Cisco Systems, Inc.

Firepower Next-Generation IPS Virtual VMware Cryptographic Module

FIPS 140-3 Non-Proprietary Security Policy

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1 General

1.1 Overview

This is Cisco Systems, Inc. non-proprietary security policy for Firepower Next-Generation IPS Virtual VMware Cryptographic Module (hereinafter referred to as the Module or NGIPS) with software version 7.0.5. The following details how this module meets the security requirements of FIPS 140-3, SP 800-140 and ISO/IEC 19790 for a Security Level 1 Software cryptographic module.

The security requirements cover areas related to the design and implementation of a cryptographic module. These areas include cryptographic module specification; cryptographic module interfaces; roles, services, and authentication; software/firmware security; operational environment; physical security; noninvasive security; sensitive security parameter management; self-tests; life-cycle assurance; and mitigation of other attacks. The following table indicates the actual security levels for each area of the cryptographic module

1.2 Security Levels

Section	Title	Security Level
1	General	1
2	Cryptographic module specification	1
3	Cryptographic module interfaces	1
4	Roles, services, and authentication	1
5	Software/Firmware security	1
6	Operational environment	1
7	Physical security	N/A
8	Non-invasive security	N/A
9	Sensitive security parameter management	1
10	Self-tests	1
11	Life-cycle assurance	1
12	Mitigation of other attacks	N/A
	Overall Level	1

Table 1: Security Levels

2 Cryptographic Module Specification

2.1 Description

Purpose and Use:

The Next-Generation IPS Virtual Cryptographic Module is the virtualized offering of the industry-leading threat protection Cisco Firepower Next-Generation IPS (NGIPS) solution. The Module is a multi-chip standalone software module with underlying operating system identified as Linux 4 (also referred to as Firepower eXtensible Operating System or FX-OS) throughout this document. The module's operational environment is modifiable. NGIPS virtual provides cryptographic functionality and services for TLSv1.2 and SSHv2.

Module Type: Software

Module Embodiment: Multi-Chip Standalone

Module Characteristics:

Cryptographic Boundary:

The cryptographic module (red dash box) is a multi-chip standalone software cryptographic module.

The block diagram below shows the boundary of the Tested Operational Environment's Physical Perimeter (TOEPP) being defined as the physical perimeter of the tested platform enclosure around which everything runs. The cryptographic boundary is the module (red dash box) and its interfaces with the operational environment.

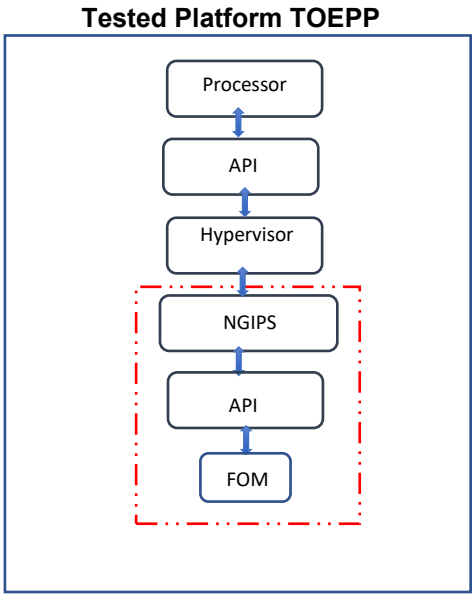

Figure 1 Block Diagram

Note: Block Diagram above comprises the following components:

- Processor = Chip on the tested platform to handle all processes.
- API = Host API between hypervisor and processor
- Hypervisor = VMWare ESXi 6.7 or 7.0
- NGIPS: Firepower Next-Generation IPS Virtual VMware Cryptographic Module
- API = Guest API between the module and FOM crypto library
- FOM = Cisco FIPS Object Module (FOM) crypto library

2.2 Tested and Vendor Affirmed Module Version and Identification

Tested Module Identification – Hardware:

N/A for this module.

Tested Module Identification – Software, Firmware, Hybrid (Executable Code Sets):

Package or File Name	Software/ Firmware Version	Features	Integrity Test
Cisco_Firepower_NGIPS_VMware-7.0.5-72-disk1.vmdk	7.0.5		HMAC-SHA2-512

Table 2: Tested Module Identification – Software, Firmware, Hybrid (Executable Code Sets)

Tested Module Identification – Hybrid Disjoint Hardware:

Model and/or Part Number	Hardware Version	Firmware Version	Processors	Features
UCS C220 M5S SFF Server	1.0	VMware ESXi 7.0	Intel Xeon Platinum 8160 (Skylake)	

Table 3: Tested Module Identification – Hybrid Disjoint Hardware

Tested Operational Environments - Software, Firmware, Hybrid:

Operating System	Hardware Platform	Processors	PAA/PAI	Hypervisor or Host OS	Version(s)
Linux 4 (FX-OS) on VMware ESXi 6.7	UCS C220 M5S SFF Server	Intel Xeon Gold 6128 (Skylake)	Yes	VMware ESXi 6.7	7.0.5
Linux 4 (FX-OS) on VMware ESXi 6.7	UCS C220 M5S SFF Server	Intel Xeon Gold 6128 (Skylake)	No	VMware ESXi 6.7	7.0.5
Linux 4 (FX-OS) on VMware ESXi 7.0	UCS C220 M5S SFF Server	Intel Xeon Gold 6128 (Skylake)	Yes	VMware ESXi 7.0	7.0.5
Linux 4 (FX-OS) on VMware ESXi 7.0	UCS C220 M5S SFF Server	Intel Xeon Gold 6128 (Skylake)	No	VMware ESXi 7.0	7.0.5

Table 4: Tested Operational Environments - Software, Firmware, Hybrid

Vendor-Affirmed Operational Environments - Software, Firmware, Hybrid:

Operating System	Hardware Platform
Linux 4 (FX-OS)	C220 M5 w/KVM/AWS
Linux 4 (FX-OS)	C240 M5 w/ESXi/KVM/AWS
Linux 4 (FX-OS)	C480 M5 w/ESXi/KVM/AWS
Linux 4 (FX-OS)	E160-M3 w/ESXi/KVM/AWS
Linux 4 (FX-OS)	E180D-M3 w/ESXi/KVM/AWS

Table 5: Vendor-Affirmed Operational Environments - Software, Firmware, Hybrid

2.3 Excluded Components

N/A for this module.

2.4 Modes of Operation

Modes List and Description:

Mode Name	Description	Type	Status Indicator
Approved	The module is always in the approved mode of operation after initial operations are performed.	Approved	"STIG" compliance is configured.

Table 6: Modes List and Description

Once the module is configured in the Approved mode of operation by following the steps in section 11 of this document, the module will be ready for approved mode of operation. The module doesn't claim the implementation of a degraded mode operation.

2.5 Algorithms

Approved Algorithms:

CiscoSSL FOM - Virtual with PAA

Algorithm	CAVP Cert	Properties	Reference
AES-CBC	A2952	Key Length - 128, 256	SP 800-38A
AES-GCM	A2952	Key Length - 128, 256	SP 800-38D
Counter DRBG	A2952	Mode - AES-256 Derivation Function Enabled - Yes	SP 800-90A Rev. 1
ECDSA KeyGen (FIPS186-4)	A2952	Curve - P-256, P-384, P-521	FIPS 186-4
ECDSA SigGen (FIPS186-4)	A2952	Curve - P-256, P-384, P-521 Hash Algorithm - SHA2-256, SHA2-384, SHA2-512	FIPS 186-4
ECDSA SigVer (FIPS186-4)	A2952	Curve - P-256, P-384, P-521 Hash Algorithm - SHA2-256, SHA2-384, SHA2-512	FIPS 186-4
HMAC-SHA-1	A2952	MAC - MAC: 32-160 Increment 8 Key Length - Key Length: 256-448 Increment 8	FIPS 198-1
HMAC-SHA2-256	A2952	MAC - MAC: 32-256 Increment 8 Key Length - Key Length: 256-448 Increment 8	FIPS 198-1
HMAC-SHA2-384	A2952	MAC - MAC: 32-384 Increment 8 Key Length - Key Length: 256-448 Increment 8	FIPS 198-1
HMAC-SHA2-512	A2952	MAC - MAC: 32-512 Increment 8 Key Length - Key Length: 256-448 Increment 8	FIPS 198-1
KAS-ECC-SSC Sp800-56Ar3	A2952	Domain Parameter Generation Methods - P-256, P-384, P-521	SP 800-56A Rev. 3

Algorithm	CAVP Cert	Properties	Reference
KAS-FFC-SSC Sp800-56Ar3	A2952	Domain Parameter Generation Methods - modp-2048	SP 800-56A Rev. 3
KDF SSH (CVL)	A2952	Cipher - AES-128, AES-192, AES-256, TDES Hash Algorithm - SHA-1, SHA2-224, SHA2-256, SHA2-384, SHA2-512	SP 800-135 Rev. 1
RSA KeyGen (FIPS186-4)	A2952	Modulo - 2048, 3072	FIPS 186-4
RSA SigGen (FIPS186-4)	A2952	Signature Type - PKCS 1.5 Modulo - 2048, 3072	FIPS 186-4
RSA SigVer (FIPS186-4)	A2952	Signature Type - PKCS 1.5 Modulo - 2048, 3072	FIPS 186-4
Safe Primes Key Generation	A2952	Safe Prime Groups - modp-2048	SP 800-56A Rev. 3
SHA-1	A2952	Message Length - Message Length: 0-65536 Increment 8	FIPS 180-4
SHA2-256	A2952	Message Length - Message Length: 0-65536 Increment 8	FIPS 180-4
SHA2-384	A2952	Message Length - Message Length: 0-65536 Increment 8	FIPS 180-4
SHA2-512	A2952	Message Length - Message Length: 0-65536 Increment 8	FIPS 180-4
TLS v1.2 KDF RFC7627 (CVL)	A2952	Hash Algorithm - SHA2-256, SHA2-384, SHA2-512	SP 800-135 Rev. 1

Table 7: Approved Algorithms - CiscoSSL FOM - Virtual with PAA

CiscoSSL FOM - Virtual without PAA

Algorithm	CAVP Cert	Properties	Reference
AES-CBC	A3376	Key Length - 128, 256	SP 800-38A
AES-GCM	A3376	Key Length - 128, 256	SP 800-38D
Counter DRBG	A3376	Mode - AES-256 Derivation Function Enabled - Yes	SP 800-90A Rev. 1
ECDSA KeyGen (FIPS186-4)	A3376	Curve - P-256, P-384, P-521	FIPS 186-4
ECDSA SigGen (FIPS186-4)	A3376	Curve - P-256, P-384, P-521 Hash Algorithm - SHA2-256, SHA2-384, SHA2-512	FIPS 186-4
ECDSA SigVer (FIPS186-4)	A3376	Curve - P-256, P-384, P-521 Hash Algorithm - SHA2-256, SHA2-384, SHA2-512	FIPS 186-4
HMAC-SHA-1	A3376	MAC - MAC: 32-160 Increment 8 Key Length - Key Length: 256-448 Increment 8	FIPS 198-1
HMAC-SHA2-256	A3376	MAC - MAC: 32-256 Increment 8 Key Length - Key Length: 256-448 Increment 8	FIPS 198-1

Algorithm	CAVP Cert	Properties	Reference
HMAC-SHA2-384	A3376	MAC - MAC: 32-384 Increment 8 Key Length - Key Length: 256-448 Increment 8	FIPS 198-1
HMAC-SHA2-512	A3376	MAC - MAC: 32-512 Increment 8 Key Length - Key Length: 256-448 Increment 8	FIPS 198-1
KAS-ECC-SSC Sp800-56Ar3	A3376	Domain Parameter Generation Methods - P-256, P-384, P-521	SP 800-56A Rev. 3
KAS-FFC-SSC Sp800-56Ar3	A3376	Domain Parameter Generation Methods - modp-2048	SP 800-56A Rev. 3
KDF SSH (CVL)	A3376	Cipher - AES-128, AES-192, AES-256, TDES Hash Algorithm - SHA-1, SHA2-224, SHA2-256, SHA2-384, SHA2-512	SP 800-135 Rev. 1
RSA KeyGen (FIPS186-4)	A3376	Modulo - 2048, 3072	FIPS 186-4
RSA SigGen (FIPS186-4)	A3376	Signature Type - PKCS 1.5 Modulo - 2048, 3072	FIPS 186-4
RSA SigVer (FIPS186-4)	A3376	Signature Type - PKCS 1.5 Modulo - 2048, 3072	FIPS 186-4
Safe Primes Key Generation	A3376	Safe Prime Groups - modp-2048	SP 800-56A Rev. 3
SHA-1	A3376	Message Length - Message Length: 0-65536 Increment 8	FIPS 180-4
SHA2-256	A3376	Message Length - Message Length: 0-65536 Increment 8	FIPS 180-4
SHA2-384	A3376	Message Length - Message Length: 0-65536 Increment 8	FIPS 180-4
SHA2-512	A3376	Message Length - Message Length: 0-65536 Increment 8	FIPS 180-4
TLS v1.2 KDF RFC7627 (CVL)	A3376	Hash Algorithm - SHA2-256, SHA2-384, SHA2-512	SP 800-135 Rev. 1

Table 8: Approved Algorithms - CiscoSSL FOM - Virtual without PAA

Vendor-Affirmed Algorithms:

Name	Properties	Implementation	Reference
CKG	Key Type:Asymmetric	N/A	The cryptographic module performs Cryptographic Key Generation (CKG) for asymmetric keys as per sections 4 and 5 in SP800-133rev2 (vendor affirmed) and FIPS 140-3 IG D.H. A seed (i.e., the random value) used in asymmetric key generation is a direct output from SP800-90Arev1 CTR_DRBG (A2952/A3376)

Table 9: Vendor-Affirmed Algorithms

Non-Approved, Allowed Algorithms:

N/A for this module.

Non-Approved, Allowed Algorithms with No Security Claimed:

N/A for this module.

Non-Approved, Not Allowed Algorithms:

N/A for this module.

2.6 Security Function Implementations

Name	Type	Description	Properties	Algorithms
KAS-FFC (SSHv2)	CKG KAS-Full	Full KAS-FFC Key Agreement used for SSHv2 service	Caveat:Key establishment methodology provides 112 bits of security strength IG : IG D.F Path 2, Scenario 2, Split Key Confirmation : No Key Derivation : IG 2.4.B SP 800-135rev1 CVL	KAS-FFC-SSC Sp800-56Ar3: (A2952, A3376) Domain Parameter Generation: MODP-2048 Safe Primes Key Generation: (A2952, A3376) KDF SSH: (A2952, A3376) Counter DRBG: (A2952, A3376) CKG: () Key Type: Asymmetric
KAS-ECC (TLSv1.2)	CKG KAS-Full	Full KAS-ECC Key Agreement used for TLSv1.2 service	Caveat:Key establishment methodology provides between 128 and 256 bits of security strength IG : IG D.F Scenario 2, Path 2, Split Key Confirmation : No Key Derivation : IG 2.4.B SP 800-135rev1 CVL	KAS-ECC-SSC Sp800-56Ar3: (A2952, A3376) Curves: P-256, P-384, P-521 TLS v1.2 KDF RFC7627: (A2952, A3376) Counter DRBG: (A2952, A3376) CKG: () Key Type: Asymmetric
KTS (SSHv2 with AES and HMAC)	KTS-Unwrap KTS-Wrap	KTS via SSHv2 service by using AES and HMAC	Caveat:Key establishment methodology	AES-CBC: (A2952, A3376) Key Length:

Name	Type	Description	Properties	Algorithms
			provides 128 or 256 bits of security strength Standard : SP 800-38F IG D.G : "combination" method: use any approved symmetric encryption mode together with an approved authentication method	128, 256 HMAC-SHA-1: (A2952, A3376) HMAC-SHA2-256: (A2952, A3376) HMAC-SHA2-384: (A2952, A3376) HMAC-SHA2-512: (A2952, A3376) SHA-1: (A2952, A3376) SHA2-256: (A2952, A3376) SHA2-384: (A2952, A3376) SHA2-512: (A2952, A3376)
KTS (TLSv1.2 with AES and HMAC)	KTS-Unwrap KTS-Wrap	KTS via TLSv1.2 service by using AES and HMAC	Caveat:Key establishment methodology provides 128 or 256 bits of security strength Standard : SP 800-38F IG D.G : "combination" method: use any approved symmetric encryption mode together with an approved authentication method	AES-CBC: (A2952, A3376) Key Length: 128, 256 HMAC-SHA-1: (A2952, A3376) HMAC-SHA2-256: (A2952, A3376) HMAC-SHA2-384: (A2952, A3376) HMAC-SHA2-512: (A2952, A3376) SHA-1: (A2952, A3376) SHA2-256: (A2952, A3376) SHA2-384: (A2952, A3376) SHA2-512: (A2952, A3376)
KTS (TLSv1.2 with AES-GCM)	KTS-Unwrap KTS-Wrap	KTS via TLSv1.2 service by using AES-GCM	Caveat:Key establishment methodology provides 128 or 256 bits of security strength Standard : SP	AES-GCM: (A2952, A3376) Key Length: 128, 256

Name	Type	Description	Properties	Algorithms
			800-38F IG D.G : "combination" method: use any approved symmetric encryption mode together with an approved authentication method	
RSA KeyGen (SSHv2, TLSv1.2)	AsymKeyPair-KeyGen CKG	RSA KeyGen for SSHv2 and TLSv1.2 services		RSA KeyGen (FIPS186-4): (A2952, A3376) Modulus: 2048, 3072 Counter DRBG: (A2952, A3376) CKG: () Key Type: Asymmetric
RSA SigGen (SSHv2, TLSv1.2)	DigSig-SigGen	RSA SigGen for SSHv2 and TLSv1.2 services		RSA SigGen (FIPS186-4): (A2952, A3376) Modulus: 2048, 3072
RSA SigVer (SSHv2, TLSv1.2)	DigSig-SigVer	RSA SigVer for SSHv2 and TLSv1.2 services		RSA SigVer (FIPS186-4): (A2952, A3376) Modulus: 2048, 3072
ECDSA KeyGen (TLSv1.2)	AsymKeyPair-KeyGen CKG	ECDSA KeyGen for TLSv1.2 service		ECDSA KeyGen (FIPS186-4): (A2952, A3376) Curves: P-256, P-384, P-521 Counter DRBG: (A2952, A3376) CKG: () Key Type: Asymmetric
ECDSA SigGen (TLSv1.2)	DigSig-SigGen	ECDSA SigGen for TLSv1.2 service		ECDSA SigGen (FIPS186-4): (A2952, A3376) Curves: P-256, P-384, P-521
ECDSA SigVer (TLSv1.2)	DigSig-SigVer	ECDSA SigVer for TLSv1.2 service		ECDSA SigVer (FIPS186-4): (A2952, A3376)

Name	Type	Description	Properties	Algorithms
				Curves: P-256, P-384, P-521
SSHv2 Session Encrypt/Decrypt	BC-UnAuth	SSHv2 session protection.	Bit-strength Caveat:Provides 128 or 256 bits of encryption strength	AES-CBC: (A2952, A3376) Key Length: 128, 256
SSHv2 Session Authentication	MAC	SSHv2 Session Authentication.		HMAC-SHA-1: (A2952, A3376) HMAC-SHA2-256: (A2952, A3376) HMAC-SHA2-384: (A2952, A3376) HMAC-SHA2-512: (A2952, A3376) SHA-1: (A2952, A3376) SHA2-256: (A2952, A3376) SHA2-384: (A2952, A3376) SHA2-512: (A2952, A3376)
SSHv2 Keying Materials Development	KAS-135KDF	SSHv2 session keying materials, used to derive SSHv2 session keys.		KDF SSH: (A2952, A3376)
TLSv1.2 Session Encrypt/Decrypt	BC-Auth BC-UnAuth	TLSv1.2 session protection.	Bit-strength Caveat:Provides 128 or 256 bits of encryption strength	AES-CBC: (A2952, A3376) Key Length: 128, 256 AES-GCM: (A2952, A3376) Key Length: 128, 256
TLSv1.2 Session Authentication	MAC	TLSv1.2 session authentication.		HMAC-SHA-1: (A2952, A3376) HMAC-SHA2-256: (A2952, A3376) HMAC-SHA2-384: (A2952, A3376) HMAC-SHA2-512: (A2952,

Name	Type	Description	Properties	Algorithms
				A3376) SHA-1: (A2952, A3376) SHA2-256: (A2952, A3376) SHA2-384: (A2952, A3376) SHA2-512: (A2952, A3376)
TLSv1.2 Keying Materials Development	KAS-135KDF	TLSv1.2 session keying materials, used to derive TLS session keys.		TLS v1.2 KDF RFC7627: (A2952, A3376)
DRBG Function	DRBG	Used for DRBG generation		Counter DRBG: (A2952, A3376)

Table 10: Security Function Implementations

2.7 Algorithm Specific Information

- For TLSv1.2, the Module's AES-GCM implementation conforms to Implementation Guidance C.H scenario #1 following RFC 5288 for TLS. The Module is compatible with TLSv1.2 and provides support for the acceptable GCM cipher suites from SP 800-52 Rev1, Section 3.3.1. The keys for the client and server negotiated in the TLSv1.2 handshake process (client_write_key and server_write_key) are compared and the module aborts the session if the key values are identical. The operations of one of the two parties involved in the TLS key establishment scheme were performed entirely within the cryptographic boundary of the module being validated. The counter portion of the IV is set by the module within its cryptographic boundary. When the IV exhausts the maximum number of possible values for a given session key, the first party, client or server, to encounter this condition will trigger a handshake to establish a new encryption key. In case the Module's power is lost and then restored, a new key for use with the AES GCM encryption/decryption shall be established.

- In accordance with FIPS 140-3 IG D.H, the cryptographic module performs Cryptographic Key Generation as per section 5 in SP800-133rev2. The resulting generated seed used in the asymmetric key generation is the unmodified output from SP800-90Arev1 DRBG.

- The module was algorithm tested based on the FIPS 186-4 standard Digital Signatures. According to IG C.K, this module is 186-5 compliant as all 186-4 CAVP tests performed are mathematically identical to the 186-5 CAVP tests. The Module does not support 186-4 DSA or RSA X9.31 for Signature Generation or Signature Verification.

2.8 RBG and Entropy

The module employs a Deterministic Random Bit Generator (DRBG) implementation based on SP800-90Arev1. This DRBG is used internally by the module (e.g. to generate symmetric keys, seeds for asymmetric key pairs, and random numbers for security functions).

The DRBG implemented is an AES-128 Counter DRBG, seeded by the Entropy within the TOEPP which is passively loaded into the Module to seed the SP 800-90Arev1 DRBG by the Operating System. The Counter DRBG utilizes the Derivation Function. It does not employ prediction resistance.

The DRBG is instantiated with a 384-bits long entropy input (corresponding to 384 bits of entropy). Additionally, the DRBG is reseeded with a 256-bits long entropy input (corresponding to 256 bits of entropy).

2.9 Key Generation

The module implements Cryptographic Key Generation (CKG, vendor affirmed), compliant with SP 800-133r2. When random values are required, they are obtained from the SP 800-90Ar1 approved DRBG, compliant with Section 4 of SP 800-133r2. The following methods are implemented:

- Safe primes key pair generation: compliant with SP 800-133rev2, Section 5.2, which maps to SP 800-56Arev3. The method described in Section 5.6.1.1.4 of SP 800-56Ar3 (“Testing Candidates”) is used.
- RSA key pair generation: compliant with SP 800-133rev2, Section 5.1, which maps to FIPS 186-4. The method described in Appendix B.3.4 of FIPS 186-4 (“Provable Primes with Conditions Based on Auxiliary Provable Primes”) is used.
- ECC (ECDH and ECDSA) key pair generation: compliant with SP 800-133r2, Section 5.1, which maps to FIPS 186-5. The method described in Appendix B.4 of FIPS 186-4 (“Testing Candidates”) is used. Note that this generation method is also used to generate ECDH key pairs.

Additionally, the module implements the following key derivation methods:

- SSH KDF, TLS 1.2 KDF: compliant with SP 800-135r1. These implementations shall only be used to generate secret keys in the context of the SSHv2 and TLSv1.2 protocols, respectively.

Intermediate key generation values are not output from the module and are explicitly zeroized after processing the service

2.10 Key Establishment

The Module provides the following key/SSP establishment services in the approved mode of operation:

KAS-FFC Shared Secret Computation:

- The Module provides SP800-56Arev3 compliant key establishment according to FIPS 140-3 IG D.F scenario 2 path (2) with KAS-FFC shared secret computation. The shared secret computation provides 112 bits of encryption strength.

- The module supports the use of the safe primes defined in RFC 4419 (SSH). Note that the module only implements domain parameter generation, key pair generation and verification, and shared secret computation:
    - SSH (RFC 4419):
        - MODP-2048 (ID = 14)

KAS-ECC Shared Secret Computation:

- The Module provides SP800-56Arev3 compliant key establishment according to FIPS 140-3 IG D.F scenario 2 path (2) with KAS-ECC shared secret computation. The shared secret computation provides between 128 and 256 bits of encryption strength.

The module also provides the following key transport mechanisms:

- Key wrapping using AES-CBC with HMAC-SHA-1, HMAC-SHA2-256, HMAC-SHA2-384, or HMAC-SHA2-512 with a security strength of 128 or 256 bits.
- Key wrapping using AES-GCM with a security strength of 128 or 256 bits.

2.11 Industry Protocols

The Module supports SSHv2 and TLSv1.2 industrial protocols. No parts of the SSHv2 or TLSv1.2 protocols, other than the KDFs, have been tested by the CAVP and CMVP. Please refer to SSPs Table for more information.

3 Cryptographic Module Interfaces

3.1 Ports and Interfaces

Physical Port	Logical Interface(s)	Data That Passes
N/A	Data Input	Arguments for an API that provide the data to be used for processed by the module.
N/A	Data Output	Arguments output from an API call.
N/A	Control Input	Arguments for an API call used to control and configure module operation.
N/A	Control Output	N/A
N/A	Status Output	Return values, and/or log messages.
N/A	Power	N/A

Table 11: Ports and Interfaces

The module’s physical perimeter encompasses the case of the tested platform mentioned in Section 2.2. The module provides its logical interfaces via Application Programming Interface (API) calls. The logical interfaces provided by the module are mapped onto the FIPS 140-3 interfaces (data input, data output, control input, control output and status output) as follows. The module’s data output interface will be disabled when performing pre-operational self-tests, zeroizing keys, or when in an error state.

4 Roles, Services, and Authentication

4.1 Authentication Methods

N/A for this module.

4.2 Roles

Name	Type	Operator Type	Authentication Methods
Crypto Officer	Role	Crypto Officer	None

Table 12: Roles

The module supports Crypto Officer (CO) role. The module does not allow concurrent operators. The Crypto Officer is implicitly assumed based on the service requested.

4.3 Approved Services

Name	Description	Indicator	Inputs	Outputs	Security Functions	SSP Access
Show Status	Provide Module's current status	None	API command to show status.	Module's current status.	None	Crypto Officer
Show Version	Provide Module's name/ID and versioning information.	None	API commands to show version.	Module's name/ID and versioning information	None	Crypto Officer
Perform Self-Tests	Perform Self-Tests (Pre-operational self-tests and Conditional Self-Tests)	None	API commands to conduct on-demand Self-Tests.	Status of the self-tests results.	None	Crypto Officer
Perform Zeroization	Perform Zeroization.	None	API commands to conduct Zeroization operation or Power down the tested platform.	Status of the SSPs zeroization.	None	Crypto Officer - DRBG Entropy Input: Z - DRBG Seed: Z - DRBG Internal State V value: Z

Name	Description	Indicator	Inputs	Outputs	Security Functions	SSP Access
						- DRBG Key: Z - SSH DH Private Key: Z - SSH DH Public Key: Z - SSH Peer DH Public Key: Z - SSH DH Shared Secret: Z - SSH RSA Private Key: Z - SSH RSA Public Key: Z - SSH Session Encryption Key: Z - SSH Session Authentication Key: Z - TLS ECDH Private Key: Z - TLS ECDH Public Key: Z - TLS Peer ECDH Public Key: Z - TLS ECDH Shared Secret: Z - TLS RSA Private Key: Z - TLS RSA Public Key:

Name	Description	Indicator	Inputs	Outputs	Security Functions	SSP Access
						Z - TLS ECDSA Private Key: Z - TLS ECDSA Public Key: Z - TLS Master Secret: Z - TLS Session Encryption Key: Z - TLS Session Authentication Key: Z
Configure Network	Sets configuration of the systems.	None	API commands to configure the module.	Status of the completion of network related configuration.	None	Crypto Officer
Configure SSHv2 Function	Configure SSHv2 Function	Global Indicator and SSHv2 configuration success status message.	API commands to configure SSHv2.	Status of the completion of SSHv2 configuration.	KTS (SSHv2 with AES and HMAC) KTS (TLSv1.2 with AES and HMAC) KTS (TLSv1.2 with AES-GCM) RSA KeyGen (SSHv2, TLSv1.2) DRBG Function	Crypto Officer - SSH RSA Private Key: G,W,E - SSH RSA Public Key: G,R,W - DRBG Entropy Input: G,W,E - DRBG Seed: G,W,E - DRBG Internal State V value: G,W,E - DRBG Key: G,W,E

Name	Description	Indicator	Inputs	Outputs	Security Functions	SSP Access
Configure HTTPS over TLSv1.2 Function	Configure HTTPS over TLSv1.2 Function.	Global Indicator and HTTPS over TLSv1.2 configuration success status message.	API commands to configure HTTPS over TLSv1.2	Status of the completion of HTTPS over TLSv1.2 configuration.	KTS (SSHv2 with AES and HMAC) KTS (TLSv1.2 with AES and HMAC) KTS (TLSv1.2 with AES-GCM) RSA KeyGen (SSHv2, TLSv1.2) ECDSA KeyGen (TLSv1.2) DRBG Function	Crypto Officer - TLS RSA Private Key: G,W,E - TLS RSA Public Key: G,R,W - TLS ECDSA Private Key: G,W,E - TLS ECDSA Public Key: G,R,W - DRBG Entropy Input: G,W,E - DRBG Seed: G,W,E - DRBG Internal State V value: G,W,E - DRBG Key: G,W,E
Run SSHv2 Function	Execute SSHv2 Function	Global Indicator and Successful SSHv2 log message.	API commands to execute SSHv2 service.	Status of SSHv2 secure tunnel establishment.	KAS-FFC (SSHv2) KTS (SSHv2 with AES and HMAC) RSA SigGen (SSHv2, TLSv1.2) RSA SigVer (SSHv2, TLSv1.2) SSHv2 Session Encrypt/Decrypt SSHv2 Session Authentication	Crypto Officer - SSH DH Private Key: G,W,E - SSH DH Public Key: G,R,W - SSH Peer DH Public Key: W,E - SSH DH Shared Secret: G,W,E - SSH RSA Private Key: G,W,E - SSH RSA

Name	Description	Indicator	Inputs	Outputs	Security Functions	SSP Access
					SSHv2 Keying Materials Development DRBG Function	Public Key: G,R,W - SSH Session Encryption Key: G,W,E - SSH Session Authentication Key: G,W,E - DRBG Entropy Input: G,W,E - DRBG Seed: G,W,E - DRBG Internal State V value: G,W,E - DRBG Key: G,W,E
Run HTTPS over TLSv1.2 Function	Execute HTTPS over TLSv1.2 Function.	Global Indicator and Successful HTTPS over TLSv1.2 log message.	API command to execute HTTPS over TLSv1.2 service.	Status of HTTPS over TLSv1.2 establishment.	KAS-ECC (TLSv1.2) KTS (TLSv1.2 with AES and HMAC) KTS (TLSv1.2 with AES-GCM) RSA SigGen (SSHv2, TLSv1.2) RSA SigVer (SSHv2, TLSv1.2) ECDSA SigGen (TLSv1.2) ECDSA SigVer (TLSv1.2) TLSv1.2 Session Encrypt/Decr	Crypto Officer - TLS ECDH Private Key: G,W,E - TLS ECDH Public Key: G,R,W - TLS Peer ECDH Public Key: W,E - TLS ECDH Shared Secret: G,W,E - TLS RSA Private Key: G,W,E - TLS RSA Public Key:

Name	Description	Indicator	Inputs	Outputs	Security Functions	SSP Access
					ypt TLSv1.2 Session Authentication TLSv1.2 Keying Materials Development DRBG Function	G,R,W - TLS ECDSA Private Key: G,W,E - TLS ECDSA Public Key: G,R,W - TLS Master Secret: G,W,E - TLS Session Encryption Key: G,W,E - TLS Session Authentication Key: G,W,E - DRBG Entropy Input: G,W,E - DRBG Seed: G,W,E - DRBG Internal State V value: G,W,E - DRBG Key: G,W,E

Table 13: Approved Services

4.4 Non-Approved Services

N/A for this module.

4.5 External Software/Firmware Loaded

N/A for this module

4.6 Bypass Actions and Status

N/A for this module.

4.7 Cryptographic Output Actions and Status

N/A for this module.

4.8 Additional Information

The module supports unauthenticated service. The unauthenticated operator can trigger the self-test service by power-cycling the module.

5 Software/Firmware Security

5.1 Integrity Techniques

The module is provided in the form of binary executable code. To ensure the software security, the module is protected by HMAC-SHA2-512 (Certs. #A2952 with PAA or #A3376 without PAA) algorithm. The software integrity test key (non-SSP) was preloaded to the module's binary the factory and used for software integrity test only at the pre-operational self-test. At Module's initialization, the integrity of the runtime executable is verified using a HMAC-SHA2-512 MAC which is compared to a value computed at build time. If at the load time the MAC does not match the stored, known MAC value, the module would enter to an Error state with all crypto functionality inhibited.

5.2 Initiate on Demand

Integrity test is performed as part of the Pre-Operational Self-Tests. It is automatically executed at power-on. The operator can power-cycle or reboot the tested platform to initiate the software integrity test on-demand.

6 Operational Environment

6.1 Operational Environment Type and Requirements

Type of Operational Environment: Modifiable

The module is a software module, which is operated in a modifiable operational environment per FIPS 140-3 level 1 specifications. The module's software version running on each tested platform is 7.0.5.

The module has control over its own SSPs. The process and memory management functionality of the host device's OS prevent unauthorized access to plaintext private and secret keys, intermediate key generation values and other SSPs by external processes during module execution. The module only allows access to SSPs through its well-defined API. The operational environments provide the capability to separate individual application processes from each other by preventing uncontrolled access to CSPs and uncontrolled modifications of SSPs regardless of whether this data is in the process memory or stored on persistent storage within

the operational environment. Processes that are spawned by the module are owned by the module and are not owned by external processes/operators.

7 Physical Security

The FIPS 140-3 physical security requirements do not apply to the Module since it is a software module.

8 Non-Invasive Security

Currently, non-invasive security is not required by FIPS 140-3 (see NIST SP 800-140F). The requirements of this area are not applicable to the module.

9 Sensitive Security Parameters Management

9.1 Storage Areas

Storage Area Name	Description	Persistence Type
DRAM	Volatile memory provided by the ESXi host for the module temporary.	Dynamic
Flash	Non-Volatile memory provided by the ESXi host for the module to retain memory across power-cycles.	Static

Table 14: Storage Areas

9.2 SSP Input-Output Methods

Name	From	To	Format Type	Distribution Type	Entry Type	SFI or Algorithm
Peer Public Key Input	External (Outside of the TOEPP)	TOEPP	Plaintext	Automated	Electronic	
Module Public Key Output	TOEPP	External (Outside of the TOEPP)	Plaintext	Automated	Electronic	
Secret Input via SSHv2 encrypted by AES and HMAC	External (Outside of the TOEPP)	TOEPP	Encrypted	Automated	Electronic	KTS (SSHv2 with AES and HMAC)
Secret Input via TLS encrypted by GCM	External (Outside of the Module's Boundary)	TOEPP	Encrypted	Automated	Electronic	KTS (TLSv1.2 with AES-GCM)
Secret Input via TLS	External (Outside of	TOEPP	Encrypted	Automated	Electronic	KTS (TLSv1.2

Name	From	To	Format Type	Distribution Type	Entry Type	SFI or Algorithm
encrypted by AES and HMAC	the Module's Boundary)					with AES and HMAC)

Table 15: SSP Input-Output Methods

9.3 SSP Zeroization Methods

Zeroization Method	Description	Rationale	Operator Initiation
Zeroization Command	CO issues zeroization service	The zeroization command will erase all SSPs stored in the DRAM of the module.	Delete the virtual machine from the VMware ESXi host.
Session Termination	Zeroization upon session termination	Session termination will automatically zeroize all session based temporary SSPs	Terminate Session
Reboot	Zeroization upon rebooting the module	Reboot to zeroize all temporary SSPs stored in volatile memory	Reboot

Table 16: SSP Zeroization Methods

9.4 SSPs

Name	Description	Size - Strength	Type - Category	Generated By	Established By	Used By
DRBG Entropy Input	Used to seed the DRBG	384 bits - at least 256 bits	Entropy Input - CSP			DRBG Function
DRBG Seed	Used in DRBG Generation	256 bits - 256 bits	DRBG Seed - CSP			DRBG Function
DRBG Internal State V value	Used in DRBG Generation	256 bits - 256 bits	DRBG Internal State V value - CSP			DRBG Function
DRBG Key	Used in DRBG Generation	256 bits - 256 bits	DRBG Key - CSP			DRBG Function
SSH DH Private Key	Used to derive the SSH DH Shared Secret	MODP-2048 - 112 bits	Private Key - CSP	KAS-FFC (SSHv2)		KAS-FFC (SSHv2)

Name	Description	Size - Strength	Type - Category	Generated By	Established By	Used By
SSH DH Public Key	Used to derive SSH DH Shared Secret	MODP-2048 - 112 bits	Public Key - PSP		KAS-FFC (SSHv2)	
SSH Peer DH Public Key	Used to derive SSH DH Shared Secret	MODP-2048 - 112 bits	Public Key - PSP			KAS-FFC (SSHv2)
SSH DH Shared Secret	Used to derive SSH Session Encryption Keys, SSH Session Authentication Keys	MODP-2048 - 112 bits	Shared Secret - CSP		KAS-FFC (SSHv2)	SSHv2 Keying Materials Development
SSH RSA Private Key	Used for SSH session authentication	Modulus: 2048, 3072 - 112-128 bits	Private Key - CSP	RSA KeyGen (SSHv2, TLSv1.2)		RSA SigGen (SSHv2, TLSv1.2)
SSH RSA Public Key	Used for SSH session authentication	Modulus: 2048, 3072 - 112-128 bits	Public Key - PSP		RSA KeyGen (SSHv2, TLSv1.2)	
SSH Session Encryption Key	Used for SSH session confidentiality protection	128, 256 bits - 128, 256 bits	Symmetric Key - CSP		SSHv2 Keying Materials Development	SSHv2 Session Encrypt/Decrypt
SSH Session Authentication Key	Used for SSH Session integrity protection	At least 160 bits - At least 160 bits	Session Key - CSP		SSHv2 Keying Materials Development	SSHv2 Session Authentication
TLS ECDH Private Key	Used to Derive TLS ECDH Shared Secret	Curves: P-256, P-384, P-521 - 128-256 bits	Private Key - CSP	KAS-ECC (TLSv1.2)		KAS-ECC (TLSv1.2)
TLS ECDH Public Key	Used to Derive TLS ECDH Shared Secret	Curves: P-256, P-384, P-521 -	Public Key - PSP		KAS-ECC (TLSv1.2)	

Name	Description	Size - Strength	Type - Category	Generated By	Established By	Used By
		128-256 bits				
TLS Peer ECDH Public Key	Used to derive TLS ECDH Shared Secret	Curves: P-256, P-384, P-521 - 128-256 bits	Public Key - PSP			KAS-ECC (TLSv1.2)
TLS ECDH Shared Secret	Used to Derive TLS Session Encryption Key and TLS Session Authentication Key	Curves: P-256, P-384, P-521 - 128-256 bits	Shared Secret - CSP		KAS-ECC (TLSv1.2)	TLSv1.2 Keying Materials Development
TLS RSA Private Key	Used to support CO HTTPS interfaces	Modulus: 2048, 3072 - 112-128 bits	Private Key - CSP	RSA KeyGen (SSHv2, TLSv1.2)		RSA SigGen (SSHv2, TLSv1.2)
TLS RSA Public Key	Used to support CO HTTPS interfaces	Modulus: 2048, 3072 - 112-128 bits	Public Key - PSP		RSA KeyGen (SSHv2, TLSv1.2)	
TLS ECDSA Private Key	Used to support CO HTTPS interfaces	Curves: P-256, P-384, P-521 - 128-256 bits	Private Key - CSP	ECDSA KeyGen (TLSv1.2)		ECDSA SigGen (TLSv1.2)
TLS ECDSA Public Key	Used to support CO HTTPS interfaces	Curves: P-256, P-384, P-521 - 128-256 bits	Public Key - PSP		ECDSA KeyGen (TLSv1.2)	
TLS Master Secret	Used to protect HTTPS Session	At least 112 bits - At least 112 bits	Master Secret - CSP		TLSv1.2 Keying Materials Development	TLSv1.2 Session Encrypt/Decrypt TLSv1.2 Session Authentication

Name	Description	Size - Strength	Type - Category	Generated By	Established By	Used By
TLS Session Encryption Key	Used to protect HTTPS Session	128, 256 bits - 128, 256 bits	Symmetric Key - CSP		TLSv1.2 Keying Materials Development	TLSv1.2 Session Encrypt/Decrypt
TLS Session Authentication Key	Used to authenticate HTTPS Session	160, 256, 384, 512 bits - 160, 256, 384, 512 bits	Message Authentication Key - CSP		TLSv1.2 Keying Materials Development	TLSv1.2 Session Authentication

Table 17: SSP Table 1

Name	Input - Output	Storage	Storage Duration	Zeroization	Related SSPs
DRBG Entropy Input		DRAM:Plaintext	Until Reboot	Zeroization Command Reboot	DRBG Seed:Used With DRBG Internal State V value:Used With DRBG Key:Used With
DRBG Seed		DRAM:Plaintext	Until Reboot	Zeroization Command Reboot	DRBG Entropy Input:Used With DRBG Internal State V value:Used With DRBG Key:Used With
DRBG Internal State V value		DRAM:Plaintext	Until Reboot	Zeroization Command Reboot	DRBG Entropy Input:Used With DRBG Seed:Used With DRBG Key:Used With
DRBG Key		DRAM:Plaintext	Until Reboot	Zeroization Command Reboot	DRBG Entropy Input:Used With DRBG Seed:Used With DRBG Internal State V value:Used With

Name	Input - Output	Storage	Storage Duration	Zeroization	Related SSPs
SSH DH Private Key		DRAM:Plaintext	While SSH session is active	Zeroization Command Session Termination Reboot	SSH DH Public Key:Paired With SSH Peer DH Public Key:Used With
SSH DH Public Key	Module Public Key Output	DRAM:Plaintext	While SSH session is active	Zeroization Command Session Termination Reboot	SSH DH Private Key:Paired With
SSH Peer DH Public Key	Peer Public Key Input	DRAM:Plaintext	While SSH session is active	Zeroization Command Session Termination Reboot	SSH DH Private Key:Used With
SSH DH Shared Secret		DRAM:Plaintext	While SSH session is active	Zeroization Command Session Termination Reboot	SSH DH Private Key:Derived From SSH Peer DH Public Key:Derived From
SSH RSA Private Key		Flash:Plaintext		Zeroization Command	SSH RSA Public Key:Paired With
SSH RSA Public Key	Module Public Key Output Secret Input via SSHv2 encrypted by AES and HMAC	Flash:Plaintext		Zeroization Command	SSH RSA Private Key:Paired With
SSH Session Encryption Key		DRAM:Plaintext	While SSH session is active	Zeroization Command Session Termination Reboot	SSH Session Authentication Key:Used With
SSH Session Authentication Key		DRAM:Plaintext	While SSH session is active	Zeroization Command Session Termination Reboot	SSH Session Encryption Key:Used With
TLS ECDH Private Key		DRAM:Plaintext	While TLS session is active	Zeroization Command Session	TLS ECDH Public Key:Paired With TLS Peer

Name	Input - Output	Storage	Storage Duration	Zeroization	Related SSPs
				Termination Reboot	ECDH Public Key:Used With
TLS ECDH Public Key	Module Public Key Output	DRAM:Plaintext	While TLS session is active	Zeroization Command Session Termination Reboot	TLS ECDH Private Key:Paired With
TLS Peer ECDH Public Key	Peer Public Key Input	DRAM:Plaintext	While TLS session is active	Zeroization Command Session Termination Reboot	TLS ECDH Private Key:Used With
TLS ECDH Shared Secret		DRAM:Plaintext	While TLS session is active	Zeroization Command Session Termination Reboot	TLS ECDH Private Key:Derived From TLS Peer ECDH Public Key:Derived From
TLS RSA Private Key		Flash:Plaintext		Zeroization Command	TLS RSA Public Key:Paired With
TLS RSA Public Key	Module Public Key Output Secret Input via TLS encrypted by GCM Secret Input via TLS encrypted by AES and HMAC	Flash:Plaintext		Zeroization Command	TLS RSA Private Key:Paired With
TLS ECDSA Private Key		Flash:Plaintext		Zeroization Command	TLS ECDSA Public Key:Paired With
TLS ECDSA Public Key	Module Public Key Output Secret Input via TLS encrypted by GCM Secret	Flash:Plaintext		Zeroization Command	TLS ECDSA Private Key:Paired With

Name	Input - Output	Storage	Storage Duration	Zeroization	Related SSPs
	Input via TLS encrypted by AES and HMAC				
TLS Master Secret		DRAM:Plaintext	While TLS session is active	Zeroization Command Session Termination Reboot	TLS ECDH Shared Secret:Derived From
TLS Session Encryption Key		DRAM:Plaintext	While TLS session is active	Zeroization Command Session Termination Reboot	TLS Session Authentication Key:Used With TLS Master Secret:Derived From
TLS Session Authentication Key		DRAM:Plaintext	While TLS session is active	Zeroization Command Session Termination Reboot	TLS Session Encryption Key:Used With TLS Master Secret:Derived From

Table 18: SSP Table 2

9.5 Transitions

SHA-1: The module includes an implementation of SHA-1 for hashing and signature verification. This implementation will be non-Approved for all uses starting January 1, 2031.

FIPS 186-4/186-5: As of February 5, 2024, the CMVP does not accept module submissions that implement DSA or RSA X9.31 in the approved mode, other than for signature verification which is approved for legacy use. This module does not implement DSA or RSA X9.31 for signature generation and therefore is unaffected by the current transition from 186-4 to 186-5. As detailed in section 2.7, the CAVP testing performed on the 186-4 algorithms is mathematically similar to the testing performed on the 186-5 algorithms and therefore this module claims compliance with 186-5. This means that no timeline exists in which any of the implemented algorithms will transition from approved to non-approved.

10 Self-Tests

10.1 Pre-Operational Self-Tests

Algorithm or Test	Test Properties	Test Method	Test Type	Indicator	Details
HMAC-SHA2-512 (A2952)	MAC with HMAC-SHA2-512	KAT	SW/FW Integrity	Module is in normal state	HMAC-SHA2-512

Table 19: Pre-Operational Self-Tests

The module performs the following self-tests, including Pre-operational and Conditional self-tests. Prior to the module providing any data output via the data output interface, the module performs and passes the pre-operational self-tests. Following the successful pre-operational self-tests, the module executes the Conditional Cryptographic Algorithm Self-tests (CASTs). The self-test success or failure results are an output of the return value of the library load API call, which is functioning as the self-test status indicator. If anyone of the self-tests fails, the module transitions into an error state and outputs the error message via the module's status output interface. While the module is in the error state, all data through the data output interface and all cryptographic operations are disabled. The error state can only be cleared by reloading the module. All self-tests must be completed successfully before the module transitions to the operational state.

10.2 Conditional Self-Tests

Algorithm or Test	Test Properties	Test Method	Test Type	Indicator	Details	Conditions
AES-CBC Encrypt KAT (A2952/A3376)	256 bits	KAT	CAST	Module is in normal state	Encrypt	Power up
AES-CBC Decrypt KAT (A2952/A3376)	256 bits	KAT	CAST	Module is in normal state	Decrypt	Power up
AES-GCM Authenticated Encrypt KAT (A2952/A3376)	256 bits	KAT	CAST	Module is in normal state	Authenticated Encrypt	Power up
AES-GCM Authenticated Decrypt KAT (A2952/A3376)	256 bits	KAT	CAST	Module is in normal state	Authenticated Decrypt	Power up
Counter DRBG Instantiate/Generate/Reseed KAT (A2952/A3376)	AES-128	KAT	CAST	Module is in normal state	Instantiate, Generate, and Reseed KATs	Power up
ECDSA SigGen (FIPS186-4) KAT (A2952/A3376)	Curve P-256 with SHA2-256	KAT	CAST	Module is in normal state	ECDSA SigGen KAT	Power up
ECDSA SigVer (FIPS186-4) KAT (A2952/A3376)	Curve P-256 with SHA2-256	KAT	CAST	Module is in normal state	ECDSA SigVer KAT	Power up
HMAC-SHA-1 KAT (A2952/A3376)	SHA-1	KAT	CAST	Module is in normal state	HMAC-SHA-1	Power up

Algorithm or Test	Test Properties	Test Method	Test Type	Indicator	Details	Conditions
HMAC-SHA2-256 KAT (A2952/A3376)	SHA2-256	KAT	CAST	Module is in normal state	HMAC-SHA2-256	Power up
HMAC-SHA2-384 KAT (A2952/A3376)	SHA2-384	KAT	CAST	Module is in normal state	HMAC-SHA2-384	Power up
HMAC-SHA2-512 KAT (A2952/A3376)	SHA2-512	KAT	CAST	Module is in normal state	HMAC-SHA2-512	Power up
KAS-ECC-SSC Sp800-56Ar3 KAT (A2952/A3376)	Curve: P-256	KAT	CAST	Module is in normal state	Primitive Z KAT	Power up
KAS-FFC-SSC Sp800-56Ar3 KAT (A2952/A3376)	MODP-2048	KAT	CAST	Module is in normal state	Primitive Z KAT	Power up
KDF SSH KAT (A2952/A3376)	N/A	KAT	CAST	Module is in normal state	N/A	Power up
RSA SigGen (FIPS186-4) KAT (A2952/A3376)	2048 bit modulus with SHA2-256	KAT	CAST	Module is in normal state	RSA	Power up
RSA SigVer (FIPS186-4) KAT (A2952/A3376)	2048 bit modulus with SHA2-256	KAT	CAST	Module is in normal state	RSA	Power up
SHA-1 KAT (A2952/A3376)	N/A	KAT	CAST	Module is in normal state	N/A	Power up
TLS v1.2 KDF RFC7627 KAT (A2952/A3376)	N/A	KAT	CAST	Module is in normal state	N/A	Power up
ECDSA KeyGen (FIPS186-4) PCT (A2952/A3376)	N/A	PCT	PCT	Module is in normal state	ECDSA	Performs all required pair-wise consisten

Algorithm or Test	Test Properties	Test Method	Test Type	Indicator	Details	Conditions
						cy tests on the newly generated key pairs before the first operational use.
KAS-ECC-SSC Sp800-56Ar3 PCT (A2952/A3376)	N/A	PCT	PCT	Module is in normal state	N/A	Performs all required pair-wise consistency tests on the newly generated key pairs before the first operational use.
KAS-FFC-SSC Sp800-56Ar3 PCT (A2952/A3376)	N/A	PCT	PCT	Module is in normal state	N/A	Performs all required pair-wise consistency tests on the newly generated key pairs before the first operational use.
RSA KeyGen (FIPS186-4) PCT (A2952/A3376)	N/A	PCT	PCT	Module is in normal state	RSA	Performs all required pair-wise consistency tests on the newly generated key pairs

Algorithm or Test	Test Properties	Test Method	Test Type	Indicator	Details	Conditions
						before the first operational use.

Table 20: Conditional Self-Tests

10.3 Periodic Self-Test Information

Algorithm or Test	Test Method	Test Type	Period	Periodic Method
HMAC-SHA2-512 (A2952)	KAT	SW/FW Integrity	Recommend 60 Days	Reboot

Table 21: Pre-Operational Periodic Information

Algorithm or Test	Test Method	Test Type	Period	Periodic Method
AES-CBC Encrypt KAT (A2952/A3376)	KAT	CAST	Recommend 60 Days	Reboot
AES-CBC Decrypt KAT (A2952/A3376)	KAT	CAST	Recommend 60 Days	Reboot
AES-GCM Authenticated Encrypt KAT (A2952/A3376)	KAT	CAST	Recommend 60 Days	Reboot
AES-GCM Authenticated Decrypt KAT (A2952/A3376)	KAT	CAST	Recommend 60 Days	Reboot
Counter DRBG Instantiate/Generate/Reseed KAT (A2952/A3376)	KAT	CAST	Recommend 60 Days	Reboot
ECDSA SigGen (FIPS186-4) KAT (A2952/A3376)	KAT	CAST	Recommend 60 Days	Reboot
ECDSA SigVer (FIPS186-4) KAT (A2952/A3376)	KAT	CAST	Recommend 60 Days	Reboot
HMAC-SHA-1 KAT (A2952/A3376)	KAT	CAST	Recommend 60 Days	Reboot
HMAC-SHA2-256 KAT (A2952/A3376)	KAT	CAST	Recommend 60 Days	Reboot
HMAC-SHA2-384 KAT (A2952/A3376)	KAT	CAST	Recommend 60 Days	Reboot
HMAC-SHA2-512 KAT (A2952/A3376)	KAT	CAST	Recommend 60 Days	Reboot
KAS-ECC-SSC Sp800-56Ar3 KAT (A2952/A3376)	KAT	CAST	Recommend 60 Days	Reboot
KAS-FFC-SSC Sp800-56Ar3 KAT (A2952/A3376)	KAT	CAST	Recommend 60 Days	Reboot
KDF SSH KAT (A2952/A3376)	KAT	CAST	Recommend 60 Days	Reboot

Algorithm or Test	Test Method	Test Type	Period	Periodic Method
RSA SigGen (FIPS186-4) KAT (A2952/A3376)	KAT	CAST	Recommend 60 Days	Reboot
RSA SigVer (FIPS186-4) KAT (A2952/A3376)	KAT	CAST	Recommend 60 Days	Reboot
SHA-1 KAT (A2952/A3376)	KAT	CAST	Recommend 60 Days	Reboot
TLS v1.2 KDF RFC7627 KAT (A2952/A3376)	KAT	CAST	Recommend 60 Days	Reboot
ECDSA KeyGen (FIPS186-4) PCT (A2952/A3376)	PCT	PCT	Recommend 60 Days	Reboot
KAS-ECC-SSC Sp800-56Ar3 PCT (A2952/A3376)	PCT	PCT	Recommend 60 Days	Reboot
KAS-FFC-SSC Sp800-56Ar3 PCT (A2952/A3376)	PCT	PCT	Recommend 60 Days	Reboot
RSA KeyGen (FIPS186-4) PCT (A2952/A3376)	PCT	PCT	Recommend 60 Days	Reboot

Table 22: Conditional Periodic Information

The module performs on-demand self-tests initiated by the operator, by powering off and powering the module back on. The full suite of self-tests is then executed. The same procedure may be employed by the operator to perform periodic self-tests.

10.4 Error States

Name	Description	Conditions	Recovery Method	Indicator
Error State	If self-test tests fail, the module is put into an error state.	Self-test failure	Reboot the module	System halt

Table 23: Error States

If any of the above-mentioned self-tests fail, the module reports the error and enters the Error state. In the Error State, no cryptographic services are provided, and data output is prohibited. The only method to recover from the error state is to reboot the module and perform the self-tests, including the pre-operational integrity test and the conditional CASTs. The module will only enter into the operational state after successfully passing the pre-operational integrity test and the conditional CASTs.

11 Life-Cycle Assurance

11.1 Installation, Initialization, and Startup Procedures

The module meets all the Level 1 requirements for FIPS 140-3. The validated module's executable file Cisco_Firepower_NGIPS_VMware-7.0.5-72-disk1.vmdk is the only allowable software image file running on the respective test platform listed in the Section 2.2 above while in the approved mode. The Crypto Officer must configure and enforce the following initialization

steps. Operating this module without maintaining the following settings would put module operated in a non-compliance state.

Step 1: For all Management Centers, the setup process must be completed by logging into the Management Center's web interface and specifying initial configuration options on a setup page.

Step 2: Choose System > Configuration (Choose SSH or HTTPS or a combination of these options to specify which ports you want to enable for these IP addresses).

Step 3: System>Licenses>Smart Licenses, add and verify licenses (Firepower Management Center Configuration Guide provides more detailed information). Install AES SMART license to use AES (for data traffic and SSH).

Step 4: System > Configuration; Devices > Platform Settings; STIG Compliance, choose Enable STIG Compliance; Click on save.

Step 5: Reboot the security appliance.

11.2 Administrator Guidance

No specific Administrator guidance.

11.3 Non-Administrator Guidance

No specific Non-Administrator guidance.

12 Mitigation of Other Attacks

The requirements under INCITS+ISO+IEC 19790+2012[2014], section 7.12 "Mitigation of other attacks", are not applicable to the module since the module currently doesn't support any mitigation of other attacks services..