

## Senetas Corporation Ltd.

### CN6000 Series Encryptors:

CN6040 1G Ethernet / 4G Fibre Channel Encryptor,  
CN6100 10G Ethernet Encryptor

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

July 2013



Model: CN6040



Model: CN6100

## Table of Contents

1. Introduction .....	3
1.1 References .....	3
1.2 Document History .....	4
1.3 Acronyms and Abbreviations .....	4
1.4 Definitions .....	5
2. Product Description.....	6
2.1 Module Identification.....	7
2.2 Operational Overview .....	8
2.2.1 General.....	8
2.2.2 Encryptor deployment .....	9
2.2.3 Encryptor management .....	10
2.2.4 Ethernet implementation .....	11
2.2.5 Fibre Channel implementation .....	13
3. Module Ports and Interfaces.....	14
3.1 CN6000 Series Ports .....	14
3.2 CN6000 Series Interfaces .....	17
4. Administrative Roles, Services and Authentication .....	20
4.1 Identification and Authentication.....	21
4.2 Roles and Services.....	22
5. Physical Security.....	24
6. Cryptographic Key Management .....	26
6.1 Cryptographic Keys and CSPs .....	26
6.2 Key and CSP zeroization.....	29
6.2.1 Zeroization sequence .....	29
6.2.2 Erase command and key press sequence .....	29
6.2.3 Approved mode of operation.....	29
6.2.4 Tamper initiated zeroization .....	30
6.2.5 “Emergency” Erase .....	30
6.3 Data privacy.....	30
6.4 Cryptographic Algorithms .....	31
7. Self Tests .....	34
8. Crypto-Officer and User Guidance .....	36
8.1 Delivery .....	37
8.2 Location .....	37
8.3 Configuration – FIPS140-Approved mode .....	37
8.4 Configuration - non-Approved mode .....	39
9. Mitigation of Other Attacks.....	40

# 1. Introduction

This is a non-proprietary FIPS 140-2 Security Policy for the Senetas Corporation Ltd. CN6000 Series Encryption devices comprising both the CN6040 and CN6100 (version 2.2.0) cryptographic models. This Security Policy specifies the security rules under which the module operates to meet the FIPS 140-2 Level 3 requirements.

FIPS 140-2 (Federal Information Processing Standards Publication 140-2), *Security Requirements for Cryptographic Modules*, specifies the security requirements for a cryptographic module utilized within a security system protecting sensitive but unclassified information. Based on four security levels for cryptographic modules this standard identifies requirements in eleven sections. For more information about the NIST/CSEC Cryptographic Module Validation Program (CMVP) and the FIPS 140-2 standard, visit [www.nist.gov/cmvp](http://www.nist.gov/cmvp).

This Security Policy, using the terminology contained in the FIPS 140-2 specification, describes how the CN6040 1G Ethernet / 4G Fibre Channel Encryptor and the CN6100 10G Ethernet Encryptor models comply with the eleven sections of the standard. In this document, the CN6040 and CN6100 Encryptors are collectively referred to as the “CN6000 Series” and individually as the “the module” or “the encryptor”.

This Security Policy contains only non-proprietary information. Any other documentation associated with FIPS 140-2 conformance testing and validation is proprietary and confidential to Senetas Corporation Ltd., and is releasable only under appropriate non-disclosure agreements. For more information describing the CN Series systems, visit <http://www.senetas.com>.

## 1.1 References

For more information on the FIPS 140-2 standard and validation program please refer to the National Institute of Standards and Technology website at [www.nist.gov/cmvp](http://www.nist.gov/cmvp).

The following standards from NIST are all available via the URL: [www.nist.gov/cmvp](http://www.nist.gov/cmvp).

- [1] *FIPS PUB 140-2: Security Requirements for Cryptographic Modules.*
- [2] *FIPS 140-2 Annex A: Approved Security Functions.*
- [3] *FIPS 140-2 Annex B: Approved Protection Profiles.*
- [4] *FIPS 140-2 Annex C: Approved Random Number Generators.*
- [5] *FIPS 140-2 Annex D: Approved Key Establishment.*
- [6] *Derived Test Requirements (DTR) for FIPS PUB 140-2, Security Requirements for Cryptographic Modules.*
- [7] *Advanced Encryption Standard (AES)*, Federal Information Processing Standards Publication 197.
- [8] *Data Encryption Standard (DES)*, Federal Information Processing Standards Publication 46-3.
- [9] *DES Modes of Operation*, Federal Information Processing Standards Publication 81.
- [10] *Digital Signature Standard (DSS)*, Federal Information Processing Standards Publication 186-2.
- [11] *Secure Hash Standard (SHS)*, Federal Information Processing Standards Publication 180-3.
- [12] ATM Security Specification (Version 1.1), af-sec-0100.002, The ATM Forum Technical Committee, March, 2001.
- [13] NIST Special Publication (SP) 800-131A, Transitions: Recommendation for Transitioning the Use of Cryptographic Algorithms and Key Lengths, January 2011

## 1.2 Document History

Authors	Date	Version	Comment
Senetas Corporation Ltd	20-Nov-2012	1.0	Release for CMVP comment
Senetas Corporation Ltd	8-Jul-2013	1.1	Annotations added to flag transitioned algorithms and key sizes in line with SP800-131A First page logo updated

## 1.3 Acronyms and Abbreviations

AES	Advanced Encryption Standard
ATM	Asynchronous Transfer Mode
CA	Certification Authority
CBC	Cipher Block Chaining
CFB	Cipher Feedback
CM	Senetas Encryptor Remote Management Application Software
CI	Connection Identifier (used interchangeably with Tunnel)
CLI	Command Line Interface
CMP	Certificate Management Protocol
CMVP	Cryptographic Module Validation Program
CSE	Communications Security Establishment
CSP	Critical Security Parameter
CTR	Counter Mode
DEK	Data Encrypting Key(s)
DES	Data Encryption Standard
DRBG	Deterministic Random Bit Generator
EDC	Error Detection Code
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
FC	Fibre Channel
FCC	Federal Communication Commission
FIPS	Federal Information Processing Standard
Gbps	Gigabits per second
HMAC	Keyed-Hash Message Authentication Code
IGMP	Internet Group Management Protocol
IP	Internet Protocol
IV	Initialization Vector
KAT	Known Answer Test
KEK	Key Encrypting Key(s)

LED	Light Emitting Diode
Mbps	Megabits per second
MLD	Multicast Listener Protocol
NC	Network Certificate
NIST	National Institute of Standards and Technology
NTU	Network Termination Unit
NVLAP	National Voluntary Laboratory Accreditation Program
OCSF	Online Certificate Status Protocol
PKCS	Public Key Cryptography Standards
PKI	Public Key Infrastructure
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
RTC	Real Time Clock
SAN	Storage Area Network
SFP	Small Form-factor Pluggable (transceiver)
SMK	System Master Key
SHA-n	Secure Hash Algorithm
XFP	10 Gigabit Small Form Factor Pluggable (transceiver)
X.509	Digital Certificate Standard RFC 2459

## 1.4 Definitions

### ***Senetas CN Series Encryptor Range***

CN1000	Ethernet/SONET/E1/T1 FIPS140-2 Level 3 validated, certificate 1267
CN1000	4G Fibre Channel Encryptor FIPS140-2 Level 3 validated, certificate 1549
CN3000	10G Ethernet/SONET FIPS140-2 Level 3 validated, certificate 1268
CN6040	1G Ethernet / 4G Fibre Channel Encryptor, subject of this submission
CN6100	10G Ethernet Encryptor, subject of this submission
(CN Series	Refers to the CN1000, CN3000, CN6040 and CN6100 encryptor variants)

## 2. Product Description

CN6000 Series Encryptors are multiple-chip standalone cryptographic modules consisting of production-grade components contained, in accordance with FIPS 140-2 Level 3, in a physically protected enclosure. Excluding the pluggable transceivers (SFP or XFP), dual redundant power supplies and replaceable fan tray module, the module's outer casing defines the cryptographic boundary. The encryptor is completely enclosed in a steel case which is protected from tampering by internal tamper protection circuitry and external tamper response seals. Any attempt to remove the cover automatically erases all sensitive information stored internally in the cryptographic module.

The module meets the overall requirements applicable to Level 3 security for FIPS 140-2.

**Table 1    Module Compliance Table**

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

## 2.1 Module Identification

CN6000 Series Encryptors, with firmware version 2.2.0, provide data privacy and access control services for Ethernet and Fibre Channel networks. See model details summarized in Table 2.

Data privacy is provided by FIPS approved AES and Triple-DES algorithms. The complete list of approved module algorithms is included in the *Approved Security Function* table.

**Table 2 CN6000 Hardware/Firmware Versions**

Hardware Versions	Interface / Protocol (Cryptographic Module)	Firmware Version
A6040B (AC)	1G Ethernet / 1, 2 and 4G Fibre Channel	2.2.0
A6041B (DC)	This model supports pluggable SFP transceivers, dual power supplies and removable fan tray which are considered to be outside the cryptographic boundary.	
A6042B (AC/DC)		
A6100B (AC)	10G – Ethernet	2.2.0
A6101B (DC)	This model supports pluggable XFP transceivers, dual power supplies and removable fan tray which are considered to be outside the cryptographic boundary.	
A6102B (AC/DC)		

## 2.2 Operational Overview

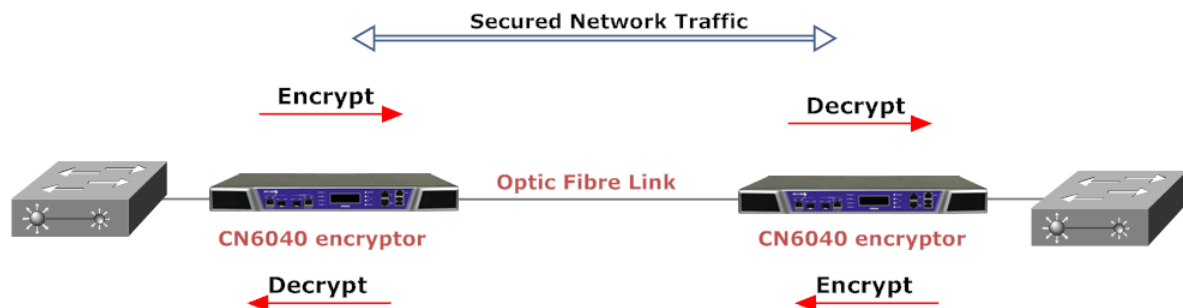
### 2.2.1 General

CN6000 Series Encryptors operate in point-to-point and point-to-multipoint network topologies and at data rates ranging from 10Mb/s to 10Gb/s.

Encryptors are typically installed between an operators' private network equipment and public network connection and are used to secure data travelling over either fibre optic or CAT5/6 cables.

Securing a data link that connects two remote office sites is a common installation application.

*Figure 1* provides an operational overview of two CN6040 encryptors positioned in the network.



**Figure 1 – CN6040 Operational Overview**

Devices establish one or more encrypted data paths referred to as 'connections'. The term refers to a connection that has been securely established and is processing data according to a defined encryption policy. Each 'connection' has a 'connection identifier' (CI) and associated CI mode that defines how data is processed for each policy. Connections are interchangeably referred to as 'tunnels'.

CN6000 Series Encryptors support CI Modes of 'Secure', 'Discard' and 'Bypass'. These CI Modes can be applied to all data carried on a connection or to a selected subset or grouping which can be user configured in accordance the specific protocol being carried on the network connection. A typical example in the case of an Ethernet network would be to make policy decisions based upon an Ethernet packet's VLAN ID.

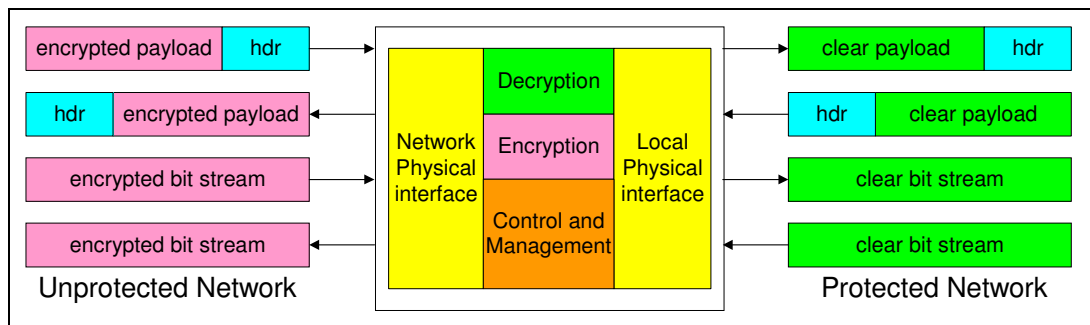
The default CI Mode negotiated between a pair of connected encryptors is 'Discard'. In this mode user data is not transmitted to the public network.

In order to enter 'Secure' mode and pass information securely, each encryptor must be 'Certified' by the same trusted body and exchange a secret 'Session Key' (DEK) using the RSA key exchange process (as specified in the ATM Forum's ATM Security Specification version 1.1). If the session key exchange is successful this results in a separate secure session per connection, without the need for secret session keys (DEKs) to be displayed or manually transported and installed.



Figure 2. illustrates the conceptual data flow through a CN6000 Series Encryptor.

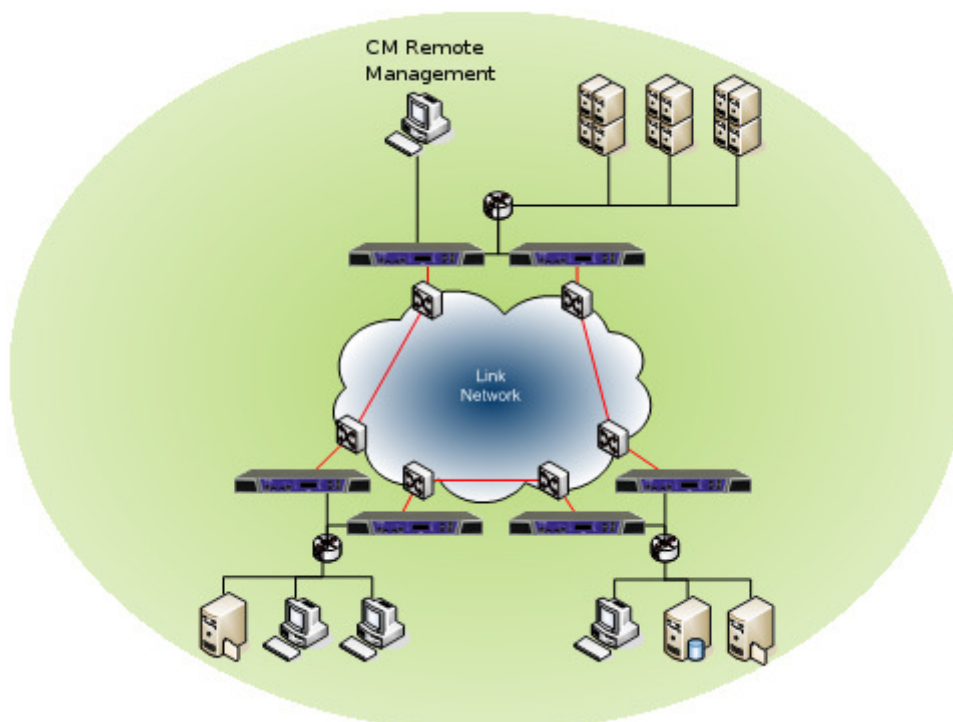
1. A data packet arrives at the encryptor's interface ports. When operating in Line mode data packets are processed according to a single CI policy, otherwise,
2. The encryptor looks up the appropriate packet header field, e.g. MAC address or VLAN ID and determines whether the field has been associated with an existing CI,
3. If a match is found, the encryptor will process the data packet according to the policy setting for that CI and send the data out the opposite port. If a match cannot be found, the data packet is processed according to the default policy setting.



**Figure 2 - Data Flow through the Encryptor**

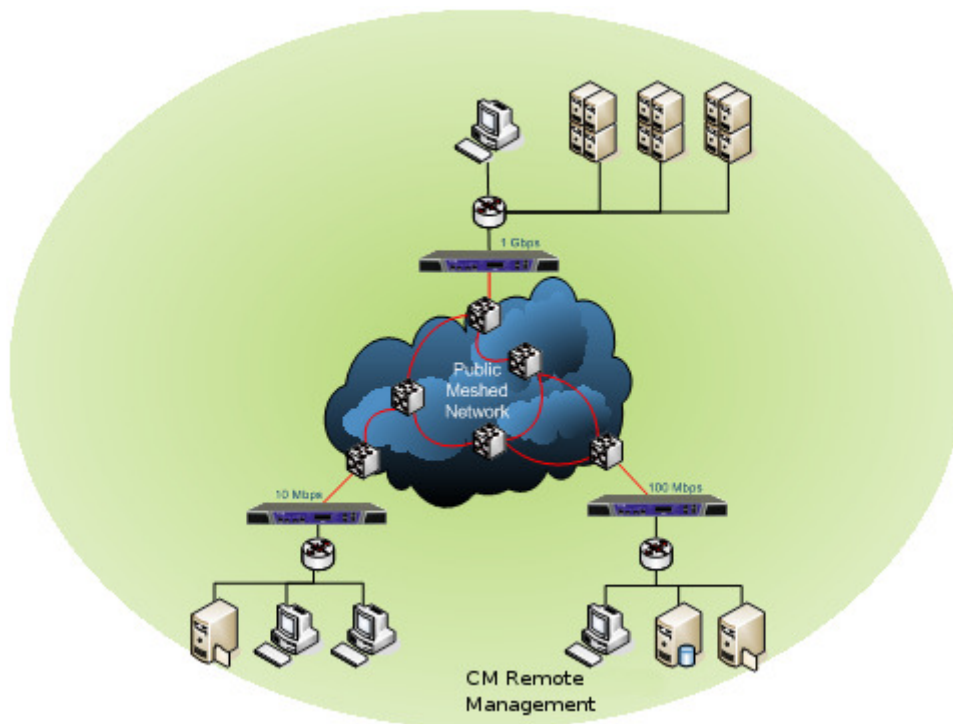
## 2.2.2 Encryptor deployment

Figure 3 illustrates a point-to-point (or link) configuration in which each module connects with a single far end module and encrypts the entire bit stream. If a location maintains secure connections with multiple remote facilities, it will need a separate pair of encryptor's for each physical connection (link).



**Figure 3 - Link Configuration**

Figure 4 illustrates a meshed network configuration. Ethernet models will generally operate in this configuration. Each CN6000 Series Encryptor is able to maintain simultaneous secured connections with many far end encryptors.



**Figure 4 - Meshed Configuration**

### 2.2.3 Encryptor management

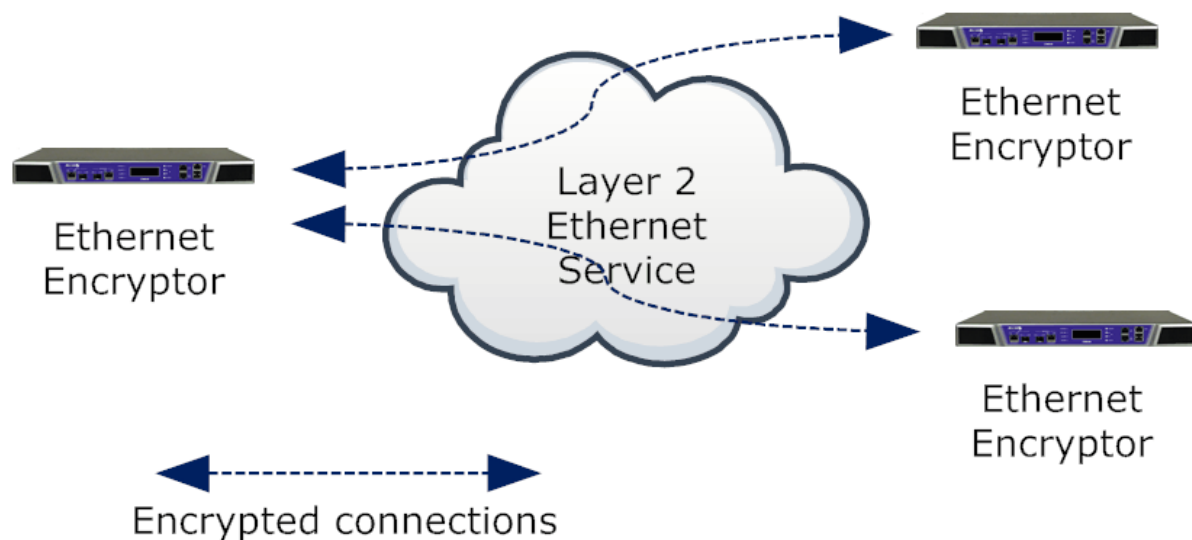
Encryptors can be centrally controlled or managed across local and remote stations using Senetas' CM Remote Management application. Encryptors support both *in-band* and *out-of-band* SNMPv3 management. *In-band* management interleaves management messages with user data on the encryptor's network interface port whilst *out-of-band* management uses the dedicated front panel Ethernet port. A Command Line Interface (CLI) is also available via the console RS-232 port.

FIPS-Approved mode of operation enforces the use of SNMPv3 privacy and authentication. Management messages are encrypted using AES128. Non-Approved mode allows message privacy to be disabled in order to interwork with 3<sup>rd</sup> party legacy management applications.

## 2.2.4 Ethernet implementation

### Basic operation

The Ethernet encryptor provides layer 2 security services by encrypting the contents of data frames across Ethernet networks. The encryptor connects between a local (protected) network and a remote (protected) network across the public (unprotected) network. An encryptor is paired with one or more remote Ethernet encryptors to provide secure data transfer over encrypted connections as shown in Figure 5 below.



**Figure 5 – Layer 2 Ethernet connections**

The encryptor's Ethernet receiver receives frames on its ingress port; valid frames are classified according to the Ethernet header then processed according to the configured policy.

Allowable policy actions are:

- Encrypt – payload of frame is encrypted according to the defined policy
- Discard – drop the frame, no portion is transmitted
- Bypass – transmit the frame without alteration

CN Series tunnels are encrypted using CAVP validated AES algorithms. The CN6040 1G Ethernet encryptor supports AES encryption with a key size of 128 or 256 bits in cipher feedback (CFB) or counter (CTR) modes.

The CN6100 10G Ethernet encryptor supports AES encryption with a key size of 128 or 256 bits in CTR mode.

Connections between encryptors use a unique key pair with a separate key for each direction. Unicast traffic can be encrypted using AES CFB or CTR modes whereas Multicast/VLAN traffic in a meshed network must use AES CTR mode.

The Ethernet transmitter module calculates and inserts the Frame Check Sequence (FCS) at the end of the frame. The frame is then encoded and transmitted. For details about Unicast and Multicast network topologies supported by the modules see next section.

## **Unicast operation**

Unicast traffic is encrypted using a key pair for each of the established connections.

When operating in line mode there is just one entry in the connection table. When operating in multipoint mode, connection table entries are managed by MAC address or VLAN ID and can be added manually, or if 'Auto discovery' is enabled, they will be automatically added based on the observed traffic. Entries do not age and will remain in the table.

## **Multicast and broadcast operation**

Multicast traffic between encryptors connected in line mode shares the same single key pair that is used by unicast traffic.

Multicast encryption is used to encrypt traffic sent from a host to all members of a multicast group. Unlike unicast encryption (which encrypts traffic from a single sender to a single receiver and uses a unique pair of keys per encrypted connection), multicast encryption within a multipoint network requires a group key management infrastructure to ensure that each encryptor can share a set of encryption keys per multicast MAC address. The Senetas group key management scheme which is used for both multicast and VLAN based encryption is responsible for ensuring group keys are maintained across the visible network.

The Senetas group key management scheme is designed to be secure, dynamic and robust; with an ability to survive network outages and topology changes automatically. It does not rely on an external key server to distribute group keys as this introduces both a single point of failure and a single point of compromise.

For robustness and security a group key master is automatically elected amongst the visible encryptors within a mesh based on the actual traffic.

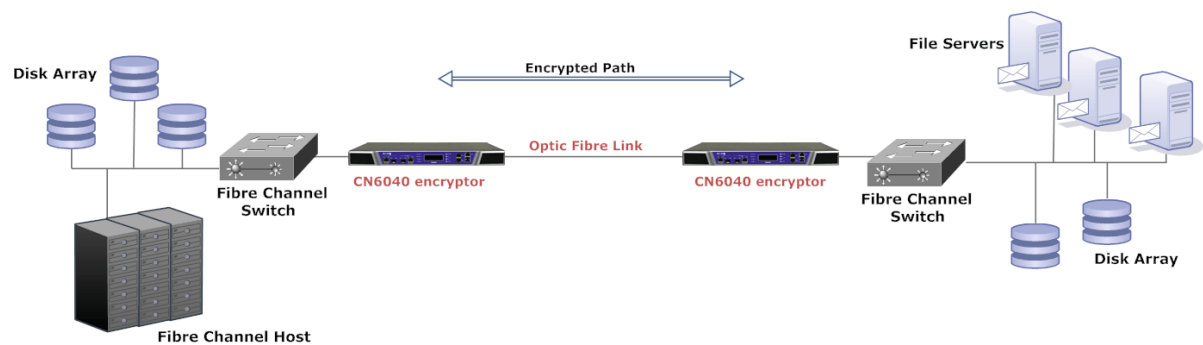
If communications problems segment the network, the group key management scheme will automatically maintain/establish new group key managers within each segment.

## 2.2.5 Fibre Channel implementation

Fibre Channel is the de-facto interconnection technology for storage networking and is optimised for the efficient movement of data between server and storage systems in a Storage Area Network (SAN).

Acting as a `Bump in the Fibre`, the CN6040 operating in Fibre Channel mode can secure point-to-point Fibre Channel network connections operating at speeds up to 4.25Gbps. *Figure 6* shows a typical Fibre Channel installation in which the encryptors are deployed to secure a public network link. In this example the encryptors provide a secure connection between two SAN components; a File Server and remote Disk Array.

Fibre Channel information is sent in discrete frames as per the Fibre Channel ANSI standard (ANSI INCITS 424-2007). The standard defines a multi-layer hierarchy of which the CN6040 Fibre Channel encryptor implements FC-0, FC-1 and the required FC-2 layer functionality to enable network interoperability with Direct Fibre, Fibre with Repeater, GFP-T and GFP-F connections. In order to interwork with Fibre Channel network devices the FC-2 header is only partially encrypted. The *Source identifier*, *Destination identifier* and *Frame Type* fields of the frame header are left unencrypted. The remaining header fields and payload are encrypted.



**Figure 6 – Fibre Channel Configuration**

### 3. Module Ports and Interfaces

#### 3.1 CN6000 Series Ports

The CN6000 Series data and management ports are located on the encryptor's front panel.

The encryptor data ports include a Local Port which connects to the physically secure private network and the Network Port which connects to an unsecured public network.

In the case of the CN6040 operating in Ethernet encryption mode, the operator can select either the RJ45 electrical or SFP optical physical interface to connect to the network.

The encryptor user access management ports, LCD display and Keypad are located on the front of the module as presented in Figure 7.

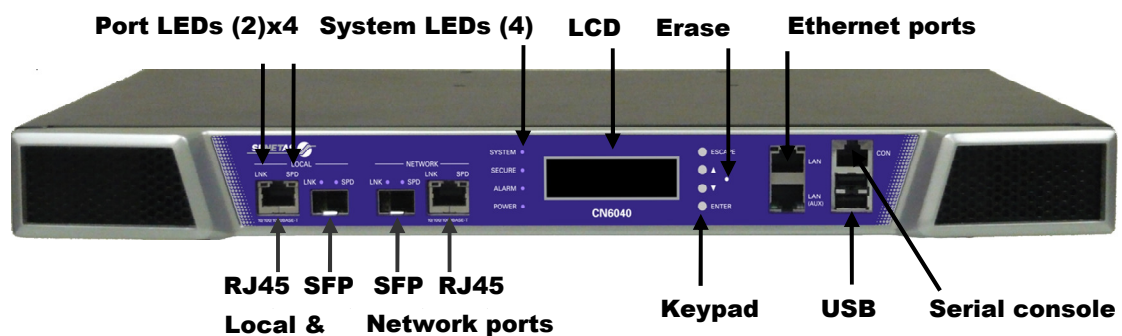


Figure 7 - Front View of the CN6040 Encryptor

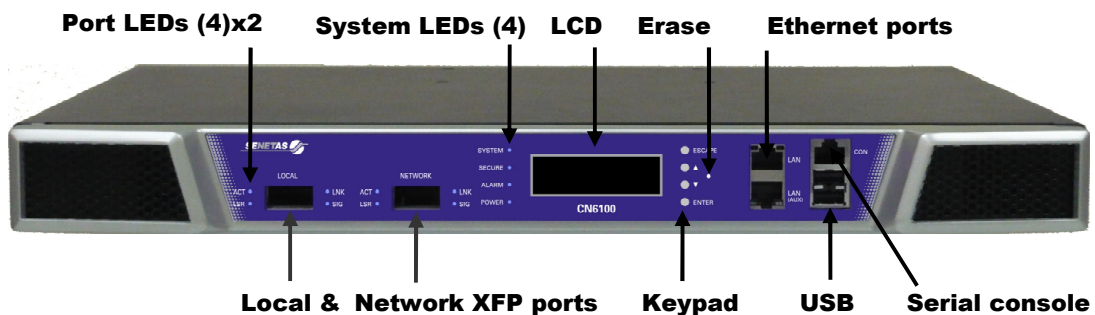


Figure 8 - Front View of the CN6100 Encryptor

CN6000 Series Encryptors support dual redundant power supplies which are available in two variants, an AC version for typical installs and a DC version for telecoms applications. Any power supply combination i.e. AC/AC, AC/DC or DC/DC is supported. Details of each can be seen in Figure 9.

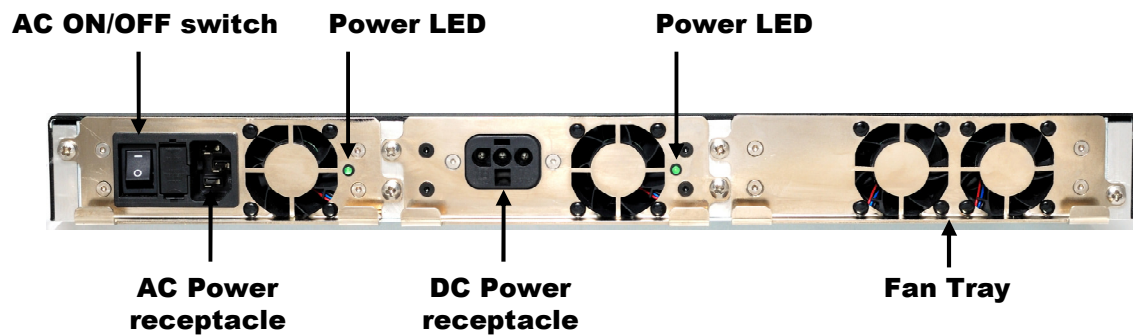


Figure 9 - Rear View of the CN6000 Series Encryptor pictured with AC and DC supplies installed



Figure 10 – A6100B 10G Ethernet port label close-up

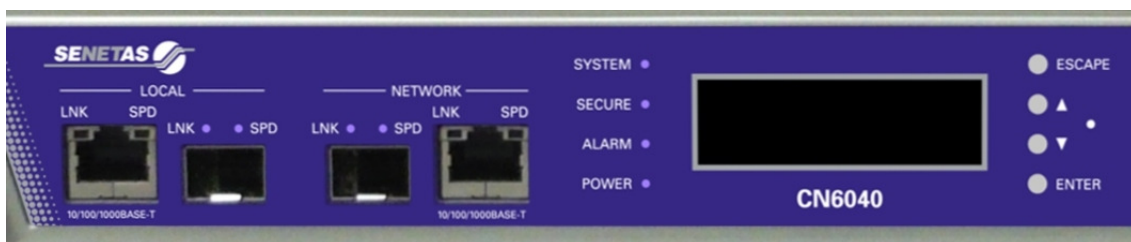


Figure 11 – A6040B 1G Ethernet / 4G Fibre Channel port label close-up



Figure 12 – Blocked LAN (AUX) RJ45 close-up

Table 3 defines the Physical Ports.

**Table 3 CN6000 Series Physical Ports**

Port	Location	Purpose
<b>RJ-45 Ethernet</b>	Front Panel (LAN)	Allows secure and authenticated remote management by the CM Remote Management application.
<b>RJ-45 Ethernet</b>	Front Panel (AUX)	Not enabled and physically blocked - port reserved for future use. See Figure 12.
<b>RJ-45 RS-232 Serial Console</b>	Front Panel	The Serial Console port connects to a local terminal and provides a simple command line interface (CLI) for initialization prior to authentication and operation in the approved mode. This port also allows administrative access and monitoring of operations. User name and password authentication is required to access this port.
<b>USB</b>	Front Panel	The USB port provides the Crypto Officer with a mechanism for applying approved and properly signed firmware updates to the module.
<b>Keypad</b>	Front Panel	Allows entry of initialization commands.
<b>LCD</b>	Front Panel	Displays configuration information in response to commands entered via the keypad. Also indicates the state of RSA keys and certificates.
<b>System LEDs</b>	Front Panel	Indicate the system state, including alarms.
<b>Port LEDs</b>	Front Panel	Indicate local and network port status and activity.
<b>Network Port</b>	Front Panel	The Network Port connects to the public network; access is protected by RSA certificates. The Network Port is of the same interface type as the Local Port.
<b>CN6040</b>		Supports SFP and RJ45 media
<b>CN6100</b>		Supports XFP media
<b>Local Port</b>	Front Panel	The Local Port connects to the private network; access is protected by RSA certificates. The Local Port is of the same interface type as the Network Port.
<b>CN6040</b>		Supports SFP and RJ45 media
<b>CN6100</b>		Supports XFP media
<b>Erase</b>	Front Panel	The concealed front panel “Emergency” Erase feature can be activated using a paperclip or similar tool and will immediately delete the System Master Key. The Erase functions irrespective of the powered state of the module.
<b>Power Connectors</b>	Rear Panel	Provides AC and/or DC power to the module depending upon which power modules have been installed
<b>Power LEDs</b>	Rear Panel	Indicates whether power is ON or OFF.



## 3.2 CN6000 Series Interfaces

Table 4 summarizes the FIPS 140-2 defined Logical Interfaces.

**Table 4 Logical Interfaces**

Interface	Explanation
<b>Data Input</b>	Interface through which data is input to the module.
<b>Data Output</b>	Interface by which data is output from the module.
<b>Control Input</b>	Interface through which commands are input to configure or control the operation of the module.
<b>Status Output</b>	Interface by which status information is output from the module.

The FIPS 140-2 Logical Interfaces map to the Physical Ports as outlined in Table 5.

**Table 5 FIPS 140-2 Logical Interface to Physical Port Mapping**

<b>FIPS 140-2 Logical Interface</b>	<b>CN6000 Series Interface</b>	<b>Physical Port</b>
<b>Data Input</b>	Private Network Interface	Local Port
	Public Network Interface	Network Port
<b>Data Output</b>	Private Network Interface	Local Port
	Public Network Interface	Network Port
<b>Control Input</b>	Local Console	RJ-45 RS-232 Serial Console
	Keypad & Display	Keypad / LCD
	CM Remote Management Interface	Management RJ-45 Ethernet Port (LAN)
	Private Network Interface	Local Port
	Public Network Interface	Network Port
<b>Status Output</b>	Local Console	RJ-45 RS-232 Serial Console
	Keypad & Display	Keypad / LCD
	CM Remote Management Interface	Management RJ-45 Ethernet Port (LAN)
	Private Network Interface	Local Port
	Public Network Interface	Network Port
	LEDs	Front & Rear LEDs
<b>Power</b>	Power Switch	Power Connector

CN6000 Series Encryptors support the FIPS 140-2 Logical Interfaces as outlined in Table 6.

**Table 6 Interface Support**

<b>Logical Interface</b>	<b>Support</b>
<b>Data Input &amp; Data Output</b>	<p><b>Local Interface:</b></p> <ul style="list-style-type: none"> <li>Connects to the local (private) network; sends and receives plaintext user data to and from the local network.</li> </ul> <p><b>Network Interface:</b></p> <ul style="list-style-type: none"> <li>Connects to the public network; sends and receives ciphertext user data, via the public network, to and from a far end cryptographic module.</li> <li>Authenticates with the far end cryptographic module(s); sends and receives authentication data and RSA key exchange components to and from a far end module.</li> </ul> <p>The module can be set to bypass allowing it to send and receive plaintext user data for selected connections.</p>
<b>Control Input</b>	<p>Control Input is provided by the Local Console, Keypad &amp; Display, and the CM Remote Management Interface as follows:</p> <ul style="list-style-type: none"> <li>The Keypad supports module initialization prior to authentication</li> </ul>

Logical Interface	Support
	<p>and operation in the approved mode. A Crypto Officer sets the IP address for remote administration by Senetas' CM application; sets the system clock; and loads, in conjunction with the CM application, the module's certificate.</p> <ul style="list-style-type: none"> <li>• As an alternative to using the Keypad, the Local Console may be used for initialization prior to certification and operation in the approved mode. The Local Console receives control input from a locally connected terminal.</li> <li>• Following initialization and authentication, the CM application can communicate with the module to receive out-of-band control input.</li> </ul> <p>When configured for in-band management, the Private and Public Network Interfaces may also receive control input. In this mode, the CM application sends control input by way of the Local or Network Port rather than the RJ-45 Ethernet.</p>
<p><b>Status Output</b></p>	<p>Status output is provided by the Keypad &amp; Display, LEDs, Local Console and the CM Remote Management Interface as follows</p> <ul style="list-style-type: none"> <li>• The Display presents the Crypto Officer with the command data being entered via the Keypad. It also indicates the state of the RSA keys and certificates.</li> <li>• The System LEDs indicate the system and tunnel state as well a combined alarm status covering network and local ports.</li> <li>• The Port LEDs indicate the state of the local and network interfaces and the presence of network traffic.</li> <li>• As an alternative to using the Keypad &amp; Display, the Local Console may be used for initialization prior to certification and operation in the approved mode. The Local Console may also be used for monitoring some operations; status output is sent to a locally connected terminal.</li> <li>• Following initialization and authentication, the module sends out-of-band status output to the CM Remote Management application.</li> </ul> <p>When configured for in-band management, the Private and Public Network Interfaces may also send status output. In this mode, the module status output is sent to the CM application by way of the Local or Network Port rather than the RJ-45 Ethernet Port.</p>

The encryptor does permit logically distinct categories of information to share the Local and Network Ports. If the module is configured to allow in-band management traffic, then the control/status information (key exchange or management commands) and user data enter and exit the module via the Network Interfaces. The module separates these two logically distinct categories of information, using the mechanisms specific to the operational protocols.

## 4. Administrative Roles, Services and Authentication

The cryptographic module supports four roles: Crypto Officer, Operator, Upgrader and User. Crypto Officers are assigned permissions based on one of two subcategories: Administrator and Supervisor. The supported roles are summarized in Table 7.

**Table 7 Roles**

Role	Description
<b>Crypto Officer</b>	<p><b>Administrator:</b> Provides cryptographic initialization and management functions. Crypto Officer functions are available via the CM Remote Management application. Limited functions are also available via the Console interface.</p> <p><b>Supervisor:</b> Provides limited operational management functions. Functions are available via the CM Remote Management application. Limited functions are also available via the Console interface.</p> <p>Services for the CO are accessible directly via the Local Console CLI or remotely via the CM Remote Management Interface and the CM Remote Management application.</p>
<b>User</b>	<p>Restricted to read-only access to module configuration data.</p> <p><b>Operator:</b> The Operator role is intended to provide sufficient restricted module access for an IT professional to monitor and ensure the network infrastructure to which the encryptor is connected is intact and operational. Services for the Operator are accessible directly via the Local Console CLI or remotely via the CM Remote Management Interface and the CM Remote Management application.</p> <p><b>Upgrader:</b> The Upgrader Role is limited to applying field upgrades to the module firmware. Additional access is restricted to read-only access to module configuration data.</p> <p>Services for the Upgrader are accessible directly via the Local Console CLI or remotely via the CM Remote Management application.</p>

Roles cannot be changed while authenticated to the module; however, the module permits multiple concurrent operators. While only one operator may connect to the Local Console at a time, multiple concurrent remote sessions are permitted. CM based management is not session oriented; thus, multiple operators may be issuing commands with each command processed individually as it is received by the module. In a meshed network the system architecture supports simultaneous interactions with many far end modules; the multiple users (remote modules) all sending data to the data input port. The module's access control rules, system timing, and internal controls maintain separation of the multiple concurrent COs, Operators, Upgraders and Users.

The module does not support a maintenance role. Since there are no field services requiring removal of the cover, physical maintenance is performed at the factory.

Note: A Crypto Officer should zeroize the module before it is returned to the factory. The module can be zeroized using several methods. When the module is powered on, the module can be zeroized by command or by performing the Erase key press sequence defined in the user manual. An immediate erase can be achieved, powered or un-powered, by depressing the concealed front panel Erase button, accessed using a "paperclip" or other suitable tool. Refer to Figure 7 for location.

## 4.1 Identification and Authentication

The module employs Identity-Based Authentication. Access is restricted as indicated in Table 8. Up to 30 unique names and passwords may be defined for operators (COs, Operators, Upgraders) of the module. Operators using the Local Console enter their name and password to authenticate directly with the module. Operators using Senetas' CM Remote Management application issue commands to the encryptor. Password based authentication and Diffie-Hellman Key Agreement allow the transport of secure messages to the module. Commands from the CM application are individually authenticated to ensure Data Origin Authentication and Data Integrity. Data Origin Authentication, based on the names and passwords, ensures the authenticity of the user claiming to have sent the command. Users employing the module's security functions and cryptographic algorithms, over the Data Input and Output ports, authenticate via certificates that have been generated and signed by a common Certificate Authority (CA). The modules exchange Key and Data Encryption keys using RSA public key wrapping.

**Table 8 Authentication Type**

Role	Type of Authentication	Authentication Data
<b>Crypto Officer Administrator Supervisor</b>	Identity-based	Crypto Officers using the Local Console present unique user names and passwords to log in to the CLI.  Crypto Officers using the CM Remote Management application have unique identities embedded in the command protocol. Each issued command is individually authenticated.
<b>Operator</b>	Identity-based	Operators follow the same authentication rules as Crypto Officers.
<b>Upgrader</b>	Identity-based	Upgraders follow the same authentication rules as Crypto Officers.

The strength of the authentication mechanisms is detailed in Table 9.

**Table 9 Strength of Authentication**

Authentication Mechanism	Strength
<b>Password</b>	COs, Operators, and Upgraders accessing the module CLI, via the Local Console, must authenticate using a password that is at least 8 characters and at most 16 characters in length. The characters used in the password must be from the ASCII character set of alphanumeric and special (shift-number) characters. This yields a minimum of $62^8$ (over 14.5 million) possible combinations. The possibility of correctly guessing a password is less than 1 in 1,000,000.  After three failed authentication attempts via the CLI, the Local Console port access is locked for 3 minutes. With the 3 minute lockout, the possibility of randomly guessing a password in 60 seconds is less than 1 in 100,000.  Note: The module also suppresses feedback of authentication data, being entered into the Local Console, by returning blank characters.

Authentication Mechanism	Strength
User Certificates	Far end modules (Users) authenticate using an RSA authentication certificate based on a 1024 or 2048 bit keys. The possibility of deriving a private RSA key is less than 1 in 1,000,000. Based on the multi-step handshaking process between modules, the possibility of randomly guessing the passphrase in 60 seconds is less than 1 in 100,000.

## 4.2 Roles and Services

CN6000 Series Encryptors support the services listed in the following tables. The tables group the authorized services by the module's defined roles and identify the Cryptographic Keys and CSPs associated with the services. The modes of access are also identified per the explanation.

**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.

The module's services are described in more detail in the CN Series documentation. Note access to and behaviour of module services are identical when operating in FIPS-Approved or non-Approved modes.

Once authenticated, the operator has access to the services required to initialize, configure and monitor the module. With the exception of passwords associated with user accounts, the operator never enters Cryptographic Keys or CSPs directly into the module (an Administrator CO will enter passwords when working with user accounts).

**Table 10 Operator – Roles and Services**

Crypto Officer		User		Authorized Service	Cryptographic Keys and CSPs	Access Type
Admin	Supv	Oper	Upgr			
✓	✓			Set Real Time Clock	none	W
✓				Load Module Certificate	RSA Public and Private Keys RSA Public Key Certificate	W W
✓				Create User Account	Password	W
✓				Modify User Account	Password	E, W
✓				Delete User Account	Password	D
✓	✓	✓	✓	View User Account	none	R
✓	✓			Edit Connection Action Table	none	W

Crypto Officer		User		Authorized Service	Cryptographic Keys and CSPs	Access Type
Admin	Supv	Oper	Upgr			
				(Bypass)		
✓	✓	✓	✓	View Connection Action Table	none	R
✓	✓	✓	✓	Show Firmware Version	none	R
✓				Clear Audit Trail	Password	W
✓	✓	✓	✓	View Audit Trail	none	R
✓				Clear Event Log	Password	W
✓	✓	✓	✓	View Event Log	none	R
✓	✓	✓	✓	View FIPS Mode Status	none	R
✓				Change FIPS Mode Status	Password	W
✓	✓			Run Self Test (Reboot Command)	Password	E
✓			✓	Install Firmware Update	none	E
✓ [1]	✓ [1]			Generate Session Key (DEK)	AES DEKs	W
✓ [1]	✓ [1]			Generate Initialization Vector	Initialization Vector	W
✓ [1]	✓ [1]			RSA signature generation	RSA Private Key	R, E
✓ [1]	✓ [1]			RSA signature verification	RSA Public Key	R, E
✓				Erase Module – Zeroize (Console Command)	System Master Key and all CSP data stored in non-volatile memory	W
✓ [2]	✓ [2]			Establish a Remote Session	Privacy Key	R, W, E

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

[2] Privacy keys are established when a remote session is initiated and used to encrypt and decrypt all subsequent directives.

Note: Plaintext Cryptographic Keys and CSPs are never output from the module regardless of the operative role or the mode of operation.

## 5. Physical Security

CN6000 Series Encryptors employ the following physical security mechanisms:

1. The encryptor is made of commercially available, production grade components meeting commercial specifications for power, temperature, reliability, shock and vibration. All Integrated Circuit (IC) chips have passivation applied to them. The steel enclosure is opaque to the visible spectrum. The ventilation holes on the encryptor's front panel are factory fitted with baffles to obscure visual access and to prevent undetected physical probing inside the enclosure. Attempts to enter the module without removing the cover will cause visible damage to the module, while removing the cover will trigger the tamper circuitry.
2. Access to the internal circuitry is restricted by the use of tamper detection and response circuitry which is operational whether or not power is applied to the module. Attempting to remove the enclosure's cover immediately causes the module to be set into 'Discard' mode and initiates the zeroization of all Keys and CSPs. For further details refer to Section 6.2.
3. Two tamper evident seals are pre-installed (at factory). Both are placed between the top cover and underside of the main enclosure (refer Figure 13). Attempting to remove the top cover to obtain access to the internal components of the module will irreparably disturb these seals, thus providing visible evidence of the tamper attempt. Replacement tamper seals cannot be ordered from Senetas. A module with damaged tamper evident seals should be returned to the manufacturer by the Crypto Officer.



**Figure 13 – Factory installed tamper seals**



While the physical security mechanisms protect the integrity of the module and its keys and CSPs, it is strongly recommend that the cryptographic module be maintained within a physically secure, limited access room or environment.

Table 11 outlines the recommended inspection practices and/or testing of the physical security mechanisms.

**Table 11 Physical Security Inspection & Test**

Security Mechanism	Inspection & Test Guidance	Frequency
<b>Tamper Evidence</b>	<p>Tamper indication is available to all user roles via the alarm mechanism and evidence by the physical tamper labels.</p> <p>The Crypto Officer is responsible for the physical security inspection.</p> <p>During normal operation, the Secure LED is illuminated <b>green</b>. When the unit is not activated and/or uncertified (has no loaded certificate as either the default factory manufactured state or user erase operation has been executed) or in the tampered state, the Secure LED is illuminated <b>red</b> and all traffic is blocked.</p> <p>Inspect the enclosure and tamper evident seals for physical signs of tampering or attempted access to the cryptographic module.</p>	In accordance with organization's Security Policy.
<b>Tamper Circuit</b>	<p>The module enters the tampered state when the circuit is triggered. Once in this state, the module blocks all user traffic until the module re-activated and re-certified.</p>	No direct inspection or test is required; triggering the circuit will block all data flow.

## 6. Cryptographic Key Management

### 6.1 Cryptographic Keys and CSPs

The following table identifies the Cryptographic Keys and Critical Security Parameters (CSPs) employed within the module.

**Table 12 Cryptographic Keys and CSPs**

Key/CSP	Key Type and Use	Key/CSP Entry		Key/CSP Output		Key/CSP Destruction	Key/CSP Archiving
		Origin	Storage	Sourced	Format		
<b>System Master Key</b>	On initialization, the module generates a 168-bit symmetric key. 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.	Internal Electronic	Plaintext, in a tamper protected memory device	No	NA	On tamper or Erase the System Master Key is zeroized.	No
<b>RSA Private Key(s)</b>	A Private 1024 or 2048 bit key is the secret component of the module's RSA Key pair. It is generated when the module receives a Load Certificate command from CM application. The RSA Private Key(s) are used to authenticate connections with other encryptors and to unwrap master session keys (KEKs) and session keys (DEKs) received from far-end encryptors.	Internal Electronic	3-key Triple-DES-encrypted format, non-volatile system memory.	No	NA	On tamper or Erase the Triple-DES System Master Key is zeroized, rendering the encrypted RSA Private Key undecipherable. Each event also deletes the RSA from non volatile memory.	No
<b>RSA Public Key(s)</b>	This Public 1024 or 2048 bit key is the public component of a module's RSA Key pair. They reside in the Network Certificate, and are used for authenticating connections with other encryptors.	Internal Electronic	3-key Triple-DES-encrypted format, in non-volatile system memory.	Electronic	Plaintext within X.509 certificate signed by trusted CA	On tamper or Erase the Triple-DES System Master Key is zeroized, rendering the encrypted RSA Public Key undecipherable. Each event also deletes the RSA keys from non volatile memory.	No

Key/CSP	Key Type and Use	Key/CSP Entry		Key/CSP Output		Key/CSP Destruction	Key/CSP Archiving
		Origin	Storage	Sourced	Format		
Module Certificate(s)	A X.509 certificate is associated with a session in an operational environment. It is produced, upon request from the module, and signed by the Certificate Authority (CA) to establish root trust between encryptors. Once a certificate has been authenticated, Far-end encryptors use the signed RSA Public Key to wrap the initial session keys (KEKs) used to encrypt a session.	Internal Electronic	Stored, in the plaintext, in non-volatile system memory	Electronic	Plaintext signed by trusted CA	The certificate is deleted from non volatile system memory on tamper or Erase command from a Crypto Officer.	No
Authentication Password	Up to 30 unique Crypto Officers (Administrator, Supervisor or Operator) may be defined, with associated passwords, within the module.  The CLI uses the Authentication Password to authenticate Crypto Officers accessing the system via the Local Console.  The CM application requires an operator password that is used to uniquely authenticate each command to the module.	Internal Electronic	Passwords and their associated Usernames are hashed and stored in the User Table which is stored 3-key Triple-DES-encrypted format in non-volatile system memory	No	NA	On tamper or Erase, the Triple-DES System Master Key is zeroized, rendering the encrypted Passwords undecipherable. Each event also deletes the User Table including passwords from non volatile system memory	No
Key Encrypting Key	For each session (CI), the module generates a symmetric KEK using the NIST SP800-90A DRBG and other input in accordance with ATM Security Specification reference [12]. The seed key and seed value are not part of the stored CSP data, but are generated on demand as required. RSA key transport is used to transfer this key to a far-end module.  The KEK persists for the life of the session and is used to secure the DEK that may be changed periodically during the session.	Internal Electronic	KEK is stored in plaintext, in volatile SDRAM system memory	Yes	Wrapped for transport using the far-end module's public RSA key	Zeroized at the end of a session, on tamper or Erase and when power is removed from unit	No
Data Encrypting Key	For each session (CI), the module also generates two DEK for each data flow path in the secure connection (one for the Initiator-Responder path and another for the Responder-Initiator path) using the NIST SP800-90A DRBG.  These keys AES encrypt and decrypt the user data transferred between the Encryptors.  These active session keys are normally changed periodically based on the duration of the session.	Internal Electronic	DEK is stored in plaintext, in volatile SDRAM system memory	Yes	Encrypted using KEK in accordance with ATM Security Specification, reference [12]	Zeroized at the end of a session, on tamper or Erase and when power is removed from unit	No

Key/CSP	Key Type and Use	Key/CSP Entry		Key/CSP Output		Key/CSP Destruction	Key/CSP Archiving
		Origin	Storage	Sourced	Format		
<b>Privacy Keys</b>	For each remote management session, the module uses an AES privacy key as part of the Diffie-Hellman key agreement process to secure the control / flow path in the secure connection.	Internal Electronic	All privacy keys are stored in plaintext, in volatile system memory	No	NA	Destroyed at the end of a remote management session and when power is removed from unit. Note Erase, reboot and tamper will end a remote session	No
<b>DRBG Seed</b>	The DRBG seed is generated in accordance with NIST SP800-90A and NIST SP800-131A DRBG guidelines.	Internal Electronic	Not stored	No	NA	NA	No
<b>Diffie Hellman Keys</b>	For each remote management session the CM application will use Oakley Group 2 base and prime values to generate the required local and private values to enable privacy key exchange.	Internal Electronic	Stored in plaintext, in volatile system memory	No	NA	Destroyed at the end of a remote management session and when power is removed from unit Note: Erase, reboot and tamper will end a remote session	No

Note 1: While the certificates, maintained within the module, are listed as CSPs, they contain only public information.

Note 2: All random data including cryptographic Key material is sourced from the NIST SP800-90A DRBG as required

## 6.2 Key and CSP zeroization

Zeroization of cryptographic Keys and CSPs is a critical module function that can be initiated by a Crypto Officer or under defined conditions, carried out automatically. Zeroization is achieved using the “Zeroization sequence” defined in section 6.2.1 below.

Crypto Officer initiated zeroization will occur when the:

1. Module Erase command issued from the CLI or CM application
2. Front Panel key press Erase sequence is selected
3. Concealed front panel “Emergency” Erase button is depressed

Automatic zeroization will occur when the module is:

1. Switched from an Approved to non-Approved mode of operation
2. Switched from an non-Approved to Approved mode of operation
3. Physically tampered

The following sections describe the specific events that occur when zeroization initiated. Note zeroization behaviour is the same whether the module is configured to run in FIPS-Approved or non-Approved mode.

### 6.2.1 Zeroization sequence

The module Zeroization sequence achieves the following:

- Sets each session (CI) to DISCARD, before zeroizing the DEKs
- Zeroizes the System Master Key rendering the RSA Private Key, User table (including authentication passwords) and other CSPs (Certificates, RSA keys) indecipherable
- Deletes all Certificate information
- Deletes RSA Private and Public keys, module Configuration and User table <sup>1</sup>
- Automatically REBOOTS the module destroying KEKs, Privacy and Diffie Hellman keys residing in volatile system memory

### 6.2.2 Erase command and key press sequence

A Crypto officer can initiate a module Erase remotely using the CM application or when physically in the presence of the module using the management console CLI interface or Front Panel key press Erase sequence.

Zeroization of the module Keys and CSPs and is achieved using the zeroization sequence as defined in section 6.2.1.

### 6.2.3 Approved mode of operation

Switching the module to and from the FIPS Approved mode of operation will automatically initiate an Zeroization sequence to as defined in section 6.2.1 above.

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<sup>1</sup> The RSA Private and Public keys, Configuration details and User table are encrypted by the System Master Key which, during an Erase, is the first CSP to be zeroized. Deleting the aforementioned CSPs is deemed good practise.

#### 6.2.4 Tamper initiated zeroization

Zeroization will be initiated upon detection of a tamper event. The Tamper Circuit is active at all times; the specific tamper response differs slightly based on the module's power state. From a practical standpoint the effect on the Keys and CSPs is the same.

The tamper initiated zeroization process achieves the following:

1. Zeroization of the System Master Key (SMK) rendering the RSA Private Key, User table and other CSPs indecipherable. Zeroization of the SMK occurs irrespective of the powered state of the module.
2. When powered on and the Tamper Circuit is triggered, the module will automatically:
  - a. Set the encryption mode for each session (CI) to DISCARD ensuring no user data is output from the module,
  - b. Log the tamper event to the Audit Log,
  - c. Set the System, Secure and Alarm LEDs to flash RED on the front panel and herald the tamper event via the internal speaker,
  - d. Initiate the Zeroization sequence zeroizing all Session Keys (DEKs) and CSPs in volatile system memory and non-volatile Configuration and User account data,
  - e. REBOOT the module.
3. When powered off and the Tamper Circuit is triggered, there are no Session Keys (DEKs) or CSPs in system volatile memory to be zeroized however upon re-powering the module, the zeroised System Master Key will indicate that the system has been tampered. The module will:
  - a. Log the tamper event to the Audit log,
  - b. Initiate the Zeroization sequence,
  - c. Continue to the BOOT, returning the module to the un-Activated factory default state.
4. When the BOOT sequence has completed the module will have:
  - a. Generated a new System Master Key,
  - b. Re-created the default administration account,
  - c. Set the encryption mode to DISCARD,
  - d. Entered the factory default state ready for Configuration (as described in Section 8.3 below).

#### 6.2.5 “Emergency” Erase

The “Emergency” Erase feature is initiated when the concealed front panel button is depressed and follows the behaviour defined in section 6.2.4 Tamper initiated zeroization above.

### 6.3 Data privacy

To ensure user data privacy the module prevents data output during system initialization. No data is output until the module is successfully authenticated (activated) and the module certificate has been properly loaded. Following system initialization, the module prevents data output during the self tests associated with a power cycle or reboot event. No data is output until all self tests have completed successfully. The module also prevents data output during and after zeroization of data plane cryptographic keys and CSPs; zeroization occurs when the tamper circuit is triggered. In addition, the system's underlying operational environment logically separates key management functions and CSP data from the data plane.

## 6.4 Cryptographic Algorithms

CN6000 Series Encryptors employ the following approved cryptographic algorithms. Table 13 lists approved embedded software algorithms that are common to the CN6000 Series. Table 14 lists approved firmware algorithms that are specific to the CN6040 and CN6100 hardware versions.

**Table 13 FIPS Approved Algorithms – CN6000 Series Common Crypto Library**

Algorithm Type	Algorithm	FIPS Validation Certificate	Target Model Notes
<b>CN Series Crypto Library</b>			<b>CN6040 / CN6100</b>
<b>Symmetric Key</b>	<b>Triple-DES</b> TCFB8 (e/d; KO 1)	TDES # 1412	
	<b>AES</b> CFB128 (e/d; 128,256)	AES # 2258	
<b>Asymmetric Key</b>	<b>RSA</b> Key(gen) (MOD: 1024, 2048 PubKey Values: 65537) ALG[RSASSA-PKCS1_V1_5]; SIG(gen); SIG(ver); 1024 <sup>1</sup> , 2048, SHS: SHA-1, SHA-256	RSA # 1157	
	<b>Hashing</b> SHA-1 (BYTE only) SHA-256 (BYTE only)	SHS # 1945	
<b>HMAC</b>	HMAC-SHA-1 (Key Sizes Ranges Tested: KS<BS) HMAC-SHA-256 (Key Sizes Ranges Tested: KS<BS)	HMAC # 1385	
<b>DRBG</b>	NIST SP800-90A Hash_Based DRBG: [ Prediction Resistance Tested: Not Enabled (SHA-256) ]	DRBG # 276	

1. Use of RSA Sig(gen) 1024 should be transitioned to Sig(gen) 2048 in line with SP800-131A.

FIPS Approved Algorithms – CN6000 Series Firmware Algorithms

Algorithm Type	Algorithm	FIPS Validation Certificate	Target Model Notes
<b>CN6040 Module – Fibre Channel Mode</b>			<b>Fibre Channel Mode</b>
<b>Symmetric Key</b>	<b>AES</b> CFB128 ( e/d; 256 )	AES # 2259	Selectable line rate of: 1/2/4Gbps
<b>CN6040 Module – Ethernet Mode</b>			<b>Ethernet Mode</b>
<b>Symmetric Key</b>	<b>AES</b> CFB128 ( e/d; 128, 256 )	AES # 2264	Selectable line rate of: 10/100/1000 Mbps
	<b>AES</b> CTR128 (int only; 128, 256 )	AES # 2264	Model number /description: A6040B:
	<b>AES</b> ECB128 ( e; 128, 256 )	AES # 2264	1G Ethernet Encryptor 4G Fibre Channel Encryptor
<b>CN6100 Module - Ethernet</b>			<b>Ethernet Model</b>
<b>Symmetric Key</b>	<b>AES</b> CTR128 ( int only; 128, 256 )	AES # 2265	Line rate: 10 Gbps
	<b>AES</b> ECB128 ( e; 128, 256 )	AES # 2265	Model number /description: A6100B 10G Ethernet Encryptor



In addition to the FIPS approved algorithms, the CN6000 Series also includes the following non-Approved and Allowed algorithms.

**Table 14 non-Approved and Allowed Algorithms**

Function	Use
<b>RSA Key Wrapping</b>	Per the ATM Forum Security Specification (Version 1.1), RSA key wrapping is employed to establish the symmetric keys used for data encryption between cryptographic modules.
<b>Diffie-Hellman Key Agreement</b>	Diffie-Hellman Key Agreement is employed to establish the symmetric keys used to secure the management interface between the CA application and the cryptographic module.

**Note: 1024 or 2048 bit keys, providing the equivalent of 80 or 112 bits of symmetric encryption strength respectively, are employed for RSA Key Wrapping and Diffie-Hellman Key Agreement.**

## 7. Self Tests

CN6000 Series cryptographic modules perform both power-up and conditional self tests to verify the integrity and correct operational functioning of the encryptor. Any failure of a self test will cause the module to transition to an error state and block all traffic on the data ports. Upon entering errored state an operator can attempt to clear the state by restarting the module. If the state cannot be cleared the module must be returned to the manufacturer. Table 15 summarizes the module's self tests.

The design of the CN6000 Series cryptographic modules 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. No CSPs, plaintext data, or other information, that if misused could lead to a compromise, is passed to the status output interface.

**Table 15 Self Tests**

Self Test	Description
<b>Mandatory Tests</b>	<b>Performed at power-up and on demand</b>
<b>Known Answer Tests</b>	Each cryptographic algorithm, employed by the encryptor, is tested using a "Known Answer Test" to verify the operation of the function. CN6000 Series KATs are divided into four distinct modules which correspond to the common and firmware modules listed in table 14.
CN6000 Series Common Crypto Library	The following CN6000 Series Common Crypto Library algorithms are tested: AES (encrypt / decrypt), Triple-DES (encrypt / decrypt), SHA-1, SHA-256, HMAC-SHA-1, HMAC-SHA-256, RSA (Sign and Verify) and SP 800-90A DRBG.
CN6040 Ethernet	Each of the AES firmware modules are tested at power-up. The CN6040 module can be configured to operate in Ethernet or Fibre Channel modes, while the CN6100 supports Ethernet mode only.
CN6040 Fibre Channel	AES CFB128 (e/d; 128, 256), CTR128 (e/d; 128, 256)
CN6100 Ethernet	AES CFB128 (e/d; 256)
CN6100 Ethernet	AES CTR128 (e/d; 128, 256)
<b>Firmware Integrity Test</b>	An Error Detection Code (20-byte SHA-1 hash) is used to verify the integrity of all components within the cryptographic firmware when the module is powered up.
<b>Bypass Test</b>	<p>CN6000 Series modules support alternating between Bypass, Discard and Encrypt modes (which can be seen from the management interface).</p> <p>The configuration files that control the bypass/discard and encrypt settings are integrity checked using a stored checksum (32 bit CRC). On power-up the module calculates a fresh checksum for all configuration files and compares each to the stored values. Upon a mismatch an error is flagged. The error condition will result in a recreation of the configuration file with the factory default settings. Factory default settings are to fail safe, setting policy to Discard. An audit message is entered to reflect the re-initialisation.</p> <p>Any user change (crypto officer) to or from encrypt, bypass or discard shall cause an audit log entry.</p>
<b>Critical Functions</b>	<b>Performed at power-up</b>
<b>Configuration Memory</b>	An EDC is calculated on all configuration memory and compared against the expected value, which is also stored in the configuration memory, to verify the configuration memory integrity. If the integrity

Self Test	Description
	check fails, the module attempts to correct the EDC and reports the failure.
<b>Battery</b>	<p>The battery voltage 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 fails, the battery low alarm condition is raised. The module continues to operate however it is advisable that the battery be replaced immediately. The battery is located in the removable fan tray and can be ordered from Senetas.</p> <p>Battery alarm indication is available to all user roles via the alarm mechanism.</p>
<b>General Purpose Memory</b>	A destructive test verifies that the general purpose memory (RAM) is operating properly. The module confirms that all legal addresses may be written to and read from, and that no address lines are open or shorted.
<b>Real Time Clock / Tamper Memory</b>	The Real Time Clock (RTC) oscillator is checked at start-up and the Tamper memory is examined for evidence of a Tamper Condition.
<b>Conditional Tests</b>	<b>Performed, as needed, during operation</b>
<b>Bypass Test</b>	<p>The module supports alternating between Bypass and Encrypt modes.</p> <p>The CI table contains settings, configured administratively, for Bypass mode. With each change to the CI table, the module generates a checksum (32 bit CRC) and stores it as a parameter to the table. On change, the module calculates a fresh checksum and compares it to the stored value. If the values do not match, the module determines that an error exists within the CI table; the module sets an alarm and blocks all traffic on the data ports. If the values do match, the module is assured that the CI table rules have not been corrupted or erroneously changed.</p>
<b>Pair-wise Consistency</b>	RSA Public and Private keys are used for the calculation and verification of digital signatures and for key transport. These keys are tested for consistency, based to their purpose, at the time they are generated. RSA wrapping keys are tested by an encrypt/decrypt pair-wise consistency test; signature keys are tested by a sign/verify pair-wise consistency test.
<b>Firmware Load</b>	The module verifies the authenticity of any firmware load that is applied to the encryptor in the field. Only firmware loads with a valid and verified RSA signature are accepted.
<b>Continuous RNG</b>	The Continuous RNG test is a “stuck at” test that checks the RNG output data for failure to a constant value. Both RNGs (approved and non-approved) are subject to this test.

Crypto Officers can run the power-up self-test on demand by issuing a module reboot command. This may be accomplished via the Local Console, or by cycling the power to the module. Use of the Local Console or power cycling the module requires a direct connection or physical access to the module respectively. Rebooting or power cycling the module causes the keys securing the configured connections to be re-established following the restoration of communications.

## 8. Crypto-Officer and User Guidance

This section provides information for Crypto Officers to install, configure and operate the CN6000 Series Encryptors in FIPS mode.

As outlined in this Security Policy, Crypto Officers (more specifically, Administrators and Supervisors) are the only administrators/operators that can make configuration changes or modify the system settings. The Crypto Officer is responsible for the physical security inspection.

The CN6000 Series is designed to operate in either a FIPS approved mode or a non-FIPS approved mode. The operator can query the FIPS status (operating mode) of a module, and authorized operators may change the FIPS mode of operation. The FIPS status can be queried from the Local Console via the CLI or remotely via the CM application.

To ensure that no CSPs are accessible from a previous operating mode an module Erase and Reboot are automatically performed upon mode change.

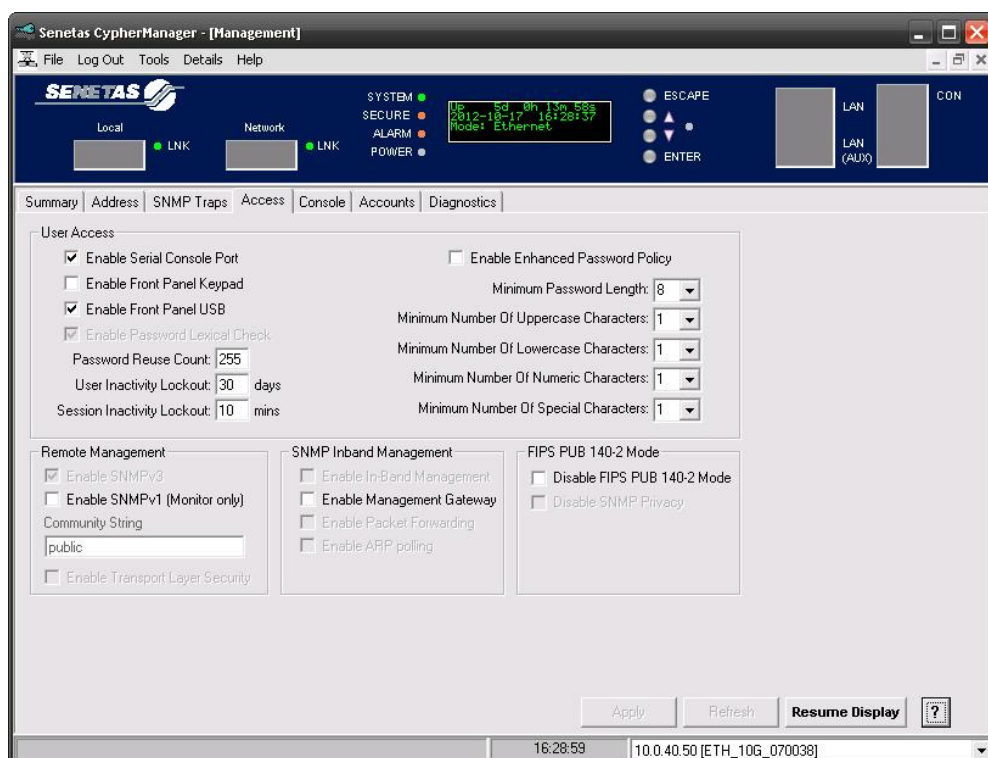
**Note: Non-FIPS mode of operation is provided for interoperability with legacy systems. The module's factory default (Erased) mode is FIPS approved and the CN6000 Series must be explicitly configured to operate in a non-FIPS approved mode.**

The console command is:

```
> fips <ENTER>
```

```
CN6100> fips  
FIPS mode enabled
```

The CM application screen for reporting the FIPS status is found on the User Management screen, in the Access tab under FIPS PUB 140-2 Mode.



**Figure 14 – FIPS Approved and non-Approved mode selection**

**Note: Read all of the instructions in this section before installing, configuring, and operating the CN6000 Series Encryptors.**

## 8.1 Delivery

When a CN6000 Series Encryptor is delivered, the CO can verify that the model and serial numbers on the outside of the packaging, the model and serial numbers attached to the encryptor itself, and the numbers listed on the order acknowledgement, all match. The CO can also verify that the encryptor has not been modified by examining the tamper evident seal on the outside of the unit. If the seal is broken, then the integrity of the encryptor cannot be assured and Senetas should be informed immediately.

Upon receipt of a CN6000 Series Encryptor, the following steps should be undertaken:

1. Inspect the shipping label as well as the label on the bottom of the system to ensure it is the correct FIPS-approved version of the hardware.
2. Inspect the encryptor for signs of tampering. Check that the tamper evident tape and the covers of the device do not show any signs of tampering. If tampering is detected, return the device to the manufacturer.

Do not install the encryptor if it shows signs of tampering or has an incorrect label. Contact your organization's Security Officer for instructions on how to proceed.

If the device has the correct label and shows no signs of tampering, proceed to the next section.

## 8.2 Location

The encryptor must be installed in a secure location to ensure that it cannot be physically bypassed or tampered with. Ultimately the security of the network is only as good as the physical security around the encryptor.

Always maintain and operate the CN6000 Series Encryptor in a protected/secure environment. If it is configured in a staging area, and then relocated to its operational location, never leave the unit unsecured and unattended.

Ideally the encryptor will be installed in a climate-controlled environment with other sensitive electronic equipment (e.g. a telecommunications room, computer room or wiring closet). The encryptor can be installed in a standard 19-inch rack or alternatively mounted on any flat surface. Choose a location that is as dry and clean as possible. Ensure that the front and rear of the encryptor are unobstructed to allow a good flow of air through the fan vents.

The encryptor is intended to be located between a trusted and an untrusted network. The Local Interface of the encryptor is connected to appropriate equipment on the trusted network and the Network Interface of the encryptor is connected to the untrusted (often public) network.

Depending on the topology of your network, the Local Interface will often connect directly to a router, switch, or Add/Drop Multiplexer, while the Network Interface will connect to the NTU provided by the network carrier.

## 8.3 Configuration – FIPS140-Approved mode

Full configuration instructions are provided in the **User Manual**. Use the guidance here to constrain the configuration so that the device is not compromised during the configuration phase. This will ensure the device boots properly and enters FIPS 140-2 approved mode.

When powering up the module for the first time, use the front panel to configure the system for network connectivity. Then use the CM Remote Management application to initialize the module and perform the configuration operations.

1. Power on the unit.

The system boot-up sequence is entered each time the module is powered on and after a firmware restart. The CN6000 Series Encryptor automatically completes its self tests and verifies the authenticity of its firmware as part of the initialization process. The results of these tests are reported on the front panel LCD and are also logged in the system audit log.

If errors are detected during the diagnostic phase, the firmware will not complete the power up sequence but will instead enter a Secure shutdown state and Halt ("Secure Halt"). If this occurs the first time power is applied or any time in the future, the module is notifying the CO

that a persistent (hard) error has occurred and that the module must be returned for inspection and repair.

2. Follow the User Manual's **Commissioning** section to set the system's IP Address, Date and Time.
3. If the CM application is being run for the first time, it will ask if the installation will act as the Certification Authority (CA) for the secure network. If the user selects yes a private and public RSA key pair that will be used to sign X.509 certificates is generated.

4. **Activate** the cryptographic module.

A newly manufactured or erased cryptographic module must be **Activated** before X.509 certificate requests can be processed. See the User Manual's **Commissioning** section for details.

Activation ensures that the default credentials of the 'admin' account are replaced with those specified by the customer prior to loading signed X.509 certificates in to the module.

The updated user credentials (username and password) are transmitted to the encryptor using RSA 2048 public key encryption, and a hashing mechanism is used by the local administrator CO to authenticate the message.

5. Install a signed **X.509 certificate** into the cryptographic module.

Version 2.2.0 and later CN Series cryptographic modules support V1/V2 and V3 X.509 Certificate Signing Requests (CSRs) and will accept certificates signed by Senetas' CM Remote Management application (when acting as a CA) as well as certificates signed by External CAs. In both cases each CN Series cryptographic module supplies upon request an unsigned X.509 certificate containing the module's details and 1024 or 2048 bit Public RSA key.

The administrator then takes the CSR and has it signed by either the trusted local CA (Senetas' CM Remote Management application for V1/2/3 certificates) or an external CA for V3 certificates. For a typical deployment this procedure is repeated for all cryptographic modules in the network and the signed certificates are installed in to each module.

After an X.509 certificate has been installed into CN Series module the administrator can create supervisor and operator accounts.

At this point the CN6000 Series Encryptor is able to encrypt in accordance with the configured security policy; the ENT key on the front panel is disabled; and the default factory account has been removed.

6. Ensure the encryptor is in FIPS 140-2 mode (default setting) via the CM applications' **Management-Access** tab. See Figure 14 for details.
7. Configure the security policy to enable encrypted tunnels with other CN Series modules.  
Configuration of the security policy is network specific; refer to the User Manual for specific details.

## 8.4 Configuration - non-Approved mode

Non-approved mode of operation is provided to interwork with legacy management systems that are unable to support SNMPv3 privacy. All other module services are identical and no additional Keys/CSPs are accessible.

The installation procedure for non-Approved operation is as described in section 8.3 above except for configuring the non-Approved mode of operation.

2. Non-Approved mode of operation can be invoked through the CM Application or via the management console. Upon changing to FIPS approved mode or to the non-Approved mode the module will automatically erase and restart.
  - i. Navigate to the FIPS PUB 140-2 setting in **Management-Access** tab within the CM Application and *SET* the *Disable FIPS PUB 140-2 Mode* checkbox
  - OR –
  - ii. Login via the front panel management console and execute the console command e.g. “CN6100> fips off”. See Figure 14 for details.
2. Upon restart, the FIPS mode state can be checked using the CM Application or management console.

## **9. Mitigation of Other Attacks**

The module does not mitigate specific attacks.

End