SafeNet Software Cryptographic Library Version 1.0

FIPS 140-2 Level 1 Non-Proprietary Security Policy

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PREFACE

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

- The SafeNet internet site contains information on the full line of security products at http://www.safenet-inc.com/products/data-protection/.
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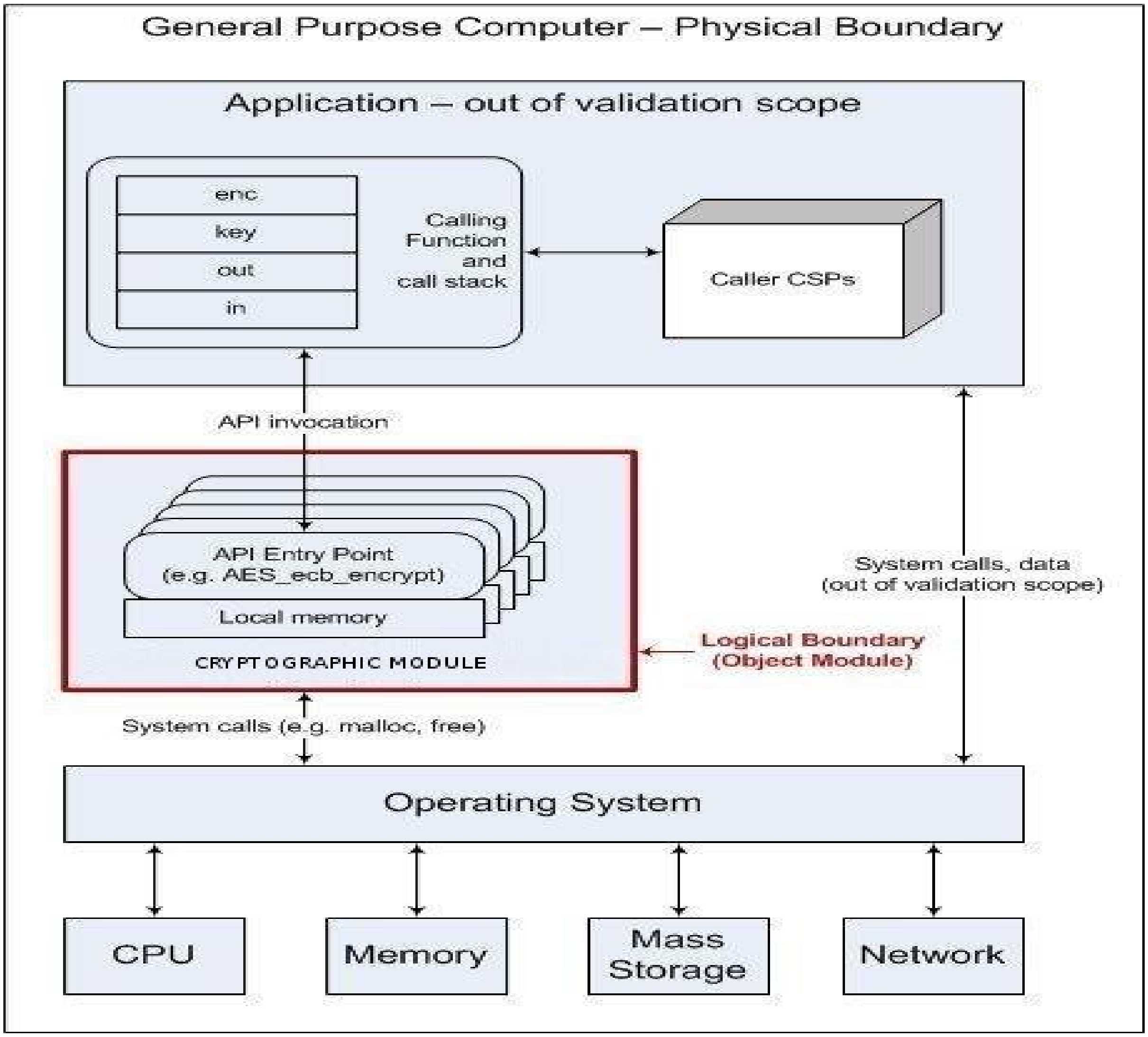
1 Introduction

This document comprises the non-proprietary FIPS 140-2 Security Policy for the SafeNet Software Cryptographic Library v1.0, hereafter referred to as the Module.


General Purpose Computer – Physical Boundary
Application – out of validation scope
enc
key
out
in
Calling Function and call stack
Caller CSPs
API invocation
API Entry Point (e.g. AES_ecb_encrypt)
Local memory
CRYPTOGRAPHIC MODULE
Logical Boundary (Object Module)
System calls, data (out of validation scope)
System calls (e.g. malloc, free)
Operating System
CPU
Memory
Mass Storage
Network

Block Diagram

The Module is a software library providing a C-language application program interface (API) for use by other processes that require cryptographic functionality. The Module is classified by FIPS 140-2 as a software module, multi-chip standalone module embodiment. The physical cryptographic boundary is the general purpose computer on which the module is installed. The logical cryptographic boundary of the Module is the fipscanister object module, a single object module file named *fipscanister.o*. The Module performs no communications other than with the calling application (the process that invokes the Module services).

The FIPS 140-2 security levels for the Module are as follows:

Security Requirement	**Security Level**
Cryptographic Module Specification	1
Cryptographic Module Ports and Interfaces	1
Roles, Services, and Authentication	1
Finite State Model	1
Physical Security	NA
Operational Environment	1
Cryptographic Key Management	1
EMI/EMC	1
Self-Tests	1
Design Assurance	3
Mitigation of Other Attacks	NA

Table 1 – Security Level of Security Requirements

The Module's software version for this validation is v1.0.

2 Tested Configurations

Operational Environment		**Processor**	**Optimizations (Target)**	**Hardware Device**
1	Windows Server 2008R2	Intel Xeon E3-1220v2 (x86)	AES-NI	Dell PowerEdge R210II
2	Windows Server 2008	Intel Xeon E3-1220v2 (x86)	none	Dell PowerEdge R210II
3	Windows 7 (64-bit)	Intel Core i5-2430M (x86)	AES-NI	Acer Aspire AS5750
4	Windows 7 (32-bit)	Intel Core i5-2430M (x86)	none	Acer Aspire AS5750

5	NetBSD 4.0 under VMware	Intel Xeon E3-1220v2 (x86)	AES-NI	Dell PowerEdge R210II
6	Android 4.0	OMAP3 (ARMv7)	NEON	Beagleboard xM
7	RHEL 6.2	Intel Xeon E3-1220v2 (x86)	AES-NI	Dell PowerEdge R210II
8	CentOS 5.6	Intel Xeon 3050 (x86)	none	Dell PowerEdge 860

Table 2 - Supported Platforms

3 Ports and Interfaces

The physical ports of the Module are the same as the computer system on which it is executing. The logical interface is a C-language application program interface (API).

Logical interface type	Description
Control input	API entry point and corresponding stack parameters
Data input	API entry point data input stack parameters
Status output	API entry point return values and status stack parameters
Data output	API entry point data output stack parameters

Table 3 - Logical interfaces

As a software module, control of the physical ports is outside module scope. However, when the module is performing self-tests, or is in an error state, all output on the logical data output interface is inhibited. The module is single-threaded and in error scenarios returns only an error value (no data output is returned).

4 Modes of Operation and Cryptographic Functionality

The Module supports only a FIPS 140-2 Approved mode. Tables 4a and 4b list the Approved and Non-approved but Allowed algorithms, respectively.

Function	Algorithm	Options	Cert #
Random Number Generation; Symmetric key generation	[ANS X9.31] RNG	AES 128/192/256	1137
	[SP 800-90A] DRBG[1] Prediction resistance supported for all variations	Hash DRBG HMAC DRBG, no reseed CTR DRBG (AES), no derivation function Dual EC DRBG[2]: P-256, P-384, P-521	283
Encryption, Decryption and CMAC	[SP 800-67] Triple-DES	3-Key TDES TECB, TCBC, TCFB, TOFB; CMAC generate and verify	1434
	[FIPS 197] AES	128/192/256 ECB, CBC, OFB, CFB 1, CFB 8, CFB 128, CTR; CCM; GCM; CMAC generate and verify; 128/256 XTS	2286
	[SP 800-38B] CMAC [SP 800-38C] CCM [SP 800-38D] GCM [SP 800-38E] XTS		
Message Digests	[FIPS 180-3]	SHA-1, SHA-2 (224, 256, 384, 512)	1967
Keyed Hash	[FIPS 198-1] HMAC	SHA-1, SHA-2 (224, 256, 384, 512)	1402
Digital Signature and Asymmetric Key Generation	[FIPS 186-2] RSA[3]	GenKey9.31, SigGen9.31, SigGenPKCS1.5, SigGenPSS, SigVer9.31, SigVerPKCS1.5, SigVerPSS (1024/1536/2048/3072/4096 with all SHA sizes)	1176
	[FIPS 186-2] DSA[2]	PQG Gen, PQG Ver, Key Pair Gen, Sig Gen, Sig Ver (1024 with SHA-1 only)	714
	[FIPS 186-3] DSA[2]	PQG Gen, PQG Ver, Key Pair Gen, Sig Gen, Sig Ver (1024/2048/3072 with all SHA sizes)	
	[FIPS 186-2] ECDSA	Key Pair, PKV, SigGen, SigVer (all NIST defined B, K, and P curves with SHA-1 only)	370
	[FIPS 186-3] ECDSA	Key Pair, PKV, SigGen, SigVer (all NIST defined B, K and P curves with all SHA sizes)	
ECC CDH (CVL)	[SP 800-56A] (§5.7.1.2)	All NIST defined B, K and P curves	45

Table 4a – FIPS Approved Cryptographic Functions

The Module supports only NIST defined curves for use with ECDSA and ECC CDH.

Note that per SP 800-131A digital signatures providing only 80 bits of security strength are deprecated through 2013 and will be disallowed post 2013.

[1] For all DRBGs the "supported security strengths" is just the highest supported security strength per [SP800-90] and [SP800-57].

[2] The Dual EC DRBG will not be available in any of SafeNet’s products.

[3] Note that per SP 800-131A digital signatures providing only 80 bits of security strength are deprecated through 2013 and will be disallowed post 2013.

Category	Algorithm	Description
Key Agreement	EC DH	Non-compliant (untested) DH scheme using elliptic curve, supporting all NIST defined B, K and P curves. Key agreement is a service provided for calling process use, but is not used to establish keys into the Module.
Key Wrapping	RSA	The RSA algorithm may be used by the calling application for wrapping of keys. No claim is made for SP 800-56B compliance, and no CSPs are established into or exported out of the module using these services.

Table 4b – Non-FIPS Approved But Allowed Cryptographic Functions

EC DH Key Agreement provides 80 to 256 bits of security strength. RSA Key Wrapping provides 80 to 256 bits of security strength.

The Module supports only a FIPS 140-2 Approved mode. The Module requires an initialization sequence (see IG 9.5): the calling application invokes FIPS_mode_set()[4], which returns a “1” for success and “0” for failure. If FIPS_mode_set() fails then all cryptographic services fail from then on. The application can test to see if FIPS mode has been successfully performed.

The Module is a cryptographic engine library, which can be used only in conjunction with additional software. Aside from the use of the NIST defined elliptic curves as trusted third party domain parameters, all other FIPS 186-3 assurances are outside the scope of the Module, and are the responsibility of the calling process.

4.1 Critical Security Parameters and Public Keys

All CSPs used by the Module are described in this section. All access to these CSPs by Module services are described in Section 4. The CSP names are generic, corresponding to API parameter data structures.

CSP Name	Description
RSA SGK	RSA (1024 to 16384 bits) signature generation key
RSA KDK	RSA (1024 to 16384 bits) key decryption (private key transport) key
DSA SGK	[FIPS 186-3] DSA (1024/2048/3072) signature generation key or [FIPS 186-2] DSA (1024) signature generation key
ECDSA SGK	ECDSA (All NIST defined B, K, and P curves) signature generation key
EC DH Private	EC DH (All NIST defined B, K, and P curves) private key agreement key.
AES EDK	AES (128/192/256) encrypt / decrypt key
AES CMAC	AES (128/192/256) CMAC generate / verify key

[4] The function call in the Module is `FIPS_module_mode_set()` which is typically used by an application via the `FIPS_mode_set()` wrapper function.

AES XTS	AES (256/512) XTS cipher key
TDES EDK	TDES (3-Key) encrypt / decrypt key
TDES CMAC	TDES (3-Key) CMAC generate / verify key
HMAC Key	Keyed hash key (160/224/256/384/512)
RNG CSPs	Seed (128 bit), AES 128/192/256 seed key and associated state variables for ANSI X9.31 AES based RNG[5]
Hash_DRBG CSPs	V (440/880 bits) and C (440/880 bits), entropy input (length dependent on security strength)
HMAC_DRBG CSPs	V (160/224/256/384/512 bits) and Key (160/224/256/384/512 bits), entropy input (length dependent on security strength)
CTR_DRBG CSPs	V (128 bits) and Key (AES 128/192/256), entropy input (length dependent on security strength)
Dual_EC_DRBG CSPs	S (P-256, P-384, P-521), entropy input (length dependent on security strength)

Table 4.1a – Critical Security Parameters

The module does not output intermediate key generation values.

CSP Name	Description
RSA SVK	RSA (1024 to 16384 bits) signature verification public key
RSA KEK	RSA (1024 to 16384 bits) key encryption (public key transport) key
DSA SVK	[FIPS 186-3] DSA (1024/2048/3072) signature verification key or [FIPS 186-2] DSA (1024) signature verification key
ECDSA SVK	ECDSA (All NIST defined B, K and P curves) signature verification key
EC DH Public	EC DH (All NIST defined B, K and P curves) public key agreement key.

Table 4.1b – Public Keys

For all CSPs and Public Keys:

Storage: RAM, associated to entities by memory location. The Module stores RNG and DRBG state values for the lifetime of the RNG or DRBG instance. The module uses CSPs passed in by the calling application on the stack. The Module does not store any CSP persistently (beyond the lifetime of an API call), with the exception of RNG and DRBG state values used for the Modules' default key generation service.

Generation: The Module implements ANSI X9.31 compliant RNG and SP 800-90 compliant DRBG services for creation of symmetric keys, and for generation of DSA, elliptic curve, and RSA keys as shown in Table 4a. The calling application is responsible for storage of generated keys returned by the module.

[5] There is an explicit test for equality of the seed and seed key inputs

Entry: All CSPs enter the Module’s logical boundary in plaintext as API parameters, associated by memory location. However, none cross the physical boundary.

Output: The Module does not output CSPs, other than as explicit results of key generation services. However, none cross the physical boundary.

Destruction: Zeroization of sensitive data is performed automatically by API function calls for temporarily stored CSPs. In addition, the module provides functions to explicitly destroy CSPs related to random number generation services. The calling application is responsible for parameters passed in and out of the module.

Private and secret keys as well as seeds and entropy input are provided to the Module by the calling application, and are destroyed when released by the appropriate API function calls. Keys residing in internally allocated data structures (during the lifetime of an API call) can only be accessed using the Module defined API. The operating system protects memory and process space from unauthorized access. Only the calling application that creates or imports keys can use or export such keys. All API functions are executed by the invoking calling application in a non-overlapping sequence such that no two API functions will execute concurrently. An authorized application as user (Crypto-Officer and User) has access to all key data generated during the operation of the Module.

In the event Module power is lost and restored the calling application must ensure that any AES GCM keys used for encryption or decryption are re-distributed.

Module users (the calling applications) shall use entropy sources that meet the security strength required for the random number generation mechanism: 128 bits for the [ANS X9.31] RNG mechanism, and as shown in [SP 800-90] Table 2 (Hash_DRBG, HMAC_DRBG), Table 3 (CTR_DRBG) and Table 4 (Dual_EC_DRBG). This entropy is supplied by means of callback functions. Those functions must return an error if the minimum entropy strength cannot be met.

5 Roles, Authentication and Services

The Module meets all FIPS 140-2 level 1 requirements for Roles and Services, implementing both Crypto-User and Crypto-Officer roles. As allowed by FIPS 140-2, the Module does not support user authentication for those roles. Only one role may be active at a time and the Module does not allow concurrent operators.

The User and Crypto Officer roles are implicitly assumed by the entity accessing services implemented by the Module. The Crypto Officer can install and initialize the Module. The Crypto Officer role is implicitly entered when installing the Module or performing system administration functions on the host operating system.

- User Role: Loading the Module and calling any of the API functions. This role has access to all of the services provided by the Module.

• Crypto-Officer Role: Installation of the Module on the host computer system. This role is assumed implicitly when the system administrator installs the Module library file.

All services implemented by the Module are listed below, along with a description of service CSP access. If the module is not initialized as per Section 4 of the Security Policy, non-conformant versions of the services in Table 5 are made available to the calling application.

Service	Role	Description
Initialize	User, CO	Module initialization, inclusive of all POST tests (FIPS_module_mode_set). Does not access CSPs.
Self-test	User, CO	Perform all POST tests (FIPS_selftest). Does not access CSPs.
Show status	User, CO	Functions that provide module status information: • Version (as unsigned long or const char *) • FIPS Mode (Boolean) Does not access CSPs.
Zeroize	User, CO	Functions that destroy CSPs: • fips_rand_prng_reset: destroys RNG CSPs. • fips_drbg_uninstantiate: for a given DRBG context, overwrites DRBG CSPs (Hash_DRBG CSPs, HMAC_DRBG CSPs, CTR_DRBG CSPs, Dual_EC_DRBG CSPs.) All other services automatically overwrite CSPs stored in allocated memory. Stack cleanup is the responsibility of the calling application.
Random number generation	User, CO	Used for random number and symmetric key generation. • Seed or reseed an RNG or DRBG instance • Determine security strength of an RNG or DRBG instance • Obtain random data Uses and updates RNG CSPs, Hash_DRBG CSPs, HMAC_DRBG CSPs, CTR_DRBG CSPs, Dual_EC_DRBG CSPs.
Asymmetric key generation	User, CO	Used to generate DSA, ECDSA and RSA keys: RSA SGK, RSA SVK; DSA SGK, DSA SVK; ECDSA SGK, ECDSA SVK There is one supported entropy strength for each mechanism and algorithm type, the maximum specified in SP800-90
Symmetric encrypt/decrypt	User, CO	Used to encrypt or decrypt data. Executes using AES EDK, TDES EDK (passed in by the calling process).
Symmetric digest	User, CO	Used to generate or verify data integrity with CMAC. Executes using AES CMAC, TDES, CMAC (passed in by the calling process).
Message digest	User, CO	Used to generate a SHA-1 or SHA-2 message digest. Does not access CSPs.

Service	Role	Description
Keyed Hash	User, CO	Used to generate or verify data integrity with HMAC. Executes using HMAC Key (passed in by the calling process).
Key transport[6]	User, CO	Used to encrypt or decrypt a key value on behalf of the calling process (does not establish keys into the module). Executes using RSA KDK, RSA KEK (passed in by the calling process).
Key agreement	User, CO	Used to perform key agreement primitives on behalf of the calling process (does not establish keys into the module). Executes using EC DH Private, EC DH Public (passed in by the calling process).
Digital signature	User, CO	Used to generate or verify RSA, DSA or ECDSA digital signatures. Executes using RSA SGK, RSA SVK; DSA SGK, DSA SVK; ECDSA SGK, ECDSA SVK (passed in by the calling process).
Utility	User, CO	Miscellaneous helper functions. Does not access CSPs.

Table 5 - Services and CSP Access

6 Self-test

The Module performs the self-tests listed below on invocation of Initialize or Self-test.

Algorithm	Type	Test Attributes
Software integrity	KAT	HMAC-SHA1
HMAC	KAT	One KAT per SHA1, SHA224, SHA256, SHA384 and SHA512 Per IG 9.3, this testing covers SHA POST requirements.
AES	KAT	Separate encrypt and decrypt, ECB mode, 128 bit key length
AES CCM	KAT	Separate encrypt and decrypt, 192 key length
AES GCM	KAT	Separate encrypt and decrypt, 256 key length
XTS-AES	KAT	128, 256 bit key sizes to support either the 256-bit key size (for XTS-AES-128) or the 512-bit key size (for XTS-AES-256)
AES CMAC	KAT	Sign and verify CBC mode, 128, 192, 256 key lengths
TDES	KAT	Separate encrypt and decrypt, ECB mode, 3-Key
TDES CMAC	KAT	CMAC generate and verify, CBC mode, 3-Key
RSA	KAT	Sign and verify using 2048 bit key, SHA-256, PKCS#1
DSA	PCT	Sign and verify using 2048 bit key, SHA-384

[6] "Key transport" can refer to a) moving keys in and out of the module or b) the use of keys by an external application. The latter definition is the one that applies to this Module.

Algorithm	Type	Test Attributes
DRBG	KAT	CTR_DRBG: AES, 256 bit with and without derivation function HASH_DRBG: SHA256 HMAC_DRBG: SHA256 Dual_EC_DRBG: P-256 and SHA256
ECDSA	PCT	Keygen, sign, verify using P-224, K-233 and SHA512. The K-233 self-test is not performed for operational environments that support prime curve only (see Table 2).
ECC CDH	KAT	Shared secret calculation per SP 800-56A §5.7.1.2, IG 9.6
X9.31 RNG	KAT	128, 192, 256 bit AES keys

Table 6a - Power On Self Tests (KAT = Known answer test; PCT = Pairwise consistency test)

The FIPS_mode_set()[7] function performs all power-up self-tests listed above with no operator intervention required, returning a "1" if all power-up self-tests succeed, and a "0" otherwise. If any component of the power-up self-test fails an internal flag is set to prevent subsequent invocation of any cryptographic function calls. The module will only enter the FIPS Approved mode if the module is reloaded and the call to FIPS_mode_set() succeeds.

The power-up self-tests may also be performed on-demand by calling FIPS_selftest(), which returns a "1" for success and "0" for failure. Interpretation of this return code is the responsibility of the calling application.

The Module also implements the following conditional tests:

Algorithm	Test
DRBG	Tested as required by [SP800-90] Section 11
DRBG	FIPS 140-2 continuous test for stuck fault
DSA	Pairwise consistency test on each generation of a key pair
ECDSA	Pairwise consistency test on each generation of a key pair
RSA	Pairwise consistency test on each generation of a key pair
ANSI X9.31 RNG	Continuous test for stuck fault

Table 6b - Conditional Tests

In the event of a DRBG self-test failure the calling application must uninstantiate and re-instantiate the DRBG per the requirements of [SP 800-90]; this is not something the Module can do itself.

Pairwise consistency tests are performed for both possible modes of use, e.g. Sign/Verify and

[7] `FIPS_mode_set()` calls Module function `FIPS_module_mode_set()`

Encrypt/Decrypt.

7 Operational Environment

The tested operating systems segregate user processes into separate process spaces. Each process space is logically separated from all other processes by the operating system software and hardware. The Module functions entirely within the process space of the calling application, and implicitly satisfies the FIPS 140-2 requirement for a single user mode of operation.

8 Design Assurance

8.1 Configuration Management

SafeNet uses a configuration management system called Agile that controls versioning control for documents within the company and a software configuration management tool called Github for managing software.

8.2 Delivery and Operation

The SafeNet Software Cryptographic Library is never released outside of SafeNet as a source code distribution. It is contained within our source code management repository that can be accessed by engineering to download a copy of the code. It is not possible to make changes to the code and replace it within this repository. When a developer downloads code for integration into a SafeNet product, the code gets integrated into the configuration management structure for that product. The module code is then linked as part of an application build process that is configured to operate in FIPS Approved Mode.

9 Mitigation of other attacks

The Module does not claim any attack mitigation beyond FIPS 140-2 Level 1 requirements.