

SafeNet Encryptor Model 600

FIPS 140-2 – Level 3 Validation Non-Proprietary Security Policy



Hardware Part Numbers

| | | |
|----------------------------------|-----------------------|----------------------|
| 155/622 MB (OC-3/12) | 2 km (904-10001-00x) | 904-30013-00x (RoHS) |
| 155/622 MB (OC-3/12) | 15 km (904-10002-00x) | 904-10014-00x (RoHS) |
| 155/622 MB (OC-3/12) | 40 km (904-10003-00x) | 904-10014-00x (RoHS) |
| 1.0 GB | 10km (904-10112-00x) | 904-10113-00x (RoHS) |
| 2.4 GB (OC-48) | 2 km (904-20001-00x) | 904-25005-00x (RoHS) |
| 2.4 GB (OC-48) | 15 km (904-20002-00x) | 904-25005-00x (RoHS) |
| 2.4 GB (OC-48) | 40 km (904-20003-00x) | 904-25005-00x (RoHS) |
| | | |
| SafeNet SONET Encryptor (SSE) | 904-511i0-00p (RoHS) | 904-511i1-00p (RoHS) |
| SafeNet Ethernet Encryptor (SEE) | 943-511i0-00p (RoHS) | 943-511i1-00p (RoHS) |

Note: See Table 2.2-1 for model numbering conventions.

with Firmware versions 4.0.2 and 4.0.3

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1 Introduction

1.1 Overview

This document is the Security Policy for the SafeNet Encryptor, Model 600 manufactured by SafeNet, Inc. This Security Policy specifies the security rules under which the module shall operate to meet the requirements of FIPS 140-2 Level 3. It also describes how the encryptor functions in order to meet the FIPS requirements, and the actions that operators must take to maintain the security of the encryptor.

This Security Policy describes the features and design of the encryptor using the terminology contained in the FIPS 140-2 specification. *FIPS 140-2, Security Requirements for Cryptographic Modules* specifies the security requirements that will be satisfied by a cryptographic module utilized within a security system protecting sensitive but unclassified information. The NIST/CSEC Cryptographic Module Validation Program (CMVP) validates cryptographic modules to FIPS 140-2. Validated products are accepted by the Federal agencies of both the USA and Canada for the protection of sensitive or designated information.

The FIPS 140-2 standard, and information on the CMVP, can be found at <http://csrc.nist.gov/groups/STM/cmvp/index.html>. More information describing the SafeNet Encryptor can be found at <http://safenet-inc.com>.

This Security Policy defines the cryptographic module for multiple interface variants from 100 Mbps to 2.4 Gbps. These variants are functionally identical.

This Security Policy contains only non-proprietary information. All other documentation submitted for FIPS 140-2 conformance testing and validation is “SafeNet - Proprietary” and is releasable only under appropriate non-disclosure agreements.

1.2 References

| Document No. | Author | Title |
|------------------------|--------|---|
| FIPS PUB 140-2 | NIST | FIPS PUB 140-2: Security Requirements for Cryptographic Modules |
| FIPS PUB 140-2 Annex A | NIST | FIPS 140-2 Annex A: Approved Security Functions |
| FIPS PUB 140-2 Annex B | NIST | FIPS 140-2 Annex B: Approved Protection Profiles |
| FIPS PUB 140-2 Annex C | NIST | FIPS 140-2 Annex C: Approved Random Number Generators |
| FIPS PUB 140-2 Annex D | NIST | FIPS 140-2 Annex D: Approved Key Establishment Techniques |
| DTR for FIPS PUB 140-2 | NIST | Derived Test Requirements (DTR) for FIPS PUB 140-2, Security Requirements for Cryptographic Modules |
| FIPS PUB 46-3 | NIST | Data Encryption Standard (DES) |
| FIPS PUB 81 | NIST | DES Modes of Operation |
| FIPS PUB 186-2 | NIST | Digital Signature Standard (DSS) |
| FIPS PUB 180-1 | NIST | Secure Hash Standard (SHS) |
| SP 800-131 | NIST | Recommendations for the Transitioning of Cryptographic Algorithms and Key Sizes (Draft – June 2010) |

All of the above references are available at URL: <http://csrc.nist.gov/groups/STM/cmvp/index.html>.

1.3 Terminology

In this document, the SafeNet Encryptor is also referred to as “the module” or “the encryptor”.

1.4 FIPS Requirements

The encryptor meets the overall requirements applicable for FIPS 140-2 to Level 3 security as shown in Table 1.4-1.

Table 1.4-1 – Cryptographic Module Security Requirements

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

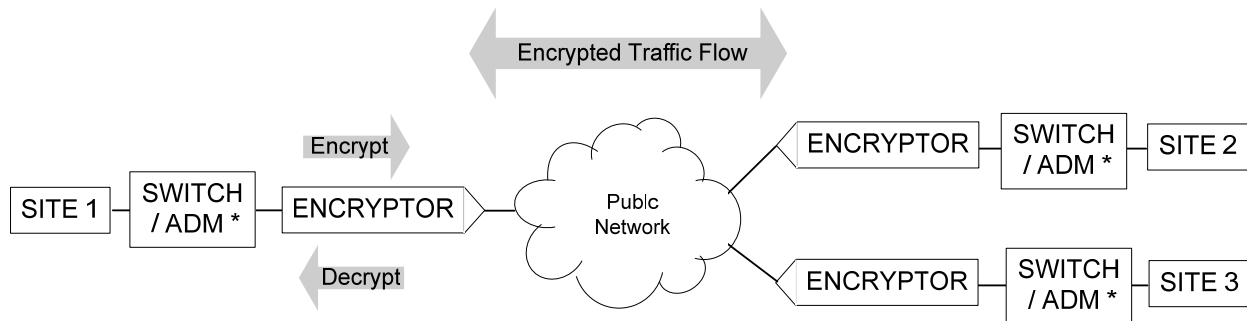
2 SafeNet Encryptor

2.1 Functional Overview

The SafeNet Encryptor provides data privacy and access control for connections between vulnerable public and private networks. It employs FIPS approved AES and Triple-DES algorithms and, with the flexibility to choose the desired interface module, can be deployed in 100 MB / 1.0 GB (Ethernet), 155/622 MB (OC-3/12), and 2.4 GB (OC-48) networks. The encryptor can be centrally controlled or managed across multiple remote stations using SafeNet's Security Management Center (SMC), a SNMPv3-based security management system.

The role of the encryptor is illustrated in Figure 2.1-1. The encryptor is installed between private network equipment and a public network. An encryptor communicates with other encryptors in the network, establishing secured connections between itself and the other modules. The encryptors selectively encrypt, zeroize, or pass in the clear, data flowing from the switch to the network. Conversely the encryptors selectively decrypt, reject, or pass information flowing from the network to the switch.

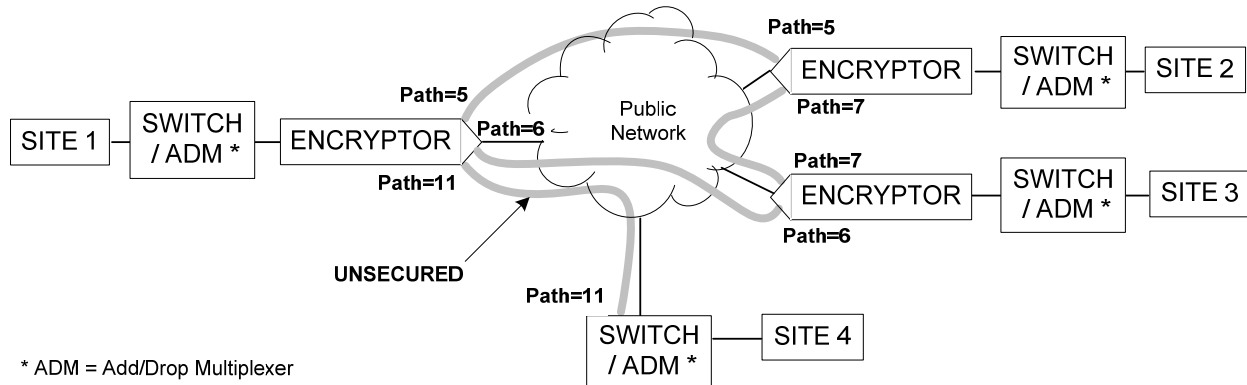
Figure 2.1-1 – Encryptor Operation



* ADM = Add/Drop Multiplexer

Secured connections are established between the cryptographic modules using the RSA key exchange process (as specified in the ATM Forum Security Specification version 1.1). This results in a separate secure session and does not require any secret session keys to ever be displayed or manually transported and installed.

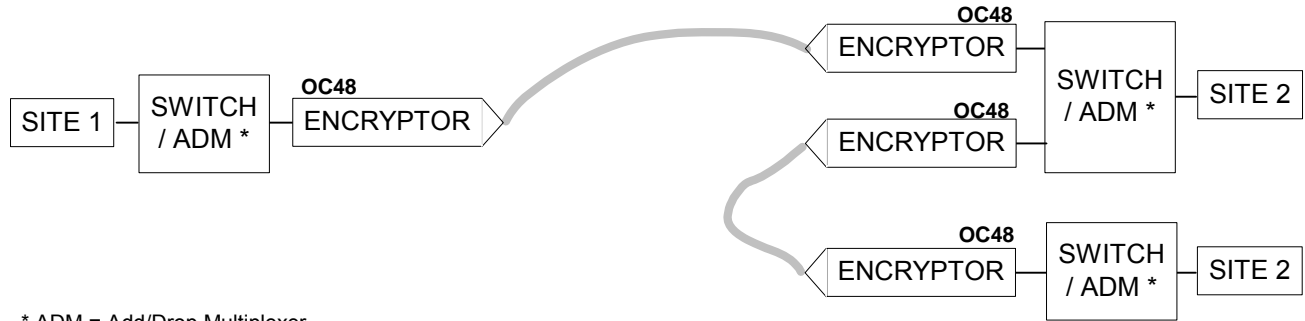
Figure 2.1-2 – Encryptor Usage in Path Encryption Mode



* ADM = Add/Drop Multiplexer

Figure 2.1-2 shows an example of three secured paths and one unsecured path between sites.

Figure 2.1-3 – Encryptor Usage in Line/Link Encryption Mode



* ADM = Add/Drop Multiplexer

Figure 2.1-3 shows an example using encryptors in line or link encryption mode.

2.2 Module Description

The SafeNet Encryptor is a multiple-chip standalone cryptographic module consisting of production-grade components contained in a physically protected enclosure in accordance with FIPS 140-2 Level 3. The module outer casing defines the cryptographic boundary. The steel case completely encloses the encryptor to protect it from tampering. Any attempt to remove the cover will automatically erase all sensitive information stored internally in the encryptor.

Table 2.2-1 – Supported Models

| | | |
|----------------------------------|-----------------------|----------------------|
| 155/622 MB (OC-3/12) | 2 km (904-10001-00x) | 904-30013-00x (RoHS) |
| 155/622 MB (OC-3/12) | 15 km (904-10002-00x) | 904-10014-00x (RoHS) |
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| SafeNet SONET Encryptor (SSE) | 904-511i0-00p (RoHS) | 904-511i1-00p (RoHS) |
| SafeNet Ethernet Encryptor (SEE) | 943-511i0-00p (RoHS) | 943-511i1-00p (RoHS) |

The 'x' in the model numbers represents the power cord variants.

Power cords are accessory kit items that are separate from the physical systems.

- 1 US power cord
- 2 UK power cord
- 4 European power cord
- 5 Swiss power cord
- 7 -48V DC power cord

| | |
|---|---|
| <p>The 'i' in the model numbers represents the interface speed variants.</p> <p>Licensing is a logical Right to Use that is separate from the physical systems.</p> | <p>For SONET Encryptors (904-)</p> <ul style="list-style-type: none"> • 0 License for OC3 • 2 License for OC12 • 4 License for OC48 <p>For Ethernet Encryptors (943-)</p> <ul style="list-style-type: none"> • 3 License for 100MBPS • 5 License for 1GBPS |
| <p>The 'p' in the model numbers represents the power variant of the module.</p> <p>The 'p' may be any of the values listed.</p> | <ul style="list-style-type: none"> • 1 AC power • 7 -48V DC power |

The models differ only in the enclosed line interface card containing the protocol-specific cryptographic accelerators. The line interface card itself is not meant to be field serviceable. Any attempt to remove the interface will tamper the encryptor, erasing all sensitive information stored internally. While the line interface cards are not field serviceable, the pluggable transceivers are. The pluggable transceivers are outside the cryptographic boundary and may be changed as needed for the specific requirements of the network infrastructure.

Module management is provided out-of-band using the dedicated front panel Ethernet port or a console port.

2.2.1 Enclosure Indicators, Connectors and Controls

The SafeNet Encryptor is a member of the Model 600 series. All 600 series models share a common enclosure. Figure 2.2-1 shows the front view, which is the same for all the 600 series models except for the labeling. The front panel provides a network management port, a console port, a USB port, an LCD display and LEDs for status, and a keypad for control input.

Figure 2.2-1 – Front View of Model 600 Encryptor

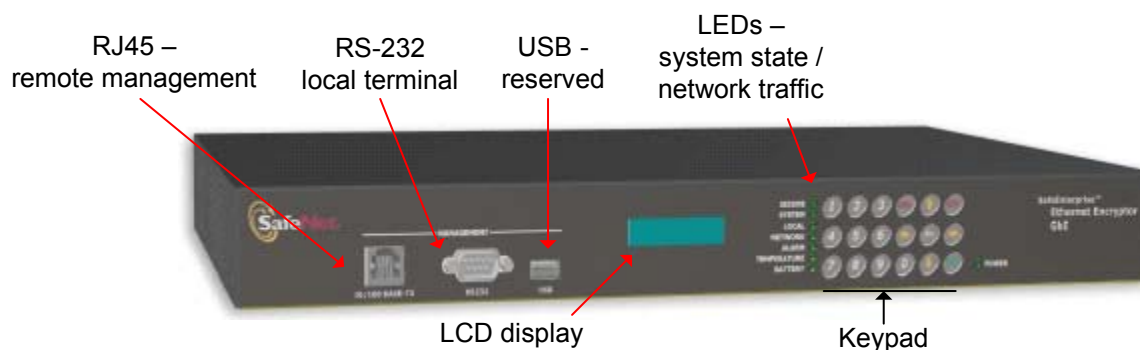
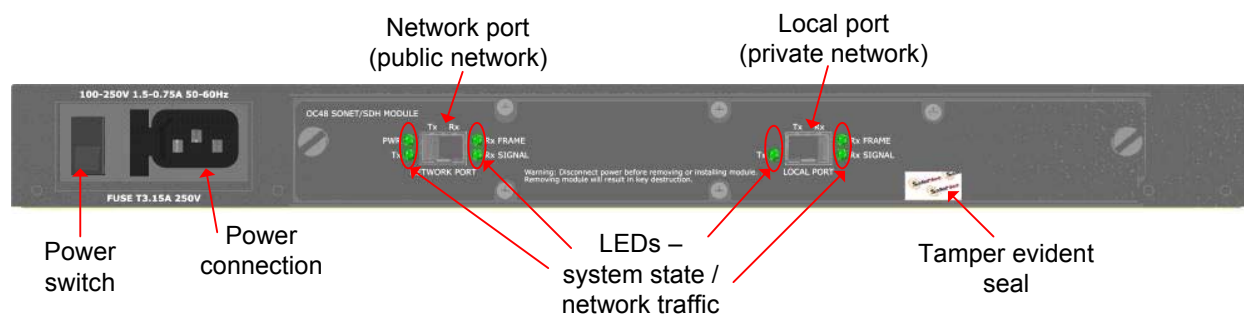


Figure 2.2-2 – Rear View of Model 600 Encryptor

The encryptor has two network interfaces located in the back of the module (Figure 2.2-2): the Local Port interface connects to a physically secure private network and the Network Port interface connects to an unsecure public network. The rear view is identical for the various models except for the labeling on the line interface card. The labeling identifies the interface card as SONET or Ethernet.

The rear panel also contains network activity LEDs, the power connector (AC connector shown), the power switch, and a tamper evident seal that indicates movement of the module cover with respect to the module enclosure.

2.2.1.1 Front Panel Physical Interfaces

- The **RJ45** Ethernet port allows remote management from the SMC application. Access is protected by SNMPv3 security mechanisms for authentication and data encryption. This port is also on the same layer 2 LAN subnet as all other encryptors in the network.
- The DB9 **RS-232** serial console port connects to a local terminal and provides a command line interface for initialization prior to authentication and operation in the approved mode. This port also allows administrative access and monitoring of operations. Access is protected by user names and passwords.
- The **USB port** is reserved for future use.
- The **keypad** allows entry of initialization commands.
- The **LCD** displays configuration information in response to commands entered using the front panel keypad and indicates the state of RSA keys and certificates.
- The **LEDs** indicate the state of the system including alarms.

2.2.1.2 Rear Panel Physical Interfaces

- The **LEDs** indicate network traffic.
- The **Network Port** connects to the public network via the transceiver's rear panel public network connector. Access is protected by RSA certificates. The Local Port and Network Port are of the same interface type.
- The **Local Port** connects to the private network via the transceiver's rear panel local network connector. The Local Port and Network Port are of the same interface type.

The logical interfaces consist of Data Input, Data Output, Control Input, and Status Output as follows:

Table 2.2-2 – Cryptographic Module Logical Interfaces

| Logical Interface | Description |
|---------------------------|--|
| Data Input Data Output | <p>Local Port:</p> <ul style="list-style-type: none"> • Connects to the private network via the transceiver, sending and receiving plaintext user data. <p>Network Port:</p> <ul style="list-style-type: none"> • Connects to the public network via the transceiver, sending and receiving ciphertext and plaintext user data to and from a far end module. • Sends authentication data and RSA key exchange components to a far end module. • Receives authentication data, RSA key exchange components from a far end module. • The module can be set to bypass, to send and receive plaintext for selected connections. |
| Control Input | <p>Control Input is provided by the front panel keypad, the serial port, the Ethernet Port (out-of-band control), and the Local and Network ports (in-band control) as follows:</p> <ul style="list-style-type: none"> • The front panel keypad is used for initialization prior to authentication and operation in the approved mode. An operator uses the keypad to set the IP address for remote administration by SMC, set the system clock and load the certificate (in conjunction with the SMC). • The front panel DB9 RS-232 serial console port may be used for initialization prior to authentication and operation in the approved mode as an alternative to using the keypad. This port receives control input (protected via a username and password) from a locally connected terminal. • The front panel RJ45 Ethernet port receives out-of-band control input from the SMC application. • Session establishment, heartbeat messages and key update messages between encryptors travel on the layer 2 LAN subnet via the front panel RJ45 Ethernet port. |
| Status Output | <p>Status output is provided by the LCD display, front and rear panel LEDs, the Front Panel DB9 RS-232 port, the Ethernet Port (out-of-band status), and the Local and Network ports (in-band status) as follows:</p> <ul style="list-style-type: none"> • The LCD indicates the state of RSA keys and certificates and displays command data being entered using the front panel keypad. • Front and rear panel LEDs indicate error states, state of the local and network interfaces, alarm, temperature, and battery state. • The front panel DB9 RS-232 serial console port may be used for initialization prior to authentication and operation in the approved mode as an alternative to using the keypad. It is also used for monitoring some operations. This port sends status output (protected via a username and password) to a locally connected terminal. • The front panel RJ45 Ethernet port sends out-of-band status output information to an SMC application. • Local and Network ports may send in-band status output information, protected via SNMPv3 security mechanisms, to the SMC application. |

Table 2.2-3 maps FIPS 140-2 logical interfaces to the cryptographic module's logical interfaces and physical ports.

Table 2.2-3 – Mapping of Logical Interfaces to Physical Ports

| FIPS 140-2 Logical Interface | Logical Interface | Physical Port |
|---|--|--|
| Data Input | 1) Public network interface 2) Private network interface | 1) Rear panel Network Port 2) Rear panel local port |
| Data Output | 1) Public network interface 2) Private network interface | 1) Rear panel Network Port 2) Rear panel local port |
| Control Input | 1) SNMPv3 interface 2) Local console 3) Keypad | 1) Front Panel RJ45 Ethernet port 2) Front Panel DB9 RS-232 serial console port, 3) Front panel Keypad |
| Status Output | 1) SNMPv3 interface 2) Local console 3) Front panel displays | 1) Front panel RJ45 Ethernet port 2) Front panel DB9 RS-232 serial console port, 3) Front panel LED and LCD displays |
| Power | Power Switch | Rear panel power connector |

2.3 Security Functions

The module provides symmetric key encryption (ES) for user data transferred through the module. AES is also used to secure the remote management interface to the module. Asymmetric keys and SHA hashing are used to authenticate remote modules, and asymmetric keys are used to wrap symmetric keys for symmetric key exchange with other modules. Asymmetric keys and SHA hashing are used to authenticate management access, and Diffie-Hellman key agreement is used to establish symmetric keys for securing management interactions.

To ensure maximum security, unique encryption keys are automatically generated for a connection only after the encryptor has positively identified and authenticated the remote module.

The encryptor implements the following approved algorithms:

Table 2.3-1 – Approved Module Algorithms

| Approved Algorithm | Encryptor | Cryptolib |
|---|------------------|------------------|
| AES (FIPS PUB 197) ECB(e only; 256); CTR(int only; 256); CFB128(e/d;256) ECB(e only; 256); CTR(int only; 256) CBC(e/d; 128,256) | 1232 713 | 725 |
| Triple-DES (FIPS PUB 46-3) TECB(d only; KO 1,2); TCBC(e/d; KO 1,2); TCFB8(e/d; KO 1,2); TCFB64(e/d; KO 1,2) | | 647 |

| Approved Algorithm | Encryptor | Cryptolib |
|--|-----------|------------|
| Hashing SHA-1, SHA256, SHA-512 (byte-oriented hashing) HMAC SHA-1, SHA256, SHA-512 | | 743 391 |
| Random Number Generation ANSI X9.31 [AES-256] | | 422 |
| Digital Signatures Key Gen ANSI X9.31 / (MOD: 1024, 2048, 4096 Pubkey Values: 65537) Sig Gen PKCS#1/ Sig Ver PKCS#1 1024 2048, 4096 SHA-1, SHA-256, SHA-512 | | 340 |

Note 1: AES certificate 1232 is for the Ethernet encryptor, AES certificate 713 is for the SONET encryptor, and all remaining certificates are for the common library shared by both encryptors.

Note 2: A hardware noise source is used as a non-Approved RNG to generate seed material (consisting of random sequences of ones and zeroes) for the FIPS-approved RNG.

The encryptor implements the following security functions:

Table 2.3-2 – Module Security Functions

| Security Function |
|---|
| Symmetric Key Encryption AES Triple-DES |
| Symmetric Key Establishment (See Note below this table) RSA key wrapping (per ATM Forum Security Spec 1.1) Diffie-Hellman key agreement Public Key Length: 1024 bits Private Key Length: 1023 bits |
| Authentication RSA asymmetric key 1024-bit (per ANSI X9.31) with HMAC SHA-1 2048-bit (per ANSI X9.31) with HMAC SHA-256 |
| Key Generation Triple-DES/AES keys – PRNG (per ANSI X9.31) RSA keys – ANSI X9.31 |

Note – Key establishment methodology provides 80-bit of encryption strength.

2.4 Modes of Operation

The module is shipped by the manufacturer with the FIPS approved mode enabled.

Each encryptor must have a unique Network Certificate (NC) issued under a common Security Management Center (SMC). During key exchange, communicating modules mutually authenticate one another by exchanging NCs in digitally-signed messages. Moreover, the module cannot establish any secure connections unless it has been issued a valid NC. This mode of operation requires a common SMC to issue NCs to all modules that will communicate securely. For backward interoperability, the module supports 1024-bit as well as 2048-bit Network Certificates. When establishing secure connections, the module will default to the 2048-bit certificate and SHA-256 hashing if a 2048-bit certificate is available. If there is no 2048-bit certificate, the module will fall back to the 1024-bit certificate and SHA-1 hashing for establishing secure connections.

User data received from the local (private) network is encrypted before being transmitted out to the public network. Similarly, user data received from the public network is decrypted before being transmitted to the local network. When a secure connection is first created, the pair of encryptors exchange an encryption master key and session key. The master key is used for all subsequent session key exchanges. When operating in this state, the two ends of the connection are in cryptographic synchronization using the defined AES algorithm. Crypto officers can force a new master key by manually restarting a connection. An organization's security policy dictates the frequency of forcing a new master key. Within a secure connection, the module encrypts all data received from the Local Port (the private network) and decrypts all data received from the Network Port (the public network). For each connection, the Connection Action Table can be set to encrypt, block, or pass data. The module supports configured encryption, blocking, or passing of user data as plaintext on a per-connection basis.

The FIPS mode status may also be queried from the management application or the console interface, and operators may run the power-on self tests on-demand by power-cycling the module. Refer to the User's Guide for more details concerning the module's modes of operation.

2.4.1 FIPS Approved Mode

The module ships with FIPS Mode enabled. FIPS mode constrains several aspects of the module's operation:

- The privacy of the SNMPv3-based management interface is ensured with AES encryption; the privacy option can not be disabled while in FIPS mode.
- All the algorithms accessible to the module are approved algorithms as noted above. Non-approved algorithms cannot be specified for use.

The FIPS mode of operation can be confirmed by logging into the console interface and using the `fips` command. It can also be confirmed by reviewing the device configuration from SMC. The module front panel SEC LED provides details about the operational configuration of the device, as detailed in the User's Guide, but does not specifically indicate the FIPS Mode status of the module.

FIPS Mode operation may be turned off as needed. When FIPS Mode operation is turned off, the SNMPv3 Privacy option may also be disabled; however, to turn FIPS Mode operation back on, SNMPv3 Privacy must first be re-enabled.

When changing from FIPS Mode to non-FIPS Mode operation, a module erase and reboot is forced. This effectively zeroizes all keys and CSPs prior to the transition.

2.4.2 Non-FIPS Approved Mode

Non-FIPS Mode operations follow the same general flow as FIPS Mode. The module must be certified, connections must be configured; the encryptors must still authenticate to each other with NCs. When the module is set by a Crypto Officer to operate in non-FIPS approved mode, several aspects of the module's operation are relaxed:

- The SNMPv3-based management interface need not be encrypted; the SNMPv3 Privacy feature may be disabled or enabled as needed.

- The module may employ non-approved algorithms.

While SNMPv3 privacy may be disabled when FIPS Mode operation is turned off, the SNMPv3 Privacy must first be re-enabled before FIPS Mode operation can be turned back on. The non-approved algorithms are disabled within the module automatically, but FIPS mode cannot be set if SNMPv3 privacy is disabled.

When changing from non-FIPS Mode to FIPS Mode operation, a module erase and reboot is forced. This effectively zeroizes all keys and CSPs prior to the transition.

2.5 Identification and Authentication

The module supports two Crypto Officer roles and a single Network User role. Services for the Crypto Officer roles (full access and read only) are accessible directly via the console or remotely via the SMC application. The Network User role services are only accessible indirectly based on the configured connections with other cryptographic modules. Roles cannot be changed while authenticated to the module.

Access to the authorized roles is restricted as follows in Table 2.5-1:

Table 2.5-1 – Roles with Required Identification and Authentication

| Role | Type of Authentication | Authentication Data |
|-------------------------------------|------------------------|---|
| Crypto Officer (Full Access) | Identity-based | Crypto Officers using the CLI present unique user names and passwords to log in to the CLI. Crypto Officers using SMC present unique identities (embedded in the SNMPv3 command protocol). |
| Crypto Officer (Read Only) | Identity-based | Crypto Officers using the CLI present unique user names and passwords to log in to the CLI. Crypto Officers using SMC present unique identities (embedded in the SNMPv3 command protocol). |
| Network User | Identity-based | Network Users (remote encryptors) must present a certificate issued by the SMC. |

Multiple concurrent Crypto Officers and Network Users are allowed. For example, a Network User may be sending data to the data input port while a Crypto Officer is connected via the console or sending an SNMPv3 command to the module. The architecture of the system allows for simultaneous interactions with many far end systems, or Network Users. Access control rules, system timing, and internal controls maintain separation of multiple concurrent Crypto Officers and Network Users.

The module employs identity-based authentication of operators and users. Up to 30 unique names and passwords can be defined for operators of the module.

- Crypto Officers using the console enter their name and password to authenticate directly with the module.
- Crypto Officers using SMC to issue SNMPv3 commands to the encryptor, use SNMPv3-based authentication to establish a secure connection / tunnel to the module. Within the secure tunnel, SNMPv3 commands are individually authenticated to ensure Data Origin Authentication, and Data Integrity for all commands sent from SMC. Data Origin Authentication, based on the above names and passwords, ensures the authenticity of the identity of the user claiming to have sent the command.

- Users (Network Users) using the module cryptographic algorithms and security functions over the Data Input and Output ports authenticate using certificates that have been generated and signed by the SMC. These Network Users exchange master and session keys using RSA public key certificates that have been generated and signed by a common SMC.

Physical Maintenance is performed at the factory, as there are no services that require the cover to be removed in the field. The module should be zeroized by a Crypto Officer before the module is returned to the factory, either by command or by removing the network interface card(s).

The strength of the authentication, per the roles in Table 2.5-1, is as follows:

Table 2.5-2 – Strength of Authentication

| Authentication Mechanism | Strength of Mechanism |
|----------------------------------|---|
| Authentication Password | <p>Crypto Officers accessing the CM using the CLI (via the console port) must authenticate using a password that is at least 8 characters and at most 30 characters. The characters used in the password must be from the ASCII character set of alphanumeric and special (shift-number) characters.</p> <ul style="list-style-type: none"> - This yields a minimum of 62^8 (over 218 trillion) possible combinations (8 characters, 62 possibilities per character); thus, the possibility of correctly guessing a password is less than 1 in 1,000,000. - After three failed authentication attempts via the CLI, console port access is locked for 3 minutes; thus, the possibility of randomly guessing a password in 60 seconds is less than 1 in 100,000. <p>Note: the module suppresses feedback of authentication data being entered into the CLI by returning blank characters.</p> |
| Authentication from SMC | <p>Authentication with SMC is accomplished via SNMPv3 and the Authentication Password described above.</p> <ul style="list-style-type: none"> - Based on the noted characteristics of the password, the possibility of correctly guessing the authentication data is less than 1 in 1,000,000. - The multi-step handshaking process for establishing a connection and then issuing an authenticated command sets the possibility of randomly guessing the passphrase in 60 seconds at less than 1 in 100,000. |
| Network User Certificates | <p>Network Users must authenticate using a 1024-bit or 2048-bit RSA authentication certificate based on a key of similar size.</p> <ul style="list-style-type: none"> - The possibility of deriving a private RSA key is less than 1 in 1,000,000 and the possibility of randomly guessing the key in 60 seconds is less than 1 in 100,000. - The multi-step handshaking process for establishing a connection sets the possibility of randomly guessing the authentication data in 60 seconds at less than 1 in 100,000. |

2.5.1 Cryptographic Keys and CSPs

Table 2.5-3 identifies the Cryptographic Keys and Critical Security Parameters (CSPs) employed within the module.

Table 2.5-3 – Cryptographic Keys and CSPs

| Data Item | Description |
|--------------------------------|--|
| System Master Key | <p>On initialization, the module generates a 168-bit symmetric key that is stored in the clear in battery-backed RAM.</p> <ul style="list-style-type: none"> - This key encrypts (using 3-key Triple-DES CFB8) the module's public and private RSA keys and the user table stored in the configuration flash memory. - On tamper, the module zeroizes the System Master Key (SMK), rendering the encrypted data in the flash memory undecipherable. |
| RSA Private Key | <p>The secret component of the module's RSA Key pair.</p> <ul style="list-style-type: none"> - This 1024-bit or 2048-bit key is generated when the module receives a load certificate command from the SMC, and is used to authenticate connections with other encryptors and to unwrap master session keys and session keys received from far-end encryptors. - This key is stored encrypted in flash memory. - On tamper, the SMK is zeroized, rendering the encrypted private key undecipherable. |
| RSA Public Key | <p>The public component of the module's RSA Key pair is stored encrypted in flash memory.</p> <ul style="list-style-type: none"> - This key resides in the Network Certificate that in turn is stored in the clear in the module's non-volatile RAM. - This key is used for authenticating connections with other encryptors. |
| Authentication Password | <p>Up to 30 passwords (and associated usernames) may be stored to allow access by up to 30 unique operators in the role of Crypto Officer (full access) or Crypto Officer (read only).</p> <ul style="list-style-type: none"> - The CLI uses the authentication password to authenticate Crypto Officers accessing the system via the console port. - SNMPv3 concatenates and hashes (with SHA1) the authentication password (8-30 characters) and the SNMPv3 unique engine ID to create an HMAC key used for Data Origin Authentication, and Data Integrity of each command. - Passwords and usernames are hashed and stored in the encrypted user table in flash memory. - On tamper, the SMK is zeroized, rendering the encrypted passwords undecipherable. |

| Data Item | Description |
|-------------------------------|--|
| Management Privacy Key | <p>The Management Privacy Key (MPK) is the parameter that is used to secure data on the remote management channel. This parameter is essentially a key that is derived from a DH key exchange between the module and the remote management station.</p> <ul style="list-style-type: none"> • The MPK persists for the life of the management session and is used to AES encrypt management traffic that may be exchanged between the module and the remote management station. • The MPK is maintained in volatile memory and may be updated periodically during the session. • The MPK is destroyed at the end of a session. |
| Master Session Key | <p>For each session, the module generates a symmetric Master Session Key (MSK) and Session Keys using the ANSI X9.31 PRNG.</p> <ul style="list-style-type: none"> • The MSK is used with RSA key exchange to transfer these keys to a far-end encryptor for data encryption and decryption purposes. • The MSK persists for the life of the session and is used to AES-encrypt Session Keys that may be changed periodically during the session. • All Session Keys are destroyed at the end of its session. |
| Session Keys | <p>For each session the module generates two Session Keys (SKs) for each data flow path in a secure connection (one for the Initiator-Responder path and another for the Responder-Initiator path).</p> <ul style="list-style-type: none"> • These keys are used to AES-encrypt user data transferred between encryptors. • SKs may be changed periodically during the session based on time or based on the amount of data transferred. • All SKs are destroyed at the end of a session. |
| Network Certificate | <p>The Network Certificate (NC) is the X.509v3 certificate associated with the module in an operational environment.</p> <ul style="list-style-type: none"> • The NC is produced and signed by the managing SMC system, then stored in the clear in the module's non-volatile system RAM and used for authenticating connections with other encryptors. • Other encryptors use the public key embedded in the NC to wrap initial SKs used to encrypt a session with Triple-DES or AES. • The NC is deleted from memory only on an Erase command from a module operator or a tamper condition. |
| PRNG Seed Key | <p>A new X9.31 PRNG Seed Key is generated from a block of 160 bits output by the hardware noise source.</p> <ul style="list-style-type: none"> • The Seed Key is not stored and is never output from the module. It exists temporarily in volatile memory and it zeroized by power cycling the module. |
| PRNG Seed Value | <p>A new X9.31 PRNG Seed Value is generated from a block of 160 bits output by the hardware noise source.</p> <ul style="list-style-type: none"> • The Seed Value is not stored and is never output from the module. It exists temporarily in volatile memory and it zeroized by power cycling the module. |

Note: While the above table lists the certificates maintained within the module, the certificates contain only public information.

The module prevents data output during initialization and self test.

- No data is output from the module until the self tests complete successfully and the NC has been properly loaded into the module.
- No data is output during and after zeroization of cryptographic keys and CSPs, as this occurs when a tamper condition exists.
- The encryptor's internal modules and timing controls work together to isolate user data input and output processes from CSP and key management functions.

2.5.2 Roles and Services

The encryptor supports services that are available to Crypto Officers and Users. All of the services are described in detail in the module's User's Guide and in the SMC User's Guide.

The Crypto Officer (full access) role provides cryptographic initialization and management functions. Crypto Officer functions are available using SMC and via the console CLI.

The Crypto Officer (read only) role is restricted to read-only access to module configuration data.

The Network User Role can negotiate encryption/decryption keys and use encryption/decryption services. (The Network User Role is available only to, or in conjunction with, other authenticated modules.)

Table 2.5-4 shows the services available to the various roles. All services except Run Self Test (Power Cycle the Module), AES or Triple-DES encryption, SHA-1 Hashing for password verification, and physical tamper, require a console operator to be authenticated by entering a username and password, or an SMC operator to use RSA public key authentication and SNMPv3 user authentication.

Table 2.5-4 – Roles and Services

| Service | No Role | Crypto Officer (Full Access) | Crypto Officer (Read Only) | Network User |
|-------------------------------------|---------|------------------------------|----------------------------|--------------|
| Load Initial Network Certificate | | ● | | |
| Load Subsequent Network Certificate | | ● | | |
| Set Real Time Clock | | ● | | |
| Edit Connection Action Table | | ● | | |
| View Connection Action Table | | ● | ● | |
| Create user accounts | | ● | | |
| Modify user accounts | | ● | | |
| Delete user accounts | | ● | | |
| Show Software Version | | ● | ● | |
| View User Accounts | | ● | ● | |
| Clear Audit Trail | | ● | | |
| View Audit Trail | | ● | ● | |
| Clear Event Log | | ● | | |

| Service | No Role | Crypto Officer (Full Access) | Crypto Officer (Read Only) | Network User |
|--|---------|------------------------------|----------------------------|--------------|
| View Event Log | | ● | ● | |
| View FIPS Mode Status | | ● [4] | ● | |
| Run Self Test (Power Cycle the Module) | ● | | | |
| Run Self Test (Reboot Command) | | ● | | |
| Generate AES session keys | | ● [1] | | ● |
| Generate Initialization Vector | | ● [1] | | ● |
| Agree on Management Privacy Key | | ● [5] | ● [5] | |
| RSA signature generation | | ● [1] | | ● |
| RSA signature verification | | ● [1] | | ● |
| AES encryption | | ● [2], [5] | ● [5] | ● |
| AES decryption | | ● [2], [5] | ● [5] | ● |
| Triple-DES encryption and decryption (for the master secret) | | ● | | |
| SHA Hashing for password verification | ● | | | |
| Generate DH keys | | | | ● |
| DH Key Agreement | | ● [1] | | ● |
| Software/firmware load test | | ● | | |
| Erase unit (Console Command) | | ● [3] | | |
| Tamper | ● | | | |
| Set FIPS mode | | ● | | |

[1] Restarting a connection causes new session keys to be generated.

[2] Plaintext data entering the Local port is encrypted if the connection is set to encrypt data.

[3] Erasing the content of the module zeroizes the module.

[4] The SNMPv3 Privacy Mode may only be changed when FIPS Mode is turned off. Privacy must be enabled before FIPS Mode can be turned on.

[5] When Privacy is enabled, all remote management connections are secured regardless of the Crypto Officer role.

Note: Plaintext Cryptographic Keys and CSPs are never output from the module.

2.5.3 Access Control

Table 2.5-5 shows services from Table 2.5-4 that use or affect cryptographic keys or CSPs. For each service, the key or CSP is indicated along with the type of access.

- R** - The item is **read** or referenced by the service.
- W** - The item is **written** or updated by the service.
- E** - The item is **executed** by the service. (The item is used as part of a cryptographic function.)
- D** - The item is **deleted** by the service.

Table 2.5-5 – Access Control

| Service | Authentication Data (Key or CSP) | Access Control |
|---------------------------------------|--|----------------|
| Authenticate Crypto Officer | RSA Public Key RSA Private Key or Password | R R,E E |
| Load Network Certificates | RSA public and private keys RSA public key certificate System Master Key | W W W |
| Create user accounts | Password (W) | W |
| Modify user accounts (reset password) | Password (W) | W |
| Delete user accounts | Password (D) | D |
| Change password | Password (E,W) | E,W |
| Generate AES session keys | AES Session Key | W |
| Generate IV | IV | W |
| Agree on Management Privacy Key | Management Privacy Key | W |
| RSA signature generation | RSA Private Key | R,E |
| RSA signature verification | RSA Public Key | R,E |
| AES encryption | Session Key | R |
| AES decryption | Session Key | R |
| Erase unit (Console Command) | System Master Key | W |
| Tamper | System Master Key | W |
| Alternating Bypass | System Master Key | E |
| Set FIPS mode | All | W |

2.6 Physical Security

The module employs the following physical security mechanisms:

The encryptor is made of commercially available, production-grade components meeting commercial specifications for power, temperature, reliability, shock and vibration.

- All integrated circuit chips have had passivation techniques and materials applied to them.
- The enclosure is strong and opaque.
- Attempts to enter the module without removing the cover will cause visible damage to the module.
- Ventilation holes on the side of the unit are fitted with baffles, or other obscuring material, to prevent undetected physical probing inside the enclosure.

Access to the circuitry contained within the encryptor is restricted by the use of tamper detection and response (CSP zeroization) circuitry. Attempting the removal of the enclosure's cover causes the immediate zeroization of the 168-bit symmetric System Master Key, rendering all cryptographic keys and CSPs indecipherable. This capability is operational whether or not power is applied to the module.

Tamper-evident tape is pre-installed over the interface module face plates, providing visible evidence of any attempt to remove the interface cards to obtain access to the internal components of the module.

Any attempts to remove the module cover are considered tampering; access to the cryptographically relevant components of the module requires the cover to be removed. Removal of the cover requires removal of the network interface cards which in triggers the Tamper Switch. When the module detects tampering it destroys the cryptographic keys and unprotected CSPs automatically, then returns to an uncertified state and remains in that state until it is re-certified.

If the Tamper Switch is triggered while the module is powered on:

- the module erases the 168-bit symmetric key which is used to encrypt the unit's private key and user localized passwords
- the module will also erase any active key material and log an event message indicating that the card has been removed

After tamper activation the system is uncertified and the Secure LED is illuminated red until a new certificate is loaded.

If the Tamper Switch is triggered while the module is powered off:

- the module erases the 168-bit symmetric System Master Key
- the event message will be logged and the Secure LED will be illuminated red after the module is powered on

While in the uncertified state, the CLI and SNMPv3 access are still active, but no user data is output from the module. The module indicates this state with the Secure LED illuminated red on the front panel.

In addition to the physical security mechanisms integrated with the module, the following recommendation should be considered in the implementation of a Security Policy governing the installation and operation of the encryptors:

- To ensure the security of the module during distribution and delivery, the User's Guide contains procedures in the Security Requirements section for inspection of the module by an authorized operator.
- Secure access to the cryptographic module within a physically secure, limited access room or environment.

Table 2.6-1 outlines the recommended inspection and/or testing of the physical security mechanisms.

Table 2.6-1 – Security Mechanism Inspection and Test

| Physical Security Mechanism | Recommended Frequency of Inspection/Test | Inspection/Test Guidance Details |
|-----------------------------|--|---|
| Tamper Switch | No direct inspection or test is required. | The module enters the tamper error state when the switch is tripped. Once in this state, the module blocks all traffic until it is physically reset. |
| Tamper Evidence | In accordance with organization's Security Policy. | Inspect the enclosure and tamper evident tape for physical signs of tampering or attempted access to the cryptographic module. During normal operation, the Secure LED is illuminated green. If the unit is uncertified or tampered, the Secure LED is illuminated red and all traffic is blocked. |

2.7 Self Tests

In addition to the physical security mechanisms noted in 2.6, the encryptor performs both power-up and conditional self tests to verify the integrity and correct operational functioning of the cryptographic module. If the system fails a self test, it transitions to an error state and blocks all traffic on the data ports. Table 2.7-1 summarizes the system self tests.

Crypto Officers can run the power-up self-test on demand by issuing a reboot command. An operator with physical access to the device can also run the power-up self-test on demand by cycling the power to the module. Rebooting or power cycling the module causes the keys securing the connections to be reestablished after communications are restored.

The design of the cryptographic module ensures that all data output via the data output interface is inhibited whenever the module is in a self-test condition. Status information displaying the results of the self-tests is allowed from the status output interface, but no CSPs, plaintext data, or other information that if misused could lead to a compromise is passed to the status output interface.

Table 2.7-1 – Self Tests

| Self Test | Description |
|--|---|
| Mandatory power-up tests performed at power-up and on demand: | |
| Cryptographic Algorithm Known Answer Tests | Each cryptographic function, performed by the encryptor, is tested using a "known answer" test to verify the operation of the function. Algorithms tested AES, HMAC, SHS (SHA-1, SHA-256, SHA-512), Triple-DES, RNG, RSA |
| Firmware | The binary image(s) of the encryptor's firmware includes a 160-bit error detection code (EDC) that allows the encryptor to verify the integrity of the firmware. The EDC is calculated for the image(s) and compared with the known value(s), using a SHA hash, to confirm the integrity of the module. |

| Self Test | Description |
|--|---|
| Bypass | <p>The Connection Action Table (CAT) contains settings for bypass mode (configured administratively). Each time the CAT is changed, the system generates a checksum and stores it as a parameter. On booting, the system calculates a fresh checksum and compares it to the stored value to assure that the CAT rules have not changed or been corrupted. If the values do not match, the encryptor determines an error exists within the CAT. The encryptor sets an alarm and does not pass data (encrypted or unencrypted) to any connection.</p> <p>To manually confirm the bypass configuration, review the settings in the CAT. This may be accomplished with the SMC application or via the console at the encryptor.</p> <ul style="list-style-type: none"> • With SMC, log into the management application and select the target encryptor from the Device table. Review device status on the Status tab or configure specific connection settings on the Security tab. Refer to the SMC documentation for details. • At the encryptor, log into the console and use the <code>sessions</code> command (SONET) or the <code>tunnels</code> command (Ethernet). Refer to the User's Guide for details. |
| Critical Functions tests performed at power-up: | |
| Configuration Memory | A test to verify the configuration memory integrity. An error detection formula is calculated on all configuration memory and compared against the expected value (EDC), which is also stored in the configuration memory. If failed, the unit attempts to correct the EDC and report the failure. |
| Real Time Clock | The real time clock is tested for valid time and date. If this test fails, the time/date is set to 01-Jan-2000 at 00:00. |
| Battery | The battery is tested to determine if it is critically low. This test is guaranteed to fail prior to the battery voltage falling below the minimum specified data retention voltage for the associated battery-backed components. If this test should fail, the battery low alarm condition will be on. The unit will continue to operate after taking whatever precautions are necessary to guarantee correct operation. |
| General Purpose Memory | A destructive test verifies that the general purpose memory (RAM) is properly operating, e.g., all legal addresses may be written to and read from, and that no address lines are open or shorted. |
| Tamper Memory | Tamper memory is examined for evidence of Tamper. |
| Conditional tests performed, as needed, during operation: | |
| Pairwise consistency | <p>Public and private keys are used for the calculation and verification of digital signatures and also for key transport. Keys are tested for consistency, according to their purpose, at the time they are generated. Encryption keys are tested by an encrypt/decrypt pairwise consistency test while signature keys are tested by a sign/verify pairwise consistency test.</p> <p>Algorithms tested: RSA</p> |
| Firmware load | Test to verify the authenticity of any software/firmware load that is applied to the encryptor in the field. The software/firmware RSA signature is verified. |
| Continuous RNG | This test is a "stuck at" test to check the RNG output data for failure to a constant value. All internal RNGs are subject to this test. |

3 Glossary of Acronyms, Terms and Abbreviations

| Term | Definition |
|-----------------|---|
| AES | Advanced Encryption Standard |
| ATM | Asynchronous Transfer Mode |
| CBC | Cipher Block Chaining |
| CFB | Cipher Feedback |
| CLI | Command Line Interface |
| CMVP | Cryptographic Module Validation Program |
| CSE | Communications Security Establishment |
| CSP | Critical Security Parameter |
| DES, Triple-DES | Data Encryption Standard |
| EDC | Error Detection Code |
| EMC | Electromagnetic Compatibility |
| EMI | Electromagnetic Interference |
| FCC | Federal Communication Commission |
| FIPS | Federal Information Processing Standard |
| HMAC | (Keyed) Hash Message Authentication Code |
| IP | Internet Protocol |
| KAT | Known Answer Test |
| LAN | Local Area Network |
| LED | Light Emitting Diode |
| MIB | Management Information Block |
| MPK | Management Privacy Key |
| MSK | Master Session Key |
| NC | Network Certificate |
| NIST | National Institute of Standards and Technology |
| NVLAP | National Voluntary Laboratory Accreditation Program |
| PRNG | Pseudo Random Number Generator |
| PUB | Publication |
| RAM | Random Access Memory |
| RFC | Request for Comment |
| ROM | Read Only Memory |
| RNG | Random Number Generator |
| RSA | Rivest Shamir and Adleman (public key algorithm) |
| SDH | Synchronous Digital Hierarchy |
| SHA-1 | Secure Hash Algorithm |
| SK | Session Key |
| SMC | Security Management Center |
| SMK | System Master Key |
| SNMPv3 | Simple Network Management Protocol version 3 |
| SONET | Synchronous Optical Network |
| SSE | SafeEnterprise SONET Encryptor |
| SEE | SafeEnterprise Ethernet Encryptor |
| VCAT | Virtual Channel Action Table |
| X.509 | Digital Certificate Standard RFC 2459 |