# Versa Networks Branch v1.0
# by Versa Networks, Inc.

# FIPS 140-2 Level 1 Non-Proprietary Security Policy

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# 1. Module Overview

The Versa Networks Branch is a software component that comprises of a comprehensive stack of network and security functions. The Versa Networks Branch software module can be deployed on a bare metal system or on a hypervisor-based Virtual Machine.

The Versa Networks Branch establishes and maintains a secure IPsec-based control channel with the Versa Networks Controller. The Versa Controller serves as an attachment point for management and control purposes between the Versa Networks Branch modules.

The Versa Networks Branch modules, that are deployed at various branch locations of an enterprise, establish, and maintain secure IPsec-based communication with each other.

The Versa Networks Branch module can be provisioned, configured, and managed through the Versa provisioning and management platform, which is also known as Versa Director. The Versa Networks Branch module also generates a variety of audit information in various protocols/formats, such as syslog, IPFIX, SNMP, etc., The audit events are forwarded to the Versa Director and/or Versa Analytics via the IPsec tunnel that is established between the Versa Networks Branch and Versa Networks Controller.

The Versa Networks Branch cryptographic module is a software module that is executing in a modifiable operational environment by a general-purpose computer.

For the purposes of the FIPS 140-2 validation, the module is a software-only, multi-chip standalone cryptographic module. FIPS 140-2 conformance testing was performed at Security Level 1. The following configuration was tested by the lab.

Table 1.1: Configuration tested by the lab

| Product | Platform | Processors | Operating Systems |
|---|---|---|---|
| Versa Networks Branch | Versa CSG750 | Intel Denverton C3558 with and without AES-NI | Ubuntu 18.04 |
| Versa Networks Branch | Supermicro X10DDW-i | Intel Xeon CPU E5-2660v4 @2.00GHz with and without AES-NI | Ubuntu-18.04 on KVM on Ubuntu-18.04 |

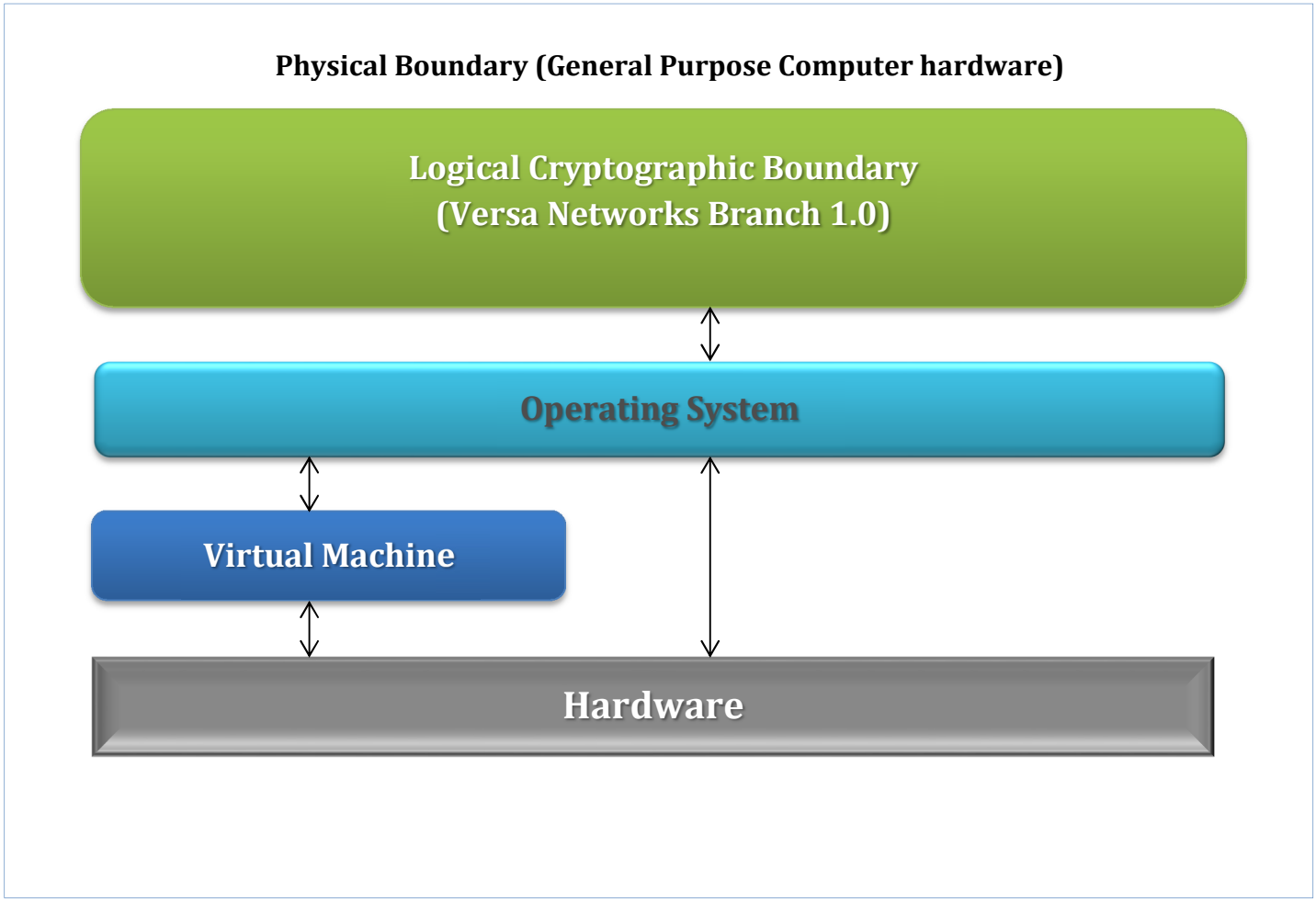
Note-1: KVM is an acronym for the Kernel-based Virtual Machine Hypervisor

Table 1.2: Module Security Level Statement

| FIPS Security Area | Security Level |
|---|---|
| Cryptographic Module Specification | 1 |
| Module Ports and Interfaces | 1 |
| Roles, Services and Authentication | 1 |
| Finite State Model | 1 |
| Physical Security | N/A |
| Operational Environment | 1 |
| Cryptographic Key Management | 1 |

| FIPS Security Area | Security Level |
|---|---|
| EMI/EMC | 1 |
| Self-tests | 1 |
| Design Assurance | 1 |
| Mitigation of Other Attacks | N/A |

Figure 1: Block Diagram for the product



# 2. Modes of Operation

The module supports two modes of operation: FIPS mode and non-FIPS mode.

FIPS Mode (Approved mode of operation): Only approved or allowed security functions with sufficient security strength can be used. To enable FIPS mode, all existing configuration shall be erased, before running the request command to enable FIPS mode on the Versa Operational CLI. After enabling the FIPS mode, Versa services need to be restarted to operate the module in FIPS mode.

```
admin> request system fips-mode enable
Please Erase config. Config Erased? Are you sure? [no,yes]yes
Restart all Versa services. Are you sure? [no,yes]yes

admin>
```

Non-FIPS Mode (non-Approved mode of operation): All approved and non-approved security functions can be used. To disable FIPS mode, all existing configuration shall be erased, before running the request command to disable FIPS mode on the Versa Operational CLI. After disabling the FIPS mode, Versa services must be restarted to operate the module in non-FIPS mode.

```
admin> request system fips-mode disable
Please Erase config. Config Erased? Are you sure? [no,yes]yes
Restart all Versa services. Are you sure? [no,yes]yes

admin>
```

## 2.1 Approved and Allowed Cryptographic Functions

The following approved cryptographic algorithms are used in FIPS approved mode of operation.

Table 2.1: Approved Cryptographic Functions.

| CAVP Cert | Library | Algorithm | Standard | Model/ Method | Key Lengths, Curves or Moduli | Use |
|---|---|---|---|---|---|---|
| C1971 | VOS ™ IPsec Cryptographic Module | CVL IKEv1 KDF[3]<br>CVL IKEv2 KDF[3] | SP800-135 | | | IPsec Key Derivation |
| C1971 | VOS ™ IPsec Cryptographic Module | AES | FIPS197, SP800-38A, SP800-38F | CBC, CTR, ECB | 128,256 | IPsec Symmetric encryption, decryption KTS[4] |
| A1644 | VOS ™ IPsec Cryptographic Module | AES | FIPS197, SP800-38A, SP800-38F | CBC, CTR, ECB | 128,256 | |

| CAVP Cert | Library | Algorithm | Standard | Model/ Method | Key Lengths, Curves or Moduli | Use |
|---|---|---|---|---|---|---|
| C1971 | VOS ™ IPsec Cryptographic Module | HMAC | FIPS198-1 | HMAC-SHA-1 | 160-bit | IPsec Message Authentication Code |
| | | | | HMAC-SHA-224 | 224-bit | |
| | | | | HMAC-SHA-256 | 256-bit | |
| | | | | HMAC-SHA-384 | 384-bit | |
| | | | | HMAC-SHA-512 | 512-bit | |
| A1644 | VOS ™ IPsec Cryptographic Module | KAS-ECC-SSC | SP800-56Ar3 | ECC Ephemeral Unified Scheme | P-224, P-256, P-384 corresponding to 112 - 192 bits of security | IPsec Shared Secret Computation |
| C1971 | VOS ™ IPsec Cryptographic Module | RSA | FIPS186-4 | PKCS#1v1.5 with SHA-256, SHA-384, SHA-512 | 1024, 2048, 3072 | IPsec Digital Signature Verification |
| C1971 | VOS ™ IPsec Cryptographic Module | RSA | FIPS186-4 | PSS with SHA-1, SHA-256, SHA-384, SHA-512 | 1024, 2048, 3072 | IPsec Digital Signature Verification |
| C1971 | VOS ™ IPsec Cryptographic Module | SHS | FIPS180-4 | SHA-1, SHA-224, SHA-256, SHA-384, SHA-512 | | IPsec Message Digest |
| C1923 | VOS ™ TLS Cryptographic Module | AES | FIPS197, SP800-38A, SP800-38D | CBC, ECB, CTR, GCM[2] | 128, 192, 256 | TLS, SSHv2 Symmetric encryption, decryption |
| A1636 | VOS ™ TLS Cryptographic Module | AES | FIPS197, SP800-38A, SP800-38D | CBC, ECB, CTR, GCM[2] | 128, 192, 256 | TLS, SSHv2 Symmetric encryption, decryption |
| C1923 | VOS ™ TLS Cryptographic Module | DRBG | SP800-90A | CTR_DRBG with AES-256 | | IPsec, TLS, SSHv2 Deterministic Random Bit Generation |
| C1923 | VOS ™ TLS Cryptographic Module | ECDSA | FIPS186-4 | | P-256, P-384, P-521 | TLS, SSHv2 Key Pair Generation |
| C1923 | VOS ™ TLS Cryptographic Module | ECDSA | FIPS186-4 | SHA-224, SHA-256, SHA-384, SHA-512 | P-256, P-384, P-521 | TLS, SSHv2 Digital Signature Generation |
| C1923 | VOS ™ TLS Cryptographic Module | ECDSA | FIPS186-4 | SHA-1, SHA-224, SHA-256, SHA-384, SHA-512 | P-256, P-384, P-521 | TLS, SSHv2 Digital Signature Verification |
| C1923 | VOS ™ TLS Cryptographic Module | HMAC | FIPS198-1 | HMAC-SHA-1 | 160-bit | TLS, SSHv2 Message Authentication Code |
| | | | | HMAC-SHA-224 | 224-bit | |
| | | | | HMAC-SHA- | 256-bit | |

| CAVP Cert | Library | Algorithm | Standard | Model/ Method | Key Lengths, Curves or Moduli | Use |
|---|---|---|---|---|---|---|
| | | | | 256 | | |
| | | | | HMAC-SHA-384 | 384-bit | |
| | | | | HMAC-SHA-512 | 512-bit | |
| A1636 | VOS ™ TLS Cryptographic Module | KAS-ECC-SSC | SP800-56Ar3 | ECC Ephemeral Unified Scheme | P-256, P-384, P-521 corresponding to 128 - 256 bits of security | TLS, SSHv2 Shared Secret Computation |
| C1923 | VOS ™ TLS Cryptographic Module | KDF CVL TLSv1.2[3] KDF CVL SSHv2[3] | SP800-135 | | | TLS, SSHv2 Key Derivation |
| C1923 | VOS ™ TLS Cryptographic Module | RSA | FIPS186-4 | | 2048, 3072 | IPsec, TLS, SSHv2 Key Pair Generation |
| C1923 | VOS ™ TLS Cryptographic Module | RSA | FIPS186-4 | PKCS#1v1.5 with SHA-224, SHA-256, SHA-384, SHA-512 | 2048, 3072 | IPsec, TLS, SSHv2 Digital Signature Generation |
| C1923 | VOS ™ TLS Cryptographic Module | RSA | FIPS186-2 | PKCS#1v1.5 with SHA1, SHA-224, SHA-256, SHA-384, SHA-512 | 1024, 1536, 2048, 3072, 4096 | TLS, SSHv2 Digital Signature Verification |
| C1923 | VOS ™ TLS Cryptographic Module | SHS | FIPS180-4 | SHA-1, SHA-224, SHA-256, SHA-384, SHA-512 | | TLS, SSHv2 Message Digest |
| A1644 C1971 | VOS ™ IPsec Cryptographic Module | KAS | SP800-56Ar3 and SP800-135 | ECC Ephemeral Unified Scheme | P-224, P-256, P-384 | IPsec Shared Secret Computation IPsec Key Derivation |
| A1636 C1923 | VOS ™ TLS Cryptographic Module | KAS | SP800-56Ar3 and SP800-135 | ECC Ephemeral Unified Scheme | P-256, P-384, P-521 | TLS, SSHv2 Shared Secret Computation TLS, SSHv2 Key Derivation |
| CKG (Vendor Affirmed) | | Cryptographic Key Generation | SP800-133 | | | Key Generation[1] |

Note 1: not all CAVS tested modes of the algorithms are used in this module.

[1] CKG is only used to generate asymmetric keys. The module directly uses the output of the DRBG. The generated seed used in the asymmetric key generation is an unmodified output from DRBG. Section 4, example 1, of SP800-133r2 "Using the Output of a Random Bit Generator" is applicable.

[2]The module's AES-GCM implementation complies with IG A.5 scenario 1 and RFC 5288, and

supports acceptable GCM cipher suites from SP 800-52 Rev2, Section 3.3.1.
AES-GCM is only used in TLS version 1.2. When the IV exhausts the maximum number of possible values for a given session key, the first party, client or server, that encounters this condition will trigger a handshake to establish a new encryption key. New AES-GCM keys are generated by the module if the module loses power.

[3]No parts of these protocols, other than the KDF, have been tested by the CAVP and CMVP.

[4] KTS: AES-CBC and CTR (Certs. #A1644 and #C1971) and HMAC (Cert. #C1971); key establishment methodology provides 128 or 256 bits of encryption strength.

## 2.2 Non-approved algorithms allowed in FIPS-approved mode

In FIPS approved mode of operation, only FIPS-approved and certified algorithms are allowed. In FIPS approved mode, none of the non-FIPS-approved or non-certified algorithms are allowed to be used.

## 2.3 All other algorithms

The below table indicates non-FIPS-approved algorithms that are only permitted to be used in non-FIPS-approved mode.

**Table 2.3: Non-Approved Cryptographic Functions**

| Algorithm | Use |
|---|---|
| RSA signature generation with keys of size < 2048 bits | Digital Signature Generation |
| RSA encryption | Key wrapping |
| 3DES (non-compliant)<br>MD5 | IPSEC |
| Blowfish, Camellia, ChaCha20, DES, RC2, RC4, SEED, Poly1305 | TLS: Symmetric Encryption and Decryption, Keyed Hash |
| ECDSA with curves P-192, K-163, B-163 and non-NIST curves KeyGen, SigGen | Digital Signature |
| ECDH with curves B-163, B-233, B-283, B-409, B-571, K-163, K-233, K-283, K-409, K-571 and non-NIST curves | Key Establishment – Non-compliant |
| HMAC with less than 112 bits key | Keyed Hash |

# 3. Ports and interfaces

The physical ports of the module are the same as those of the computer system on which it is executing. The logical interfaces of the module are implemented via an Application Programming Interface (API). The table below describes the logical interfaces provided by the module.

**Table 3: FIPS 140-2 Logical Interfaces.**

| Logical Interface | Description |
|---|---|
| Data Input | Input parameters that are supplied to the API commands |
| Data Output | Output parameters that are returned by the API commands |
| Control Input | API commands |
| Status Output | Return status provided by API commands |

# 4. Roles and Services

**Roles**

The module supports the following roles:

- **User Role:** performs services of establish, maintain, and close SSH, IPsec and TLS sessions.
- **Crypto Officer Role:** performs services of module installation and configuration of Versa services, monitoring status, troubleshooting, and running self-tests.

**Services**

The module provides services to users that assume one of the available roles. All services are shown in Table 4 and described in detail in the user documentation.

Table 4 shows the services, the roles to perform the service, the cryptographic keys, or Critical Security Parameters (CSPs) involved and how they are accessed. The following convention is used to specify access rights to a CSP:

- **Create**: create a new CSP.
- **Read**: read the CSP.
- **Update**: write a new value to the CSP.
- **Zeroize**: zeroize the CSP.
- **Blank**: does not access any CSP or key during its operation.

**Table 4: Roles and Services**

| Service | Corresponding Roles | Types of Access to Cryptographic Keys and CSPs |
|---|---|---|
| Module Installation | Crypto Officer | |
| Enable/Disable FIPS Mode | Crypto Officer | **All Keys/Certificates:** Zeroize |
| Configure SSH, IPsec, TLS, and perform general configuration | Crypto Officer | **SSH Keys:** Create, Read, Update, Delete<br>**IPsec Keys, Certificates:** Create, Read, Update, Delete<br>**TLS Keys, Certificates:** Create, Read, Update, Delete<br>**DRBG CSPs:** Read, Update |
| Show status | Crypto Officer | **SSH Keys:** Create, Read<br>**IPsec Keys, Certificates:** Create, Read<br>**DRBG CSPs:** Read, Update |
| Self-Tests | Crypto Officer | |
| SSH Connection | Crypto Officer | **SSH Keys:** Create, Read<br>**DRBG CSPs:** Read, Update |
| Zeroization | Crypto Officer | **All Keys/Certificates:** Zeroize |
| Reboot | Crypto Officer | |
| IPsec Connection to Versa Networks Controller | User | **IPsec Keys, Certificates:** Create, Read<br>**DRBG CSPs:** Read, Update |

| Service | Corresponding Roles | Types of Access to Cryptographic Keys and CSPs |
|---|---|---|
| IPsec Connection to other Versa Networks Branch modules | User | **IPsec Keys, Certificates:** Create, Read<br>**DRBG CSPs:** Read, Update |
| TLS Connection/Proxy | User | **TLS Keys, Certificates:** Create, Read<br>**DRBG CSPs:** Read, Update |
| IPsec Connection – Remote Access Server and Remote Access Client | User | **IPsec Keys, Certificates:** Create, Read<br>**DRBG CSPs:** Read, Update |

# 5. Cryptographic Keys and CSPs

The table below describes cryptographic keys and CSPs used by the module.

**Table 5: Cryptographic Keys and CSPs**

| Protocol | Key | Description/Usage | Storage |
|---|---|---|---|
| IPsec | RSA private keys<br><br>Established using DRBG | Used in IPsec handshake. | DRAM (plaintext) |
| IPsec | RSA public keys<br><br>Established using DRBG | Used in IPsec handshake. | DRAM (plaintext) |
| IPsec | Elliptic Curve Diffie Hellman private key<br><br>Established using DRBG | The private key used in Diffie Hellman (DH) exchange. | DRAM (plaintext) |
| IPsec | Elliptic Curve Diffie Hellman public key<br><br>Established using DRBG | The public key used in Diffie Hellman (DH) exchange. This key is derived per the Diffie-Hellman key agreement. | DRAM (plaintext) |
| IPsec | Pre-Shared Key<br><br>Set by operators | A shared secret known only to IPsec peers. | DRAM (plaintext) |
| IPsec | AES Encryption Keys<br><br>Established using KDF IKE | The IPsec encryption keys. | DRAM (plaintext) |
| IPsec | HMAC Keys<br><br>Established using KDF IKE | Used for computation of Hash-based Message Authentication Code (HMAC). | DRAM (plaintext) |
| SSHv2 | AES Encryption Keys<br><br>Established using KDF SSH | These are the SSHv2 session keys. They are used to encrypt all SSHv2 data traffic traversing between the endpoints. | DRAM (plaintext) |
| SSHv2 | HMAC Keys<br><br>Established using KDF SSH | Used for computation of Hash-based Message Authentication Code (HMAC). | DRAM (plaintext) |
| SSHv2 | Elliptic Curve Diffie Hellman private key<br><br>Established using DRBG | The private key used in Diffie Hellman (DH) exchange. | DRAM (plaintext) |
| SSHv2 | Elliptic Curve Diffie Hellman public key<br><br>Established using DRBG | The public key used in Diffie Hellman (DH) exchange. This key is derived per the Diffie-Hellman key agreement. | DRAM (plaintext) |

| Protocol | Key | Description/Usage | Storage |
|---|---|---|---|
| SSHv2 | ECDSA private key<br><br>Established using DRBG | Used in SSHv2 handshake. | DRAM (plaintext) |
| SSHv2 | ECDSA public key<br><br>Established using DRBG | Used in SSHv2 handshake. | DRAM (plaintext) |
| TLS | RSA private keys<br><br>Established using DRBG | Used in TLS handshake. | DRAM (plaintext) |
| TLS | RSA public keys<br><br>Established using DRBG | Used in TLS handshake. | DRAM (plaintext) |
| TLS | TLS pre-master secret<br><br>Established using KAS-ECC-SSC | Shared secret created/derived using asymmetric cryptography from which new HTTPS session keys can be created. | DRAM (plaintext) |
| TLS | TLS master secret<br><br>Established using KDF TLS | Shared secret created/derived via key derivation function (SP800-135 KDF TLS) | DRAM (plaintext) |
| TLS | AES Encryption Key<br><br>Established using KDF TLS | Used in HTTPS connections. Generated using TLS protocol. | DRAM (plain text) |
| TLS | HMAC Key<br><br>Established using KDF TLS | Used for computation of Hash-based Message Authentication Code (HMAC) | DRAM (plaintext) |
| TLS | Elliptic Curve Diffie Hellman private key<br><br>Established using DRBG | The private key used in Diffie Hellman (DH) exchange. | DRAM (plaintext) |
| TLS | Elliptic Curve Diffie Hellman public key<br><br>Established using DRBG | The public key used in Diffie Hellman (DH) exchange. This key is derived per the Diffie-Hellman key agreement. | DRAM (plaintext) |
| IPsec, TLS, SSHv2 | CTR_DRBG CSPs: entropy input, V and Key<br><br>Entropy is loaded externally | Used during generation of random numbers. | DRAM (plaintext) |

Note-1: public keys are not considered CSPs

Note-2: All keys, that are generated by this module, are generated by using AES-CTR-DRBG with AES-256. Entropy is loaded externally. Minimum number of bits of entropy loaded is 256-bits, since the minimum length of the entropy field is 256-bits.

Note-3: Keys can be provided to the module via API input parameters and output via API output parameters. The module does not enter or output keys outside its physical boundary. Zeroization is performed using power cycle.

# 6. Self-tests

The module performs the following power-up and conditional self-tests. Upon failure or a power-up or conditional self-test the module halts its operation.

**Power-Up Tests**

The module performs power-up tests when the module is restarted or when the underlying system is rebooted or power-cycled, without operator intervention. Power-up tests ensure that the module is not corrupted and that the cryptographic algorithms work as expected.

While the module is executing the power-up tests, services are not available, and input and output are inhibited. The module is not available for use until the power-up tests are completed successfully.

If any power-up test fails, the module disables all services, and then enters error state. Thus, no further cryptographic operations are possible. If the power-up tests complete successfully, the module will startup normally and will provide the cryptographic operation service requests.

**Conditional Tests**
The module performs conditional tests on the cryptographic algorithms, using the Pair-wise Consistency Tests (PCT) and Continuous Random Number Generator Test (CRNGT).

The software integrity test is performed during startup using RSA 2048-bit keys, with SHA256 Signature Verification.

**Table 6: Self-Tests**

| Algorithm | Test |
|---|---|
| Software Integrity Power On Self Test | Software integrity test is performed using RSA key of length of at least 2048 bits and SHA256 Signature Verification |
| Power On Self Test for VOS TLS Cryptographic Subsystem | For VOS TLS Cryptographic Subsystem, the test validation routines are performed:<br>1. AES encryption and decryption are separately tested (key sizes tested: 128, 192, 256)<br>a. CBC<br>b. ECB<br>c. GCM<br>d. CTR<br>2. RSA KAT (key sizes tested: 2048, 3072), using SHA256<br>3. SHA<br>a. SHA-1<br>b. SHA-224<br>c. SHA-256<br>d. SHA-384<br>e. SHA-512 |

| Algorithm | Test |
|---|---|
| | 4. HMAC<br>a. HMAC-SHA-1<br>b. HMAC-SHA-224<br>c. HMAC-SHA-256<br>d. HMAC-SHA-384<br>e. HMAC-SHA-512<br>5. DRBG KAT<br>6. KAS (ECC-SSC) Primitive "Z" Computation KAT per implementation guidance<br>7. ECDSA PCT (curve sizes P-224, K-233) using SHA512<br>8. KDF KAT – For SSH and TLS |
| Power On Self Test for IPsec Subsystem | For IPsec Subsystem, the test validation routines are performed:<br>1. AES encryption and decryption are separately tested (key sizes tested are 128, 192, 256)<br>a. CBC<br>b. ECB<br>2. RSA KAT (key sizes tested are 2048, 3072)<br>3. SHA<br>a. SHA-1<br>b. SHA-224<br>c. SHA-256<br>d. SHA-384<br>e. SHA-512<br>4. HMAC<br>a. HMAC-SHA-1<br>b. HMAC-SHA-224<br>c. HMAC-SHA-256<br>d. HMAC-SHA-384<br>e. HMAC-SHA-512<br>5. KAS (ECC-SSC) Primitive "Z" Computation KAT per implementation guidance<br>6. KDF KAT – For IKEv1 and IKEv2 |
| Conditional Test for RSA Key Generation | PCT using SHA-256, signature generation and verification.<br>PCT for encryption and decryption. |
| Conditional Test for ECDSA Key Generation | PCT using SHA-256, signature generation and verification. |
| Conditional Test for ECC DH Public/Private Key Validation (IPsec) | ECC DH Private/Public Key Validation tests as per SP800-56Ar3 including ECC Full Public-Key Validation Routine |
| Conditional Test for ECC DH Public/Private Key Validation (TLS, SSH) | ECC DH Private/Public Key Validation tests as per SP800-56Ar3 including ECC Full Public-Key Validation Routine |
| DRBG | DRBG Health Test<br>Performed per SP 800-90A Section 11.3 |
| Conditional Test for DRBG | CRNGT |

| Algorithm | Test |
|---|---|
| Entropy Test | Continuous Random Number Test for the entropy data |

# 7. References

**Table 7: References**

| Reference | Specification |
|---|---|
| [ANS X9.31] | Digital Signatures Using Reversible Public Key Cryptography for the Financial Services Industry (rDSA) |
| [FIPS 140-2] | Security Requirements for Cryptographic modules, May 25, 2001 |
| [FIPS 180-4] | Secure Hash Standard (SHS) |
| [FIPS 186-2/4] | Digital Signature Standard |
| [FIPS 197] | Advanced Encryption Standard |
| [FIPS 198-1] | The Keyed-Hash Message Authentication Code (HMAC) |
| [FIPS 202] | SHA-3 Standard: Permutation-Based Hash and Extendable-Output Functions |
| [PKCS#1 v2.1] | RSA Cryptography Standard |
| [PKCS#5] | Password-Based Cryptography Standard |
| [PKCS#12] | Personal Information Exchange Syntax Standard |
| [SP 800-38A] | Recommendation for Block Cipher Modes of Operation: Three Variants of Ciphertext Stealing for CBC Mode |
| [SP 800-38B] | Recommendation for Block Cipher Modes of Operation: The CMAC Mode for Authentication |
| [SP 800-38C] | Recommendation for Block Cipher Modes of Operation: The CCM Mode for Authentication and Confidentiality |
| [SP 800-38D] | Recommendation for Block Cipher Modes of Operation: Galois/Counter Mode (GCM) and GMAC |
| [SP 800-38F] | Recommendation for Block Cipher Modes of Operation: Methods for Key Wrapping |
| [SP 800-56A] | Recommendation for Pair-Wise Key Establishment Schemes Using Discrete Logarithm Cryptography |
| [SP 800-56B] | Recommendation for Pair-Wise Key Establishment Schemes Using Integer Factorization Cryptography |
| [SP 800-56C] | Recommendation for Key Derivation through Extraction-then-Expansion |
| [SP 800-67R1] | Recommendation for the Triple Data Encryption Algorithm (TDEA) Block Cipher |
| [SP 800-89] | Recommendation for Obtaining Assurances for Digital Signature Applications |
| [SP 800-90A] | Recommendation for Random Number Generation Using Deterministic Random Bit Generators |

| Reference | Specification |
|---|---|
| [SP 800-108] | Recommendation for Key Derivation Using Pseudorandom Functions |
| [SP 800-132] | Recommendation for Password-Based Key Derivation |
| [SP 800-135] | Recommendation for Existing Application –Specific Key Derivation Functions |