
Overall Level 2 (Sections 3 and 10 Level 3) Validation

Version 0.11

October 2013
# Introduction

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Introduction

This is a non-proprietary Cryptographic Module Security Policy for the Cisco Catalyst 6503-E, Catalyst C6504-E, Catalyst 6506-E, Catalyst 6509-E and Catalyst 6513-E Switches with Supervisor Cards (VS-S2T-10G and VS-S2T-10G-XL) and Line Cards (WS-X6908-10G, WS-X6908-10G-2TXL, WS-X6904-40G-2T and WS-X6904-40G-2TXL), referred to in this document as the modules or switches. This security policy describes how modules meet the security requirements of FIPS 140-2 and how to run the modules in a FIPS 140-2 mode of operation and may be freely distributed.

The module may be deployed in multiple configurations of linecards and supervisors installed in the module chassis. The following table identifies the possible combinations of hardware.

<table>
<thead>
<tr>
<th>Chassis</th>
<th>Supervisor Cards</th>
<th>Line Cards</th>
</tr>
</thead>
<tbody>
<tr>
<td>6503-E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C6504-E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6506-E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6509-E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6513-E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6513-E</td>
<td>One VS-S2T-10G</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Two VS-S2T-10G</td>
<td></td>
</tr>
<tr>
<td></td>
<td>One VS-S2T-10G-XL</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Two VS-S2T-10G-XL</td>
<td></td>
</tr>
<tr>
<td></td>
<td>WS-X6904-40G-2T</td>
<td></td>
</tr>
<tr>
<td></td>
<td>WS-X6904-40G-2TXL</td>
<td></td>
</tr>
<tr>
<td></td>
<td>WS-X6908-10G</td>
<td></td>
</tr>
<tr>
<td></td>
<td>WS-X6908-10G-2TXL</td>
<td></td>
</tr>
</tbody>
</table>

X (Up to 2)
X (Up to 3)
X (Up to 5)
X (Up to 8)
X (Up to 12)
X (Up to 2)
X (Up to 4)
X (Up to 7)
X (Up to 11)
X (Up to 2)
X (Up to 3)
X (Up to 5)
X (Up to 8)
<table>
<thead>
<tr>
<th>Chassis</th>
<th>Supervisor Cards</th>
<th>Line Cards</th>
</tr>
</thead>
<tbody>
<tr>
<td>6503-E</td>
<td></td>
<td>X (Up to 12)</td>
</tr>
<tr>
<td>6504-E</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>6505-E</td>
<td></td>
<td>X (Up to 2)</td>
</tr>
<tr>
<td>6513-E</td>
<td></td>
<td>X (Up to 4)</td>
</tr>
<tr>
<td>6506-E</td>
<td></td>
<td>X (Up to 7)</td>
</tr>
<tr>
<td>6509-E</td>
<td></td>
<td>X (Up to 11)</td>
</tr>
<tr>
<td>6513-E</td>
<td></td>
<td>X (Up to 2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X (Up to 3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X (Up to 5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X (Up to 8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X (Up to 12)</td>
</tr>
<tr>
<td>6503-E</td>
<td></td>
<td>X (Up to 12)</td>
</tr>
<tr>
<td>6505-E</td>
<td></td>
<td>X (Up to 2)</td>
</tr>
<tr>
<td>6513-E</td>
<td></td>
<td>X (Up to 3)</td>
</tr>
<tr>
<td>6509-E</td>
<td></td>
<td>X (Up to 5)</td>
</tr>
<tr>
<td>6513-E</td>
<td></td>
<td>X (Up to 8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X (Up to 12)</td>
</tr>
<tr>
<td>6503-E</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>6505-E</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>6513-E</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>6509-E</td>
<td></td>
<td>X (Up to 2)</td>
</tr>
<tr>
<td>Chassis</td>
<td>Supervisor Cards</td>
<td>Line Cards</td>
</tr>
<tr>
<td>---------</td>
<td>------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>6503-E</td>
<td>One VS-S2T-10G</td>
<td>WS-X6904-40G-2T</td>
</tr>
<tr>
<td>6504-E</td>
<td>Two VS-S2T-10G</td>
<td>WS-X6904-40G-2TXL</td>
</tr>
<tr>
<td>6506-E</td>
<td>One VS-S2T-10G-XL</td>
<td>WS-X6904-40G-2TXL</td>
</tr>
<tr>
<td>6513-E</td>
<td>Two VS-S2T-10G-XL</td>
<td>WS-X6908-10G</td>
</tr>
<tr>
<td>6516-E</td>
<td>Two VS-S2T-10G-XL</td>
<td>WS-X6908-10G-2TXL</td>
</tr>
</tbody>
</table>

Table 1: Module Configurations

- X (Up to 4)  
- X (Up to 7)  
- X (Up to 11)
Versions:
- 6503-E –H0
- 6504-E -G0
- 6506-E –M0
- 6509-E –N0
- 6513-E -S0
- Supervisor Card VS-S2T-10G -B0
- Supervisor Card VS-S2T-10G-XL -C0
- Line Card WS-X6904-40G-2T -A0
- Line Card WS-X6904-40G-2TXL –A0
- Line Card WS-X6908-10G –A0
- Line Card WS-X6908-10G-2TXL–B0
- Slot Cover SPA-BLANK – G0
- FIPS kit packaging (CVPN6500FIPS/KIT=)
- IOS version 15.1(1)SY1

References
This document deals only with operations and capabilities of the module in the technical terms of a FIPS 140-2 cryptographic module security policy. More information is available on the module from the following sources:

- The Cisco Systems website ([http://www.cisco.com](http://www.cisco.com)) contains information on the full line of products from Cisco Systems.

FIPS 140-2 Submission Package
The security policy document is one document in a FIPS 140-2 Submission Package. In addition to this document, the submission package includes:

- Vendor Evidence
- Finite State Machine
- Other supporting documentation as additional references

With the exception of this non-proprietary security policy, the FIPS 140-2 validation documentation is proprietary to Cisco Systems, Inc. and is releasable only under appropriate non-disclosure agreements. For access to these documents, please contact Cisco Systems, Inc. See “Obtaining Technical Assistance” section for more information.
Module Description

Branch office networking requirements are dramatically evolving, driven by web and e-commerce applications to enhance productivity and merging the voice and data infrastructure to reduce costs. The Catalyst 6500 series switches offer versatility, integration, and security to branch offices. With numerous network modules and service modules available, the modular architecture of the Cisco switches easily allows interfaces to be upgraded to accommodate network expansion. The Catalyst 6500 series switches provide a scalable, secure, manageable remote access server that meets FIPS 140-2 Level 2 requirements, as a multi-chip standalone module.

The switches include cryptographic algorithms implemented in IOS software as well as hardware ASICs. The line card ASICs implement Cisco TrustSec (CTS) protocol supporting IEEE 802.1AE for Layer 2 CTS and contain hardware implementations of the GCM and ECB modes of the AES algorithm.

The switches support the Cisco TrustSec protocol which provides policy-based access control, identity-aware networking, and data confidentiality and integrity; and Virtual Switching System which is a system virtualization technology that allows the pooling of multiple Catalyst 6500 switches into a single virtual switch.

The switches also support SSH and TLS to provide remote administrative access to the module.

Module Validation Level

The following table lists the level of validation for each area in the FIPS PUB 140-2.

<table>
<thead>
<tr>
<th>No.</th>
<th>Area Title</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cryptographic Module Specification</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Cryptographic Module Ports and Interfaces</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Roles, Services, and Authentication</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Finite State Model</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Physical Security</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>Operational Environment</td>
<td>N/A</td>
</tr>
<tr>
<td>7</td>
<td>Cryptographic Key management</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>Electromagnetic Interface/Electromagnetic Compatibility</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>Self-Tests</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>Design Assurance</td>
<td>3</td>
</tr>
<tr>
<td>11</td>
<td>Mitigation of Other Attacks</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Overall module validation level</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 2: Module Validation Level
Cryptographic Boundary
The cryptographic boundary is defined as being the physical enclosure of the chassis.

All of the functionality described in this publication is provided by components within this cryptographic boundary. The module incorporates one or two supervisor blades, and one or more line cards in a single configuration.

Cryptographic Module Ports and Interfaces
Each module provides a number of physical and logical interfaces to the device, and the physical interfaces provided by the module are mapped to four FIPS 140-2 defined logical interfaces: data input, data output, control input, and status output. The module also supports a power interface. The logical interfaces and their mapping are described in the following tables:

<table>
<thead>
<tr>
<th>Physical Interface</th>
<th>Logical Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervisor Card 1G SFP Ports</td>
<td>Data Input Interface</td>
</tr>
<tr>
<td>Supervisor Card 10G Ethernet Ports</td>
<td></td>
</tr>
<tr>
<td>Line Card 10G Ethernet Ports</td>
<td></td>
</tr>
<tr>
<td>Console Port</td>
<td></td>
</tr>
<tr>
<td>Management Port</td>
<td></td>
</tr>
<tr>
<td>Supervisor Card 1G SFP Ports</td>
<td>Data Output Interface</td>
</tr>
<tr>
<td>Supervisor Card 10G Ethernet Ports</td>
<td></td>
</tr>
<tr>
<td>Line Card 10G Ethernet Ports</td>
<td></td>
</tr>
<tr>
<td>Console Port</td>
<td></td>
</tr>
<tr>
<td>Management Port</td>
<td></td>
</tr>
<tr>
<td>Supervisor Card 1G SFP Ports</td>
<td>Control Input Interface</td>
</tr>
<tr>
<td>Console Port</td>
<td></td>
</tr>
<tr>
<td>Management Port</td>
<td></td>
</tr>
<tr>
<td>Supervisor Card 1G SFP Ports</td>
<td>Status Output Interface</td>
</tr>
<tr>
<td>LEDs</td>
<td></td>
</tr>
<tr>
<td>Power Plug</td>
<td>Power Interface</td>
</tr>
</tbody>
</table>

Table 3: Physical To Logical Interfaces

Roles, Services, and Authentication
Authentication is identity-based. Each user is authenticated upon initial access to the module. There are two roles in the Switch that operators may assume: the Crypto Officer (CO) role and the User role. The administrator of the Switch assumes the CO role in order to configure and maintain the Switch using CO services, while the Users exercise security services over the network. The module supports RADIUS for authentication.
**User Role**

The role assumed by users obtaining general security services. From a logical view, user activity exists in the data-plane. Users access via network ports using CTS protocols. CTS uses 802.1AE(EAP-FAST) for authentication.

CTS can use password based credentials – in such a case the user passwords must be at least eight (8) characters long, including at least one letter and at least one number character, in length (enforced procedurally). If six (6) integers, one (1) special character and one (1) alphabet are used without repetition for an eight (8) digit PIN, the probability of randomly guessing the correct sequence is one (1) in 832,000,000. In order to successfully guess the sequence in one minute would require the ability to make over 13,000,000 guesses per second, which far exceeds the operational capability of the console port. Including the rest of the alphanumeric characters drastically decreases the odds of guessing the correct sequence.

CTS can also use certificate credentials using 1024 bit RSA keys and SHA-1 – in such a case the security strength is 80 bits, so an attacker would have a 1 in $2^{80}$ chance of a successful authentication which is much stronger than the one in a million chance required by FIPS 140-2. To exceed a one in 100,000 probability of a successful random key guess in one minute, an attacker would have to be capable of approximately $1.8 \times 10^{31}$ attempts per minute, which vastly exceeds the operational capabilities of the module to support.

**CO Role**

The role assumed by an authorized CO connecting to the switch via CLI or GUI and performing management functions and module configuration. From a logical view, CO activity exists only in the control plane. IOS prompts the CO for their username and password, if the password is validated against the CO’s password in IOS memory, the user is allowed entry to the IOS executive program. A CO can assign permission to access the CO role to additional accounts, thereby creating additional COs.

CO passwords must be at least eight (8) characters long, including at least one letter and at least one number character, in length (enforced procedurally). If six (6) integers, one (1) special character and one (1) alphabet are used without repetition for an eight (8) digit PIN, the probability of randomly guessing the correct sequence is one (1) in 832,000,000. In order to successfully guess the sequence in one minute would require the ability to make over 13,000,000 guesses per second, which far exceeds the operational capability of the console port. Including the rest of the alphanumeric characters drastically decreases the odds of guessing the correct sequence.
### Table 4: Services

<table>
<thead>
<tr>
<th>Role</th>
<th>Authentication Method</th>
<th>Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>User</td>
<td>CTS Authentication</td>
<td>CTS Network Functions: authentication, access control, confidentiality and data integrity services provided by the CTS protocol.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Perform Self Tests: occurs upon system startup</td>
</tr>
<tr>
<td>Cryptographic Officer</td>
<td>CLI/GUI login</td>
<td>Configure the switch: define network interfaces and settings, create command aliases, set the protocols the switch will support, enable interfaces and network services, set system date and time, and load authentication information.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Define rules and filters: create packet filters that are applied to user data streams on each interface. Each filter consists of a set of rules, which define a set of packets to permit or deny based on characteristics such as protocol ID, addresses, ports, TCP connection establishment, or packet direction.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Status functions: view the switch configuration, routing tables, and active sessions; view health, temperature, memory status, voltage, and packet statistics; review accounting logs, and view physical interface status.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manage the module - Log off users, shutdown or reload the router, manually back up router configurations, view complete configurations, manager user rights, initiate power-on self tests on demand and restore router configurations.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Set Encryption/Bypass - Place module into Encryption or Bypass state</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Perform Self-Tests - Perform the FIPS 140 start-up tests on demand.</td>
</tr>
<tr>
<td>Unauthenticated</td>
<td>N/A</td>
<td>Show status (viewing LEDs), passing traffic through the device, power-cycling the device.</td>
</tr>
</tbody>
</table>
Cryptographic Key/CSP Management

The module securely administers both cryptographic keys and other critical security parameters such as passwords. The tamper evidence seals provide physical protection for all keys. All keys are also protected by the password-protection on the CO role login, and can be zeroized by the CO. All zeroization consists of overwriting the memory that stored the key. Keys are exchanged and entered electronically. Persistent keys are entered by the CO via the console port CLI, transient keys are generated or established and stored in DRAM. If present, a VSS link can export all DRAM and NVRAM keys to another switch over a secure connection for high availability purposes.

The module supports the following critical security parameters (CSPs):

<table>
<thead>
<tr>
<th>ID</th>
<th>Algorithm/Size/Mode</th>
<th>Size</th>
<th>Description</th>
<th>Origin</th>
<th>Storage</th>
<th>Zeroization Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRBG entropy input</td>
<td>SP 800-90 CTR_DRBG</td>
<td>256-bits</td>
<td>This is the entropy for SP 800-90 RNG.</td>
<td>Generated by internal entropy source</td>
<td>DRAM (plaintext)</td>
<td>power cycle the device</td>
</tr>
<tr>
<td>DRBG seed</td>
<td>SP 800-90 CTR_DRBG</td>
<td>384-bits</td>
<td>This is the seed for SP 800-90 RNG.</td>
<td>Generated by entropy source via the CTR_DRBG derivation function</td>
<td>DRAM (plaintext)</td>
<td>power cycle the device</td>
</tr>
<tr>
<td>DRBG V</td>
<td>SP 800-90 CTR_DRBG</td>
<td>128-bits</td>
<td>Internal V value used as part of SP 800-90 CTR_DRBG</td>
<td>Generated by entropy source via the CTR_DRBG derivation function. It is stored in DRAM with plaintext form.</td>
<td>DRAM (plaintext)</td>
<td>power cycle the device</td>
</tr>
<tr>
<td>DRBG Key</td>
<td>SP 800-90 CTR_DRBG</td>
<td>256-bits</td>
<td>Internal Key value used as part of SP 800-90 CTR_DRBG</td>
<td>generated from entropy source via the CTR_DRBG derivation function</td>
<td>DRAM (plaintext)</td>
<td>power cycle the device</td>
</tr>
<tr>
<td>DH shared secret</td>
<td>Diffie-Hellman</td>
<td>256 bits</td>
<td>Shared secret generated by the Diffie-Hellman Key exchange.</td>
<td>Shared secret generated by the Diffie-Hellman Key exchange</td>
<td>DRAM (plaintext)</td>
<td>Automatically when session expires</td>
</tr>
<tr>
<td>CTS password</td>
<td>Shared Secret</td>
<td>Up to 256 bytes</td>
<td>This is CTS credential. Used for CTS device to authenticate itself. The maximum size is 256 bytes.</td>
<td>User configured</td>
<td>NVRAM (plaintext)</td>
<td>Via the following CLI, “clear cts credentials”.</td>
</tr>
<tr>
<td>CTS PAC key</td>
<td>Shared Secret</td>
<td>256-bits</td>
<td>CTS PAC is a Protected Access Credential that is mutually and uniquely shared</td>
<td>Generated and sent by ACS to the CTS device</td>
<td>NVRAM (plaintext)</td>
<td>Via the following CLI, “clear cts pacs”</td>
</tr>
<tr>
<td>ID</td>
<td>Algorithm/Size/Mode</td>
<td>Size</td>
<td>Description</td>
<td>Origin</td>
<td>Storage</td>
<td>Zerforderization Method</td>
</tr>
<tr>
<td>----</td>
<td>---------------------</td>
<td>------</td>
<td>-------------</td>
<td>--------</td>
<td>---------</td>
<td>------------------------</td>
</tr>
<tr>
<td>SAP Pairwise Master Key (PMK)</td>
<td>Shared Secret</td>
<td>64 byte key used to derive PTK which is used to generate CTS session MAC and Encryption keys. Only the first 32 bytes are used by CTS.</td>
<td></td>
<td>Generated by ACS and sent to Authenticator and generated internally by supplicant in CTS dot1x mode.</td>
<td>DRAM (plaintext)</td>
<td>unconfigure the PMK in CTS manual mode or unconfigure cts dot1x in CTS dot1x mode.</td>
</tr>
<tr>
<td>SAP Pairwise Transient Key (PTK)</td>
<td>Shared Secret</td>
<td>256 bits</td>
<td>Concatenation of KCK and KEK.</td>
<td>Concatenation of KCK and KEK.</td>
<td>DRAM (plaintext)</td>
<td>Automatically when session expires</td>
</tr>
<tr>
<td>SAP Key Encryption Key (KEK)</td>
<td>AES</td>
<td>128-bit</td>
<td>Used to encrypt SAP payloads during SAP protocol implementations.</td>
<td>Derived by SAP</td>
<td>DRAM (plaintext)</td>
<td>Automatically when session expires</td>
</tr>
<tr>
<td>SAP Key Confirmation Key (KCK)</td>
<td>HMAC-SHA-1</td>
<td>160-bit</td>
<td>Used to protect SAP payloads integrity during SAP protocol implementations.</td>
<td>Derived by SAP</td>
<td>DRAM (plaintext)</td>
<td>Automatically when session expires</td>
</tr>
<tr>
<td>802.1ae Session Keys</td>
<td>AES-GCM</td>
<td>128-bit</td>
<td>Used for bulk encryption of data</td>
<td>Derived by SAP</td>
<td>Ganita or Alkindi or Radian ASIC (plaintext)</td>
<td>Automatically when session expires</td>
</tr>
<tr>
<td>VSL PMK</td>
<td>Shared Secret</td>
<td>256-bit</td>
<td>The preshared key used for VSS connections</td>
<td>User configured</td>
<td>NVRAM (plaintext)</td>
<td>clear switch virtual pmk</td>
</tr>
<tr>
<td>VSL session keys</td>
<td>AES-GCM</td>
<td>128-bit</td>
<td>Used for bulk encryption of data in the event of failover</td>
<td>Derived from VSL PMK</td>
<td>Ganita or Alkindi or Radian ASIC (plaintext)</td>
<td>Automatically when VSL session expires</td>
</tr>
<tr>
<td>RADIUS AES KEK WRAP KEY</td>
<td>AES key wrap KEK</td>
<td>256-bit</td>
<td>[pac]</td>
<td>[keywrap encryption-key &lt;secret&gt; message-auth-code-key &lt;secret&gt;] [format [ascii</td>
<td>hex]] key &lt;shared-secret&gt;</td>
<td>User configured</td>
</tr>
<tr>
<td>ID</td>
<td>Algorithm/Size/Mode</td>
<td>Size</td>
<td>Description</td>
<td>Origin</td>
<td>Storage</td>
<td>Zeroization Method</td>
</tr>
<tr>
<td>----</td>
<td>---------------------</td>
<td>------</td>
<td>-------------</td>
<td>--------</td>
<td>---------</td>
<td>-------------------</td>
</tr>
<tr>
<td>RADIUS AES KEK WRAP MACK</td>
<td>AES key wrap MACK</td>
<td>160-bit</td>
<td>[pac]</td>
<td>[keywrap encryption-key &lt;secret&gt; message- auth-code-key &lt;secret&gt;] [format (ascii</td>
<td>hex)] key &lt;shared-secret&gt;</td>
<td>User configured</td>
</tr>
<tr>
<td>SSH RSA private Key</td>
<td>RSA</td>
<td>1024-2048-bit</td>
<td>private key used in SSH protocol</td>
<td>crypto key generate rsa</td>
<td>NVRAM (plaintext)</td>
<td>crypto key zeroize rsa</td>
</tr>
<tr>
<td>SSH session key</td>
<td>Triple-DES / AES</td>
<td>Triple-DES (Key Size 168 bits)/AES (Key Size 128/192/256 bits)</td>
<td>This is the SSH session key. It is used to encrypt all SSH data traffics traversing between the SSH client and SSH server.</td>
<td>Created as part of SSH session establishment</td>
<td>DRAM (plaintext)</td>
<td>Zeriozed when SSH session is terminated</td>
</tr>
<tr>
<td>SSH session authentication key</td>
<td>HMAC-SHA-1</td>
<td>160-bit</td>
<td>This key is used to perform the authentication between the SSH client and SSH server.</td>
<td>Created as part of SSH session establishment</td>
<td>DRAM (plaintext)</td>
<td>Zeriozed when SSH session is terminated</td>
</tr>
<tr>
<td>TLS Server RSA private key</td>
<td>RSA</td>
<td>1024/2048-bit</td>
<td>Identity certificates for module itself and also used in TLS negotiations.</td>
<td>crypto key generate rsa</td>
<td>NVRAM (plaintext)</td>
<td>Automatically when TLS session terminated.</td>
</tr>
<tr>
<td>TLS pre-master secret</td>
<td>Shared Secret</td>
<td>384-bits</td>
<td>Shared secret created using asymmetric cryptography from which new HTTPS session keys can be created.</td>
<td>Created as part of TLS session establishment</td>
<td>DRAM (plaintext)</td>
<td>Automatically when TLS session terminated.</td>
</tr>
<tr>
<td>TLS Traffic Keys</td>
<td>Triple-DES/AES/ HMAC SHA-1 keys</td>
<td>Triple-DES (168-bits)/AES (128/192/256-bits)/HMAC (160-bits)</td>
<td>This is the TLS session key.</td>
<td>Generated using the TLS protocol</td>
<td>DRAM (plaintext)</td>
<td>Automatically when TLS session terminated.</td>
</tr>
<tr>
<td>Skeyid</td>
<td>HMAC-SHA-1</td>
<td>160-bits</td>
<td>Used to derive skey_d.</td>
<td>Value derived from the shared secret within IKE exchange. Zeroized when IKE session is terminated.</td>
<td>DRAM (plaintext)</td>
<td>Automatically after IKE session terminated.</td>
</tr>
<tr>
<td>skeyid_d</td>
<td>HMAC-SHA-1</td>
<td>160-bits</td>
<td>Derived as part of the IKE process.</td>
<td>The IKE key derivation key for non ISAKMP security</td>
<td>DRAM (plaintext)</td>
<td>Automatically after IKE session terminated.</td>
</tr>
<tr>
<td>ID</td>
<td>Algorithm/Size/Mode</td>
<td>Size</td>
<td>Description</td>
<td>Origin</td>
<td>Storage</td>
<td>Zerorization Method</td>
</tr>
<tr>
<td>----------------</td>
<td>---------------------</td>
<td>------</td>
<td>-------------</td>
<td>-------------------------</td>
<td>-------------</td>
<td>-----------------------------------------</td>
</tr>
<tr>
<td>IKE session encrypt key</td>
<td>Triple-DES/AES</td>
<td>Triple-DES (168-bits)/AES (256-bits)</td>
<td>The IKE session encrypt key.</td>
<td>Generated by RNG</td>
<td>DRAM (plaintext)</td>
<td>Automatically after IKE session terminated.</td>
</tr>
<tr>
<td>IKE session authentication key</td>
<td>HMAC-SHA-1</td>
<td>160-bits</td>
<td>The IKE session authentication key.</td>
<td>Generated as part of IKE</td>
<td>DRAM (plaintext)</td>
<td>Automatically after IKE session terminated.</td>
</tr>
<tr>
<td>ISAKMP preshared Secret</td>
<td>Shared Secret</td>
<td>At least eight characters</td>
<td>The key used to generate IKE skeyid during preshared-key authentication. This key can have two forms based on whether the key is related to the hostname or the IP address.</td>
<td>Configured by CO</td>
<td>NVRAM (plaintext)</td>
<td>&quot;# no crypto isakmp key&quot;</td>
</tr>
<tr>
<td>IKE RSA Authentication private key</td>
<td>RSA</td>
<td>1024-bits/2048-bits</td>
<td>RSA private key for IKE authentication.</td>
<td>Generated or entered with &quot;crypto keyring&quot; or &quot;ca trust-point&quot;</td>
<td>NVRAM (plaintext)</td>
<td>&quot;# crypto key zeroize rsa&quot;</td>
</tr>
<tr>
<td>IPSec encryption key</td>
<td>Triple-DES/AES</td>
<td>Triple-DES (168-bits)/AES (256-bits)</td>
<td>The IPSec encryption key. Zerized when IPSec session is terminated.</td>
<td>Derived using the IKE key derivation function</td>
<td>DRAM (plaintext)</td>
<td>Automatically when IPSec session terminated.</td>
</tr>
<tr>
<td>IPSec authentication key</td>
<td>HMAC-SHA-1</td>
<td>160-bits</td>
<td>The IPSec authentication key. The zerorization is the same as above.</td>
<td>Derived using the IKE key derivation function</td>
<td>DRAM (plaintext)</td>
<td>Automatically when IPSec session terminated.</td>
</tr>
<tr>
<td>User password</td>
<td>Shared Secret</td>
<td>eight (8) characters long</td>
<td>Password of the user role</td>
<td>User configured</td>
<td>NVRAM (plaintext)</td>
<td>Set new password</td>
</tr>
<tr>
<td>Enable password</td>
<td>Shared Secret</td>
<td>eight (8) characters long</td>
<td>CO password</td>
<td>User configured</td>
<td>NVRAM (plaintext)</td>
<td>Set new password</td>
</tr>
<tr>
<td>Enable secret</td>
<td>Shared Secret</td>
<td>eight (8) characters long</td>
<td>Obfuscated password of the CO role.</td>
<td>User configured</td>
<td>NVRAM (plaintext)</td>
<td>Set new password</td>
</tr>
<tr>
<td>RADIUS secret</td>
<td>Shared Secret</td>
<td>eight (8) characters long</td>
<td>The RADIUS Shared Secret</td>
<td>User configured</td>
<td>NVRAM (plaintext)</td>
<td>&quot;# no radius-server key&quot;</td>
</tr>
<tr>
<td>TACACS+ secret</td>
<td>Shared Secret</td>
<td>eight (8) characters long</td>
<td>The TACACS+ shared secret</td>
<td>User configured</td>
<td>NVRAM (plaintext)</td>
<td>&quot;# no tacacs-server key&quot;</td>
</tr>
</tbody>
</table>
The services accessing the CSPs, the type of access and which role accesses the CSPs are listed below.

<table>
<thead>
<tr>
<th>Role</th>
<th>Service</th>
<th>Critical Security Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Role</td>
<td>Network Functions</td>
<td>DRBG entropy input, DRBG seed, DRBG V, DRBG Key, DH private exponent, DH shared secret, SAP Pairwise Master Key (PMK), SAP Pairwise Transient Key (PTK), SAP Key Encryption Key (KEK), SAP Key Confirmation Key (KCK), CTS Password, CTS PAC Key, Secure RADIUS KEK, Secure RADIUS MACK, 802.1ae Session Keys, VSL session keys, SSH session key, SSH session authentication key, TLS pre-master secret, TLS Traffic Keys, Skeyid, skeyid_d, IKE session encrypt key, IKE session authentication key, ISAKMP preshared, IKE RSA Authentication private Key, IPsec encryption key, IPsec authentication key (R) User password (W)</td>
</tr>
<tr>
<td>Crypto-Officer Role</td>
<td>Configure the Switch</td>
<td>SAP Pairwise Master Key (PMK), VSL PMK, Secure RADIUS KEK, Secure RADIUS MACK, CTS Password, SSH RSA private Key, Enable Password, TLS Server RSA private key, Enable secret, RADIUS secret, TACACS+ secret, Skeyid, skeyid_d, IKE session encrypt key, IKE session authentication key, ISAKMP preshared, IKE RSA Authentication private Key, IPsec encryption key, IPsec authentication key (R/W/D)</td>
</tr>
</tbody>
</table>

R = Read, W = Write, D = Delete

Table 6: Role CSP Access
Cryptographic Algorithms

Approved Cryptographic Algorithms

The Cisco Switches support many different cryptographic algorithms. However, only FIPS approved algorithms may be used while in the FIPS mode of operation. The following table identifies the approved algorithms included in the Switches for use in the FIPS mode of operation.

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Implementation</th>
<th>CAVP Certificate</th>
</tr>
</thead>
<tbody>
<tr>
<td>AES</td>
<td>IOS Firmware</td>
<td>#2252</td>
</tr>
<tr>
<td></td>
<td>Hardware</td>
<td>#1426, #1427, #1589</td>
</tr>
<tr>
<td>DRBG</td>
<td>IOS Firmware</td>
<td>#274</td>
</tr>
<tr>
<td>HMAC</td>
<td>IOS Firmware</td>
<td>#1380</td>
</tr>
<tr>
<td>RSA</td>
<td>IOS Firmware</td>
<td>#1155</td>
</tr>
<tr>
<td>SHS</td>
<td>IOS Firmware</td>
<td>#1940</td>
</tr>
<tr>
<td>Triple-DES</td>
<td>IOS Firmware</td>
<td>#1409</td>
</tr>
</tbody>
</table>

Table 7: FIPS-Approved Algorithms for use in FIPS Mode

Non-Approved Algorithms

The cryptographic module implements the following non-approved algorithms that are not permitted for use in FIPS 140-2 mode of operations:

- DES
- HMAC-MD5
- MD5
- RC4

In addition, the modules support the following key establishment/derivation schemes:

- Diffie-Hellman (key agreement; key establishment methodology provides between 80 and 112 bits of encryption strength)
- RSA (key wrapping; key establishment methodology provides between 80 and 112 bits of encryption strength)
- AES (Cert. #2252, key wrapping; key establishment methodology provides 256 bits of encryption strength)

Self-Tests

The modules include an array of self-tests that are run during startup and periodically during operations to prevent any secure data from being released and to ensure all components are functioning correctly. The modules implement the following power-on self-tests:
- IOS Known Answer Tests:
  - AES KAT
  - DRBG KAT
  - HMAC-SHA-1 KAT
  - RSA KAT
  - SHA-1 KAT
  - SHA-256 KAT
  - SHA-512 KAT
  - Triple-DES KAT

- Linecard (Alkindi, Ganita and Radian ASICs) Known Answer Tests:
  - AES-GCM KAT

- Firmware Integrity Test

The modules perform all power-on self-tests automatically at boot. All power-on self-tests must be passed before any operator can perform cryptographic services. The power-on self-tests are performed after the cryptographic systems are initialized but prior any other operations; this prevents the module from passing any data during a power-on self-test failure.

In addition, the modules also provide the following conditional self-tests:

- Continuous Random Number Generator test for the FIPS-approved RNG
- Conditional Alternating Bypass Test (for IPSec Bypass test)
- Conditional Alternating Bypass Test (for TrustSec Bypass test)
- Conditional Pairwise Consistency Test for RSA
**Physical Security**

This module is a multi-chip standalone cryptographic module.

The FIPS 140-2 level 2 physical security requirements for the modules are met by the use of opacity shields covering the front panels of modules to provide the required opacity and tamper evident seals to provide the required tamper evidence. The following sections illustrate the physical security provided by the module.

**Module Opacity**

To install an opacity shield on the Catalyst 6500 series switches, follow these steps:

1. The opacity shield is designed to be installed on a Catalyst 6500 series switch chassis that is already rack-mounted. If your Catalyst 6500 series switch chassis is not rack-mounted, install the chassis in the rack using the procedures contained in the Catalyst 6500 Series Switches Installation Guide. If your Catalyst 6500 series switch chassis is already rack-mounted, proceed to step 2.

2. Open the FIPS kit packaging (part number CVPN6500FIPS/KIT=). The kit contains the following items:
   - A packaged opacity shield assembly with installation hardware for the Catalyst 6503-E switch chassis.
   - A packaged opacity shield assembly with installation hardware for the Catalyst 6504-E switch chassis.
   - A packaged opacity shield assembly with installation hardware for the Catalyst 6506 and Catalyst 6506-E switch chassis.
   - A packaged opacity shield assembly with installation hardware for the Catalyst 6509 and Catalyst 6509-E switch chassis.
   - A packaged opacity shield assembly with installation hardware for the Catalyst 6513 and Catalyst 6513-E switch chassis.
   - An envelope with 60 FIPS tamper evidence labels.
   - An envelope containing a disposable ESD wrist strap.

3. Select the appropriate opacity shield kit for your system. Set the other opacity shield kit aside.

4. Open the protective packaging and remove the opacity shield and the two bags of installation hardware. The bag with the part number 69-1497 contains the installation hardware for -E chassis. Select the bag of installation hardware appropriate for your installation. Set the second bag of fasteners aside; you will not need them for this installation.

5. Open the bag of installation hardware (Bag with part number 69-1497) and remove the following: Two M4 thumbscrews, four M4 snap rivet fastener sleeves, and four M4 snap rivet pins.
Note 1: Extra snap fasteners are included in the bags of installation hardware in case of loss or damage.

Note 2: Any unused TELs must be securely stored, accounted for, and maintained by the CO in a protected location.

Note 3: Installation hardware from one bag is not interchangeable with the installation hardware from the second bag.

The following figures illustrate the installation of the opacity shields for each platform.

Figure 1: Cisco Catalyst 6503-E Opacity Shield Installation

Figure 2: Cisco Catalyst 6504-E Opacity Shield Installation
Figure 3: Cisco Catalyst 6506-E Opacity Shield Installation

Figure 4: Cisco Catalyst 6509-E Opacity Shield Installation
Tamper Evidence

The module is validated when tamper evident labels and security devices are installed on the initially built configuration as indicated. Any changes, modifications or repairs performed after the initially built configuration that requires the removal of any TEL will invalidate the module.

The number of tamper evident labels required for the configuration is dependent on the cards installed in the chasis.
Once the module has been configured to meet overall FIPS 140-2 Level 2 requirements, the module cannot be accessed without signs of tampering. The CO shall inspect for signs of tampering periodically.

If the CO must remove or change TELs (tamper-evidence labels) for any reason, the CO must examine the location from which the TEL was removed and ensure that no residual debris is still remaining on the chassis or card. If residual debris remains, the CO must remove the debris using a damp cloth.

To seal the system, CO should apply TELs as depicted in the figures below. Please notice that the TELs applications illustrated in the figures below are only for two supervisor cards and one line card configuration. For the case of two or more line cards in a single configuration, the Crypto Officer should apply the TELs horizontally to cover each port on the line card below the top one to protect against any unauthorized physical attempts.

The number of TELs required is dependent on the card on which the TELs are being applied. The following identifies the number of seals per card type:

- Supervisor Card: Three (3) TELs per card plus one on the edge of the card at the seam where the card is adjacent to other cards/the top or bottom of the chassis.
- Line Card: Four (4) TELs per card plus one on the edge of the card at the seam where the card is adjacent to other cards/the top or bottom of the chassis.
- Blank Card: Two (2) TELs per card.

The following figures illustrate the installation of the TELs for each platform.

Figure 6: Cisco Catalyst 6503-E Opacity Shield Installation with two Supervisor cards and one Line card (WS-X6908-10G /WS-X6908-10G-2TXL)
Figure 7: Cisco Catalyst 6503-E Opacity Shield Installation with two Supervisor cards and one Line card (WS-X6904-40G-2T /WS-X6904-40G-2TXL)

Figure 8: Cisco Catalyst 6504-E Opacity Shield Installation with two Supervisor cards and one Line card (WS-X6908-10G /WS-X6908-10G-2TXL)

Figure 9: Cisco Catalyst 6504-E Opacity Shield Installation with two Supervisor cards and one Line card (WS-X6904-40G-2T /WS-X6904-40G-2TXL)

Figure 10: Cisco Catalyst 6506-E TELs Installation with two Supervisor cards and one Line card (WS-X6908-10G /WS-X6908-10G-2TXL)
Figure 11: Cisco Catalyst 6506-E TELs Installation with two Supervisor cards and one Line card (WS-X6904-40G-2T/WS-X6904-40G-2TXL)

Figure 12: Cisco Catalyst 6509-E TELs Installation with two Supervisor cards and one Line card (WS-X6908-10G/WS-X6908-10G-2TXL)
Figure 13: Cisco Catalyst 6509-E TELs Installation with two Supervisor cards and one Line card (WS-X6904-40G-2T /WS-X6904-40G-2TXL)

Figure 14: Cisco Catalyst 6513-E TELs Installation with two Supervisor cards and one Line card (WS-X6908-10G /WS-X6908-10G-2TXL)
Figure 15: Cisco Catalyst 6513-E TELs Installation with two Supervisor cards and one Line card (WS-X6904-40G-2T /WS-X6904-40G-2TXL)
Secure Operation

The Switches meet all the overall Level 2 requirements for FIPS 140-2. Follow the setup instructions provided below to place the module in FIPS-approved mode. Operating this Switch without maintaining the following settings will remove the module from the FIPS approved mode of operation.

Initial Setup

1. The CO must apply opacity shield and tamper evidence labels as described above.

System Initialization and Configuration

1. The value of the boot field must be 0x0102. This setting disables break from the console to the ROM monitor and automatically boots. From the “configure terminal” command line, the CO enters the following syntax:

   Switch (config)# config-register 0x0102

2. The CO must create the “enable” password for the CO role. Procedurally, the password must be at least 8 characters, including at least one letter and at least one number, and is entered when the CO first engages the “enable” command. The CO enters the following syntax at the “#” prompt:

   Switch (config)# enable secret [PASSWORD]

3. The CO must always assign passwords (of at least 8 characters, including at least one letter and at least one number) to users. Identification and authentication on the console/auxiliary port is required for Users. From the “configure terminal” command line, the CO enters the following syntax:

   Switch (config)# line con 0
   Switch (config)# password [PASSWORD]
   Switch (config)# login authentication default

4. The CO must assign VSS Preshared Master Keys (PMKs) in order to establish the encrypted link between switches. A 16 character ASCII key shall be used in the following command:

   Switch# conf t
   Switch (config)# hostname VSS
   VSS# switch pmk <key>
   VSS(config)# switch virtual domain 100
   VSS(config-vs-domain)# switch 1 [or 2]
   VSS(config-vs-domain)# vsl-encryption
   Switch# switch convert mode virtual

5. The CO must enable FIPS mode on the module using the following command:

   Switch (config)# fips

6. The CO may configure the module to use RADIUS or TACACS+ for authentication. If the module is configured to use RADIUS, the Crypto-Officer must define RADIUS
or shared secret keys that are at least 8 characters long, including at least one letter and at least one number.

7. Firmware update is not allowed in FIPS mode.

8. The CO shall only assign users to a privilege level 1 (the default).

9. The CO shall not assign a command to any privilege level other than its default.

Remote Access

1. SSH access to the module is allowed in FIPS approved mode of operation, using SSH v2 and a FIPS approved algorithm.

2. HTTPS/TLS access to the module is allowed in FIPS approved mode of operation, using SSLv3.1/TLSv1.0 and a FIPS approved algorithm.

Identifying Switch Operation in an Approved Mode

The following activities are required to verify that the module is operating in an Approved mode of operation.

1. Verify that the tamper evidence labels and FIPS opacity shields have been properly placed on the module based on the instructions specified in the “Physical Security” and “Secure Operation” sections of this document.

2. Verify that the length of User and Crypto Officer passwords and all shared secrets are at least eight (8) characters long, include at least one letter, and include at least one number character, as specified in the “Secure Operation” section of this document.

3. Verified that the output of "The FIPS mode is on" was shown on the Command Line Interface after login Crypto Officer role.
Related Documentation
This document deals only with operations and capabilities of the security appliances in the technical terms of a FIPS 140-2 cryptographic device security policy. More information is available on the security appliances from the sources listed in this section and from the following source:

- The NIST Cryptographic Module Validation Program website (http://csrc.nist.gov/groups/STM/cmvp/index.html) contains contact information for answers to technical or sales-related questions for the security appliances.

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- Obtain assistance with security incidents that involve Cisco products.
- Register to receive security information from Cisco.

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http://www.cisco.com/go/psirt

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- **Nonemergencies** — psirt@cisco.com

In an emergency, you can also reach PSIRT by telephone:

- 1 877 228-7302
- 1 408 525-6532

Tip

We encourage you to use Pretty Good Privacy (PGP) or a compatible product to encrypt any sensitive information that you send to Cisco. PSIRT can work from encrypted information that is compatible with PGP versions 2.x through 8.x. Never use a revoked or an expired encryption key. The correct public key to use in your correspondence with PSIRT is the one linked in the Contact Summary section of the Security Vulnerability Policy page at this URL:


The link on this page has the current PGP key ID in use.

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Use the Cisco Product Identification (CPI) tool to locate your product serial number before submitting a web or phone request for service. You can access the CPI tool from the Cisco Technical Support & Documentation website by clicking the **Tools & Resources** link under Documentation & Tools. Choose **Cisco Product Identification Tool** from the Alphabetical Index drop-down list, or click the **Cisco Product Identification Tool** link under Alerts & RMAs. The CPI tool offers three search options: by product ID or model name; by tree view; or for certain products, by copying and pasting `show` command output. Search results show an illustration of your product with the serial number label location highlighted. Locate the serial number label on your product and record the information before placing a service call.

**Submitting a Service Request**

Using the online TAC Service Request Tool is the fastest way to open S3 and S4 service requests. (S3 and S4 service requests are those in which your network is minimally impaired or for which you require product information.) After you describe your situation, the TAC Service Request Tool provides recommended solutions. If your issue is not resolved using the recommended resources, your service request is assigned to a Cisco engineer. The TAC Service Request Tool is located at this URL:


For S1 or S2 service requests or if you do not have Internet access, contact the Cisco TAC by telephone. (S1 or S2 service requests are those in which your production network is down or severely degraded.) Cisco engineers are assigned immediately to S1 and S2 service requests to help keep your business operations running smoothly.

To open a service request by telephone, use one of the following numbers:

Asia-Pacific: +61 2 8446 7411 (Australia: 1 800 805 227)
EMEA: +32 2 704 55 55
USA: 1 800 553-2447

For a complete list of Cisco TAC contacts, go to this URL:


**Definitions of Service Request Severity**

To ensure that all service requests are reported in a standard format, Cisco has established severity definitions.

- **Severity 1 (S1)** – Your network is “down,” or there is a critical impact to your business operations. You and Cisco will commit all necessary resources around the clock to resolve the situation.

- **Severity 2 (S2)** – Operation of an existing network is severely degraded, or significant aspects of your business operation are negatively affected by inadequate performance of Cisco products. You and Cisco will commit full-time resources during normal business hours to resolve the situation.

- **Severity 3 (S3)** – Operational performance of your network is impaired, but most business operations remain functional. You and Cisco will commit resources during normal business hours to restore service to satisfactory levels.
Severity 4 (S4) – You require information or assistance with Cisco product capabilities, installation, or configuration. There is little or no effect on your business operations.

**Obtaining Additional Publications and Information**

Information about Cisco products, technologies, and network solutions is available from various online and printed sources.

- Cisco Marketplace provides a variety of Cisco books, reference guides, documentation, and logo merchandise. Visit Cisco Marketplace, the company store, at this URL:
  
  http://www.cisco.com/go/marketplace/

- *Cisco Press* publishes a wide range of general networking, training and certification titles. Both new and experienced users will benefit from these publications. For current Cisco Press titles and other information, go to Cisco Press at this URL:

  http://www.ciscopress.com

- *Packet* magazine is the Cisco Systems technical user magazine for maximizing Internet and networking investments. Each quarter, Packet delivers coverage of the latest industry trends, technology breakthroughs, and Cisco products and solutions, as well as network deployment and troubleshooting tips, configuration examples, customer case studies, certification and training information, and links to scores of in-depth online resources. You can access Packet magazine at this URL:

  http://www.cisco.com/packet

- *iQ Magazine* is the quarterly publication from Cisco Systems designed to help growing companies learn how they can use technology to increase revenue, streamline their business, and expand services. The publication identifies the challenges facing these companies and the technologies to help solve them, using real-world case studies and business strategies to help readers make sound technology investment decisions. You can access iQ Magazine at this URL:

  http://www.cisco.com/go/iqmagazine

  or view the digital edition at this URL:

  http://ciscoiq.texterity.com/ciscoiq/sample/

- *Internet Protocol Journal* is a quarterly journal published by Cisco Systems for engineering professionals involved in designing, developing, and operating public and private internets and intranets. You can access the Internet Protocol Journal at this URL:

  http://www.cisco.com/ipj

- Networking products offered by Cisco Systems, as well as customer support services, can be obtained at this URL:
Networking Professionals Connection is an interactive website for networking professionals to share questions, suggestions, and information about networking products and technologies with Cisco experts and other networking professionals. Join a discussion at this URL:

http://www.cisco.com/discuss/networking

World-class networking training is available from Cisco. You can view current offerings at this URL:


Definition List

AES – Advanced Encryption Standard
CMVP – Cryptographic Module Validation Program
CSEC – Communications Security Establishment Canada
CSP – Critical Security Parameter
CTS – Cisco TrustSec
FIPS – Federal Information Processing Standard
HMAC – Hash Message Authentication Code
HTTP – Hyper Text Transfer Protocol
KAT – Known Answer Test
LED – Light Emitting Diode
MAC – Message Authentication Code
NIST – National Institute of Standards and Technology
NVRAM – Non-Volatile Random Access Memory
RAM – Random Access Memory
RNG – Random Number Generator
SHA – Secure Hash Algorithm
Triple-DES – Triple Data Encryption Standard