KLC GROUP

CipherDrive v1.2.3

Security Target

Version 1.3

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Document History

Version	Date	Description
1.0	23 Dec 2020	Release for certification.
1.1	4 Feb 2021	Update CAVP.
1.2	22 Dec 2022	New TOE version.
1.3	18 Jan 2023	Update section 2.4.3

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1 Introduction

1.1 Overview

1 This Security Target (ST) defines the CipherDrive Target of Evaluation (TOE) for the purposes of Common Criteria (CC) evaluation.

2 CipherDrive provides user authentication and drive/system unlock software running on an endpoint, which may be a workstation or a laptop, equipped with a Self-Encrypting Drive (SED).

1.2 Identification

Table 1: Evaluation identifiers

Target of Evaluation	KLC Group LLC CipherDrive v1.2.3 Build: 1
Security Target	KLC Group LLC CipherDrive v1.2.3 Security Target, v1.3

1.3 Conformance Claims

3 This ST supports the following conformance claims:

a) CC version 3.1 revision 5

b) CC Part 2 extended

c) CC Part 3 conformant

d) collaborative Protection Profile for Full Drive Encryption – Authorization Acquisition, v2.0 + Errata 20190201 (referenced within as CPP_FDE_AA)

e) NIAP Technical Decisions per Table 2

Table 2: NIAP Technical Decisions

TD #	Name	Rationale if n/a
TD0458	FIT Technical Decision for FPT_KYP_EXT.1 evaluation activities	
TD0606	FIT Technical Recommendation for Evaluating a NAS against the FDE AA and FDEE	The TOE is not a NAS device

1.4 Terminology

Table 3: Terminology

Term	Definition
AA	Authorization Acquisition
AES	Advanced Encryption Standard

Term	Definition
BEV	Border Encryption Value
BIOS	Basic Input Output System
CBC	Cipher Block Chaining
CC	Common Criteria
CCM	Counter with CBC-Message Authentication Code
CEM	Common Evaluation Methodology
CPP	Collaborative Protection Profile
DAR	Data At Rest
DEK	Data Encryption Key
DRBG	Deterministic Random Bit Generator
DSS	Digital Signature Standard
ECC	Elliptic Curve Cryptography
ECDSA	Elliptic Curve Digital Signature Algorithm
EE	Encryption Engine
EEPROM	Electrically Erasable Programmable Read-Only Memory
EFI	Extensible Firmware Interface
ESP	EFI System Partition
FIPS	Federal Information Processing Standards
FDE	Full Drive Encryption
FFC	Finite Field Cryptography
GCM	Galois Counter Mode
GPT	GUID Partition Table
GUID	Globally Unique Identifier
HMAC	Keyed-Hash Message Authentication Code
HW	Hardware

Term	Definition
IEEE	Institute of Electrical and Electronics Engineers
IT	Information Technology
ITSEF	IT Security Evaluation Facility
ISO/IEC	International Organization for Standardization / International Electrotechnical Commission
IV	Initialization Vector
KEK	Key Encryption Key
KLC	KLC Group LLC
KMD	Key Management Description
KRK	Key Release Key
LKRNG	Linux Kernel Random Number Generator
MBR	Master Boot Record
NIST	National Institute of Standards and Technology
Opal 2.0	Trusted Computing Group standard for SEDs.
OS	Operating System
PBKDF	Password-Based Key Derivation Function
PIV-CAC	Personal Identity Verification Common Access Card
PRF	Pseudo Random Function
PXE	Preboot eXecution Environment
RBG	Random Bit Generator
RNG	Random Number Generator
RSA	Rivest Shamir Adleman Algorithm
RSAEP	RSA Encryption Primitive
RSADP	RSA Decryption Primitive
SAR	Security Assurance Requirements
SED	Self-Encrypting Drive

Term	Definition
SHA	Secure Hash Algorithm
SFR	Security Functional Requirements
ST	Security Target
SPD	Security Problem Definition
SPI	Serial Peripheral Interface
TOE	Target of Evaluation
TPM	Trusted Platform Module
TSF	TOE Security Functionality
TSS	TOE Summary Specification
UEFI	Unified Extensible Firmware Interface
USB	Universal Serial Bus
XOR	Exclusive or
XTS	XEX (XOR Encrypt XOR) Tweakable Block Cipher with Ciphertext Stealing

2 TOE Description

2.1 Type

4 The TOE is software that provides pre-boot authentication (PBA) for use with a SED.

2.2 Usage

5 The TOE provides pre-boot user authentication for Opal 2.0 compliant SEDs. It is designed to be used with a SED as a loosely coupled system to deliver secure Data-At-Rest (DAR) encryption.

6 The TOE is installed on a 128MB read-only Shadow MBR partition on the SED by booting from an external USB thumb drive or DVD containing the installer. After installation, the user authenticates to the TOE (via username/password and/or smartcard) which will unlock the SED drive and chain-boot to the host OS or Hypervisor environment.

2.3 Security Functions / Logial Scope

7 The TOE provides the following security functions:

a) **Data Protection.** The TOE enables encryption of data on a storage device to protect it from unauthorized disclosure. The TOE enables the data encryption function of a SED drive by providing pre-boot user authentication and key management capabilities.

b) **Secure Key Material.** The TOE ensures key material used for storage encryption is properly generated and protected from disclosure. It also implements cryptographic key and key material destruction during transitioning to a Compliant power saving state, or when all keys and key material are no longer needed.

c) **Secure Management.** The TOE enables management of its security functions, including:

i) forwarding requests to change the DEK to the SED,

ii) forwarding requests to cryptographically erase the DEK to the SED,

iii) allowing authorized users to change authorization factors or set of authorization factors used,

iv) initiate TOE firmware/software updates,

v) configure authorization factors.

d) **Trusted Update.** The TOE ensures the authenticity and integrity of software updates through digital signatures using RSA 4096 with SHA-512.

e) **Cryptographic Operations.** The TOE performs cryptographic operations as shown in Table 4, which includes relevant Cryptographic Algorithm Validation Program (CAVP) certificates.

Table 4: CAVP Certificates

Capability	Certificate
AES-CBC, 128, 256	C1980

Capability	Certificate
SHA-512	
HMAC-SHA-512	
CTR_DRBG	
RSA Sig Ver (186-4)	A972

2.4 Physical Scope

8 The physical boundary of the TOE encompasses the KLC CipherDrive v1.2.3 software (including Linux Kernel). Users download the software after purchase from KLC's web portal. Alternatively, CipherDrive may come preinstalled on a partner OEM Opal2 compatible SSD/HDD disk.

2.4.1 Guidance Documents

9 The TOE includes the following guidance documents:

a) KLC Group LLC, CipherDrive v1.2, KLC PBA, 10-11-2022 (PDF)

b) KLC CipherDrive v1.2 Common Criteria Guide, v1.3 (PDF)

10 Users download the guidance documents from KLC's web portal.

2.4.2 Non-TOE Components

11 The TOE operates with the following components in the environment:

a) **SED.** Opal 2.0 compliant SED. CC testing performed using SEDs:

   i) Digistor DIG-M25126-SI

   ii) Digistor DIG-M2N22566-UI

b) **Protected OS.** The TOE supports protection of Linux Operating Systems/Linux based Hypervisors and Windows Operating Systems.

c) **Computer Hardware.** Intel based UEFI booted systems that supports Intel Secure Key Technology. CC Testing performed using CPUs:

   i) Intel Atom x7-E3950

   ii) Intel Core i5-9400H

d) **Smartcard and reader.** When dual factor authentication is used, Federal Information Processing Standard (FIPS) 201 Personal Identity Verification Common Access Card (PIV-CAC) compliant smartcards and readers are required.

2.4.3 Security Functions not included in the TOE Evaluation

12 The evaluation is limited to those security functions identified in section 2.3.

13 The following configurations / features have not been evaluated:

a) Use of multiple drives

b) Disk wipe after configurable number of logon failures

c) Remote Help

d) Stealth login via USB

e) Dead-Man-Switch crypto erase

f) OS Chain-loader

3 Security Problem Definition

14 The Security Problem Definition is reproduced from the CPP_FDE_AA.

3.1 Threats

Table 5: Threats

Identifier	Description
T.UNAUTHORIZED_ DATA_ACCESS	The cPP addresses the primary threat of unauthorized disclosure of protected data stored on a storage device. If an adversary obtains a lost or stolen storage device (e.g., a storage device contained in a laptop or a portable external storage device), they may attempt to connect a targeted storage device to a host of which they have complete control and have raw access to the storage device (e.g., to specified disk sectors, to specified blocks).
T.KEYING_MATERIAL _COMPROMISE	Possession of any of the keys, authorization factors, submasks, and random numbers or any other values that contribute to the creation of keys or authorization factors could allow an unauthorized user to defeat the encryption. The cPP considers possession of key material of equal importance to the data itself. Threat agents may look for key material in unencrypted sectors of the storage device and on other peripherals in the operating environment (OE), e.g. BIOS configuration, SPI flash.
T.KEYSPACE_ EXHAUST	Threat agents may perform a cryptographic exhaust against the key space. Poorly chosen encryption algorithms and/or parameters allow attackers to exhaust the key space through brute force and give them unauthorized access to the data.
T.UNAUTHORIZED_ UPDATE	Threat agents may attempt to perform an update of the product which compromises the security features of the TOE. Poorly chosen update protocols, signature generation and verification algorithms, and parameters may allow attackers to install software and/or firmware that bypasses the intended security features and provides them unauthorized access to data.

3.2 Assumptions

Table 6: Assumptions

Identifier	Description
A.INITIAL_DRIVE_ STATE	Users enable Full Drive Encryption on a newly provisioned or initialized storage device free of protected data in areas not targeted for encryption. The cPP does not intend to include requirements to find all the areas on storage devices that potentially contain protected data. In some cases, it may not be possible - for example, data contained in "bad" sectors. While inadvertent exposure to data contained in bad sectors or un-partitioned space is unlikely, one may use forensics tools to recover data from such areas of the storage device. Consequently, the cPP assumes bad sectors, un-partitioned space, and areas that must contain unencrypted code (e.g., MBR and AA/EE pre-authentication software) contain no protected data.
A.SECURE_STATE	Upon the completion of proper provisioning, the drive is only assumed secure when in a powered off state up until it is powered on and receives initial authorization.
A.TRUSTED_ CHANNEL	Communication among and between product components (e.g., AA and EE) is sufficiently protected to prevent information disclosure. In cases in which a single product fulfils both cPPs, then the communication between the components does not extend beyond the boundary of the TOE (e.g., communication path is within the TOE boundary). In cases in which independent products satisfy the requirements of the AA and EE, the physically close proximity of the two products during their operation means that the threat agent has very little opportunity to interpose itself in the channel between the two without the user noticing and taking appropriate actions.
A.TRAINED_USER	Authorized users follow all provided user guidance, including keeping password/passphrases and external tokens securely stored separately from the storage device and/or platform.
A.PLATFORM_STATE	The platform in which the storage device resides (or an external storage device is connected) is free of malware that could interfere with the correct operation of the product.
A.SINGLE_USE_ET	External tokens that contain authorization factors are used for no other purpose than to store the external token authorization factors.
A.POWER_DOWN	The user does not leave the platform and/or storage device unattended until all volatile memory is cleared after a power-off, so memory remnant attacks are infeasible. Authorized users do not leave the platform and/or storage device in a mode where sensitive information persists in non-volatile storage (e.g., lock screen). Users power the platform and/or storage device down or place it into a power managed state, such as a "hibernation mode".

Identifier	Description
A.PASSWORD_ STRENGTH	Authorized administrators ensure password/passphrase authorization factors have sufficient strength and entropy to reflect the sensitivity of the data being protected.
A.PLATFORM_I&A	The product does not interfere with or change the normal platform identification and authentication functionality such as the operating system login. It may provide authorization factors to the operating system's login interface, but it will not change or degrade the functionality of the actual interface.
A.STRONG_CRYPTO	All cryptography implemented in the Operational Environment and used by the product meets the requirements listed in the cPP. This includes generation of external token authorization factors by a RBG.
A.PHYSICAL	The platform is assumed to be physically protected in its Operational Environment and not subject to physical attacks that compromise the security and/or interfere with the platform’s correct operation.

3.3 Organizational Security Policies

15 None defined.

4 Security Objectives

16 The security objectives are reproduced from the CPP_FDE_AA.

Table 7: Security Objectives for the Operational Environment

Identifier	Description
OE.TRUSTED_ CHANNEL	Communication among and between product components (i.e., AA and EE) is sufficiently protected to prevent information disclosure.
OE.INITIAL_DRIVE_ STATE	The OE provides a newly provisioned or initialized storage device free of protected data in areas not targeted for encryption.
OE.PASSPHRASE_ STRENGTH	An authorized administrator will be responsible for ensuring that the passphrase authorization factor conforms to guidance from the Enterprise using the TOE.
OE.POWER_DOWN	Volatile memory is cleared after power-off so memory remnant attacks are infeasible.
OE.SINGLE_USE_ET	External tokens that contain authorization factors will be used for no other purpose than to store the external token authorization factor.
OE.STRONG_ ENVIRONMENT_ CRYPTO	The Operating Environment will provide a cryptographic function capability that is commensurate with the requirements and capabilities of the TOE and Appendix A.

Identifier	Description
OE.TRAINED_USERS	Authorized users will be properly trained and follow all guidance for securing the TOE and authorization factors.
OE.PLATFORM_ STATE	The platform in which the storage device resides (or an external storage device is connected) is free of malware that could interfere with the correct operation of the product.
OE.PLATFORM_I&A	The Operational Environment will provide individual user identification and authentication mechanisms that operate independently of the authorization factors used by the TOE.
OE.PHYSICAL	The Operational Environment will provide a secure physical computing space such than an adversary is not able to make modifications to the environment or to the TOE itself.

5 Security Requirements

5.1 Conventions

17 This document uses the following font conventions to identify the operations defined by the CC:

a) **Assignment.** Indicated with italicized text.

b) **Refinement.** Indicated with bold text and strikethroughs.

c) **Selection.** Indicated with underlined text.

d) **Assignment within a Selection:** Indicated with italicized and underlined text.

e) **Iteration.** Indicated by appending parentheses that contain a letter that is unique for each iteration, e.g. (a), (b), (c) and/or with a slash (/) followed by a descriptive string for the SFR's purpose, e.g. /Server.

18 **Note:** Operations performed within the Security Target are denoted within brackets []. Operations shown without brackets are reproduced from the PP.

5.2 Extended Components Definition

19 Refer to Annex A: Extended Components Definition.

5.3 Functional Requirements

Table 8: Summary of SFRs

Requirement	Title
FCS_AFA_EXT.1	Authorization Factor Acquisition
FCS_AFA_EXT.2	Timing of Authorization Factor Acquisition
FCS_CKM.4(a)	Cryptographic Key Destruction (Power Management)
FCS_CKM.4(d)	Cryptographic Key Destruction (Software TOE, 3rd Party Storage)
FCS_CKM_EXT.4(a)	Cryptographic Key and Key Material Destruction (Destruction Timing)
FCS_CKM_EXT.4(b)	Cryptographic Key and Key Material Destruction (Power Management)
FCS_KYC_EXT.1	Key Chaining (Initiator)
FCS_SNI_EXT.1	Cryptographic Operation (Salt, Nonce, and Initialization Vector Generation)
FMT_MOF.1	Management of Functions Behavior
FMT_SMF.1	Specification of Management Functions

Requirement	Title
FMT_SMR.1	Security Roles
FPT_KYP_EXT.1	Protection of Key and Key Material
FPT_PWR_EXT.1	Power Saving States
FPT_PWR_EXT.2	Timing of Power Saving States
FPT_TUD_EXT.1	Trusted Update
Selection based	
FCS_CKM.1(b)	Cryptographic Key Generation (Symmetric Keys)
FCS_COP.1(a)	Cryptographic Operation (Signature Verification)
FCS_COP.1(b)	Cryptographic Operation (Hash Algorithm)
FCS_COP.1(c)	Cryptographic Operation (Keyed Hash Algorithm)
FCS_COP.1(g)	Cryptographic Operation (Key Encryption)
FCS_KDF_EXT.1	Cryptographic Key Derivation
FCS_PCC_EXT.1	Cryptographic Password Construct and Conditioning
FCS_RBG_EXT.1	Cryptographic Operation (Random Bit Generation)
FCS_SMC_EXT.1	Submask Combining

5.3.1 Cryptographic Support (FCS)

FCS_AFA_EXT.1 Authorization Factor Acquisition

FCS_AFA_EXT.1.1 The TSF shall accept the following authorization factors: [

- a submask derived from a password authorization factor conditioned as defined in FCS_PCC_EXT.1,
- an external Smartcard factor that is at least the same bit-length as the DEK, and is protecting a submask that is [generated by the TOE (using the RBG as specified in FCS_RBG_EXT.1)] protected using RSA with key size [4096 bits], with user presence proved by presentation of the smartcard and [an OE defined PIN].

].

FCS_AFA_EXT.2 Timing of Authorization Factor Acquisition

FCS_AFA_EXT.2.1 The TSF shall reacquire the authorization factor(s) specified in FCS_AFA_EXT.1 upon transition from any Compliant power saving state specified in FPT_PWR_EXT.1 prior to permitting access to plaintext data.

FCS_CKM.1(b) Cryptographic Key Generation (Symmetric Keys)

FCS_CKM.1.1(b) **Refinement:** The TSF shall generate **symmetric** cryptographic keys using **a Random Bit Generator as specified in FCS_RBG_EXT.1** and specified cryptographic key sizes [<u>128 bit, 256 bit</u>] that meet the following: [*no standard*].

FCS_CKM.4(a) Cryptographic Key Destruction (Power Management)

FCS_CKM.4.1(a) **Refinement:** The TSF **shall [<u>erase</u>] cryptographic keys and key material from volatile memory when transitioning to a Compliant power saving state as defined by FPT_PWR_EXT.1** that meets the following: *a key destruction method specified in FCS_CKM.4(d)*.

FCS_CKM.4(d) Cryptographic Key Destruction (Software TOE, 3rd Party Storage)

FCS_CKM.4.1(d) **Refinement:** The TSF shall destroy cryptographic keys in accordance with a specified cryptographic key destruction method [

- **<u>For volatile memory, the destruction shall be executed by a [</u>**
  - **<u>single overwrite consisting of [</u>**
    - **<u>a pseudo-random pattern using the TSF's RBG,</u>**
    - **<u>a new value of a key,</u>**

      <u>],</u>

    <u>];</u>
- **<u>For non-volatile storage that consists of the invocation of an interface provided by the underlying platform that [</u>**
  - **<u>instructs the underlying platform to destroy the abstraction that represents the key]</u>**

    ]

that meets the following: [no standard].

FCS_CKM_EXT.4(a) Cryptographic Key and Key Material Destruction (Destruction Timing)

FCS_CKM_EXT.4.1(a) The TSF shall destroy all keys and key material when no longer needed.

FCS_CKM_EXT.4.1(b) Cryptographic Key and Key Material Destruction (Power Management)

FCS_CKM_EXT.4.1(b) **Refinement:** The TSF shall destroy all **key material, BEV, and authentication factors stored in plaintext when transitioning to a Compliant power saving state as defined by FPT_PWR_EXT.1.**

FCS_COP.1(a) Cryptographic Operation (Signature Verification)

FCS_COP.1.1(a) **Refinement:** The TSF shall perform *cryptographic signature services (verification)* in accordance with a [

- **RSA Digital Signature Algorithm with a key size (modulus) of [4096-bit];**

]

that meet the following: [

- ***FIPS PUB 186-4, “Digital Signature Standard (DSS)”, Section 5.5, using PKCS #1 v2.1 Signature Schemes RSASSA-PSS and/or RSASSA-PKCS1-v1_5; ISO/IEC 29 9796-2, Digital signature scheme 2 or Digital Signature scheme 3, for RSA schemes*]**

FCS_COP.1(b) Cryptographic Operation (Hash Algorithm)

FCS_COP.1.1(b) **Refinement:** The TSF shall perform *cryptographic hashing services* in accordance with a specified cryptographic algorithm [**SHA-512**] ~~and cryptographic key sizes [assignment: cryptographic key sizes]~~ that meet the following: *ISO/IEC 10118-3:2004*.

FCS_COP.1(c) Cryptographic Operation (Keyed Hash Algorithm)

FCS_COP.1.1(c) **Refinement:** The TSF shall perform cryptographic *keyed-hash message authentication* in accordance with a specified cryptographic algorithm [**HMAC-SHA-512**] and cryptographic key sizes [***512 bits***] that meet the following: *ISO/IEC 9797-2:2011, Section 7 “MAC Algorithm 2”*.

FCS_COP.1(g) Cryptographic Operation (Key Encryption)

FCS_COP.1.1(g) **Refinement:** The TSF shall perform *key encryption and decryption* in accordance with a specified cryptographic algorithm *AES used in* [CBC] *mode* and cryptographic key sizes [256 bits] that meet the following: *AES as specified in ISO /IEC 18033-3,* [CBC as specified in ISO/IEC 10116].

FCS_KDF_EXT.1 Cryptographic Key Derivation

FCS_KDF_EXT.1.1 The TSF shall accept [a conditioned password submask] to derive an intermediate key, as defined in [

- NIST SP 800-132],

using the keyed-hash functions specified in FCS_COP.1(c), such that the output is at least of equivalent security strength (in number of bits) to the BEV.

FCS_KYC_EXT.1 Key Chaining (Initiator)

FCS_KYC_EXT.1.1 The TSF shall maintain a key chain of: [

- intermediate keys originating from one or more submask(s) to the BEV using the following method(s): [
  - key derivation as specified in FCS_KDF_EXT.1,
  - key combining as specified in FCS_SMC_EXT.1,
  - key encryption as specified in FCS_COP.1(g)]]

while maintaining an effective strength of [256 bits] for symmetric keys and an effective strength of [128 bits] for asymmetric keys.

Application Note: Keys are combined per FCS_SMC_EXT.1 to maintain an effective strength of 256 bits along the key chain.

FCS_KYC_EXT.1.2 The TSF shall provide at least a [128 bit, 256 bit] BEV to [*the SED*] [

- without validation taking place].

Application Note: The TOE may be configured to provide either 128 or 256 bit BEVs. The keychain remains the same in either case.

FCS_PCC_EXT.1 Cryptographic Password Construct and Conditioning

FCS_PCC_EXT.1.1 A password used by the TSF to generate a password authorization factor shall enable up to [*128*] characters in the set of {upper case characters, lower case characters, numbers, and [*“!”, “@”, “#”, “$”, “%”, “^”, “&”, “*”, “(“, “)”*]} and shall perform Password-based Key Derivation Functions in accordance with a specified cryptographic algorithm HMAC-[SHA-512], with [*100,000*] iterations, and output cryptographic key sizes [256 bits] that meet the following: *NIST SP 800-132*.

FCS_RBG_EXT.1 Cryptographic Operation (Random Bit Generation)

FCS_RBG_EXT.1.1 The TSF shall perform all deterministic random bit generation services in accordance with [[NIST SP 800-90A]] using [CTR_DRBG (AES)].

FCS_RBG_EXT.1.2 The deterministic RBG shall be seeded by at least one entropy source that accumulates entropy from [

- [*1*] hardware-based noise source(s),]

with a minimum of [256 bits] of entropy at least equal to the greatest security strength, according to ISO/IEC 18031:2011 Table C.1 “Security Strength Table for Hash Functions”, of the keys and hashes that it will generate.

FCS_SMC_EXT.1 Submask Combining

FCS_SMC_EXT.1.1 The TSF shall combine submasks using the following method [exclusive OR (XOR)] to generate an [*intermediary key ~~or BEV~~*].

Application Note: Submask combining is used for dual factor authentication.

FCS_SNI_EXT.1 Cryptographic Operation (Salt, Nonce, and Initialization Vector Generation)

FCS_SNI_EXT.1.1 The TSF shall [use salts that are generated by a [DRBG as specified in FCS_RBG_EXT.1]].

FCS_SNI_EXT.1.2 The TSF shall use [no nonces].

FCS_SNI_EXT.1.3 The TSF shall create IVs in the following manner [

- CBC: IVs shall be non-repeating and unpredictable;].

5.3.2 Security Management (FMT)

FMT_MOF.1 Management of Functions Behavior

FMT_MOF.1.1 The TSF shall restrict the ability to modify the behaviour of the functions *use of Compliant power saving state* to *authorized users*.

FMT_SMF.1 Specification of Management Functions

FMT_SMF.1.1 **Refinement:** The TSF shall be capable of performing the following management functions:

a) forwarding requests to change the DEK to the EE,

b) forwarding requests to cryptographically erase the DEK to the EE,

c) allowing authorized users to change authorization factors or set of authorization factors used,

d) initiate TOE firmware/software updates,

e) **[configure authorization factors, disable key recovery functionality].**

FMT_SMR.1 Security Roles

FMT_SMR.1.1 The TSF shall maintain the roles *authorized user*.

FMT_SMR.1.2 The TSF shall be able to associate users with roles.

5.3.3 Protection of the TSF (FPT)

FPT_KYP_EXT.1 Protection of Key and Key Material

FPT_KYP_EXT.1.1 The TSF shall [

- only store keys in non-volatile memory when ~~wrapped, as specified in FCS_COP.1(d), or~~ encrypted, as specified in FCS_COP.1(g) or FCS_COP.1(e)]

FPT_PWR_EXT.1 Power Saving States

FPT_PWR_EXT.1.1 The TSF shall define the following Compliant power saving states: [S4, G2(S5), G3]

FPT_PWR_EXT.2 Timing of Power Saving States

FPT_PWR_EXT.2.1 For each Compliant power saving state defined in FPT_PWR_EXT.1.1, the TSF shall enter the Compliant power saving state when the following conditions occur: user-initiated request, [*[as prompted by the protected OS]*].

FPT_TUD_EXT.1 Trusted Update

FPT_TUD_EXT.1.1 **Refinement:** The TSF shall provide *authorized users* the ability to query the current version of the TOE **[software] ~~software/firmware~~.**

FPT_TUD_EXT.1.2 **Refinement:** The TSF shall provide *authorized users* the ability to initiate updates to TOE **[software] ~~software/firmware~~**.

FPT_TUD_EXT.1.3 **Refinement:** The TSF shall verify updates to the TOE software using a digital signature **as specified in FCS_COP.1(a)** by the manufacturer prior to installing those updates.

5.4 Assurance Requirements

20 The TOE security assurance requirements are summarized in Table 9.

Table 9: Assurance Requirements

Assurance Class	Components	Description
Security Target Evaluation	ASE_CCL.1	Conformance Claims
	ASE_ECD.1	Extended Components Definition
	ASE_INT.1	ST Introduction
	ASE_OBJ.1	Security Objectives for the operational environment
	ASE_REQ.1	Stated Security Requirements
	ASE_SPD.1	Security Problem Definition
	ASE_TSS.1	TOE Summary Specification
Development	ADV_FSP.1	Basic Functional Specification
Guidance Documents	AGD_OPE.1	Operational User Guidance
	AGD_PRE.1	Preparative Procedures
Life Cycle Support	ALC_CMC.1	Labelling of the TOE
	ALC_CMS.1	TOE CM Coverage
Tests	ATE_IND.1	Independent Testing - sample
Vulnerability Assessment	AVA_VAN.1	Vulnerability Survey

21 In accordance with section 6.1 of the CPP_FDE_AA, the following refinement is made to ASE:

a) **ASE_TSS.1.1C Refinement:** The TOE summary specification shall describe how the TOE meets each SFR, **including a proprietary Key Management Description (Appendix E), and [Entropy Essay].**

6 TOE Summary Specification

22 The following sections describe how the TOE fulfils each SFR included in section 5.3.

6.1 Context

6.1.1 Core TOE Concepts

23 The following are core concepts and TOE components relevant to understanding the TSS:

a) **Installer.** The TOE installer runs from a bootable device such as a USB drive, DVD or from a network share (such as executing via PXE boot). It will accept the SED administrator password and new TOE administrator password as input, bring the SED device from factory state to functional Opal state, take ownership of the SED, enable the Shadow MBR, create the ESP and install all the TOE components. At completion of the install, the hardware platform administrator sets the new TOE partition as the first boot option in the UEFI boot option list.

b) **Shadow MBR.** A 128-MB read-only partition of the SED that is the only partition visible until the SED is unlocked by the TOE. Once the SED is unlocked the Shadow MBR is mapped out and the protected partitions mapped in.

c) **ESP.** EFI System Partition (ESP) is a GPT partition with FAT32 file system located in the Shadow MBR. The system firmware loads files from this partition to boot and load the TOE.

d) **Database.** The TOE includes a database that stores the user and key tables. The database is obfuscated to prevent casual viewing and cryptographic keys are individually encrypted as described in the following sections.

e) **GUI.** The TOE provides a local GUI for PBA (SED unlock via username/password and/or smartcard) and TOE / user management.

f) **User Management.** The TOE enforces role-based access control with the following roles defined:

   i) **Admin.** Can unlock the SED, add other users and update TOE firmware.

   ii) **Security Officer.** Can unlock the SED, perform wipe-disk function and delete logs.

   iii) **Login User.** Can unlock the SED.

   iv) **Helpdesk.** Can view logs and reset user passwords.

g) **Protected OS.** The host OS or Hypervisor environment on the SED that is booted after successful TOE authentication.

6.1.2 Key Management

24 The following sections describe the fundamental key management aspects of the TOE. The figures below depict the resulting keychains designed with sufficient strength to protect a 256-bit DEK on the SED (the TOE also supports 128-bit DEKs & BEVs).

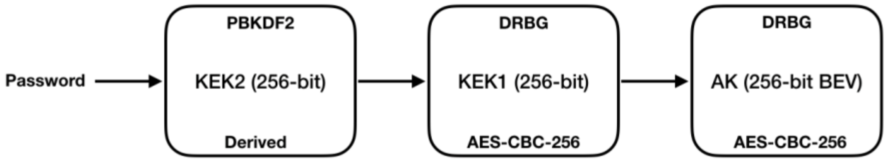


Figure 1: BEV Keychain for Password Authorization

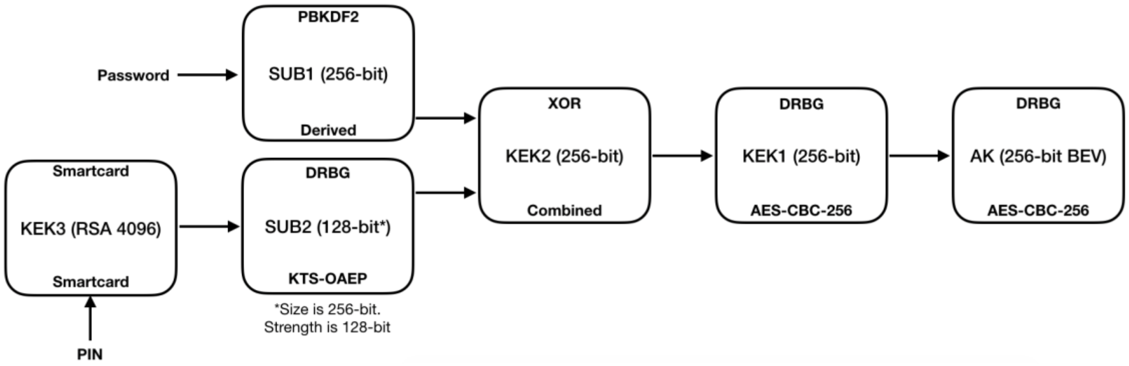


Figure 2: BEV Keychain for Dual Factor Authorization

6.1.2.1 Authentication Keys (BEV)

25 The TOE generates and manages the Authentication Keys (AKs) used to unlock a SED (AKs are the BEV referred to by the CPP_FDE_AA). The OPAL 2.0 standard specifies the following standard SED ‘user accounts’:

a) **SID.** Security ID – the owner of the SED (e.g. root).

b) **ADMIN SP.** This is the Administrative Security Provider. It is the OPAL construct that administers the security on the SED.

c) **LOCKING SP.** This is the Locking Security Provider. It is the OPAL construct that manages the locking and unlocking of the locking ranges on the SED.

26 During installation, the TOE generates 128-bit or 256-bit (depending on configuration AKs for the SID, ADMIN SP and LOCKING SP SED user accounts. The AKs are encrypted using AES and stored in the TOE’s database.

6.1.2.2 KEKs

27 As shown in Figure 1 and Figure 2 the TOE uses a chain of up to three KEKs to the BEV (AK):

a) **KEK1.** 256-bit AES key generated by the TOE and used to encrypt the AK.

b) **KEK2.** 256-bit AES key used to encrypt KEK1. This key is derived differently depending on the authorization factors in use:

i) **Username and Password.** KEK2 is derived from the user’s password via PBKDF2.

ii) **Dual Factor.** KEK2 is a combined key which is an XOR of:

- **SUB1.** 256-bit submask derived from the user’s password via PBKDF2.

- **SUB2.** 128-bit strength (256-bit length) submask generated by the TOE. SUB2 is RSA encrypted (per below) and stored in the TOE database.

c) **KEK3.** 4096 RSA private key stored on a smartcard and used (by the smartcard) to encrypt SUB2. **Note:** the RSA (KTS-OAEP) encryption is performed by the Smartcard and not the TOE.

28 KEKs are further delineated depending on the type of user. This detail is described in the proprietary Key Management Description (KMD).

6.1.3 Authentication / SED Unlock Flow

29 At a high-level, the basic start-up and authentication flow is as follows:

a) When the TOE starts up, the database is copied, de-obfuscated and mounted in RAM. The user enters their username and password, and, if dual factor authentication is configured, presents a smartcard and PIN.

b) Depending on the authentication method:

i) Validate username against the database

ii) For smartcard, authenticate PIN against the smartcard and pass SUB2 to the smartcard for decryption.

c) The TOE derives KEK2 and decrypts KEK1

d) The TOE uses the KEK1 to decrypt the appropriate AK based on the user's role

e) Provide the AK to the SED (with relevant OPAL commands)

6.2 Cryptographic Support (FCS)

6.2.1 FCS_AFA_EXT.1 Authorization Factor Acquisition

30 The TOE supports the use of username/password and smartcards (dual factor).

6.2.1.1 Username / Password

31 The password authentication process is as follows:

a) The user enters their username and password

b) The TOE will attempt to locate the username in the database

c) The TOE will return a generic authentication error if the username is not found

d) The TOE will compare a SHA512 hash of username + password. If there is a mismatch with value computed at enrolment, the TOE will return a generic authentication error

e) The TOE will perform PBKDF2 on the password and decrypt KEK1

f) The TOE will use KEK1 to decrypt the AK

g) The TOE will use the AK to establish a session with the SED

h) If SED session establishment fails, the TOE will return a generic authentication error. If SED session creation succeeds, the user is authenticated / authorized.

6.2.1.2 Dual Factor

32 The TOE supports an external smartcard factor that is at least the same bit-length as the DEK (256-bit) - SUB2 is 256-bits in length.

33 The TOE generates SUB2 using the RBG as specified in FCS_RBG_EXT.1 and stores it in encrypted form using RSA with key size 4096 bits.

34 The dual factor authentication process is as follows:

a) The user enters their username and password

b) The TOE will attempt to locate the username in the database

c) The TOE will return a generic authentication error if the username is not found

d) The TOE will compare a SHA512 hash of username + password. If there is a mismatch with value computed at enrolment, the TOE will return a generic authentication error.

e) The TOE will generate SUB1 via PBKDF2 and the user will be prompted to present a smartcard

f) The user presents a smartcard and enters the smartcard PIN

g) The smartcard will verify the PIN, if verification fails the TOE will return a generic authentication error

h) If PIN verification succeeds, the TOE will pass the encrypted SUB2 to smartcard for decryption with KEK3

i) The smartcard returns the decrypted SUB2 to the TOE

j) The TOE combines SUB1 and SUB2 (XOR) to form KEK2

k) The TOE decrypts KEK1 with KEK2

l) The TOE will use KEK1 to decrypt the AK

m) The TOE will use the AK to establish a session with the SED

n) If SED session establishment fails, the TOE will return a generic authentication error. If SED session creation succeeds, the user is authenticated / authorized.

6.2.2 FCS_AFA_EXT.2 Timing of Authorization Factor Acquisition

35 The user must authenticate via password or dual factor to gain access to user data after the TOE entered a Compliant power saving state described by FPT_PWT_EXT.1 below.

6.2.3 FCS_CKM.1(b) Cryptographic Key Generation (Symmetric Keys)

36 The TOE generates the following 256-bit AES keys: all AKs, KEK1 and SUB2.

6.2.4 FCS_CKM.4(a) Cryptographic Key Destruction (Power Management)

37 The TOE erases cryptographic keys and key material from volatile memory when transitioning to a Compliant power saving state with a single overwrite consisting of a pseudo-random pattern or overwrite with a new value of a key.

6.2.5 FCS_CKM.4(d) Cryptographic Key Destruction (Software TOE, 3rd Party Storage)

38 Details regarding how keys are managed in volatile memory are provided in the KMD.

6.2.6 FCS_CKM_EXT.4(a) Cryptographic Key and Key Material Destruction (Destruction Timing)

39 Detail regarding timing of key destruction are provided in the KMD.

6.2.7 FCS_CKM_EXT.4(b) Cryptographic Key and Key Material Destruction (Power Management)

40 Details regarding key destruction when entering a Compliant power saving state are provided in the KMD.

6.2.8 FCS_COP.1(a) Cryptographic Operation (Signature Verification)

41 The TOE performs signature verification using RSA 4096 with SHA-512 for trusted updates as follows:

a) TOE updates are signed with the KLC code signing private key

b) The obfuscated public key is embedded in the TOE binary

c) When the user triggers the TOE update from the GUI, the TOE verifies the digital signature using the embedded public key

d) If the digital signature verification succeeds, the upgrade process is carried out

e) If the digital signature verification fails, the upgrade process is aborted, and an error is displayed to the user.

6.2.9 FCS_COP.1(b) Cryptographic Operation (Hash Algorithm)

42 The TOE makes use of SHA-512 for digital signature verification.

43 The TOE makes use of SHA-512 for PBKDF.

6.2.10 FCS_COP.1(c) Cryptographic Operation (Keyed Hash Algorithm)

44 The TOE implements HMAC-SHA-512 with the following characteristics:

a) **Key length.** 512 bits.

b) **Block size.** 1024 bits.

c) **MAC length.** 512 bits.

6.2.11 FCS_COP.1(g) Cryptographic Operation (Key Encryption)

45 The TOE performs key encryption using AES-CBC-256.

6.2.12 FCS_KDF_EXT.1 Cryptographic Key Derivation

46 Passwords are conditioned via PBKDF2 using HMAC-SHA-512 with 100,000 iterations, resulting in a 256-bit key in accordance with NIST SP 800-132.

6.2.13 FCS_KYC_EXT.1 Key Chaining (Initiator)

47 The TOE key chain is described at section 6.1.2.

48 The TOE supports a BEV size of 128 or 256 bits (AK) depending on configuration.

6.2.14 FCS_PCC_EXT.1 Cryptographic Password Construct and Conditioning

49 The TOE implements a configurable password policy with the following options:

a) Minimum Length (8 – 128)

b) Require at least one uppercase

c) Require at least one lowercase

d) Require at least one numeric

e) Require at least one special character
(“!”, “@”, “#”, “$”, “%”, “^”, “&”, “*”, “(“, “)”)

f) History (Can repeat same password after how many times)

g) No of consecutive failed validation attempts before reboot is required

50 Passwords are conditioned via PBKDF2 using HMAC-SHA-512 with 100,000 iterations, resulting in a 256-bit key in accordance with NIST SP 800-132.

6.2.15 FCS_RBG_EXT.1 Cryptographic Operation (Random Bit Generation)

51 The TOE uses a DRBG that complies with NIST SP 800-90A for all cryptographic operations. The DRBG is seeded with entropy sourced from Intel RDSEED via /dev/random.

6.2.16 FCS_SMC_EXT.1 Submask Combining

52 SUB1 and SUB2 are XORed together to form intermediate key KEK2.

6.2.17 FCS_SNI_EXT.1 Cryptographic Operation (Salt, Nonce, and Initialization Vector Generation)

53 The TOE generates 32 byte salts using RAND_bytes at the time of encryption which are then stored in a database for use during decryption.

54 IVs are generated using RAND_bytes and are appended to the encrypted data.

55 The TOE does not make use of nonces.

6.3 Security Management (FMT)

6.3.1 FMT_MOF.1 Management of Functions Behavior

56 The TOE does not allow any modification related to power saving states.

6.3.2 FMT_SMF.1 Specification of Management Functions

57 The TOE sends the request to the SED to change the DEK in the following manner: on user’s request, Opal Gen Key command is sent to the drive using the Admin AK.

58 The TOE sends the request to the SED to cryptographically erase the DEK in the following manner: on user's request for cryptographic erase of SED, Opal Revert Tper command is sent to the drive using the Admin AK.

59 The TOE GUI may be used by the user to change their password. The TOE GUI may also be used for new smartcard enrollments with a changed PIN.

60 The TOE GUI (maintenance screen) can be used to initiate updates. Key recovery functionality (export configuration or backup database) can be disabled at install time (using '-n noexport' as one of the command-line parameters) or recovery can be administratively disabled at runtime (by setting the appropriate configuration item in the Settings Console as the Security Officer).

6.3.3 FMT_SMR.1 Security Roles

61 The TOE restricts access to authorized users.

6.4 Protection of the TSF (FPT)

6.4.1 FPT_KYP_EXT.1 Protection of Key and Key Material

62 Keys are protected as described in section 6.1.2.

6.4.2 FPT_PWR_EXT.1 Power Saving States

63 The TOE supports the following Compliant power saving states:

a) **S4.** In this state, the system appears to be off and consumes lowest power. While transitioning to this state from higher power, it may save the contents of the volatile memory to a file. When the system restarts, it will load the contents of the file for a quick boot only after KLC PBA authentication/authorization.

b) **G2(S5).** In this state, the system appears to be off and involves a complete shutdown and boot process and hence KLC PBA will be invoked for authentication/authorization.

c) **G3.** In this state, the system is completely off and it does not consume any power. The system returns to the working state only after a complete reboot and hence KLC PBA will be invoked for authentication/authorization.

6.4.3 FPT_PWR_EXT.2 Timing of Power Saving States

64 The TOE enters a Compliant power saving states as prompted by the protected OS and user-initiated requests.

6.4.4 FPT_TUD_EXT.1 Trusted Update

65 Update files are digitally signed (RSA per FCS_COP.1(a)) by KLC Group and verified prior to installation.

7 Rationale

7.1 Conformance Claim Rationale

66 The following rationale is presented with regard to the PP conformance claims:

a) **TOE type.** As identified in section 2.1, the TOE is consistent with the CPP_FDE_AA.

b) **Security problem definition.** As shown in section 3, the threats, OSPs and assumptions are reproduced directly from the CPP_FDE_AA.

c) **Security objectives.** As shown in section 4, the security objectives are reproduced directly from the CPP_FDE_AA.

d) **Security requirements.** As shown in section 5, the security requirements are reproduced directly from the CPP_FDE_AA. No additional requirements have been specified.

7.2 Security Objectives Rationale

67 All security objectives are drawn directly from the CPP_FDE_AA.

7.3 Security Requirements Rationale

68 All security requirements are drawn directly from the CPP_FDE_AA. No optional SFRs are included in the ST. The following selection based SFRs have been included:

a) FCS_CKM.1(b)

b) FCS_COP.1(a)

c) FCS_COP.1(b)

d) FCS_COP.1(c)

e) FCS_COP.1(g)

f) FCS_KDF_EXT.1

g) FCS_PCC_EXT.1

h) FCS_RBG_EXT.1

i) FCS_SMC_EXT.1

8 Annex A: Extended Components Definition

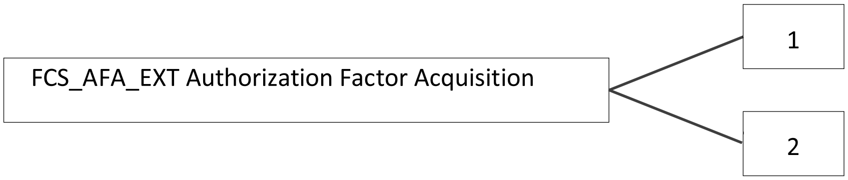
69 Included from Annex C of CPP_FDE_AA as required by the Canadian Common Criteria Scheme.

FCS_AFA_EXT Authorization Factor Acquisition

Family Behavior

Components in this family address the ability for the TOE to accept a variety of authorization factors.

Component Leveling



FCS_AFA_EXT.1 Authorization Factor Acquisition, requires authorization factors to be accepted by the TOE.

FCS_AFA_EXT.2 Timing of Authorization Factor Acquisition, defines situations in which the TOE is to accept authorization factors.

Management: FCS_AFA_EXT.1
The following actions could be considered for the management functions in FMT:

- Change the authorization factors to be used
- Generate external authorization factors using the TSF DRBG

Audit: FCS_AFA_EXT.1
There are no auditable events foreseen.

Management: FCS_AFA_EXT.2
There are no management activities foreseen.

Audit: FCS_AFA_EXT.2
There are no auditable events foreseen.

FCS_AFA_EXT.1 Authorization Factor Acquisition

Hierarchical to: No other components

Dependencies: No dependencies

FCS_AFA_EXT.1.1 The TSF shall accept the following authorization factors: [selection: a submask derived from a password authorization factor conditioned as defined in FCS_PCC_EXT.1, an external Smartcard factor that is at least the same bit-length as the DEK, and is protecting a submask that is [selection: generated by the TOE (using the RBG as specified in FCS_RBG_EXT.1), generated by the Host Platform] protected using RSA with key size [selection: 2048 bits, 3072 bits, 4096 bits], with user presence proved by presentation of the smartcard and [selection: none, an OE defined PIN, a configurable PIN], an external USB token factor that is at least the same security strength as the BEV, and is providing a submask generated by the TOE, using the RBG as specified in FCS_RBG_EXT.1, an external USB token factor that is at least the same security strength as the BEV, and is providing a submask generated by the Host Platform].

FCS_AFA_EXT.2 Authorization Factor Acquisition

Hierarchical to: No other components

Dependencies: FCS_AFA_EXT.1 Authorization Factor Acquisition,

FCS_AFA_EXT.2.1 The TSF shall reacquire the authorization factor(s) specified in FCS_AFA_EXT.1 upon transition from any Compliant power saving state specified in FPT_PWR_EXT.1 prior to permitting access to plaintext data.

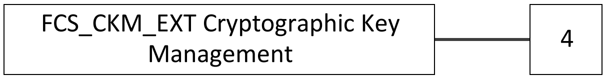
FCS_CKM_EXT Cryptographic Key Management

Family Behavior

Cryptographic keys must be managed throughout their life cycle. This family is intended to support that lifecycle and consequently defines requirements for the following activities: cryptographic key generation, cryptographic key distribution, cryptographic key access and cryptographic key destruction. This family should be included whenever there are functional requirements for the management of cryptographic keys.

The creation of this family is necessary because CC Part 2 provides the ability to specify the method of key destruction but does not define SFRs for the timing of key destruction or the ability to implement multiple key destruction methods.

Component Leveling



FCS_CKM_EXT.4 Key and Key Material Destruction, requires the TSF to specify circumstances when keys are destroyed (as opposed to the actual method of destruction, which is defined in CC Part 2 as FCS_CKM.4). The number 4 was chosen to reflect the similarity between the two SFRs.

Management: FCS_CKM_EXT.4
No specific management functions are identified.

Audit: FCS_CKM_EXT.4
There are no auditable events foreseen.

Management: FCS_CKM_EXT.4
No specific management functions are identified.

Audit: FCS_CKM_EXT.4
There are no auditable events foreseen.

FCS_CKM_EXT.4 **Cryptographic Key and Key Material Destruction**

Hierarchical to: No other components

Dependencies: No dependencies

FCS_CKM_EXT.4.1 The TSF shall destroy all keys and key material when no longer needed.

FCS_KDF_EXT Cryptographic Key Derivation

Family Behavior

This family specifies the means by which an intermediate key is derived from a specified set of submasks.

Component Leveling

FCS_KDF_EXT.1 Cryptographic Key Derivation, requires the TSF to derive intermediate keys from submasks using the specified hash functions.

Management: FCS_KDF_EXT.1
No specific management functions are identified.

Audit: FCS_KDF_EXT.1
There are no auditable events foreseen.

FCS_KDF_EXT.1 **Cryptographic Key Derivation**

Hierarchical to: No other components

Dependencies: FCS_COP.1(c) Cryptographic Operation (Keyed Hash Algorithm)

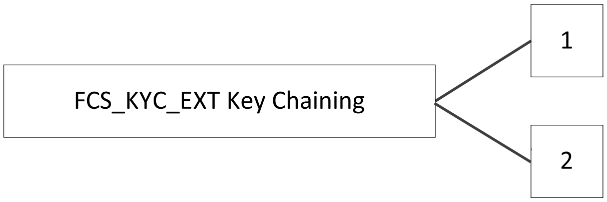
FCS_KDF_EXT.1.1 The TSF shall accept [selection: a RNG generated submask as specified in FCS_RBG_EXT.1, a conditioned password submask, imported submask] to derive an intermediate key, as defined in [selection: NIST SP 800-108 [selection: KDF in Counter Mode, KDF in Feedback Mode, KDF in Double-Pipeline Iteration Mode], NIST SP 800-132], using the keyed-hash functions specified in FCS_COP.1(c), such that the output is at least of equivalent security strength (in number of bits) to the BEV.

FCS_KYC_EXT Key Chaining

Family Behavior

This family provides the specification to be used for using multiple layers of encryption keys to ultimately secure the protected data encrypted on the drive.

Component Leveling



FCS_KYC_EXT.1 Key Chaining (Initiator), requires the TSF to maintain a key chain for a BEV that is provided to a component external to the TOE.

FCS_KYC_EXT.2 Key Chaining (Recipient), requires the TSF to be able to accept a BEV that is then chained to a DEK used by the TSF through some method. Note that this cPP does not include FCS_KYC_EXT.2; it is only included here to provide a complete definition of the FCS_KYC_EXT family.

Management: FCS_KYC_EXT.1
No specific management functions are identified.

Audit: FCS_KYC_EXT.1
There are no auditable events foreseen.

Management: FCS_KYC_EXT.2
No specific management functions are identified.

Audit: FCS_KYC_EXT.2
There are no auditable events foreseen.

FCS_KYC_EXT.1 **Key Chaining (Initiator)**

Hierarchical to: No other components

Dependencies: FCS_CKM.1(a) Cryptographic Key Generation (Asymmetric Keys),
FCS_CKM.1(b) Cryptographic Operation (Symmetric Keys),
FCS_COP.1(d) Cryptographic Operation (Key Wrapping),
FCS_COP.1(e) Cryptographic Operation (Key Transport),
FCS_COP.1(g) Cryptographic Operation (Key Encryption),
FCS_SMC_EXT.1 Submask Combining,
FCS_VAL_EXT.1 Validation

FCS_KYC_EXT.1.1 The TSF shall maintain a key chain of: [selection:

- one, using a submask as the BEV;
- intermediate keys generated by the TSF using the following method(s): [selection:
- asymmetric key generation as specified in FCS_CKM.1(a),
- symmetric key generation as specified in FCS_CKM.1(b)];
- intermediate keys originating from one or more submask(s) to the BEV using the
- following method(s): [selection:

- key derivation as specified in FCS_KDF_EXT.1,
- key wrapping as specified in FCS_COP.1(d),
- key combining as specified in FCS_SMC_EXT.1,
- key transport as specified in FCS_COP.1(e),
- key encryption as specified in FCS_COP.1(g)]]

while maintaining an effective strength of [selection: 128 bits, 256 bits] for symmetric keys and an effective strength of [selection: not applicable, 112 bits, 128 bits, 192 its, 256 bits] for asymmetric keys.

FCS_KYC_EXT.1.2 The TSF shall provide a at least [selection: 128 bit, 256 bit] BEV to [*assignment: one or more external entities*] [selection: after the TSF has successfully performed the validation process as specified in FCS_VAL_EXT.1, without validation taking place].

Application Note: Key Chaining is the method of using multiple layers of encryption keys to ultimately secure the BEV. The number of intermediate keys will vary – from one (e.g., taking the conditioned password authorization factor and directly using it as the BEV) to many. This applies to all keys that contribute to the ultimate wrapping or derivation of the BEV; including those in areas of protected storage (e.g. TPM stored keys, comparison values).

FCS_KYC_EXT.2 **Key Chaining (Recipient)**

Hierarchical to: No other components

Dependencies: No dependencies

FCS_KYC_EXT.2.1 The TSF shall accept a BEV of at least [selection: 128 bits, 256 bits] from [*assignment: one or more external entities*].

FCS_KYC_EXT.2.2 The TSF shall maintain a chain of intermediary keys originating from the BEV to the DEK using the following method(s): [selection: asymmetric key generation as specified in FCS_CKM.1(a), symmetric key generation as specified in FCS_CKM.1(b), key derivation as specified in FCS_KDF_EXT.1, key wrapping as specified in FCS_COP.1(d), key transport as specified in FCS_COP.1(e), key encryption as specified in FCS_COP.1(g)] while maintaining an effective strength of [selection: 128 bits, 256 bits] while maintaining an effective strength of [selection: 128 bits, 256 bits] for symmetric keys and an effective strength of [selection: not applicable, 112 bits, 128 bits, 192 bits, 256 bits] for asymmetric keys.

Application Note: Key Chaining is the method of using multiple layers of encryption keys to ultimately secure the protected data encrypted on the drive. The number of intermediate keys will vary – from one (e.g., using the BEV as a key encrypting key (KEK)) to many. This applies to all keys that contribute to the ultimate wrapping or derivation of the DEK; including those in areas of protected storage (e.g. TPM stored keys, comparison values).

FCS_PCC_EXT Cryptographic Password Construction and Conditioning

Family Behavior

This family ensures that passwords used to produce the BEV are robust (in terms of their composition) and are conditioned to provide an appropriate-length bit string.

Component Leveling

FCS_PCC_EXT Cryptographic Password Construction and Conditioning
1

FCS_PCC_EXT.1 Cryptographic Password Construction and Conditioning, requires the TSF to accept passwords of a certain composition and condition them appropriately.

Management: FCS_PCC_EXT.1
No specific management functions are identified.

Audit: FCS_PCC_EXT.1
There are no auditable events foreseen.

FCS_PCC_EXT.1 **Cryptographic Password Construction and Conditioning**

Hierarchical to: No other components

Dependencies: FCS_COP.1(c) Cryptographic Operation (Keyed Hash Algorithm)

FCS_PCC_EXT.1.1 A password used by the TSF to generate a password authorization factor shall enable up to [assignment: positive integer of 64 or more] characters in the set of {upper case characters, lower case characters, numbers, and [assignment: other supported special characters]} and shall perform Password-based Key Derivation Functions in accordance with a specified cryptographic algorithm HMAC-[selection: SHA-256, SHA-384, SHA-512], with [assignment: positive integer of 1000 or more] iterations, and output cryptographic key sizes [selection: 128 bits, 256 bits] that meet the following: [assignment: PBKDF recommendation or specification].

FCS_RBG_EXT Random Bit Generation

Family Behavior

Components in this family address the requirements for random bit/number generation. This is a new family defined for the FCS class.

Component Leveling

FCS_RBG_EXT.1 Random Bit Generation, requires random bit generation to be performed in accordance with selected standards and seeded by an entropy source.

Management: FCS_RBG_EXT.1
No specific management functions are identified.

Audit: FCS_RBG_EXT.1
The following actions should be auditable if FAU_GEN Security audit data generation is included in the PP/ST: Failure of the randomization process

FCS_RBG_EXT.1 Cryptographic Operation (Random Bit Generation)

Hierarchical to: No other components

Dependencies: FCS_COP.1(b) Cryptographic Operation (Hash Algorithm), FCS_COP.1(c) Cryptographic Operation (Keyed Hash Algorithm)

FCS_RBG_EXT.1.1 The TSF shall perform all deterministic random bit generation services in accordance with [selection: ISO/IEC 18031:2011, [*assignment: other RBG standards*]] using [selection: Hash_DRBG (any), HMAC_DRBG (any), CTR_DRBG (AES)].

FCS_RBG_EXT.1.2 The deterministic RBG shall be seeded by at least one entropy source that accumulates entropy from [selection: [*assignment: number of software-based sources*] software-based noise source(s), [*assignment: number of hardware-based sources*] hardware-based noise source(s)] with a minimum of [selection: 128 bits, 256 bits] of entropy at least equal to the greatest security strength, according to ISO/IEC 18031:2011 Table C.1 “Security Strength Table for Hash Functions”, of the keys and hashes that it will generate.

Application Note: ISO/IEC 18031:2011contains three different methods of generating random numbers; each of these, in turn, depends on underlying cryptographic primitives (hash functions/ciphers). The ST author will select the function used, and include the specific underlying cryptographic primitives used in the requirement. While any of the identified hash functions (SHA-256, SHA-384, SHA-512) are allowed for Hash_DRBG or HMAC_DRBG, only AES-based implementations for CTR_DRBG are allowed.

FCS_SMC_EXT Submask Combining

Family Behavior

This family specifies the means by which submasks are combined, if the TOE supports more than one submask being used to derive or protect the BEV.

Component Leveling

FCS_SMC_EXT.1 Submask Combining, requires the TSF to combine the submasks in a predictable fashion.

Management: FCS_SMC_EXT.1
No specific management functions are identified.

Audit: FCS_SMC_EXT.1
There are no auditable events foreseen.

FCS_SMC_EXT.1 Submask Combining

Hierarchical to: No other components

Dependencies: FCS_COP.1(b) Cryptographic Operation (Hash Algorithm)

FCS_SMC_EXT.1.1 The TSF shall combine submasks using the following method [selection: exclusive OR (XOR), SHA-256, SHA-384, SHA-512] to generate an [*assignment: types of keys*].

FCS_SNI_EXT Cryptographic Operation (Salt, Nonce, and Initialization Vector Generation)

Family Behavior

This family ensures that salts, nonces, and IVs are well formed.

Component Leveling

FCS_SNI_EXT Cryptographic Operation (Salt, Nonce, and Initialization Vector Generation)
1

FCS_SNI_EXT.1 Cryptographic Operation (Salt, Nonce, and Initialization Vector Generation), requires the generation of salts, nonces, and IVs to be used by the cryptographic components of the TOE to be performed in the specified manner.

Management: FCS_SNI_EXT.1
No specific management functions are identified.

Audit: FCS_SNI_EXT.1
There are no auditable events foreseen.

FCS_SNI_EXT.1 Cryptographic Operation (Salt, Nonce, and Initialization Vector Generation)

Hierarchical to: No other components

Dependencies: FCS_RBG_EXT.1 Cryptographic Operation (Random Bit Generation)

FCS_SNI_EXT.1.1 The TSF shall [selection: use no salts, use salts that are generated by [selection: DRBG as specified in FCS_RBG_EXT.1, DRBG provided by the host platform]].

FCS_SNI_EXT.1.2 The TSF shall use [selection: no nonces, unique nonces with a minimum size of [*64*] bits].

FCS_SNI_EXT.1.3 The TSF shall create IVs in the following manner [selection: CBC: IVs shall be non-repeating and unpredictable; CCM: Nonce shall be non-repeating and unpredictable; XTS: No IV. Tweak values shall be non-negative integers, assigned consecutively, and starting at an arbitrary non-negative integer; GCM: IV shall be non-repeating. The number of invocations of GCM shall not exceed 2^32 for a given secret key].

FCS_VAL_EXT Validation of Cryptographic Elements

Family Behavior

This family specifies the means by which submasks and/or BEVs are determined to be valid prior to their use.

Component Leveling

FCS_VAL_EXT.1 Validation, requires the TSF to validate submasks and BEVs by one or more of the specified methods.

Management: FCS_VAL_EXT.1
No specific management functions are identified.

Audit: FCS_VAL_EXT.1
There are no auditable events foreseen.

FCS_VAL_EXT.1 Validation

Hierarchical to: No other components

Dependencies: FCS_COP.1(b) Cryptographic Operation (Hash Algorithm),
FCS_COP.1(c) Cryptographic Operation (Keyed Hash Algorithm),
FCS_COP.1(d) Cryptographic Operation (Key Wrapping),

FCS_COP.1(f) Cryptographic Operation (AES Data Encryption/Decryption)

FCS_VAL_EXT.1.1 The TSF shall perform validation of the [selection: submask, intermediate key, BEV] using the following method(s): [selection: key wrap as specified in FCS_COP.1(d); hash the [selection: submask, intermediate key, BEV] as specified in [selection: FCS_COP.1(b), FCS_COP.1(c)] and compare it to a stored hashed [selection: submask, intermediate key, BEV]; decrypt a known value using the [selection: submask, intermediate key, BEV] as specified in FCS_COP.1(f) and compare it against a stored known value]

FCS_VAL_EXT.1.2 The TSF shall require validation of the [selection: submask, intermediate key, BEV] prior to [*assignment: activity requiring validation*].

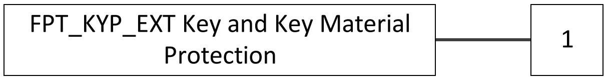
FCS_VAL_EXT.1.3 The TSF shall [selection: perform a key sanitization of the DEK upon a [selection: configurable number, [*assignment: ST author specified number*]] of consecutive failed validation attempts, institute a delay such that only [*assignment: ST author specified number of attempts*] can be made within a 24 hour period, block validation after [*assignment: ST author specified number of attempts*] of consecutive failed validation attempts, require power cycle/reset the TOE after [*assignment: ST author specified number of attempts*] of consecutive failed validation attempts].

FPT_KYP_EXT Key and Key Material Protection

Family Behavior

This family requires that key and key material be protected if and when written to non-volatile storage.

Component Leveling



FPT_KYP_EXT.1 Protection of Key and Key Material, requires the TSF to ensure that no plaintext key or key material are written to non-volatile storage.

Management: FPT_KYP_EXT.1
No specific management functions are identified.

Audit: FPT_KYP_EXT.1
There are no auditable events foreseen.

FPT_KYP_EXT.1 **Protection of Key and Key Material**

Hierarchical to: No other components

Dependencies: FCS_COP.1(d) Cryptographic Operation (Key Wrapping),

FCS_COP.1(e) Cryptographic Operation (Key Transport),
FCS_COP.1(g) Cryptographic Operation (Key Encryption),
FCS_KYC_EXT.1 Key Chaining (Initiator),
FCS_KYC_EXT.2 Key Chaining (Recipient),
FCS_SMC_EXT.1 Submask Combining

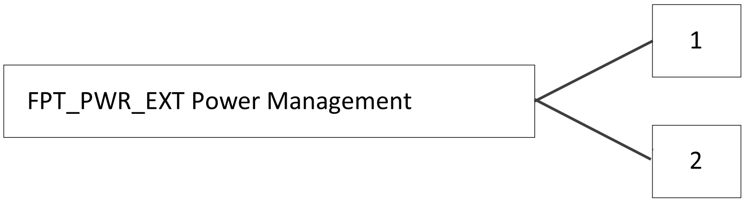
FPT_KYP_EXT.1.1 The TSF shall [selection: not store keys in non-volatile memory only store keys in non-volatile memory when wrapped, as specified in FCS_COP.1(d), or encrypted, as specified in FCS_COP.1(g) or FCS_COP.1(e), only store plaintext keys that meet any one of the following criteria [selection: the plaintext key is not part of the key chain as specified in FCS_KYC_EXT.1, the plaintext key will no longer provide access to the encrypted data after initial provisioning, the plaintext key is a key split that is combined as specified in FCS_SMC_EXT.1, and the other half of the key split is [selection: wrapped as specified in FCS_COP.1(d), encrypted as specified in FCS_COP.1(g) or FCS_COP.1(e), derived and not stored in non-volatile memory], the non-volatile memory the key is stored on is located in an external storage device for use as an authorization factor, the plaintext key is [selection: used to wrap a key as specified in FCS_COP.1(d), used to encrypt a key as specified in FCS_COP.1(g) or FCS_COP.1(e)] that is already [selection: wrapped as specified in FCS_COP.1(d), encrypted as specified in FCS_COP.1(g) or FCS_COP.1(e)]]].

FPT_PWR_EXT Power Management

Family Behavior

This family defines secure behavior of the TSF when the TOE supports multiple power saving states. The use of Compliant power saving states (i.e. power saving states that purge security-relevant data upon entry) is essential for ensuring that state transitions cannot be used as attack vectors to bypass TOE self-protection mechanisms.

Component Leveling



FPT_PWR_EXT.1 Power Saving States, defines the Compliant power saving states that are implemented by the TSF.

FPT_PWR_EXT.2 Timing of Power Saving States, describes the situations that cause Compliant power saving states to be entered. Enable or disable the use of individual power saving states. Specify one or more power saving state configurations

Management: FPT_PWR_EXT.1

The following actions could be considered for the management functions in FMT:
There are no management activities foreseen

Audit: FPT_PWR_EXT.1
There are no auditable events foreseen.

Management: FPT_PWR_EXT.2
There are no management activities foreseen.

Audit: FPT_PWR_EXT.2
The following actions should be auditable if FAU_GEN Security audit data generation included in the PP/ST: Transition of the TSF into different power saving states

FPT_PWR_EXT.1 **Power Saving States**

Hierarchical to: No other components

Dependencies: No dependencies

FPT_PWR_EXT.1.1 The TSF shall define the following Compliant power saving states: [selection: choose at least one of: S3, S4, G2(S5), G3, [*assignment: other power saving states*]].

FPT_PWR_EXT.2 **Power Saving States**

Hierarchical to: No other components

Dependencies: FPT_PWR_EXT.1 Power Saving States

FPT_PWR_EXT.2.1 For each Compliant power saving state defined in FPT_PWR_EXT.1.1, the TSF shall enter the Compliant power saving state when the following conditions occur: user-initiated request, [selection: shutdown, user inactivity, request initiated by remote management system, [*assignment: other conditions*], no other conditions].

FPT_TST_EXT TSF Testing

Family Behavior

Components in this family address the requirements for self-testing the TSF for selected correct operation.

Component Leveling

FPT_TST_EXT TSF Testing
1

FPT_TST_EXT.1 TSF Testing, requires a suite of self-tests to be run during initial start-up in order to demonstrate correct operation of the TSF.

Management: FPT_TST_EXT.1
No specific management functions are identified.

Audit: FPT_TST_EXT.1
The following actions should be auditable if FAU_GEN Security audit data generation is
included in the PP/ST: Indication that TSF self-test was completed

FPT_TST_EXT.1 **TSF Testing**

Hierarchical to: No other components

Dependencies: No other components

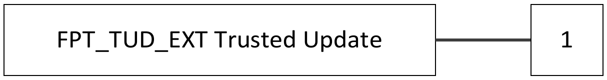
FPT_TST_EXT.1.1 The TSF shall run a suite of the following self-tests [selection: during initial start-up (on power on), periodically during normal operation, at the request of the authorized user, at the conditions [*assignment: conditions under which self-tests should occur*]] to demonstrate the correct operation of the TSF: [*assignment: list of self-tests run by the TSF*].

FPT_TUD_EXT Trusted Update

Family Behavior

Components in this family address the requirements for updating the TOE firmware and/or software.

Component Leveling



FPT_TUD_EXT.1 Trusted Update, requires the capability to be provided to update the TOE firmware and software, including the ability to verify the updates prior to installation.

Management: FPT_TUD_EXT.1
The following actions could be considered for the management functions in FMT:
Ability to update the TOE and to verify the updates

Audit: FPT_TUD_EXT.1
The following actions should be auditable if FAU_GEN Security audit data generation is included
in the PP/ST: Initiation of the update process.
Any failure to verify the integrity of the update

FPT_TUD_EXT.1 Trusted Update

Hierarchical to: No other components

Dependencies: FCS_COP.1(a) Cryptographic Operation (Signature Verification), FCS_COP.1(b) Cryptographic Operation (Hash Algorithm)

FPT_TUD_EXT.1.1 The TSF shall provide [*assignment: list of subjects*] the ability to query the current version of the TOE software/firmware.

FPT_TUD_EXT.1.2 The TSF shall provide [*assignment: list of subjects*] the ability to initiate updates to TOE software/firmware.

FPT_TUD_EXT.1.3 The TSF shall verify updates to the TOE software/firmware using a [selection: digital signature, published hash] by the manufacturer prior to installing those updates.