generation and verification
- DSA with 1024-bit keys for digital signature generation and verification
- RSA with 1024 or 2048-bit keys for digital signature generation and verification
- Triple-DES (three key) for encryption/decryption
- SHA-1 for hashing
- SHA-2 for hashing (SHA-224, SHA-256, SHA-384, SHA-512)
- HMAC-SHA-1
- HMAC-SHA-256
- AES-128-CMAC
- FIPS 186-2 RNG (with Change Notice)

The cryptographic module also supports the following non-Approved algorithms:

- RSA with 1024-bit keys (key wrapping; key establishment methodology provides 80 bits of encryption strength)
- MD5 for hashing (used during authentication)
- Diffie-Hellman with 1024-bit keys (key agreement; key establishment methodology provides 80 bits of encryption strength)
- Non-Approved RNG (used to seed Approved FIPS 186-2 RNG)

The cryptographic module supports the commercially available TLS, IKEv1, and SSH protocols for key establishment in accordance with FIPS 140-2 Annex D.

The cryptographic module relies on the implemented deterministic random number generator (RNG) that is compliant with FIPS 186-2 for generation of all cryptographic keys in accordance with FIPS 140-2 Annex C.

### Non-FIPS Mode of Operation

The cryptographic module does not provide a non-Approved mode of operation.

## 4. Ports and Interfaces

The cryptographic module supports the following physical ports and corresponding logical interfaces:

- **Ethernet:** Data Input, Data Output, Control Input, Status Outputs
- **Serial:** Data Input, Data Output, Control Input, Status Outputs
- **Power interface:** Power Input
- **LEDs:** Status Output

The flow of input and output of data, control, and status is managed by the cryptographic module's defined service interfaces. These physical interfaces are mapped to the logical interfaces which include SSH, TLS (Ethernet) and Console (Serial). The physical cryptographic boundary additionally supports a PC card slot. This port is not supported for use by the logical cryptographic module boundary.

## 5. Identification and Authentication Policy

### Assumption of Roles

The cryptographic module supports six distinct operator roles as follows:

- User
- Cryptographic Officer (CO)
- AS2-FIPS PIC
- RE-to-RE
- IKE Peer
- Protocol Peer

The cryptographic module shall enforce the separation of roles using either identity-based or role-based operator authentication; the cryptographic module meets Level 2 requirements because identity-based authentication is not enforced for all authorized services.

Table 3. Roles and Required Identification and Authentication

Role	Type of Authentication	Authentication Data
<b>User</b>	Identity-based operator authentication	<ul style="list-style-type: none"> <li>• Via Console: Username and password</li> <li>• Via TLS: Username and password</li> <li>• Via SSH: Password or RSA signature verification or DSA signature verification</li> </ul>
	Role-based authentication	<ul style="list-style-type: none"> <li>• Via RADIUS or TACACS+: pre-shared secret, minimum 10 characters</li> </ul>
<b>Cryptographic Officer</b>	Identity-based operator authentication	<ul style="list-style-type: none"> <li>• Via Console: Username and password</li> <li>• Via TLS: Username and password</li> <li>• Via SSH: Password or RSA signature verification or DSA signature verification</li> </ul>
	Role-based authentication	<ul style="list-style-type: none"> <li>• Via RADIUS or TACACS+: pre-shared secret, minimum 10 characters</li> </ul>
<b>AS2-FIPS PIC</b>	Identity-based operator authentication	Serial Number (6 bytes) and password (32 bytes)
<b>RE-to-RE</b>	Identity-based operator authentication	<p>Pre-shared keys</p> <p>The RE role will use pre-shared keys for secure communication.</p>
<b>IKE Peer</b>	Identity-based operator authentication	<p>IKE pre-shared keys</p> <p>Uses IKE to establish keys to be used by the PIC for IPsec communication with IPsec clients.</p>
<b>Protocol Peer</b>	Role-based authentication	<p>Will use pre-shared keys to send encrypted traffic. Uses TCP/UDP MD5 MAC only to authenticate operator.</p> <p>Alternatively, a manually configured IPsec SA can be used for authentication.</p>



Table 4. Strengths of Authentication Mechanisms

Authentication Mechanism	Strength of Mechanism
<b>Username and password</b>	<p>The module enforces 10-character passwords (at minimum) chosen from the 96+ human readable ASCII characters.</p> <p>The module enforces a timed access mechanism as follows: For the first two failed attempts (assuming 0 time to process), no timed access is enforced. Upon the third attempt, the module enforces a 5-second delay. Each failed attempt thereafter results in an additional 5-second delay above the previous (e.g. 4<sup>th</sup> failed attempt = 10-second delay, 5<sup>th</sup> failed attempt = 15-second delay, 6<sup>th</sup> failed attempt = 20-second delay, 7<sup>th</sup> failed attempt = 25-second delay).</p> <p>This leads to a maximum of 7 possible attempts in a one-minute period for each getty. The best approach for the attacker would be to disconnect after 4 failed attempts, and wait for a new getty to be spawned. This would allow the attacker to perform roughly 9.6 attempts per minute (576 attempts per hour/60 mins); this would be rounded down to 9 per minute, because there is no such thing as 0.6 attempts. Thus the probability of a successful random attempt is <math>1/96^{10}</math>, which is less than 1/1 million. The probability of a success with multiple consecutive attempts in a one-minute period is <math>9/(96^{10})</math>, which is less than 1/100,000.</p>
<b>RSA signature</b>	<p>The module supports RSA (1024 or 2048-bit), which has a minimum equivalent computational resistance to attack of either <math>2^{80}</math> or <math>2^{112}</math> depending on the modulus size. Thus the probability of a successful random attempt is <math>1/(2^{80})</math> or <math>1/(2^{112})</math>, which are both less than 1/1,000,000. The probability of a success with multiple consecutive attempts in a one-minute period is <math>5.6e7/(2^{80})</math> or <math>5.6e7/(2^{112})</math>, which are both less than 1/100,000.</p>
<b>DSA signature</b>	<p>The module supports DSA (1024-bit only) which have an equivalent computational resistance to attack of <math>2^{80}</math>. Thus the probability of a successful random attempt is <math>1/2^{80}</math>, which is less than 1/1,000,000. The probability of a success with multiple consecutive attempts in a one-minute period is <math>5.6e7/(2^{80})</math>, which is less than 1/100,000.</p>
<b>AS2-FIPS PIC password</b>	<p>The module supports 32 byte passwords to authenticate the PIC. Thus the probability of a successful random attempt is <math>1/(255^{32})</math>, which is less than 1/1,000,000. The probability of a success with multiple consecutive attempts in a one minute period is <math>4,940,716/(255^{32})</math>, which is less than 1/100,000.</p>
<b>RE-to-RE pre-shared keys</b>	<p>The module uses 160-bit HMAC keys for RE-to-RE authentication. Thus the probability of a successful random attempt is <math>1/(2^{160})</math>, which is less than 1/1,000,000. The probability of a success with multiple consecutive attempts in a one-minute period is <math>54,347,880/(2^{160})</math>, which is less than 1/100,000.</p>
<b>IKE pre-shared keys</b>	<p>The module uses 160-bit HMAC keys for RE-to-RE authentication. Thus the probability of a successful random attempt is <math>1/(2^{160})</math>, which is less than 1/1</p>

Authentication Mechanism	Strength of Mechanism
	million. The probability of a success with multiple consecutive attempts in a one minute period is $54,347,880/(2^{160})$ , which is less than 1/100,000.
<b>Protocol peer pre-shared keys</b>	The module supports TCP-MD5 with a 128-bit pre-shared key. Thus the probability of a successful random attempt is $1/(2^{128})$ , which is less than 1/1,000,000. The probability of a success with multiple consecutive attempts in a one minute period is $54,347,880/(2^{128})$ , which is less than 1/100,000.

## 6. Access Control Policy

### Roles and Services

Table 5. Services Authorized for Roles

Role	Authorized Services
<b>User:</b> Configures and monitors the router via the console, SSH, or TLS.	<ul style="list-style-type: none"> <li>• <u>Configuration Management</u>: Allows the user to configure the router.</li> <li>• <u>Router Control</u>: Allows the user to modify the state of the router. (Example: shutdown, reboot)</li> <li>• <u>Status Checks</u>: Allows the user to get the current status of the router.</li> <li>• <u>JUNOScript</u>: Provides script handling service for module via SSH or TLS session.</li> <li>• <u>SSH</u>: Provides encrypted login via the SSH protocol.</li> <li>• <u>TLS</u>: Provides encrypted login via the TLS protocol.</li> <li>• <u>Console Access</u>: Provides direct login access via the console.</li> </ul>
<b>Cryptographic Officer:</b> Configures and monitors the RE via the console, SSH, or TLS. Also has permissions to view and edit secrets within the RE.	<ul style="list-style-type: none"> <li>• <u>Configuration Management</u>: Allows the CO to configure the router.</li> <li>• <u>Router Control</u>: Allows the user to modify the state of the router. (Example: shutdown, reboot)</li> <li>• <u>Status Checks</u>: Allows the user to get the current status of the router.</li> <li>• <u>Zeroize</u>: Allows the user to zeroize the configuration (all CSPs) within the module.</li> <li>• <u>Load New Software</u>: Allows the verification and loading of new software into the router. Note: Loading of software invalidates the module's FIPS 140-2 validation.</li> <li>• <u>JUNOScript</u>: Provides script handling service for module via SSH or TLS session.</li> <li>• <u>SSH</u>: Provides encrypted login via the SSH protocol.</li> <li>• <u>TLS</u>: Provides encrypted login via the TLS protocol.</li> <li>• <u>Console Access</u>: Provides direct login access via the console.</li> </ul>
<b>AS2-FIPS PIC</b>	<ul style="list-style-type: none"> <li>• <u>Receives SAs</u>: Allows the PIC to receive the SAs associated with a particular IPsec tunnel.</li> <li>• <u>Secure IPC Tunnel</u>: Allows the PIC to communicate with the RE using a secure tunnel.</li> </ul>

Role	Authorized Services
<p><b>RE-to-RE</b></p> <p>The RE role is able to communicate with other REs to enable failover capabilities.</p>	<ul style="list-style-type: none"> <li>• <u>Configuration Management</u>: Allows propagation of configuration database to the backup RE.</li> <li>• <u>Router Control</u>: Allows the master RE to control the state of the backup RE.</li> <li>• <u>Status Checks</u>: This service will allow the user to get the current status of the router (ports, number of packets, uptime, and so forth)</li> <li>• <u>Secure Transport</u>: Allows the master RE to communicate with the backup RE using a secure IPsec connection.</li> <li>• <u>Secure IPC Tunnel</u>: Allows the PIC to communicate with the RE using a secure tunnel.</li> </ul>
<p><b>IKE Peer</b></p> <p>This role performs IKE negotiation with the RE.</p> <p>The IKE peer will create SAs for the AS2-FIPS PIC to use when using IPsec with a VPN client in cyberspace.</p>	<ul style="list-style-type: none"> <li>• <u>Key Agreement</u>: Allows the negotiation of keys for use with an IPsec tunnel.</li> </ul>
<p><b>Protocol Peer</b></p> <p>This role allows remote router to communicate with the RE via standard networking protocols. The supported routing protocols (BGP, ISIS, LDP, MSDP, OSPF, RIP2, RSVP, VRRP, and NTP) authenticate peers to each other for purpose of updating routing tables.</p>	<ul style="list-style-type: none"> <li>• <u>Mutual Authentication</u>: Allows validating a known protocol peer.</li> <li>• <u>Protocol Exchange</u>: Allows the peers to communicate using an agreed-upon protocol.</li> <li>• <u>Secure Protocol Transport</u>: Allows IPsec connection between protocol peer and router.</li> </ul>

**Unauthenticated Services**

The cryptographic module supports the following unauthenticated services:

- PIC Software Image Load: Downloads PIC software image to PIC.
- Receive Service Set Configuration: Allows the PIC to receive service set configuration database.
- Show Status: Provides the current status of the cryptographic module.
- Self-tests: Executes the suite of self-tests required by FIPS 140-2.
- Routing Protocols: Unauthenticated routing protocols (e.g., TCP, UDP)
- SNMP Traps (Status)

**Definition of Critical Security Parameters (CSPs)**

Table 6. Table of CSPs

CSP	Description
<p><b>SSH Private Host Key</b></p>	<p>The first time SSH is configured, the key is generated. RSA, DSA. Used to Identify the host. 1024-bit length set as minimum.</p>

CSP	Description
<b>SSH Session Key</b>	Session keys used with SSH, TDES (3 key), AES 128, 192, 256, HMAC-SHA-1 key (160), DH Private Key 1024
<b>TLS Host Certificate, Private Portion</b>	X.509 certificates for TLS for authentication. RSA or DSA
<b>TLS Session Parameters</b>	Session keys used with TLS, TDES (2 or 3 key), AES 128, 192, 256, HMAC-SHA-1; Pre-master Secret
<b>User Authentication Key</b>	HMAC-SHA-1 Key Used to authenticate users to the module.
<b>CO Authentication Key</b>	HMAC-SHA-1 Key Used to authenticate COs to the module.
<b>IPsec SAs</b>	Session keys used within IPsec. TDES (3 key), HMAC-SHA-1
<b>IKE Session Parameters</b>	Nonces, DH Private Key 1024-bit keys, TDES, HMAC-SHA-1, used within IKE
<b>Secure IPC (Internal) Session Key</b>	TDES (3 Key) Used to communicate securely between the RE and the PIC
<b>RE-to-RE Authentication Key</b>	HMAC Key (Manual IPsec SA) 160 bit key with 96 bit truncated MAC.
<b>RE-to-RE Encryption Key</b>	TDES key (Manual IPsec SA)
<b>Protocol Peer Authentication Keys</b>	TCP-MD5 key to authenticate the routing peer role for the following protocols: BGP, ISIS, LDP, MSDP, OSPF, RIP2, RSVP, VRRP, NTP, APSCP
<b>ASPIC password</b>	32 byte password
<b>RADIUS shared secret</b>	Used to authenticate COs and Users (10 chars minimum) This includes the Authentication Data Block
<b>TACACS+ shared secret</b>	Used to authenticate COs and Users (10 chars minimum) This includes the Authentication Data Block
<b>Manual SA for PIC</b>	Entered into the RE, which is then passed over to the PIC for use by PIC with IPSEC

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CSP	Description
<b>RNG State</b>	Internal state and seed key of RNG

## Definition of Public Keys

Table 7. Table of Public Keys

Key	Description/Usage
<b>SSH Public Host Key</b>	First time SSH is configured, the key is generated. RSA (1024 or 2048-bit), DSA. Identify the host.
<b>TLS Host Certificate, Public Portion</b>	X.509 certificates for TLS for authentication. RSA (1024 or 2048-bit) or DSA
<b>User Authentication Public Keys</b>	Used to authenticate users to the module. RSA (1024 or 2048-bit) or DSA
<b>CO Authentication Public Keys</b>	Used to authenticate CO to the module. RSA (1024 or 2048-bit) or DSA
<b>JuniperRootCA</b>	RSA 2048-bit X.509 certificate Used to verify the validity of the Juniper image at software load and also at runtime for integrity.
<b>EngineeringCA</b>	RSA 2048-bit X.509 certificate Used to verify the validity of the Juniper image at software load and also at runtime for integrity.
<b>PackageCA</b>	RSA 2048-bit X.509 certificate Used to verify the validity of the Juniper image at software load and also at runtime for integrity.
<b>PackageProduction</b>	RSA 2048-bit X.509 certificate Certificate that holds the public key of the signing key that was used to generate all the signatures used on the packages and signature lists.
<b>RE RSA Verify Key (Public Authentication key)</b>	RSA 1024-bit key sent to the PIC to sign data to allow the PIC to authenticate to the RE by having the PIC sign data that is verified by the RE.
<b>PIC RSA Verify (Public Authentication) Key</b>	RSA 1024-bit key to allow the RE to authenticate to the PIC by signing data and having the PIC verify the signature.
<b>PIC RSA Encrypt Key</b>	RSA 1024-bit key used to encrypt the TDES session key.
<b>RE RSA Encrypt Key</b>	RSA 1024-bit key sent to the PIC; note that the PIC never uses this key.

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Key	Description/Usage
<b>DH Public Keys</b>	Used within IKE and SSH for key establishment.

**Definition of CSP Modes of Access**

Table 8 defines the relationship between access to CSPs and the different module services. The modes of access shown in the table are defined as follows:

Table 8. CSP Access Rights within Roles & Services

Role						Service	Cryptographic Keys and CSP Access Operation R=Read, W=Write, D=Delete
CO	User	RE-to-RE	AS2-FIPS PIC	IKE Peer	Prot. Peer		
X						Configuration Management	All CSPs (R, W, D)
	X					Configuration Management	No access to CSPs
		X				Configuration Management	All CSPs (R, W)
X	X	X				Router Control	No access to CSPs
X	X	X				Status Checks	No access to CSPs
X						Zeroize	All CSPs (D)
			X			Receives SAs	Relevant IPsec SAs (R)
				X		Key Agreement	IPsec SAs (R)
					X	Mutual Authentication	Relevant Authentication data: (R)
					X	Protocol Exchange (OSPF, VRRP, etc)	No access to CSPs
X						Load New Software	No access to CSPs
X						JUNOScript	All CSPs (R, W, D)
	X					JUNOScript	No access to CSPs
X	X					SSH	SSH session key (R)
X	X					TLS	TLS session parameters (R)



Role						Service	Cryptographic Keys and CSP Access Operation R=Read, W=Write, D=Delete
CO	User	RE-to-RE	AS2-FIPS PIC	IKE Peer	Prot. Peer		
X	X					Console Access	CO Authentication Key, User Authentication Key (R)
		X	X			Secure IPC Tunnel	Secure IPC (Internal) Session Key (R)
		X				Secure transport	RE-to-RE Encryption Key, RE-to-RE Authentication Key (R)
					X	Secure Protocol transport	Protocol Peer Authentication Keys (R)

## 7. Operational Environment

The FIPS 140-2 Area 6 Operational Environment requirements are not applicable because the cryptographic module is a limited operational environment.

## 8. Security Rules

The cryptographic module’s design corresponds to the cryptographic module’s security rules. This section documents the security rules enforced by the cryptographic module to implement the security requirements of this FIPS 140-2 Level 1 module.

1. The cryptographic module shall provide six distinct operator roles. These are the User role, the Cryptographic Officer role, RE-to-RE role, AS2-FIPS PIC role, IKE Peer role, and Protocol Peer role.
2. The cryptographic module shall support both role-based and identity-based authentication mechanisms.
3. Authentication of identity to an authorized role is required for all services that modify, disclose, or substitute CSPs, use Approved security functions, or otherwise affect the security of the cryptographic module.
4. The cryptographic module shall perform the following tests:
  - Power up tests
    - A. Cryptographic algorithm tests
      - i. DES - KAT<sup>1</sup>
      - ii. TDES - KAT
      - iii. AES - KAT
      - iv. AES - CMAC KAT
      - v. SHA-1 KAT
      - vi. SHA-224, 256, 384, 512 KAT
      - vii. HMAC-SHA-1 KAT
      - viii. HMAC-SHA-256 KAT
      - ix. ECDH KAT
      - x. ECDSA pairwise consistency test (sign/verify) and KAT
      - xi. RSA pairwise consistency test (sign/verify and encrypt/decrypt) and KAT
      - xii. DSA pairwise consistency test (sign/verify) and KAT
      - xiii. FIPS 186-2 RNG KAT
      - xiv. KDF-IKEv1 KAT

<sup>1</sup>The DES function is used to implement TDES and is not otherwise available for use in the cryptomodule.

B. Firmware integrity test:

- i. RSA digital signature verification (PKCS1.5, 2048-bit key, SHA-1) and SHA-1 hash verification

C. Critical functions tests

- i. Verification of Limited Environment
- ii. Verification of Integrity of Optional Packages

- Conditional tests

D. Pairwise consistency tests

- i. ECDSA Pairwise Consistency test
- ii. RSA pairwise consistency test (sign/verify and encrypt/decrypt)
- iii. DSA pairwise consistency test (sign/verify)

E. Firmware load test: RSA digital signature verification (2048-bit key)

F. Manual key entry test: duplicate key entries test

G. Continuous random number generator test: performed on the Approved FIPS 186-2, Appendix 3.1 RNG, and on a non-Approved RNG that is used to seed the Approved RNG.

H. Bypass test is not applicable.

5. Any time the cryptographic module is in an idle state, the operator shall be capable of commanding the module to perform the power-up self-test by power-cycling the module.
6. Prior to each use, the internal RNG shall be tested using the continuous random number generation conditional test.
7. Data output shall be inhibited during self-tests and error states.
8. Key generation, manual key entry and zeroization processes shall be logically isolated from data output.
9. Status information shall not contain CSPs or sensitive data that if misused could lead to a compromise of the module.
10. The module shall support concurrent operators.
11. The Routing Engine hardware implements a PC card slot. The slot is not supported as an interface for use with the module's logical cryptographic boundary.
12. The Routing Engine must be installed in one of the approved platforms as listed in Table 1, per Juniper installation guidance.

## 9. Physical Security Policy

### Physical Security Mechanisms

The JUNOS-FIPS 9.3 OS firmware module's physical embodiment, as represented by the tested platform, is a multi-chip embedded routing engine that meets Level 1 physical security requirements. The module implements production grade components.

## 10. Mitigation of Other Attacks Policy

The module has not been designed to mitigate attacks that are outside the scope of FIPS 140-2.

Table 9. Mitigation of Other Attacks

Other Attacks	Mitigation Mechanism	Specific Limitations
N/A	N/A	N/A

## 11. Acronyms

ACRONYM	DESCRIPTION
<b>AES</b>	Advanced Encryption Standard
<b>DES</b>	Data Encryption Standard
<b>DSA</b>	Digital Signature Algorithm
<b>EMC</b>	Electromagnetic Compatibility
<b>EMI</b>	Electromagnetic Interference
<b>FIPS</b>	Federal Information Processing Standard
<b>GMPLS</b>	General Multiprotocol Label Switching
<b>HMAC-SHA-1</b>	Keyed-Hash Message Authentication Code
<b>IKE</b>	Internet Key Exchange Protocol
<b>IPsec</b>	Internet Protocol Security
<b>MD5</b>	Message Digest 5
<b>MPLS</b>	Multiprotocol Label Switching
<b>PIC</b>	Physical Interface Card
<b>RADIUS</b>	Remote Authentication Dial-In User Service
<b>RE</b>	Routing Engine
<b>RSA</b>	Public-key encryption technology developed by RSA Data Security, Inc. The acronym stands for Rivest, Shamir, and Adelman.
<b>SA</b>	Security Association
<b>SHA-1</b>	Secure Hash Algorithms
<b>SSH</b>	Secure Shell
<b>SSL</b>	Secure Sockets Layer
<b>TACACS</b>	Terminal Access Controller Access Control System
<b>TCP</b>	Transmission Control Protocol
<b>TDES</b>	Triple - Data Encryption Standard

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ACRONYM	DESCRIPTION
<b>TLS</b>	Transport Layer Security
<b>UDP</b>	User Datagram Protocol

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