Mobile Device Fundamentals

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National Information Assurance Partnership

Revision History

Version	Date	Comment
1.0	2013-10-21	Initial Release
1.1	2014-01-12	Typographical changes and additional clarifications in application notes. Removed assignment from FCS_TLS_EXT.1 and limited testing to those ciphersuites in both FCS_TLS_EXT.1 and FCS_TLS_EXT.2.
2.0	2015-09-14	Included changes based on Technical Rapid Response Team Decisions. Clarified many requirements and assurance activities. Mandated objective requirements: • Application Access Control (FDP_ACF_EXT.1.2) • VPN Information Flow Control (FDP_IFC_EXT.1) Added new objective requirements: • Suite B cryptography for IEEE 802.11 • Certificate enrollment • Protection of additional key material types • Heap overflow protection • Bluetooth requirements • Cryptographic operation services for applications • Remote Attestation (FPT_NOT_EXT.1) Added transition dates for some objective requirements. Included hardware-isolated REK and key storage selections. Allowed key derivation by REK. Clarified FTP_ITC_EXT.1 and added FDP_UPC_EXT.1. Mandated HTTPS and TLS for application use. (FDP_UPC_EXT.1) Removed Dual_EC_DRBG as an approved DRBG. Adopted new TLS requirements. Mandated TSF Wipe upon authentication failure limit and required number of authentication failures be maintained across reboot. Clarified Management Class. Included more domain isolation discussion and tests. Updated Audit requirements and added Auditable Events table. Added SFR Category Mapping Table. Updated Use Case Templates. Moved Glossary to Introduction.
3.0	2015-09-17	Included changes based on Technical Rapid Response Team Decisions. Clarified many requirements and assurance activities. Mandated objective requirements: • Generation of Audit Records (FAU_GEN.1) • Audit Storage Protection (FAU_STG.1) • Audit Storage Overwrite (FAU_STG.4) • Lock Screen DAR (FDP_DAR_EXT.2) • Discard Bluetooth Connection Attempts from Bluetooth Addresses with Existing Connection (FIA_BLT_EXT.3) • JTAG Disablement (FPT_JTA) Added new objective requirements: • Application Backup • Biometric Authentication Factor • Access Control • User Authentication • Bluetooth Encryption WLAN client requirements moved to Extended Package for WLAN Client. Added SFRs to support BYOD Use Case BYOD Use Case Updated key destruction SFR
3.1	2017-04-05	Included changes based on Technical Rapid Response Team Decisions and incorporated Technical Decisions. Modified biometric requirements: • FIA_UAU.5 - Added iris, face, voice and vein as supported modalities, in addition to fingerprint (allowed in version 3) • FIA_BMG_EXT.1.1 - Clarified AA to specify that vendor evidence is acceptable and expectations of evidence provided. • FIA_BMG_EXT.1.2 - SAFAR was changed to an assignment of a SAFAR no greater than 1:500. • FIA_AFL_EXT.1 - Updated to allow each biometric modality to utilize an individual or shared counter. FCS_TLSC_EXT.1.1 - Removed TLS ciphersuites that utilized SHA1 and updated optional ciphersuites to be uniformed across PPs. FCS_STG_EXT.2.2 - Modified to require long term trusted channel key material be encrypted by an approved method. FIA_UAU_EXT.1.1 - Modified to allow the long term trusted channel key material to be available prior to password being entered at start-up.

3.2	2019-03-01	Removed TLS SFRs and utilized TLS Functional Package Removed Bluetooth SFRs and utilized Bluetooth Module. Bluetooth SFR moved to Implementation Dependent. FPT_TUD_EXT.4.2 renumbered to FPT_TUD_EXT.5.1

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1 Introduction

1.1 Objectives of Document

This document presents the Common Criteria (CC) Protection Profile (PP) to express the fundamental security and evaluation requirements for a Mobile Device.

1.2 Terms

The following sections list Common Criteria and technology terms used in this document.

1.2.1 Common Criteria Terms

Assurance	Grounds for confidence that a TOE meets the SFRs [CC].
Common Criteria (CC)	Common Criteria for Information Technology Security Evaluation.
Common Evaluation Methodology (CEM)	Common Evaluation Methodology for Information Technology Security Evaluation.
Distributed TOE	A TOE composed of multiple components operating as a logical whole.
Operational Environment	Hardware and software that are outside the TOE boundary that support the TOE functionality and security policy.
Protection Profile (PP)	An implementation-independent set of security requirements for a category of products.
Protection Profile Configuration	A comprehensive set of security requirements for a product type that consists of at least one Base-PP and at least one PP-Module.
Protection Profile Module (PP-Module)	An implementation-independent statement of security needs for a TOE type complementary to one or more Base Protection Profiles.
Security Assurance Requirement (SAR)	A requirement to assure the security of the TOE.
Security Functional Requirement (SFR)	A requirement for security enforcement by the TOE.
Security Target (ST)	A set of implementation-dependent security requirements for a specific product.
TOE Security Functionality (TSF)	The security functionality of the product under evaluation.
TOE Summary Specification (TSS)	A description of how a TOE satisfies the SFRs in a ST.
Target of Evaluation (TOE)	The product under evaluation.

1.2.2 Technical Terms

(Biometric) Feature(s)	Distinctive mathematical characteristic(s) derived from a biometric sample, used to generate enrollment or authentication templates.
(Biometric) Modality	A type or class of biometric system, such as fingerprint recognition, facial recognition, iris recognition, voice recognition, signature/sign, and others.
(Biometric) Template	A digital representation of an individual's distinct characteristics, representing information extracted from a biometric sample. This PP further defines enrollment templates and authentication templates.
Adaptive (template)	Authentication templates that evolve with each sample that is verified and introduced into the biometrics database or gallery.
Address Space Layout Randomization (ASLR)	An anti-exploitation feature, which loads memory mappings into unpredictable locations. ASLR makes it more difficult for an attacker to redirect control to code that they have introduced into the address space of a process or the kernel.
Administrator	The Administrator is responsible for management activities, including setting the policy that is applied by the enterprise on the Mobile Device. This administrator is likely to be acting remotely and could be the Mobile Device Management (MDM) Administrator acting through an MDM Agent. If the device is unenrolled, the user is the administrator.
Authentication Template	A digital representation of an individual's distinct characteristics, representing information extracted from a biometric sample. Such templates are used during biometric authentication and verification as the basis for comparison. Unlike enrollment templates, these templates can be adaptive.

Auxiliary Boot Modes	Auxiliary boot modes are states in which the device provides power to one or more components to provide an interface that enables an unauthenticated user to interact with either a specific component or several components that exist outside of the device's fully authenticated, operational state.
Biometric Authentication Factor (BAF)	Authentication factor, which uses biometric sample, matched to a biometric authentication template to help establish identity.
Biometric Data	Digital data created during a biometric process. It encompasses raw sensor observations, biometric samples, models, templates, and/or similarity scores, among other data. This data is used to describe the information collected during an enrollment, verification, or identification process, but does not apply to end user information such as user name, password (unless tied to the biometric modality), demographic information, and authorizations.
Biometric Sample	Information or computer data obtained from a biometric sensor device or captured from an individual to the sensor.
Biometric System	Multiple individual components (such as sensor, matching algorithm, and result display) that combine to make a fully operational system completely contained within the TOE. A biometric system is automated and capable of: 1. Capturing a biometric sample from an end user 2. Extracting and processing the biometric data from that sample 3. Generating various templates based on processing of that sample during enrollment, or, if adaptive, during verification as well 4. Storing the extracted information in a database on the device 5. Comparing the biometric data with data contained in one or more authentication templates 6. Deciding how well they match and indicating whether or not an identification or verification of identity has been achieved.
Common Application Developer	Application developers (or software companies) often produce many applications under the same name. Mobile devices often allow shared resources by such applications where otherwise resources would not be shared.
Critical Security Parameter (CSP)	Security-related information whose disclosure or modification can compromise the security of a cryptographic module and/or authentication system.
Data	Program/application or data files that are stored or transmitted by a server or Mobile Device (MD).
Data Encryption Key (DEK)	A key used to encrypt data-at-rest.
Developer Modes	Developer modes are states in which additional services are available to a user in order to provide enhanced system access for debugging of software.
Encrypted Software Keys	These keys are stored in the main file system encrypted by another key and can be changed and sanitized.
Enrolled state	The state in which the Mobile Device is managed with active policy settings from the administrator.
Enrollment (Biometrics)	The process of collecting a biometric sample from an end user, converting it into an enrollment and/or authentication template, and storing it in the biometric system's database. If an enrollment template is generated, it is used during the enrollment process for later comparison to other enrollment templates already stored. If there are multiple enrollment templates, they may be fused, averaged, or otherwise, in order to create authentication templates, which are used for later comparison in verification.
Enrollment Template	A digital representation of an individual's distinct characteristics, representing information extracted from a biometric sample. Such templates are generated during the enrollment process and utilized in various ways (including averaging, fusion, etc.) in order to generate an authentication template.
Enterprise Applications	Applications that are provided and managed by the enterprise.
Enterprise Data	Enterprise data is any data residing in the enterprise servers, or temporarily stored on Mobile Devices to which the Mobile Device user is allowed access according to security policy defined by the enterprise and implemented by the administrator.
Ephemeral Keys	These keys are stored in volatile memory.
False Accept Rate (FAR)	A statistic used to measure biometric performance when operating in verification, defined as the percentage of times a system produces a false accept, which occurs when an individual is incorrectly matched to another individual's existing biometric. For example, Mallory claims to be Alice and the system verifies the claim.
False Reject Rate (FRR)	A statistic used to measure biometric performance in verification, defined as the percentage of times the system produces a false reject. A false reject occurs when an individual is not matched to his or her own existing biometric template. For example, John claims to be John, but the system incorrectly denies the

	claim.
File Encryption Key (FEK)	A DEK used to encrypt a file or a director when File Encryption is used. FEKs are unique to each encrypted file or directory.
Hardware-Isolated Keys	The Rich OS can only access these keys by reference, if at all, during runtime.
Hybrid Authentication	A hybrid authentication factor is one where a user has to submit a combination of biometric sample and PIN or password with both to pass and without the user being made aware of which factor failed, if either fails.
Immutable Hardware Key	These keys are stored as hardware-protected raw key and cannot be changed or sanitized.
Key Chaining	The method of using multiple layers of encryption keys to protect data. A top layer key encrypts a lower layer key, which encrypts the data; this method can have any number of layers.
Key Encryption Key (KEK)	A key used to encrypt other keys, such as DEKs or storage that contains keys.
Liveness Detection	A technique used to ensure that the biometric sample submitted is from an end user. A liveness detection method can help protect the system against some types of spoofing attacks.
Locked State	Powered on but most functionality is unavailable for use. User authentication is required to access functionality.
MDM Agent	The MDM Agent is installed on a Mobile Device as an application or is part of the Mobile Device's OS. The MDM Agent establishes a secure connection back to the MDM Server controlled by the administrator.
Minutia Point	Friction ridge characteristics that are used to individualize a fingerprint image. Minutia are the points where friction ridges begin, terminate, or split into two or more ridges. In many fingerprint systems, the minutia points are compared for recognition purposes.
Mobile Device (MD)	A device which is composed of a hardware platform and its system software. The device typically provides wireless connectivity and may include software for functions like secure messaging, email, web, VPN connection, and VoIP (Voice over IP), for access to the protected enterprise network, enterprise data and applications, and for communicating to other Mobile Devices.
Mobile Device Management (MDM)	Mobile device management (MDM) products allow enterprises to apply security policies to mobile devices. This system consists of two primary components: the MDM Server and the MDM Agent.
Mobile Device User (User)	The individual authorized to physically control and operate the Mobile Device. Depending on the use case, this can be the device owner or an individual authorized by the device owner.
Mutable Hardware Key	These keys are stored as hardware-protected raw key and can be changed or sanitized.
NIST Fingerprint Image Quality (NFIQ)	A machine-learning algorithm that reflects the predictive positive or negative contribution of an individual sample to the overall performance of a fingerprint matching system. NFIQ 1.0 scores are calculated on a scale from 1 to 5, where NFIQ = 1 indicates high quality samples and NFIQ = 5 indicates poor quality samples [NFIQ 1.0]. NFIQ 2.0 scores are calculated on a scale from 0 to 100, where NFIQ = 0 indicates poor quality samples and NFIQ = 100 indicates high quality samples [NFIQ 2.0].
Operating System (OS)	Software, which runs at the highest, privilege level and can directly control hardware resources. Modern Mobile Devices typically have at least two primary operating systems: one, which runs on the cellular baseband processor and one, which runs on the application processor. The OS of the application processor handles most user interaction and provides the execution environment for apps. The OS of the cellular baseband processor handles communications with the cellular network and may control other peripherals. The term OS, without context, may be assumed to refer to theOS of the application processor.
PIN	A PIN factor is a set of numeric or alphabetic characters that may be used in addition to a biometric factor to provide a hybrid authentication factor. At this time it is not considered as a standalone authentication mechanism.
Password Authentication Factor	A type of authentication factor requiring the user to provide a secret set of characters to gain access.
Powered Off State	The device has been shut down such that no TOE function can be performed.
Presentation Attack Detection (PAD)	A technique used to ensure that the biometric sample submitted is from an end user. A presentation attack detection method can help protect the system against some types of spoofing attacks.
Protected Data (PD)	Protected data is all non-TSF data, including all user or enterprise data. Protected data includes all keys in software-based secure key storage. Some or all of this data may be considered sensitive data as well.
Rich Operating	This term is a synonym used to refer to the primary operating system of the application processor defined

System (Rich OS)	above under "Operating System (OS)". This term is used to distinguish the primary operating system from an operating system executing in a smaller, isolated execution environment that may be present on the processor.
Root Encryption Key (REK)	A key tied to the device used to encrypt other keys.
Sensitive data	Sensitive data shall be identified in the TSS section of the Security Target (ST) by the ST author. Sensitive data is a subset or all of the Protected data. Sensitive data may include all user or enterprise data or may be specific application data such as emails, messaging, documents, calendar items, and contacts. Sensitive data is protected while in the locked state (FDP_DAR_EXT.2). Sensitive data must minimally include some or all keys in software-based key storage.
Software Keys	The Rich OS access the raw bytes of these keys during runtime.
TSF Data	Data for the operation of the TSF upon which the enforcement of the requirements relies.
Threshold	A user setting for biometric systems operating in verification. Thresholds are also used in enrollment if enrollment templates are created and compared to each other. The acceptance or rejection of biometric data in verification is dependent on the match score falling above or below the threshold. The threshold is adjustable so that the biometric system can be more or less strict, depending on the requirements of any given biometric application.
Trust Anchor Database	A list of trusted root Certificate Authority certificates.
Unenrolled state	The state in which the Mobile Device is not managed.
Unlocked State	Powered on and device functionality is available for use. Implies user authentication has occurred (when so configured).
Verification (Biometrics)	A task where the biometric system attempts to confirm an individual's claimed identity by comparing a submitted sample to one or more previously enrolled authentication templates.

1.3 Scope of Document

The scope of the Protection Profile within the development and evaluation process is described in the Common Criteria for Information Technology Security Evaluation [CC]. In particular, a PP defines the IT security requirements of a generic type of TOE and specifies the functional and assurance security measures to be offered by that TOE to meet stated requirements [CC].

1.4 Intended Readership

The target audiences of this PP are Mobile Device developers, CC consumers, evaluators and schemes.

1.5 TOE Overview

This assurance standard specifies information security requirements for Mobile Devices for use in an enterprise. A Mobile Device in the context of this assurance standard is a device, which is composed of a hardware platform and its system software. The device typically provides wireless connectivity and may include software for functions like secure messaging, email, web, VPN connection, and VoIP (Voice over IP), for access to the protected enterprise network, enterprise data and applications, and for communicating to other Mobile Devices.

Figure 1 illustrates the network operating environment of the Mobile Device.

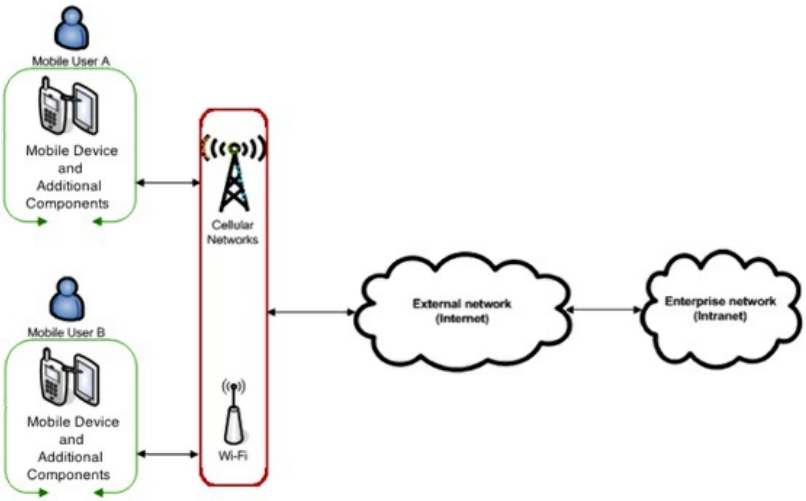

Figure 1: Mobile Device Network Environment

Examples of a "Mobile Device" that should claim conformance to this Protection Profile include smartphones, tablet computers, and other Mobile Devices with similar capabilities.

The Mobile Device provides essential services, such as cryptographic services, data-at-rest protection, and key storage services to support the secure operation of applications on the device. Additional security features such as security policy enforcement, application mandatory access control, anti-exploitation features, user authentication, and software integrity protection are implemented in order to address threats.

This assurance standard describes these essential security services provided by the Mobile Device and serves as a foundation for a secure mobile architecture. The wireless connectivity shall be validated against the Extended Package for WLAN Client. If the mobile device contains Bluetooth functionality (i.e., has Bluetooth hardware), the Bluetooth connectivity shall be evaluated against the PP-Module for Bluetooth. As illustrated in Figure 2, it is expected that a typical deployment would also include either third-party or bundled components. Whether these components are bundled as part of the Mobile Device by the manufacturer or developed by a third-party, they must be separately validated against the related assurance standards such as the PP-Module for MDM Agent, PP-Module for VPN Client, and VoIP Application Extended Package. It is the responsibility of the architect of the overall secure mobile architecture to ensure validation of these components. Additional applications that may come pre-installed on the Mobile Device that are not validated are considered to be potentially flawed, but not malicious. Examples include email client and web browser.

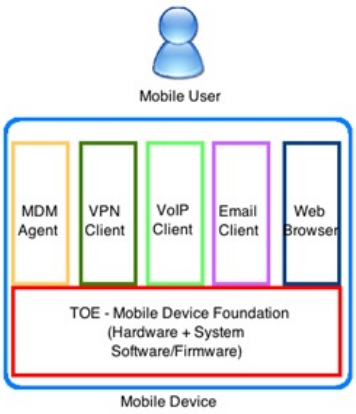

Figure 2: Optional Additional Mobile Device Components

1.6 TOE Usage

The Mobile Device may be operated in a number of use cases. Appendix D - Use Case Templates provides use case templates that list those selections, assignments, and objective requirements that best support the use cases identified by this Protection Profile. In addition to providing essential security services, the Mobile Device includes the necessary security functionality to support configurations for these various use cases. Each use case may require additional configuration and applications to achieve the desired security. A selection of these use cases is elaborated below.

Several of the use case templates include objective requirements that are strongly desired for the indicated use cases. Readers can expect those requirements to be made mandatory in the next revision of this protection profile, and industry should aim to include that security functionality in products in the near-term.

As of publication of this version of the Protection Profile, meeting the requirements in Section 5 Security Requirements is necessary for all use cases.

[USE CASE 1] Enterprise-owned device for general-purpose enterprise use and limited personal use

An enterprise-owned device for general-purpose business use is commonly called Corporately Owned, Personally Enabled (COPE). This use case entails a significant degree of enterprise control over configuration and, possibly, software inventory. The enterprise elects to provide users with Mobile Devices and additional applications (such as VPN or email clients) in order to maintain control of their Enterprise data and security of their networks. Users may use Internet connectivity to browse the web or access corporate mail or run enterprise applications, but this connectivity may be under significant control of the enterprise.

[USE CASE 2] Enterprise-owned device for specialized, high-security use

An enterprise-owned device with intentionally limited network connectivity, tightly controlled configuration, and limited software inventory is appropriate for specialized, high-security use cases. For example, the device may not be permitted connectivity to any external peripherals. It may only be able to communicate via its Wi-Fi or cellular radios with the enterprise-run network, which may not even permit connectivity to the Internet. Use of the device may entail compliance with policies that are more restrictive than those in any general-purpose use case, yet may mitigate risks to highly sensitive information. As in the previous case, the enterprise will look for additional applications providing enterprise connectivity and services to have a similar level of assurance as the platform.

[USE CASE 3] Personally-owned device for personal and enterprise use

A personally-owned device, which is used, for both personal activities and enterprise data is commonly called Bring Your Own Device (BYOD). The device may be provisioned for access to enterprise resources after significant personal usage has occurred. Unlike in the enterprise-owned cases, the enterprise is limited in what security policies it can enforce because the user purchased the device primarily for personal use and is unlikely to accept policies that limit the functionality of the device. However, because the enterprise allows the user full (or nearly full) access to the enterprise network, the enterprise will require their own security controls to ensure that enterprise resources are protected from potential threats posed by the personal activities on the device. These controls could potentially be enforced by a separation mechanism built-in to the device itself to distinguish between enterprise and personal activities, or by a third-party application that provides access to enterprise resources and leverages security capabilities provided by the mobile device. Based upon the operational environment and the acceptable risk level of the enterprise, those security functional requirements outlined in Section 5 Security Requirements of this PP along with the selections in the Use Case 3 template defined in Appendix D - Use Case Templates are sufficient for the secure implementation of this BYOD use case.

[USE CASE 4] Personally-owned device for personal and limited enterprise use

A personally-owned device, which is used, for both personal activities and enterprise data is commonly called Bring Your Own Device (BYOD). This device may be provisioned for limited access to enterprise resources such as enterprise email. Because the user does not have full access to the enterprise or enterprise data, the enterprise may not need to enforce any security policies on the device. However, the enterprise may want secure email and web browsing with assurance that the services being provided to those clients by the Mobile Device are not compromised. Based upon the operational environment and the acceptable risk level of the enterprise, those security functional requirements outlined in Section 5 Security Requirements of this PP are sufficient for the secure implementation of this BYOD use case.

2 Conformance Claims

Conformance Statement

An ST must claim exact conformance to this PP, as defined in the CC and CEM addenda for Exact Conformance, Selection-Based SFRs, and Optional SFRs (dated May 2017).

CC Conformance Claims

This PP is conformant to Parts 2 (extended) and 3 (conformant) of Common Criteria Version 3.1, Revision 5.

PP Claim

This PP does not claim conformance to any Protection Profile.

Module Claim

The following PP-Modules are allowed to be specified in a PP-Configuration with this PP.

- PP-Module for VPN Client, Version 2.1
- PP-Module for Bluetooth, Version 1

Package Claim

This PP is TLS Package Conformant.

3 Security Problem Definition

3.1 Threats

Mobile devices are subject to the threats of traditional computer systems along with those entailed by their mobile nature. The threats considered in this Protection Profile are those of network eavesdropping, network attacks, physical access, malicious or flawed applications, persistent presence, and backup as detailed in the following sections.

T.NETWORK_EAVESDROP
An attacker is positioned on a wireless communications channel or elsewhere on the network infrastructure. Attackers may monitor and gain access to data exchanged between the Mobile Device and other endpoints.

T.NETWORK_ATTACK
An attacker is positioned on a wireless communications channel or elsewhere on the network infrastructure. Attackers may initiate communications with the Mobile Device or alter communications between the Mobile Device and other endpoints in order to compromise the Mobile Device. These attacks include malicious software update of any applications or system software on the device. These attacks also include malicious web pages or email attachments, which are usually delivered to devices over the network.

T.PHYSICAL_ACCESS
An attacker, with physical access, may attempt to access user data on the Mobile Device including credentials. These physical access threats may involve attacks, which attempt to access the device through external hardware ports, impersonate the user authentication mechanisms, through its user interface, and also through direct and possibly destructive access to its storage media. Note: Defending against device re-use after physical compromise is out of scope for this Protection Profile.

T.MALICIOUS_APP
Applications loaded onto the Mobile Device may include malicious or exploitable code. This code could be included intentionally or unknowingly by the developer, perhaps as part of a software library. Malicious apps may attempt to exfiltrate data to which they have access. They may also conduct attacks against the platform’s system software, which will provide them with additional privileges and the ability to conduct further malicious activities. Malicious applications may be able to control the device's sensors (GPS, camera, microphone) to gather intelligence about the user's surroundings even when those activities do not involve data resident or transmitted from the device. Flawed applications may give an attacker access to perform network-based or physical attacks that otherwise would have been prevented

T.PERSISTENT_PRESENCE
Persistent presence on a device by an attacker implies that the device has lost integrity and cannot regain it. The device has likely lost this integrity due to some other threat vector, yet the continued access by an attacker constitutes an on-going threat in itself. In this case, the device and its data may be controlled by an adversary as well as by its legitimate owner.

3.2 Assumptions

The specific conditions listed below are assumed to exist in the TOE’s Operational Environment. These include both practical realities in the development of the TOE security requirements and the essential environmental conditions on the use of the TOE.

A.CONFIG
It is assumed that the TOE’s security functions are configured correctly in a manner to ensure that the TOE security policies will be enforced on all applicable network traffic flowing among the attached networks.

A.NOTIFY
It is assumed that the mobile user will immediately notify the administrator if the Mobile Device is lost or stolen.

A.PRECAUTION
It is assumed that the mobile user exercises precautions to reduce the risk of loss or theft of the Mobile Device.

A.PROPER_USER
Mobile device users are not willfully negligent or hostile, and use the device within compliance of a reasonable Enterprise security policy.

3.3 Organizational Security Policy

There are no OSPs for the Mobile Device.

4 Security Objectives

4.1 Security Objectives for the TOE

The security objectives for the Mobile Device are defined as follows.

O.PROTECTED_COMMS

To address the network eavesdropping (T.EAVESDROP) and network attack (T.NETWORK) threats described in Section 3.1 Threats, concerning wireless transmission of Enterprise and user data and configuration data between the TOE and remote network entities, conformant TOEs will use a trusted communication path. The TOE will be capable of communicating using one (or more) of these standard protocols: IPsec, DTLS, TLS, HTTPS, or Bluetooth. The protocols are specified by RFCs that offer a variety of implementation choices. Requirements have been imposed on some of these choices (particularly those for cryptographic primitives) to provide interoperability and resistance to cryptographic attack.

While conformant TOEs must support all of the choices specified in the ST including any optional SFRs defined in this PP, they may support additional algorithms and protocols. If such additional mechanisms are not evaluated, guidance must be given to the administrator to make clear the fact that they were not evaluated.

Addressed by: FCS_CKM.1, FCS_CKM.2/UNLOCKED, FCS_CKM.2/LOCKED, FCS_CKM_EXT.8 (Bluetooth Module), FCS_COP.1/ENCRYPT, FCS_COP.1/HASH, FCS_COP.1/SIGN, FCS_COP.1/KEYHMAC, FCS_COP.1/CONDITION, FCS_DTLS_EXT.1 (TLS Package), FCS_HTTPS_EXT.1, FCS_RBG_EXT.1, FCS_RBG_EXT.2(Objective), FCS_RBG_EXT.3(Objective), FCS_SRV_EXT.1, CS_SRV_EXT.2(Objective), FCS_TLSC_EXT.1 (TLS Package), FCS_TLSC_EXT.2 (TLS Package), FCS_TLSC_EXT.3 (TLS Package), FDP_BLT_EXT.1 (Bluetooth Module), FDP_IFC_EXT.1, FDP_STG_EXT.1, FDP_UPC_EXT.1/NORMAL, FDP_UPC_EXT.1/BLUETOOTH, FIA_BLT_EXT.1 (Bluetooth Module), FIA_BLT_EXT.2 (Bluetooth Module), FIA_BLT_EXT.3 (Bluetooth Module), FIA_BLT_EXT.4 (Bluetooth Module), FIA_BLT_EXT.5 (Bluetooth Module), FIA_BLT_EXT.6 (Bluetooth Module), FIA_BLT_EXT.7 (Bluetooth Module), FIA_X509_EXT.1, FIA_X509_EXT.2, FIA_X509_EXT.3, FIA_X509_EXT.4(Objective), FIA_X509_EXT.5(Objective), FPT_BLT_EXT.1(Objective), FTP_BLT_EXT.1 (Bluetooth Module), FTP_BLT_EXT.2 (Bluetooth Module), FTP_BLT_EXT.3/BR (Bluetooth Module), FTP_BLT_EXT.3/LE (Bluetooth Module), FTP_ITC_EXT.1

O.PROTECTED_STORAGE

To address the issue of loss of confidentiality of user data in the event of loss of a Mobile Device (T.PHYSICAL), conformant TOEs will use data-at-rest protection. The TOE will be capable of encrypting data and keys stored on the device and will prevent unauthorized access to encrypted data.

Addressed by: FCS_CKM_EXT.1, FCS_CKM_EXT.2, FCS_CKM_EXT.3, FCS_CKM_EXT.4, FCS_CKM_EXT.5, FCS_CKM_EXT.6, FCS_CKM_EXT.7(Sel-Based), FCS_COP.1/ENCRYPT, FCS_COP.1/HASH, FCS_COP.1/SIGN, FCS_COP.1/KEYHMAC, FCS_COP.1/CONDITION, FCS_IV_EXT.1, FCS_RBG_EXT.1, FCS_RBG_EXT.2(Objective), FCS_RBG_EXT.3(Objective), FCS_STG_EXT.1, FCS_STG_EXT.2, FCS_STG_EXT.3, FDP_ACF_EXT.2(Sel-Based), FDP_ACF_EXT.3(Objective), FDP_DAR_EXT.1, FDP_DAR_EXT.2, FIA_UAU_EXT.1, FPT_KST_EXT.1, FPT_KST_EXT.2, FPT_KST_EXT.3, FPT_JTA_EXT.1

O.CONFIGURATION

To ensure a Mobile Device protects user and enterprise data that it may store or process, conformant TOEs will provide the capability to configure and apply security policies defined by the user and the Enterprise Administrator. If Enterprise security policies are configured these must be applied in precedence of user specified security policies.

Addressed by: FMT_MOF_EXT.1, FMT_SMF_EXT.1, FMT_SMF_EXT.2, FTA_TAB.1(Objective)

O.AUTH

To address the issue of loss of confidentiality of user data in the event of loss of a Mobile Device (T.PHYSICAL), users are required to enter an authentication factor to the device prior to accessing protected functionality and data. Some non-sensitive functionality (e.g., emergency calling, text notification) can be accessed prior to entering the authentication factor. The device will automatically lock following a configured period of inactivity in an attempt to ensure authorization will be required in the event of the device being lost or stolen.

Authentication of the endpoints of a trusted communication path is required for network access to ensure attacks are unable to establish unauthorized network connections to undermine the integrity of the device.

Repeated attempts by a user to authorize to the TSF will be limited or throttled to enforce a delay between unsuccessful attempts.

Addressed by: FCS_CKM.2/UNLOCKED, FDP_PBA_EXT.1(Sel-Based), FIA_AFL_EXT.1, FIA_BLT_EXT.1 (Bluetooth Module), FIA_BLT_EXT.2 (Bluetooth Module), FIA_BLT_EXT.3 (Bluetooth Module), FIA_BMG_EXT.1(Sel-Based) FIA_BMG_EXT.2(Objective), FIA_BMG_EXT.3(Objective), FIA_BMG_EXT.4(Objective), FIA_BMG_EXT.5(Objective), FIA_BMG_EXT.6(Objective), FIA_PMG_EXT.1, FIA_TRT_EXT.1, FIA_UAU_EXT.1, FIA_UAU_EXT.2, FIA_UAU_EXT.4(Optional), FIA_UAU.5, FIA_UAU.6, FIA_UAU.7, FIA_X509_EXT.2, FIA_X509_EXT.4(Objective), FIA_X509_EXT.5, FTA_SSL_EXT.1

O.INTEGRITY

To ensure the integrity of the Mobile Device is maintained conformant TOEs will perform self-tests to ensure the integrity of critical functionality, software/firmware and data has been maintained. The user shall be notified of any failure of these self-tests. This will protect against the threat T.PERSISTENT.

To address the issue of an application containing malicious or flawed code (T.FLAWAPP), the integrity of downloaded updates to software/firmware will be verified prior to installation/execution of the object on the Mobile Device. In addition, the TOE will restrict applications to only have access to the system services and data they are permitted to interact with. The TOE will further protect against malicious applications from gaining access to data they are not authorized to access by randomizing the memory layout.

Addressed by: FAU_GEN.1, FAU_SAR.1(Objective), FAU_SEL.1(Objective), FAU_STG.1, FAU_STG.4, FCS_COP.1/HASH, FCS_COP.1/SIGN, FDP_ACF_EXT.1, FDP_ACF_EXT.3(Objective), FPT_AEX_EXT.1, FPT_AEX_EXT.2, FPT_AEX_EXT.3, FPT_AEX_EXT.4, FPT_AEX_EXT.5(Objective), FPT_AEX_EXT.6(Objective), FPT_AEX_EXT.7(Objective), FPT_BBD_EXT.1(Objective), FPT_NOT_EXT.1, FPT_NOT_EXT.2(Objective), FPT_STM.1, FPT_TST_EXT.1, FPT_TST_EXT.2/PREKERNEL,

FPT_TST_EXT.2/POSTKERNEL, FPT_TST_EXT.3(Sel-Based), FPT_TUD_EXT.1, FPT_TUD_EXT.2, FPT_TUD_EXT.3(Sel-Based), FPT_TUD_EXT.4(Objective), FPT_TUD_EXT.5(Objective)

O.PRIVACY

In a BYOD environment (use cases 3 and 4), a personally-owned mobile device is used for both personal activities and enterprise data. Enterprise management solutions may have the technical capability to monitor and enforce security policies on the device. However, the privacy of the personal activities and data must be ensured. In addition, since there are limited controls that the enterprise can enforce on the personal side, separation of personal and enterprise data is needed. This will protect against the T.FLAWAPP and T.PERSISTENT threats.

Addressed by: FDP_ACF_EXT.1, FDP_BCK_EXT.1(Objective), FMT_SMF_EXT.1, FMT_SMF_EXT.3(Objective)

4.2 Security Objectives for the Operational Environment

The following security objectives for the operational environment assist the OS in correctly providing its security functionality. These track with the assumptions about the environment.

OE.CONFIG

TOE administrators will configure the Mobile Device security functions correctly to create the intended security policy

OE.NOTIFY

The Mobile User will immediately notify the administrator if the Mobile Device is lost or stolen.

OE.PRECAUTION

The Mobile User exercises precautions to reduce the risk of loss or theft of the Mobile Device.

4.3 Security Objectives Rationale

This section describes how the assumptions, threats, and organization security policies map to the security objectives.

Threat, Assumption, or OSP	Security Objectives	Rationale
T.NETWORK_EAVESDROP	O.COMMS, O.CONFIG, O.AUTH	The threat T.NETWORK_EAVESDROP is countered by O.COMMS as this provides the capability to communicate using one (or more) standard protocols as a means to maintain the confidentiality of data that are transmitted outside of the TOE. The threat T.NETWORK_EAVESDROP is countered by O.CONFIG as this provides a secure configuration of the mobile device to protect data that it processes. The threat T.NETWORK_EAVESDROP is countered by O.AUTH as this provides authentication of the endpoints of a trusted communication path.
T.NETWORK_ATTACK	O.COMMS, O.CONFIG, O.AUTH	The threat T.NETWORK_ATTACK is countered by O.COMMS as this provides the capability to communicate using one (or more) standard protocols as a means to maintain the confidentiality of data that are transmitted outside of the TOE. The threat T.NETWORK_ATTACK is countered by O.CONFIG as this provides a secure configuration of the mobile device to protect data that it processes. The threat T.NETWORK_ATTACK is countered by O.AUTH as this provides authentication of the endpoints of a trusted communication path.
T.PHYSICAL_ACCESS	O.STORAGE, O.AUTH	The threat T.PHYSICAL_ACCESS is countered by O.STORAGE as this provides the capability to encrypt all user and enterprise data and authentication keys to ensure the confidentiality of data that it stores. The threat T.PHYSICAL_ACCESS is countered by O.AUTH as this provides the capability to authenticate the user prior to accessing protected functionality and data.
T.MALICIOUS_APP	O.COMMS, O.CONFIG, O.AUTH, O.INTEGRITY, O.PRIVACY	The threat T.MALICIOUS_APP is countered by O.COMMS as this provides the capability to communicate using one (or more) standard protocols as a means to maintain the confidentiality of data that are transmitted outside of the TOE. The threat T.MALICIOUS_APP is countered by O.CONFIG as this provides the capability to configure and apply security policies to ensure the Mobile Device can protect user and enterprise data that it may store or process. The threat T.MALICIOUS_APP is countered by O.AUTH as this provides the capability to authenticate the user and endpoints of a trusted path to ensure they are communicating with an authorized entity with appropriate privileges. The threat T.MALICIOUS_APP is countered by O.INTEGRITY as this provides the capability to perform self-tests to ensure the integrity of critical functionality,

		software/firmware and data has been maintained. The threat T.MALICIOUS_APP is countered by O.PRIVACY as this provides separation and privacy between user activities.
T.PERSISTENT_PRESENCE	O.INTEGRITY, O.PRIVACY	The threat T.PERSISTENT_PRESENCE is countered by O.INTEGRITY as this provides the capability to perform self-tests to ensure the integrity of critical functionality, software/firmware and data has been maintained. The threat T.PERSISTENT_PRESENCE is countered by O.PRIVACY as this provides separation and privacy between user activities.
A.CONFIG	OE.CONFIG	The operational environment objective OE.CONFIG is realized through A.CONFIG.
A.NOTIFY	OE.NOTIFY	The operational environment objective OE.NOTIFY is realized through A.NOTIFY.
A.PRECAUTION	OE.PRECAUTION	The operational environment objective OE.PRECAUTION is realized through A.PRECAUTION.
A.PROPER_USER	OE.DATA_PROPER_USER	The operational environment objective OE.DATA_PROPER_USER is realized through A.PROPER_USER.

5 Security Requirements

5.1 Security Fundamental Requirements

The individual security functional requirements are specified in the sections below.

The following conventions are used for the completion of operations:

- [*Italicized text within square brackets*] indicates an operation to be completed by the ST author
- Underlined text indicates additional text provided as a refinement.
- [***Bold and italicized text within square brackets***] indicates the completion of an assignment.
- [*Italicized text within square brackets*] indicates the completion of a selection.
- An identifier following a slash after an SFR name, e.g. /EXAMPLE, indicates the completion of an iteration.

5.1.1 Class: Security Audit (FAU)

FAU_GEN.1 Audit Data Generation

FAU_GEN.1.1 The TSF shall be able to generate an audit record of the following auditable events:

1. Start-up and shutdown of the audit functions
2. All auditable events for the [not selected] level of audit
3. All administrative actions
4. Start-up and shutdown of the RichOS
5. Insertion or removal of removable media
6. Specifically defined auditable events in Table 1
7. [**selection**: *Audit records reaching [**assignment**: integer value less than 100] percentage of audit capacity, [**assignment**: other auditable events derived from this profile]*]
8. [**selection**: *Specifically defined auditable event in Table 2, no additional auditable events*]

Requirement	Auditable Events	Additional Audit Record Contents
FAU_GEN.1	None.	
FAU_STG.1	None.	
FAU_STG.4	None.	
FCS_CKM_EXT.1	[**selection**: *generation of a REK*, *None*].	No additional information.
FCS_CKM_EXT.2	None.	
FCS_CKM_EXT.3	None.	
FCS_CKM_EXT.4	None.	
FCS_CKM_EXT.5	[**selection**: *Failure of the wipe*, *None*].	No additional information.
FCS_CKM_EXT.6	None.	
FCS_CKM.1	[**selection**: *Failure of key generation activity for authentication keys*, *None*].	No additional information.
FCS_CKM.2/UNLOCKED	None.	
FCS_CKM.2/LOCKED	None.	
FCS_COP.1/ENCRYPT	None.	
FCS_COP.1/HASH	None.	
FCS_COP.1/SIGN	None.	
FCS_COP.1/KEYHMAC	None.	
FCS_COP.1/CONDITION	None.	
FCS_IV_EXT.1	None.	
FCS_SRV_EXT.1	None.	
FCS_STG_EXT.1	Import or destruction of key.	Identity of key. Role and identity of requestor.

	[**selection**: *Exceptions to use and destruction rules*, *No other events*]	
FCS_STG_EXT.2	None.	
FCS_STG_EXT.3	Failure to verify integrity of stored key.	Identity of key being verified.
FDP_DAR_EXT.1	[**selection**: *Failure to encrypt/decrypt data*, *None*].	No additional information.
FDP_DAR_EXT.2	Failure to encrypt/decrypt data.	No additional information.
FDP_IFC_EXT.1	None.	
FDP_STG_EXT.1	Addition or removal of certificate from Trust Anchor Database.	Subject name of certificate.
FIA_PMG_EXT.1	None.	
FIA_TRT_EXT.1	None.	
FIA_UAU_EXT.1	None.	
FIA_UAU.5	None.	
FIA_UAU.7	None.	
FIA_X509_EXT.1	Failure to validate X.509v3 certificate.	Reason for failure of validation.
FMT_MOF_EXT.1	None.	
FPT_AEX_EXT.1	None.	
FPT_AEX_EXT.2	None.	
FPT_AEX_EXT.3	None.	
FPT_JTA_EXT.1	None.	
FPT_KST_EXT.1	None.	
FPT_KST_EXT.2	None.	
FPT_KST_EXT.3	None.	
FPT_NOT_EXT.1	[**selection**: *Measurement of TSF software*, *None*].	[**selection**: *Integrity verification value*, *No additional information*].
FPT_STM.1	None.	
FPT_TST_EXT.1	Initiation of self-test.	[**selection**: *Algorithm that caused the failure*, *none*]
	Failure of self-test.	
FPT_TST_EXT.2/PREKERNEL	Start-up of TOE.	No additional information.
	[**selection**: *Detected integrity violation*, *none*]	[**selection**: *The TSF code file that caused the integrity violation*, *No additional information*]
FPT_TUD_EXT.1	None.	
FTA_SSL_EXT.1	None.	

Table 1: Mandatory Auditable Events

Requirement	Auditable Events	Additional Audit Record Contents
FAU_SAR.1	None.	
FAU_SEL.1	All modifications to the audit configuration that	No additional Information.

	occur while the audit collection functions are operating.	
FCS_CKM_EXT.7	None.	
FCS_DTLS_EXT.1 (TLS Package)	Failure of the certificate validity check.	Issuer Name and Subject Name of certificate.
FCS_HTTPS_EXT.1	Failure of the certificate validity check.	Issuer Name and Subject Name of certificate. [**selection**: *User's authorization decision*, *No additional information*].
FCS_RBG_EXT.1	Failure of the randomization process.	No additional information.
FCS_RBG_EXT.2	None.	
FCS_RBG_EXT.3	None.	
FCS_SRV_EXT.2	None.	
FCS_TLSC_EXT.1 (TLS Package)	Establishment/termination of a TLS session.	Non-TOE endpoint of connection.
	Failure to establish a TLS session.	Reason for failure.
	Failure to verify presented identifier.	Presented identifier and reference identifier.
FCS_TLSC_EXT.2 (TLS Package)	None.	
FCS_TLSC_EXT.3 (TLS Package)	None.	
FDP_ACF_EXT.1	None.	
FDP_ACF_EXT.2	None.	
FDP_ACF_EXT.3	None.	
FDP_BCK_EXT.1	None.	
FDP_PBA_EXT.1	None.	
FDP_UPC_EXT.1/NORMAL	Application initiation of trusted channel.	Name of application. Trusted channel protocol. Non-TOE endpoint of connection.
FDP_UPC_EXT.1/BLUETOOTH	Application initiation of trusted channel.	Name of application. Trusted channel protocol. Non-TOE endpoint of connection.
FIA_AFL_EXT.1	Excess of authentication failure limit.	Authentication factor used.
FIA_BMG_EXT.1	None.	
FIA_BMG_EXT.2	None.	
FIA_BMG_EXT.3	None.	
FIA_BMG_EXT.4	None.	
FIA_BMG_EXT.5	None.	
FIA_BMG_EXT.6	None.	
FIA_UAU_EXT.2	Action performed before authentication.	No additional information.
FIA_UAU.6	User changes Password Authentication Factor.	No additional information.
FIA_UAU_EXT.4	None.	
FIA_X509_EXT.2	Failure to establish	No additional information.

	connection to determine revocation status.	
FIA_X509_EXT.3	None.	
FIA_X509_EXT.4	Generation of Certificate Enrollment Request.	Issuer and Subject name of EST Server. Method of authentication. Issuer and Subject name of certificate used to authenticate. Content of Certificate Request Message.
	Success or failure of enrollment.	Issuer and Subject name of added certificate or reason for failure.
	Update of EST Trust Anchor Database	Subject name of added Root CA.
FIA_X509_EXT.5	None.	
FMT_SMF_EXT.1	[**selection**: *Initiation of policy update*, *none*].	[**selection**: *Policy name*, *none*].
	[**selection**: *Change of settings*, *none*]	[**selection**: *Role of user that changed setting*, *Value of new setting*, *none*].
	[**selection**: *Success of failure of function*, *none*]	[**selection**: *Role of user that performed function*, *Function performed*, *Reason for failure, none*].
	Initiation of software update.	Version of update.
	Initiation of application installation or update.	Name and version of application.
FMT_SMF_EXT.2	[**selection**: *Unenrollment*, *Initiation of unenrollment*, *none*]	[**selection**: *Identity of administrator Remediation action performed*, *failure of accepting command to unenroll*, *none*]
FMT_SMF_EXT.3	None.	
FPT_AEX_EXT.4	None.	
FPT_AEX_EXT.5	None.	
FPT_AEX_EXT.6	None.	
FPT_AEX_EXT.7	None.	
FPT_BBD_EXT.1	None.	
FPT_BLT_EXT.1	None.	
FPT_NOT_EXT.2	None.	
FPT_TST_EXT.2/POSTKERNEL	[**selection**: *Detected integrity violation*, *none*]	[**selection**: *The TSF code file that caused the integrity violation*, *No additional information*]
FPT_TST_EXT.3	None.	
FPT_TUD_EXT.2	Success or failure of signature verification for software updates.	No additional information.
	Success or failure of signature verification for applications.	No additional information.
FPT_TUD_EXT.3	None.	
FPT_TUD_EXT.4	None.	
FPT_TUD_EXT.5	None.	

FTA_TAB.1	None.	
FTP_ITC_EXT.1	Initiation and termination of trusted channel.	Trusted channel protocol. Non-TOE endpoint of connection.

Table 2: Additional Auditable Events

Application Note: Administrator actions are defined as functions labeled as mandatory for FMT_MOF_EXT.1.2 (i.e. 'M-MM' in Table 6). If the TSF does not support removable media, number 4 is implicitly met.

The TSF shall generate an audit record for all events contained in Table 1. Generating audit records for events in Table 2 is currently objective. It is acceptable to include individual SFRs from Table 2 in the ST, without including the entirety of Table 2.

Table 1 Application Note:
FPT_TST_EXT.1 – Audit of self-tests is required only at initial start-up. Since the TOE "transitions to non-operational mode" upon failure of a self-test, per FPT_NOT_EXT.1, this is considered equivalent evidence to an audit record for the failure of a self-test.

FDP_DAR_EXT.1 - "None" shall be selected, if the TOE utilizes whole volume encryption for protected memory, since it is not feasible to audit when the encryption/decryption fails. If the TOE utilizes file-based encryption for protected data and audits when this encryption/decryption fails, then that auditable event shall be selected.

Table 2 Application Note:
If the audit event for FMT_SMF_EXT.1 is included in the ST, it is acceptable for the initiation of the software update to be audited without indicating the outcome (success or failure) of the update.

FAU_GEN.1.2 The TSF shall record within each audit record at least the following information:

1. Date and time of the event
2. Type of event
3. Subject identity
4. The outcome (success or failure) of the event
5. Additional information in Table 1
6. [**selection**: *Additional information in Table 2*, *no additional information*]

Application Note: The subject identity is usually the process name/ID. The event type is often indicated by a severity level, for example, 'info', 'warning', or 'error'.

If "no additional auditable events" is selected in the second selection of FAU_GEN.1.1, then "no additional information" shall be selected.

For each audit event selected from Table 2 in FAU_GEN.1.1 if additional information is required to be recorded within the audit record, it should be included in this selection.

Evaluation Activity

TSS
The evaluator shall check the TSS and ensure that it lists all of the auditable events and provides a format for audit records. Each audit record format type must be covered, along with a brief description of each field. The evaluator shall check to make sure that every audit event type mandated by the PP is described and that the description of the fields contains the information required in FAU_GEN.1.2.

Guidance
The evaluator shall also make a determination of the administrative actions that are relevant in the context of this PP including those listed in the Management section. The evaluator shall examine the administrative guide and make a determination of which administrative commands are related to the configuration (including enabling or disabling) of the mechanisms implemented in the TOE that are necessary to enforce the requirements specified in the PP. The evaluator shall document the methodology or approach taken while determining which actions in the administrative guide are security relevant with respect to this PP. The evaluator may perform this activity as part of the activities associated with ensuring the AGD_OPE guidance satisfies the requirements.

Tests
The evaluator shall test the TOE's ability to correctly generate audit records by having the TOE generate audit records for the events listed in the provided table and administrative actions. This should include all instances of an event. The evaluator shall test that audit records are generated for the establishment and termination of a channel for each of the cryptographic protocols contained in the ST. For administrative actions, the evaluator shall test that each action determined by the evaluator above to be security relevant in the context of this PP is auditable. When verifying the test results, the evaluator shall ensure the audit records generated during testing match the format specified in the administrative guide, and that the fields specified in FAU_GEN.1.2 are

contained in each audit record.

Note that the testing here can be accomplished in conjunction with the testing of the security mechanisms directly. For example, testing performed to ensure that the administrative guidance provided is correct verifies that AGD_OPE.1 is satisfied and should address the invocation of the administrative actions that are needed to verify the audit records are generated as expected.

FAU_SAR.1 Audit Review

This is an objective component.

FAU_SAR.1.1 The TSF shall provide the administrator with the capability to read all audited events and record contents from the audit records.

Application Note: The administrator shall have access to read the audit record, perhaps through an API or via an MDM Agent, which transfers the local records stored on the TOE to the MDM Server where the enterprise administrator may view them. If this requirement is included in the ST, function 32 shall be included in the selection of FMT_SMF_EXT.1.

FAU_SAR.1.2 The TSF shall provide the audit records in a manner suitable for the user to interpret the information.

Evaluation Activity

Tests
The assurance activity for this requirement is performed in conjunction with test for function 32 of FMT_SMF_EXT.1.

FAU_SEL.1 Selective Audit

This is an objective component.

FAU_SEL.1.1 The TSF shall be able to select the set of events to be audited from the set of all auditable events based on the following attributes [**selection**:

- *event type*,
- *success of auditable security events*,
- *failure of auditable security events*,
- *[**assignment**: other attributes]*

].

Application Note: The intent of this requirement is to identify all criteria that can be selected to trigger an audit event. This can be configured through an interface on the TSF for a user or administrator to invoke. For the ST author, the assignment is used to list any additional criteria or "none".

Evaluation Activity

Guidance
The evaluator shall review the administrative guidance to ensure that the guidance itemizes all event types, as well as describes all attributes that are to be selectable in accordance with the requirement, to include those attributes listed in the assignment. The administrative guidance shall also contain instructions on how to set the pre-selection as well as explain the syntax (if present) for multi-value pre-selection. The administrative guidance shall also identify those audit records that are always recorded, regardless of the selection criteria currently being enforced.

Tests
The evaluator shall also perform the following tests:

- ***Test 1:*** *For each attribute listed in the requirement, the evaluator shall devise a test to show that selecting the attribute causes only audit events with that attribute (or those that are always recorded, as identified in the administrative guidance) to be recorded.*

- ***Test 2:*** *[conditional] If the TSF supports specification of more complex audit pre-selection criteria (e.g., multiple attributes, logical expressions using attributes) then the evaluator shall devise tests showing that this capability is correctly implemented. The evaluator shall also, in the test plan, provide a short narrative justifying the set of tests as representative and sufficient to exercise the capability.*

FAU_STG.1 Audit Storage Protection

FAU_STG.1.1 The TSF shall protect the stored audit records in the audit trail from unauthorized deletion.

FAU_STG.1.2 The TSF shall be able to prevent unauthorized modifications to the stored audit records in the audit trail.

Evaluation Activity

> ***TSS***
> *The evaluator shall ensure that the TSS lists the location of all logs and the access controls of those files such that unauthorized modification and deletion are prevented.*
> ***Tests***
> - ***Test 1:*** *The evaluator shall attempt to delete the audit trail in a manner that the access controls should prevent (as an unauthorized user) and shall verify that the attempt fails.*
> - ***Test 2:*** *The evaluator shall attempt to modify the audit trail in a manner that the access controls should prevent (as an unauthorized application) and shall verify that the attempt fails.*

FAU_STG.4 Prevention of Audit Data Loss

FAU_STG.4.1 The TSF shall overwrite the oldest stored audit records if the audit trail is full.

Evaluation Activity

> ***TSS***
> *The evaluator shall examine the TSS to ensure that it describes the size limits on the audit records, the detection of a full audit trail, and the action(s) taken by the TSF when the audit trail is full. The evaluator shall ensure that the action(s) results in the deletion or overwrite of the oldest stored record.*

5.1.2 Class: Cryptographic Support (FCS)

This section describes how keys are generated, derived, combined, released and destroyed. There are two major types of keys: DEKs and KEKs. (A REK is considered a KEK.) DEKs are used to protect data (as in the DAR protection described in FDP_DAR_EXT.1 and FDP_DAR_EXT.2). KEKs are used to protect other keys – DEKs, other KEKs, and other types of keys stored by the user or applications. The following diagram shows an example key hierarchy to illustrate the concepts of this profile. This example is not meant as an approved design, but ST authors will be expected to provide a diagram illustrating their key hierarchy in order to demonstrate that they meet the requirements of this profile. Please note if a BAF is selected in FIA_UAU.5.1, the BAF shall be illustrated in the key hierarchy diagram, to include a description of when and how the BAF is used to release keys. If "hybrid" is selected in FIA_UAU.5.1, meaning that a PIN or password must be used in conjunction with the BAF this interaction shall be included.

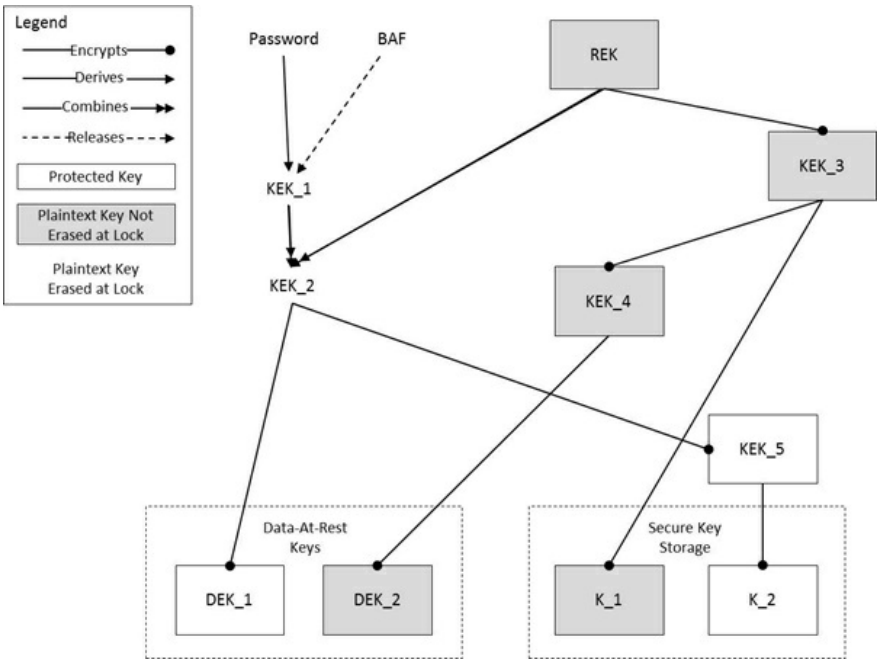

Figure 3: An Illustrative Key Hierarchy

FCS_CKM.1 Cryptographic key generation

FCS_CKM.1.1 The TSF shall generate asymmetric cryptographic keys in accordance with a specified cryptographic key generation algorithm [**selection**:

- *RSA schemes using cryptographic key sizes of 2048-bit or greater that meet FIPS PUB 186-4, "Digital Signature Standard (DSS)", Appendix B.3,*
- *ECC schemes using [**selection**:*

- *"NIST curves" P-384 and [**selection**: P-256, P-521, no other curves] that meet the following: FIPS PUB 186-4, "Digital Signature Standard (DSS)", Appendix B.4,*
- *Curve25519 schemes that meet the following: RFC 7748*

] ,

- *FFC schemes using [**selection**:*
  - *cryptographic key sizes of 2048-bit or greater that meet the following: FIPS PUB 186-4, "Digital Signature Standard (DSS)", Appendix B.1,*
  - *Diffie-Hellman group 14 that meet the following: RFC3526, Section 3,*
  - *"safe-prime" groups that meet the following: 'NIST Special Publication 800-56A Revision 3, "Recommendation for Pair-Wise Key Establishment Schemes Using Discrete Logarithm Cryptography"', and [**selection**: RFC 3526, RFC 7919]*

]

].

Application Note: The ST author shall select all key generation schemes used for key establishment and entity authentication. When key generation is used for key establishment, the schemes in FCS_CKM.2/UNLOCKED and selected cryptographic protocols must match the selection. When key generation is used for entity authentication, the public key may be associated with an X.509v3 certificate.

If the TOE acts as a receiver in the RSA key establishment scheme, the TOE does not need to implement RSA key generation.

Curve25519 can only be used for ECDH and in conjunction with FDP_DAR_EXT.2.2.

Evaluation Activity

TSS
The evaluator shall ensure that the TSS identifies the key sizes supported by the TOE. If the ST specifies more than one scheme, the evaluator shall examine the TSS to verify that it identifies the usage for each scheme.

Guidance
The evaluator shall verify that the AGD guidance instructs the administrator how to configure the TOE to use the selected key generation scheme(s) and key size(s) for all uses defined in this PP.

Tests
Assurance Activity Note: *The following tests require the developer to provide access to a test platform that provides the evaluator with tools that are typically not found on factory products.*

Key Generation for FIPS PUB 186-4 RSA Schemes

The evaluator shall verify the implementation of RSA Key Generation by the TOE using the Key Generation test. This test verifies the ability of the TSF to correctly produce values for the key components including the public verification exponent e, the private prime factors p and q, the public modulus n and the calculation of the private signature exponent d.

Key Pair generation specifies 5 ways (or methods) to generate the primes p and q. These include:

1. *Random Primes:*
   - *Provable primes*
   - *Probable primes*
2. *Primes with Conditions:*
   - *Primes p1, p2, q1,q2, p and q shall all be provable primes*
   - *Primes p1, p2, q1, and q2 shall be provable primes and p and q shall be probable primes*
   - *Primes p1, p2, q1,q2, p and q shall all be probable primes*

To test the key generation method for the Random Provable primes method and for all the Primes with Conditions methods, the evaluator must seed the TSF key generation routine with sufficient data to deterministically generate the RSA key pair. This includes the random seed(s), the public exponent of the RSA key, and the desired key length. For each key length supported, the evaluator shall have the TSF generate 25 key pairs. The evaluator shall verify the correctness of the TSF's implementation by comparing values generated by the TSF with those generated from a known good implementation.

If possible, the Random Probable primes method should also be verified against a known good implementation as described above. Otherwise, the evaluator shall have the TSF generate 10 keys pairs for each supported key length nlen and verify:

- *n = p*q*
- *p and q are probably prime according to Miller-Rabin tests*
- *GCD(p-1,e) = 1*
- *GCD(q-1,e) = 1*

- *2^16 < e < 2^256 and e is an odd integer*
- *|p-q| > 2^(nlen/2 – 100)*
- *p >= squareroot(2)*(2^(nlen/2 -1))*
- *q >= squareroot(2)*(2^(nlen/2 -1))*
- *2^(nlen/2) < d < LCM(p-1,q-1)*
- *e*d = 1 mod LCM(p-1,q-1)*

Key Generation for FIPS 186-4 Elliptic Curve Cryptography (ECC)
FIPS 186-4 ECC Key Generation Test

For each supported NIST curve, i.e. P-256, P-384 and P-521, the evaluator shall require the implementation under test (IUT) to generate 10 private/public key pairs. The private key shall be generated using an approved random bit generator (RBG). To determine correctness, the evaluator shall submit the generated key pairs to the public key verification (PKV) function of a known good implementation.

FIPS 186-4 Public Key Verification (PKV) Test

For each supported NIST curve, i.e. P-256, P-384 and P-521, the evaluator shall generate 10 private/public key pairs using the key generation function of a known good implementation and modify five of the public key values so that they are incorrect, leaving five values unchanged (i.e. correct). The evaluator shall obtain in response a set of 10 PASS/FAIL values.

Key Generation for Curve25519

The evaluator shall require the implementation under test (IUT) to generate 10 private/public key pairs. The private key shall be generated as specified in RFC 7748 using an approved random bit generator (RBG) and shall be written in little-endian order (least significant byte first). To determine correctness, the evaluator shall submit the generated key pairs to the public key verification (PKV) function of a known good implementation.

Note: Assuming the PKV function of the good implementation will (using little-endian order):

a. *confirm the private and public keys are 32-byte values*
b. *confirm the three least significant bits of the first byte of the private key are zero*
c. *confirm the most significant bit of the last byte is zero*
d. *confirm the second most significant bit of the last byte is one*
e. *calculate the expected public key from the private key and confirm it matches the supplied public key*

The evaluator shall generate 10 private/public key pairs using the key generation function of a known good implementation and modify 5 of the public key values so that they are incorrect, leaving five values unchanged (i.e. correct). The evaluator shall obtain in response a set of 10 PASS/FAIL values.

Key Generation for Finite-Field Cryptography (FFC)
The evaluator shall verify the implementation of the Parameters Generation and the Key Generation for FFC by the TOE using the Parameter Generation and Key Generation test. This test verifies the ability of the TSF to correctly produce values for the field prime p, the cryptographic prime q (dividing p-1), the cryptographic group generator g, and the calculation of the private key x and public key y.
The Parameter generation specifies 2 ways (or methods) to generate the cryptographic prime q and the field prime p:

Cryptographic and Field Primes:

- *Primes q and p shall both be provable primes*
- *Primes q and field prime p shall both be probable primes*

and two ways to generate the cryptographic group generator g:

Cryptographic Group Generator:

- *Generator g constructed through a verifiable process*
- *Generator g constructed through an unverifiable process*

The Key generation specifies 2 ways to generate the private key x:

Private Key:

- *len(q) bit output of RBG where 1 <= x <= q-1*
- *len(q) + 64 bit output of RBG, followed by a mod q-1 operation where 1<= x<=q-1*

The security strength of the RBG must be at least that of the security offered by the FFC parameter set.

To test the cryptographic and field prime generation method for the provable primes method and/or the group generator g for a verifiable process, the evaluator must seed the TSF parameter generation routine with sufficient data to deterministically generate the parameter set.

For each key length supported, the evaluator shall have the TSF generate 25 parameter sets and key pairs. The evaluator shall verify the correctness of the TSF's implementation by comparing values generated by the TSF with those generated from a known good implementation. Verification must also confirm

- *g != 0,1*
- *q divides p-1*
- *g^q mod p = 1*
- *g^x mod p = y*

for each FFC parameter set and key pair.

Diffie-Hellman Group 14 and FFC Schemes using "safe-prime" groups

Testing for FFC Schemes using Diffie-Hellman group 14 and/or "safe-prime" groups is done as part of testing in FCS_CKM.2/UNLOCKED.

FCS_CKM.2/UNLOCKED Cryptographic key establishment

FCS_CKM.2.1/UNLOCKED The TSF shall perform cryptographic key establishment in accordance with a specified cryptographic key establishment method [**selection**:

- *RSA-based key establishment schemes that meet the following [**selection**:*
  - *NIST Special Publication 800-56B, "Recommendation for Pair-Wise Key Establishment Schemes Using Integer Factorization Cryptography",*
  - *RSAES-PKCS1-v1_5 as specified in Section 7.2 of RFC 8017, "Public-Key Cryptography Standards (PKCS) #1:RSA Cryptography Specifications Version 2.1"*

  ],
- *Elliptic curve-based key establishment schemes that meets the following: NIST Special Publication 800-56A Revision 3, "Recommendation for Pair-Wise Key Establishment Schemes Using Discrete Logarithm Cryptography"*,
- *Finite field-based key establishment schemes that meets the following: NIST Special Publication 800-56A Revision 3, "Recommendation for Pair-Wise Key Establishment Schemes Using Discrete Logarithm Cryptography"*,
- *Key establishment schemes using Diffie-Hellman group 14 that meets the following: RFC 3526, Section 3*,
- *FFC schemes using "safe-prime" groups that meet the following: 'NIST Special Publication 800-56A Revision 3, "Recommendation for Pair-Wise Key Establishment Schemes Using Discrete Logarithm Cryptography'", and [**selection**: RFC 3526, RFC 7919]*,
- *No other schemes*

].

Application Note: The ST author shall select all key establishment schemes used for the selected cryptographic protocols.

The RSA-based key establishment schemes are described in Section 9 of NIST SP 800-56B; however, Section 9 relies on implementation of other sections in SP 800-56B. If the TOE acts as a receiver in the RSA key establishment scheme, the TOE does not need to implement RSA key generation.

The elliptic curves used for the key establishment scheme shall correlate with the curves specified in FCS_CKM.1.1.

The domain parameters used for the finite field-based key establishment scheme are specified by the key generation according to FCS_CKM.1.1.

Evaluation Activity

TSS
The evaluator shall ensure that the supported key establishment schemes correspond to the key generation schemes identified in FCS_CKM.1.1. If the ST specifies more than one scheme, the evaluator shall examine the TSS to verify that it identifies the usage for each scheme.

If Diffie-Hellman group 14 is selected from FCS_CKM.2/UNLOCKED, the TSS shall describe how the implementation meets RFC 3526 Section 3.

Guidance
The evaluator shall verify that the AGD guidance instructs the administrator how to configure the TOE to use the selected key establishment scheme(s).

Tests

Assurance Activity Note: *The following tests require the developer to provide access to a test platform that provides the evaluator with tools that are typically not found on factory products.*

The evaluator shall verify the implementation of the key establishment schemes supported by the TOE using the applicable tests below.

SP800-56A Revision 3 Key Establishment Schemes

The evaluator shall verify a TOE's implementation of SP800-56A Revision 3 key aestablishment schemes using the following Function and Validity tests. These validation tests for each key agreement scheme verify that a TOE has implemented the components of the key agreement scheme according to the specifications in the Recommendation. These components include the calculation of the DLC primitives (the shared secret value Z) and the calculation of the derived keying material (DKM) via the Key Derivation Function (KDF). If key confirmation is supported, the evaluator shall also verify that the components of key confirmation have been implemented correctly, using the test procedures described below. This includes the parsing of the DKM, the generation of MACdata and the calculation of MACtag.

Function Test

The Function test verifies the ability of the TOE to implement the key agreement schemes correctly. To conduct this test the evaluator shall generate or obtain test vectors from a known good implementation of the TOE supported schemes. For each supported key agreement scheme-key agreement role combination, KDF type, and, if supported, key confirmation role- key confirmation type combination, the tester shall generate 10 sets of test vectors. The data set consists of one set of domain parameter values (FFC) or the NIST approved curve (ECC) per 10 sets of public keys. These keys are static, ephemeral or both depending on the scheme being tested.

The evaluator shall obtain the DKM, the corresponding TOE's public keys (static and/or ephemeral), the MAC tag(s), and any inputs used in the KDF, such as the Other Information field OI and TOE id fields.

If the TOE does not use a KDF defined in SP 800-56A Revision 3, the evaluator shall obtain only the public keys and the hashed value of the shared secret.

The evaluator shall verify the correctness of the TSF's implementation of a given scheme by using a known good implementation to calculate the shared secret value, derive the keying material DKM, and compare hashes or MAC tags generated from these values.

If key confirmation is supported, the TSF shall perform the above for each implemented approved MAC algorithm.

Validity Test

The Validity test verifies the ability of the TOE to recognize another party's valid and invalid key agreement results with or without key confirmation. To conduct this test, the evaluator shall obtain a list of the supporting cryptographic functions included in the SP800-56A Revision 3 key agreement implementation to determine which errors the TOE should be able to recognize. The evaluator generates a set of 24 (FFC) or 30 (ECC) test vectors consisting of data sets including domain parameter values or NIST approved curves, the evaluator's public keys, the TOE's public/private key pairs, MACTag, and any inputs used in the KDF, such as the other info and TOE id fields.

The evaluator shall inject an error in some of the test vectors to test that the TOE recognizes invalid key agreement results caused by the following fields being incorrect: the shared secret value Z, the DKM, the other information field OI, the data to be MACed, or the generated MACTag. If the TOE contains the full or partial (only ECC) public key validation, the evaluator will also individually inject errors in both parties' static public keys, both parties' ephemeral public keys and the TOE's static private key to assure the TOE detects errors in the public key validation function and/or the partial key validation function (in ECC only). At least two of the test vectors shall remain unmodified and therefore should result in valid key agreement results (they should pass).

The TOE shall use these modified test vectors to emulate the key agreement scheme using the corresponding parameters. The evaluator shall compare the TOE's results with the results using a known good implementation verifying that the TOE detects these errors.

SP800-56B Key Establishment Schemes

The evaluator shall verify that the TSS describes whether the TOE acts as a sender, a

recipient, or both for RSA-based key establishment schemes.

If the TOE acts as a sender, the following assurance activity shall be performed to ensure the proper operation of every TOE supported combination of RSA-based key establishment scheme:
To conduct this test the evaluator shall generate or obtain test vectors from a known good implementation of the TOE supported schemes. For each combination of supported key establishment scheme and its options (with or without key confirmation if supported, for each supported key confirmation MAC function if key confirmation is supported, and for each supported mask generation function if KTS-OAEP is supported), the tester shall generate 10 sets of test vectors. Each test vector shall include the RSA public key, the plaintext keying material, any additional input parameters if applicable, the MacKey and MacTag if key confirmation is incorporated, and the outputted ciphertext. For each test vector, the evaluator shall perform a key establishment encryption operation on the TOE with the same inputs (in cases where key confirmation is incorporated, the test shall use the MacKey from the test vector instead of the randomly generated MacKey used in normal operation) and ensure that the outputted ciphertext is equivalent to the ciphertext in the test vector.

If the TOE acts as a receiver, the following assurance activities shall be performed to ensure the proper operation of every TOE supported combination of RSA-based key establishment scheme:
To conduct this test the evaluator shall generate or obtain test vectors FCS_CKM.2.1/LOCKED from a known good implementation of the TOE supported schemes. For each combination of supported key establishment scheme and its options (with our without key confirmation if supported, for each supported key confirmation MAC function if key confirmation is supported, and for each supported mask generation function if KTS-OAEP is supported), the tester shall generate 10 sets of test vectors. Each test vector shall include the RSA private key, the plaintext keying material (KeyData), any additional input parameters if applicable, the MacTag in cases where key confirmation is incorporated, and the outputted ciphertext. For each test vector, the evaluator shall perform the key establishment decryption operation on the TOE and ensure that the outputted plaintext keying material (KeyData) is equivalent to the plaintext keying material in the test vector. In cases where key confirmation is incorporated, the evaluator shall perform the key confirmation steps and ensure that the outputted MacTag is equivalent to the MacTag in the test vector.

The evaluator shall ensure that the TSS describes how the TOE handles decryption errors. In accordance with NIST Special Publication 800-56B, the TOE must not reveal the particular error that occurred, either through the contents of any outputted or logged error message or through timing variations. If KTS-OAEP is supported, the evaluator shall create separate contrived ciphertext values that trigger each of the three decryption error checks described in NIST Special Publication 800-56B section 7.2.2.3, ensure that each decryption attempt results in an error, and ensure that any outputted or logged error message is identical for each. If KTS-KEMKWS is supported, the evaluator shall create separate contrived ciphertext values that trigger each of the three decryption error checks described in NIST Special Publication 800-56B section 7.2.3.3, ensure that each decryption attempt results in an error, and ensure that any outputted or logged error message is identical for each.

RSAES-PKCS1-v1_5 Key Establishment Schemes

The evaluator shall verify the correctness of the TSF's implementation of RSAES-PKCS1-v1_5 by using a known good implementation for each protocol selected in FTP_ITC_EXT.1 that uses RSAES-PKCS1-v1_5.

Diffie-Hellman Group 14

The evaluator shall verify the correctness of the TSF's implementation of Diffie-Hellman group 14 by using a known good implementation for each protocol selected in FTP_ITC_EXT.1 that uses Diffie-Hellman Group 14.

FFC Schemes using "safe-prime" groups

The evaluator shall verify the correctness of the TSF's implementation of "safe-prime" groups by using a known good implementation for each protocol selected in FTP_ITC_EXT.1 that uses "safe-prime" groups. This test must be performed for each "safe-prime" group that each protocol uses.

FCS_CKM.2/LOCKED Cryptographic key establishment

FCS_CKM.2.1/LOCKED The TSF shall perform cryptographic key establishment in accordance with a specified cryptographic key establishment method: [**selection**:

- *RSA-based key establishment schemes that meet the following: NIST Special Publication 800-56B, "Recommendation for Pair-Wise Key Establishment Schemes Using Integer Factorization Cryptography",*
- *Elliptic curve-based key establishment schemes that meets the following: [**selection**:*
  - *NIST Special Publication 800-56A Revision 3, "Recommendation for Pair-Wise Key Establishment Schemes Using Discrete Logarithm Cryptography",*
  - *RFC 7748, "Elliptic Curves for Security"*

] ,

- *Finite field-based key establishment schemes that meets the following: NIST Special Publication 800-56A Revision 3, "Recommendation for Pair-Wise Key Establishment Schemes Using Discrete Logarithm Cryptography"*

] for the purposes of encrypting sensitive data received while the device is locked.

Application Note: The RSA-based key establishment schemes are described in Section 9 of NIST SP 800-56B; however, Section 9 relies on implementation of other sections in SP 800-56B. If the TOE acts as a receiver in the RSA key establishment scheme, the TOE does not need to implement RSA key generation.

The elliptic curves used for the key establishment scheme shall correlate with the curves specified in FCS_CKM.1.1.

The domain parameters used for the finite field-based key establishment scheme are specified by the key generation according to FCS_CKM.1.1.

Evaluation Activity

Tests
The test for SP800-56A Revision 3 and SP800-56B key establishment schemes is performed in association with FCS_CKM.2/UNLOCKED.

Curve25519 Key Establishment Schemes

The evaluator shall verify a TOE's implementation of the key agreement scheme using the following Function and Validity tests. These validation tests for each key agreement scheme verify that a TOE has implemented the components of the key agreement scheme according to the specification. These components include the calculation of the shared secret K and the hash of K.

Function Test

The Function test verifies the ability of the TOE to implement the key agreement schemes correctly. To conduct this test the evaluator shall generate or obtain test vectors from a known good implementation of the TOE supported schemes. For each supported key agreement role and hash function combination, the tester shall generate 10 sets of public keys. These keys are static, ephemeral or both depending on the scheme being tested.

The evaluator shall obtain the shared secret value K, and the hash of K.

The evaluator shall verify the correctness of the TSF's implementation of a given scheme by using a known good implementation to calculate the shared secret value K and compare the hash generated from this value.

Validity Test

The Validity test verifies the ability of the TOE to recognize another party's valid and invalid key agreement results. To conduct this test, the evaluator generates a set of 30 test vectors consisting of data sets including the evaluator's public keys and the TOE's public/private key pairs.

The evaluator shall inject an error in some of the test vectors to test that the TOE recognizes invalid key agreement results caused by the following fields being incorrect: the shared secret value K or the hash of K. At least two of the test vectors shall remain unmodified and therefore should result in valid key agreement results (they should pass).

The TOE shall use these modified test vectors to emulate the key agreement scheme using the corresponding parameters. The evaluator shall compare the TOE's results with the results using a known good implementation verifying that the TOE detects these errors.

FCS_CKM_EXT.1 Extended: Cryptographic Key Support

FCS_CKM_EXT.1.1 The TSF shall support [**selection**: *immutable hardware*, *mutable hardware*] REK(s) with a [**selection**: *symmetric*, *asymmetric*] key of strength [**selection**: *112 bits*, *128 bits*, *192 bits*, *256 bits*].

FCS_CKM_EXT.1.2 Each REK shall be hardware-isolated from Rich OS on the TSF in runtime.

FCS_CKM_EXT.1.3 Each REK shall be generated by a RBG in accordance with FCS_RBG_EXT.1.

Application Note: Either asymmetric or symmetric keys are allowed; the ST author makes the selection appropriate for the device. Symmetric keys must be of size 128 or 256 bits in order to correspond with FCS_COP.1/ENCRYPT. Asymmetric keys may be of any strength

corresponding to FCS_CKM.1.

The raw key material of "immutable hardware" REK(s) is computationally processed by hardware and software cannot access the raw key material. Thus if "immutable-hardware" is selected in FCS_CKM_EXT.1.1 it implicitly meets FCS_CKM_EXT.7. If "mutable-hardware" is selected in FCS_CKM_EXT.1.1, FCS_CKM_EXT.7 must be included in the ST.

The lack of a public/documented API for importing or exporting the REK, when a private/undocumented API exists, is not sufficient to meet this requirement.

The RBG used to generate a REK may be a RBG native to the hardware key container or may be an off-device RBG. If performed by an off-device RBG, the device manufacturer shall not be able to access a REK after the manufacturing process has been completed. The assurance activities for these two cases differ.

Evaluation Activity

TSS
The evaluator shall review the TSS to determine that a REK is supported by the TOE, that the TSS includes a description of the protection provided by the TOE for a REK, and that the TSS includes a description of the method of generation of a REK.

The evaluator shall verify that the description of the protection of a REK describes how any reading, import, and export of that REK is prevented. (For example, if the hardware protecting the REK is removable, the description should include how other devices are prevented from reading the REK.) The evaluator shall verify that the TSS describes how encryption/decryption/derivation actions are isolated so as to prevent applications and system-level processes from reading the REK while allowing encryption/decryption/derivation by the key.

The evaluator shall verify that the description includes how the Rich OS is prevented from accessing the memory containing REK key material, which software is allowed access to the REK, how any other software in the execution environment is prevented from reading that key material, and what other mechanisms prevent the REK key material from being written to shared memory locations between the Rich OS and the separate execution environment.

If key derivation is performed using a REK, the evaluator shall ensure that the TSS description includes a description of the key derivation function and shall verify the key derivation uses an approved derivation mode and key expansion algorithm according to FCS_CKM_EXT.3.2.

The evaluator shall verify that the generation of a REK meets the FCS_RBG_EXT.1.1 and FCS_RBG_EXT.1.2 requirements:

- *If REK(s) is/are generated on-device, the TSS shall include a description of the generation mechanism including what triggers a generation, how the functionality described by FCS_RBG_EXT.1 is invoked, and whether a separate instance of the RBG is used for REK(s).*
- *If REK(s) is/are generated off-device, the TSS shall include evidence that the RBG meets FCS_RBG_EXT.1. This will likely necessitate a second set of RBG documentation equivalent to the documentation provided for the RBG assurance activities. In addition, the TSS shall describe the manufacturing process that prevents the device manufacturer from accessing any REK(s).*

FCS_CKM_EXT.2 Extended: Cryptographic Key Random Generation

FCS_CKM_EXT.2.1 All DEKs shall be [**selection**:

- *randomly generated*,
- *from the combination of a randomly generated DEK with another DEK or salt in a way that preserves the effective entropy of each factor by [**selection**: using an XOR operation, concatenating the keys and using a KDF (as described in SP 800-108), concatenating the keys and using a KDF (as described in SP 800-56C)]*

] with entropy corresponding to the security strength of AES key sizes of [**selection**: *128*, *256*] bits.

Application Note: The intent of this requirement is to ensure that the DEK cannot be recovered with less work than a full exhaust of the key space for AES. The key generation capability of the TOE uses a RBG implemented on the TOE device (FCS_RBG_EXT.1). Either 128-bit or 256-bit (or both) are allowed; the ST author makes the selection appropriate for the device. A DEK is used in addition to the KEK so that authentication factors can be changed without having to re-encrypt all of the user data on the device.

The ST author selects all applicable DEK generation types implemented by the TOE.

If combined, the ST author shall describe which method of combination is used in order to justify that the effective entropy of each factor is preserved, and the ST author shall describe that each combined value was originally generated from an Approved DRBG described in

FCS_RBG_EXT.1

The documentation of the product's encryption key management should be detailed enough that, after reading, the evaluator will thoroughly understand the product's key management and how it meets the requirements to ensure the keys are adequately protected. This documentation should include an essay and diagram(s). This documentation is not required to be part of the TSS - it can be submitted as a separate document and marked as developer proprietary.

SP 800-56C specifies a two-step key derivation procedure that employs an extraction-then-expansion technique for deriving keying material from a shared secret generated during a key establishment scheme. The Randomness Extraction step as described in Section 5 of SP 800-56C is followed by Key Expansion using the key derivation functions defined in SP 800-108 (as described in Section 6 of SP 800-56C).

Evaluation Activity

TSS
The evaluator shall examine the key hierarchy section of the TSS to ensure that the formation of all DEKs is described and that the key sizes match that described by the ST author. The evaluator shall examine the key hierarchy section of the TSS to ensure that each DEK is generated or combined from keys of equal or greater security strength using one of the selected methods.

- *If the symmetric DEK is generated by an RBG, the evaluator shall review the TSS to determine that it describes how the functionality described by FCS_RBG_EXT.1 is invoked. The evaluator uses the description of the RBG functionality in FCS_RBG_EXT.1 or documentation available for the operational environment to determine that the key size being requested is greater than or equal to the key size and mode to be used for the encryption/decryption of the data.*
- *If the DEK is formed from a combination, the evaluator shall verify that the TSS describes the method of combination and that this method is either an XOR, or a KDF.*
- *If "concatenating the keys and using a KDF (as described in (SP 800-56C)" is selected, the evaluator shall ensure the TSS includes a description of the randomness extraction step.*

The description must include how an approved untruncated MAC function is being used for the randomness extraction step and the evaluator must verify the TSS describes that the output length (in bits) of the MAC function is at least as large as the targeted security strength (in bits) of the parameter set employed by the key establishment scheme (see Tables 1-3 of SP 800-56C).

The description must include how the MAC function being used for the randomness extraction step is related to the PRF used in the key expansion and verify the TSS description includes the correct MAC function:

- *If an HMAC-hash is used in the randomness extraction step, then the same HMAC-hash (with the same hash function hash) is used as the PRF in the key expansion step.*
- *If an AES-CMAC (with key length 128, 192, or 256 bits) is used in the randomness extraction step, then AES-CMAC with a 128-bit key is used as the PRF in the key expansion step.*
- *The description must include the lengths of the salt values being used in the randomness extraction step and the evaluator shall verify the TSS description includes correct salt lengths:*
- *If an HMAC-hash is being used as the MAC, the salt length can be any value up to the maximum bit length permitted for input to the hash function hash.*
- *If an AES-CMAC is being used as the MAC, the salt length shall be the same length as the AES key (i.e. 128, 192, or 256 bits).*

(conditional) If a KDF is used, the evaluator shall ensure that the TSS includes a description of the key derivation function and shall verify the key derivation uses an approved derivation mode and key expansion algorithm according to SP 800-108 or SP 800-56C.

Guidance
The evaluator uses the description of the RBG functionality in FCS_RBG_EXT.1 or documentation available for the operational environment to determine that the key size being generated or combined is identical to the key size and mode to be used for the encryption/decryption of the data.

Tests
If a KDF is used, the evaluator shall perform one or more of the following tests to verify the correctness of the key derivation function, depending on the mode(s) that are supported. Table 3 maps the data fields to the notations used in SP 800-108 and SP 800-56C.

Table 3: Notations used in SP 800-108 and SP 800-56C

Data Fields	Notations

	SP 800-108	SP 800-56C
Pseudorandom function	PRF	PRF
Counter length	r	r
Length of output of PRF	h	h
Length of derived keying material	L	L
Length of input values	l length	l length
Pseudorandom input values I	K1 (key derivation key)	Z (shared secret)
Pseudorandom salt values	n/a	s
Randomness extraction MAC	n/a	MAC

Counter Mode Tests:

The evaluator shall determine the following characteristics of the key derivation function:

- *One or more pseudorandom functions that are supported by the implementation (PRF).*
- *One or more of the values {8, 16, 24, 32} that equal the length of the binary representation of the counter (r).*
- *The length (in bits) of the output of the PRF (h).*
- *Minimum and maximum values for the length (in bits) of the derived keying material (L). These values can be equal if only one value of L is supported. These must be evenly divisible by h.*
- *Up to two values of L that are NOT evenly divisible by h.*
- *Location of the counter relative to fixed input data: before, after, or in the middle.*
    - *Counter before fixed input data: fixed input data string length (in bytes), fixed input data string value.*
    - *Counter after fixed input data: fixed input data string length (in bytes), fixed input data string value.*
    - *Counter in the middle of fixed input data: length of data before counter (in bytes), length of data after counter (in bytes), value of string input before counter, value of string input after counter.*
- *The length (I_length) of the input values I.*

For each supported combination of I_length, MAC, salt, PRF, counter location, value of r, and value of L, the evaluator shall generate 10 test vectors that include pseudorandom input values I, and pseudorandom salt values. If there is only one value of L that is evenly divisible by h, the evaluator shall generate 20 test vectors for it. For each test vector, the evaluator shall supply this data to the TOE in order to produce the keying material output.

The results from each test may either be obtained by the evaluator directly or by supplying the inputs to the implementer and receiving the results in response. To determine correctness, the evaluator shall compare the resulting values to those obtained by submitting the same inputs to a known good implementation.

Feedback Mode Tests:

The evaluator shall determine the following characteristics of the key derivation function:

- *One or more pseudorandom functions that are supported by the implementation (PRF).*
- *The length (in bits) of the output of the PRF (h).*
- *Minimum and maximum values for the length (in bits) of the derived keying material (L). These values can be equal if only one value of L is supported. These must be evenly divisible by h.*
- *Up to two values of L that are NOT evenly divisible by h.*
- *Whether or not zero-length IVs are supported.*
- *Whether or not a counter is used, and if so:*
    - *One or more of the values {8, 16, 24, 32} that equal the length of the binary representation of the counter (r).*
    - *Location of the counter relative to fixed input data: before, after, or in the middle.*
        - *Counter before fixed input data: fixed input data string length (in bytes), fixed input data string value.*
        - *Counter after fixed input data: fixed input data string length (in bytes), fixed input data string value.*
        - *Counter in the middle of fixed input data: length of data before counter (in bytes), length of data after counter (in bytes), value of string input before counter, value of string input after counter.*

- *The length (I_length) of the input values I.*

For each supported combination of I_length, MAC, salt, PRF, counter location (if a counter is used), value of r (if a counter is used), and value of L, the evaluator shall generate 10 test vectors that include pseudorandom input values I and pseudorandom salt values. If the KDF supports zero-length IVs, five of these test vectors will be accompanied by pseudorandom IVs and the other five will use zero-length IVs. If zero-length IVs are not supported, each test vector will be accompanied by an pseudorandom IV. If there is only one value of L that is evenly divisible by h, the evaluator shall generate 20 test vectors for it.

For each test vector, the evaluator shall supply this data to the TOE in order to produce the keying material output. The results from each test may either be obtained by the evaluator directly or by supplying the inputs to the implementer and receiving the results in response. To determine correctness, the evaluator shall compare the resulting values to those obtained by submitting the same inputs to a known good implementation.

Double Pipeline Iteration Mode Tests:

The evaluator shall determine the following characteristics of the key derivation function:

- *One or more pseudorandom functions that are supported by the implementation (PRF).*
- *The length (in bits) of the output of the PRF (h).*
- *Minimum and maximum values for the length (in bits) of the derived keying material (L). These values can be equal if only one value of L is supported. These must be evenly divisible by h.*
- *Up to two values of L that are NOT evenly divisible by h.*
- *Whether or not a counter is used, and if so:*
  - *One or more of the values {8, 16, 24, 32} that equal the length of the binary representation of the counter (r).*
  - *Location of the counter relative to fixed input data: before, after, or in the middle.*
    - *Counter before fixed input data: fixed input data string length (in bytes), fixed input data string value.*
    - *Counter after fixed input data: fixed input data string length (in bytes), fixed input data string value.*
    - *Counter in the middle of fixed input data: length of data before counter (in bytes), length of data after counter (in bytes), value of string input before counter, value of string input after counter.*
- *The length (I_length) of the input values I.*

For each supported combination of I_length, MAC, salt, PRF, counter location (if a counter is used), value of r (if a counter is used), and value of L, the evaluator shall generate 10 test vectors that include pseudorandom input values I, and pseudorandom salt values. If there is only one value of L that is evenly divisible by h, the evaluator shall generate 20 test vectors for it.

For each test vector, the evaluator shall supply this data to the TOE in order to produce the keying material output. The results from each test may either be obtained by the evaluator directly or by supplying the inputs to the implementer and receiving the results in response. To determine correctness, the evaluator shall compare the resulting values to those obtained by submitting the same inputs to a known good implementation.

FCS_CKM_EXT.3 Extended: Cryptographic Key Generation

FCS_CKM_EXT.3.1 The TSF shall use [**selection**:

- *asymmetric KEKs of [**assignment**: security strength greater than or equal to 112 bits] security strength*,
- *symmetric KEKs of [**selection**: 128-bit, 256-bit] security strength corresponding to at least the security strength of the keys encrypted by the KEK*

].

Application Note: The ST author selects all applicable KEK types implemented by the TOE.

FCS_CKM_EXT.3.2 The TSF shall generate all KEKs using one of the following methods:

- Derive the KEK from a Password Authentication Factor according to FCS_COP.1.1/CONDITION and

[**selection**:

- *Generate the KEK using an RBG that meets this profile (as specified in FCS_RBG_EXT.1)*,
- *Generate the KEK using a key generation scheme that meets this profile (as specified in FCS_CKM.1)*,
- *Combine the KEK from other KEKs in a way that preserves the effective entropy of each factor by [**selection**: using an XOR operation, concatenating the keys and using a KDF (as described in SP 800-108), concatenating the keys and using a KDF (as described in SP 800-56C), encrypting one key with another]*

].

Application Note: The conditioning of passwords is performed in accordance with FCS_COP.1/CONDITION.

It is expected that key generation derived from conditioning, using an RBG or generation scheme, and through combination, will each be necessary to meet the requirements set out in this document. In particular, Figure 3 has KEKs of each type: KEK_3 is generated, KEK_1 is derived from a Password Authentication Factor, and KEK_2 is combined from two KEKs. In Figure 3, KEK_3 may either be a symmetric key generated from anRBG or an asymmetric key generated using a key generation scheme according to FCS_CKM.1.

If combined, the ST author shall describe which method of combination is used in order to justify that the effective entropy of each factor is preserved.

The documentation of the product's encryption key management should be detailed enough that, after reading, the evaluator will thoroughly understand the product's key management and how it meets the requirements to ensure the keys are adequately protected. This documentation should include an essay and diagram(s). This documentation is not required to be part of the TSS - it can be submitted as a separate document and marked as developer proprietary.

SP 800-56C specifies a two-step key derivation procedure that employs an extraction-then-expansion technique for deriving keying material from a shared secret generated during a key establishment scheme. The Randomness Extraction step as described in Section 5 of SP 800-56C is followed by Key Expansion using the key derivation functions defined in SP 800-108 (as described in Section 6 of SP 800-56C).

Evaluation Activity

TSS
The evaluator shall examine the key hierarchy section of the TSS to ensure that the formation of all KEKs are described and that the key sizes match that described by the ST author. The evaluator shall examine the key hierarchy section of theTSS to ensure that each key (DEKs, software-based key storage, and KEKs) is encrypted by keys of equal or greater security strength using one of the selected methods.

The evaluator shall review the TSS to verify that it contains a description of the conditioning used to derive KEKs. This description must include the size and storage location of salts. This activity may be performed in combination with that for FCS_COP.1/CONDITION.

(conditional) If the symmetric KEK is generated by an RBG, the evaluator shall review the TSS to determine that it describes how the functionality described by FCS_RBG_EXT.1 is invoked. The evaluator uses the description of the RBG functionality in FCS_RBG_EXT.1 or documentation available for the operational environment to determine that the key size being requested is greater than or equal to the key size and mode to be used for the encryption/decryption of the data.

(conditional) If the KEK is generated according to an asymmetric key scheme, the evaluator shall review the TSS to determine that it describes how the functionality described by FCS_CKM.1 is invoked. The evaluator uses the description of the key generation functionality in FCS_CKM.1 or documentation available for the operational environment to determine that the key strength being requested is greater than or equal to 112 bits.

(conditional) If the KEK is formed from a combination, the evaluator shall verify that the TSS describes the method of combination and that this method is either an XOR, a KDF, or encryption.

(conditional) If a KDF is used, the evaluator shall ensure that the TSS includes a description of the key derivation function and shall verify the key derivation uses an approved derivation mode and key expansion algorithm according to SP 800-108.

(conditional) If "concatenating the keys and using a KDF (as described in (SP 800-56C)" is selected, the evaluator shall ensure the TSS includes a description of the randomness extraction step. The description must include

- *How an approved untruncated MAC function is being used for the randomness extraction step and the evaluator must verify the TSS describes that the output length (in bits) of the MAC function is at least as large as the targeted security strength (in bits) of the parameter set employed by the key establishment scheme (see Tables 1-3 of SP 800-56C).*
- *How the MAC function being used for the randomness extraction step is related to the PRF used in the key expansion and verify the TSS description includes the correct MAC function:*
    - *If an HMAC-hash is used in the randomness extraction step, then the same HMAC-hash (with the same hash function hash) is used as the PRF in the key expansion step.*
    - *If an AES-CMAC (with key length 128, 192, or 256 bits) is used in the*

randomness extraction step, then AES-CMAC with a 128-bit key is used as the PRF in the key expansion step.

- *The lengths of the salt values being used in the randomness extraction step and the evaluator shall verify the TSS description includes correct salt lengths:*
  - *If an HMAC-hash is being used as the MAC, the salt length can be any value up to the maximum bit length permitted for input to the hash function hash.*
  - *If an AES-CMAC is being used as the MAC, the salt length shall be the same length as the AES key (i.e. 128, 192, or 256 bits).*

Tests
If a KDF is used, the evaluator shall perform one or more of the following tests to verify the correctness of the key derivation function, depending on the mode(s) that are supported. Table 4 maps the data fields to the notations used in SP 800-108 and SP 800-56C.

Table 4: Notations used in SP 800-108 and SP 800-56C

Data Fields	***Notations***	
	SP 800-108	***SP 800-56C***
Pseudorandom function	*PRF*	*PRF*
Counter length	*r*	*r*
Length of output of PRF	*h*	*h*
Length of derived keying material	*L*	*L*
Length of input values	*I_length*	*I_length*
Pseudorandom input values I	K_1 *(key derivation key)*	*Z (shared secret)*
Pseudorandom salt values	*n/a*	*s*
Randomness extraction MAC	*n/a*	*MAC*

Counter Mode Tests:

The evaluator shall determine the following characteristics of the key derivation function:

- *One or more pseudorandom functions that are supported by the implementation (PRF).*
- *One or more of the values {8, 16, 24, 32} that equal the length of the binary representation of the counter (r).*
- *The length (in bits) of the output of the PRF (h).*
- *Minimum and maximum values for the length (in bits) of the derived keying material (L). These values can be equal if only one value of L is supported. These must be evenly divisible by h.*
- *Up to two values of L that are NOT evenly divisible by h.*
- *Location of the counter relative to fixed input data: before, after, or in the middle.*
  - *Counter before fixed input data: fixed input data string length (in bytes), fixed input data string value.*
  - *Counter after fixed input data: fixed input data string length (in bytes), fixed input data string value.*
  - *Counter in the middle of fixed input data: length of data before counter (in bytes), length of data after counter (in bytes), value of string input before counter, value of string input after counter.*
- *The length (I_length) of the input values I.*

For each supported combination of I_length, MAC, salt, PRF, counter location, value of r, and value of L, the evaluator shall generate 10 test vectors that include pseudorandom input values I, and pseudorandom salt values. If there is only one value of L that is evenly divisible by h, the evaluator shall generate 20 test vectors for it. For each test vector, the evaluator shall supply this data to the TOE in order to produce the keying material output.

The results from each test may either be obtained by the evaluator directly or by supplying the inputs to the implementer and receiving the results in response. To determine correctness, the evaluator shall compare the resulting values to those obtained by submitting the same inputs to a known good implementation.

Feedback Mode Tests:
The evaluator shall determine the following characteristics of the key derivation function:

- *One or more pseudorandom functions that are supported by the implementation*

(PRF).
- *The length (in bits) of the output of the PRF (h).*
- *Minimum and maximum values for the length (in bits) of the derived keying material (L). These values can be equal if only one value of L is supported. These must be evenly divisible by h.*
- *Up to two values of L that are NOT evenly divisible by h.*
- *Whether or not zero-length IVs are supported.*
- *Whether or not a counter is used, and if so:*
  - *One or more of the values {8, 16, 24, 32} that equal the length of the binary representation of the counter (r).*
  - *Location of the counter relative to fixed input data: before, after, or in the middle.*
    - *Counter before fixed input data: fixed input data string length (in bytes), fixed input data string value.*
    - *Counter after fixed input data: fixed input data string length (in bytes), fixed input data string value.*
    - *Counter in the middle of fixed input data: length of data before counter (in bytes), length of data after counter (in bytes), value of string input before counter, value of string input after counter.*
- *The length (I_length) of the input values I.*

For each supported combination of I_length, MAC, salt, PRF, counter location (if a counter is used), value of r (if a counter is used), and value of L, the evaluator shall generate 10 test vectors that include pseudorandom input values I and pseudorandom salt values. If the KDF supports zero-length IVs, five of these test vectors will be accompanied by pseudorandom IVs and the other five will use zero-length IVs. If zero-length IVs are not supported, each test vector will be accompanied by an pseudorandom IV. If there is only one value of L that is evenly divisible by h, the evaluator shall generate 20 test vectors for it.

For each test vector, the evaluator shall supply this data to the TOE in order to produce the keying material output. The results from each test may either be obtained by the evaluator directly or by supplying the inputs to the implementer and receiving the results in response. To determine correctness, the evaluator shall compare the resulting values to those obtained by submitting the same inputs to a known good implementation.

Double Pipeline Iteration Mode Tests:
The evaluator shall determine the following characteristics of the key derivation function:
- *One or more pseudorandom functions that are supported by the implementation (PRF).*
- *The length (in bits) of the output of the PRF (h).*
- *Minimum and maximum values for the length (in bits) of the derived keying material (L). These values can be equal if only one value of L is supported. These must be evenly divisible by h.*
- *Up to two values of L that are NOT evenly divisible by h.*
- *Whether or not a counter is used, and if so:*
  - *One or more of the values {8, 16, 24, 32} that equal the length of the binary representation of the counter (r).*
  - *Location of the counter relative to fixed input data: before, after, or in the middle.*
    - *Counter before fixed input data: fixed input data string length (in bytes), fixed input data string value.*
    - *Counter after fixed input data: fixed input data string length (in bytes), fixed input data string value.*
    - *Counter in the middle of fixed input data: length of data before counter (in bytes), length of data after counter (in bytes), value of string input before counter, value of string input after counter.*
- *The length (I_length) of the input values I.*

For each supported combination of I_length, MAC, salt, PRF, counter location (if a counter is used), value of r (if a counter is used), and value of L, the evaluator shall generate 10 test vectors that include pseudorandom input values I, and pseudorandom salt values. If there is only one value of L that is evenly divisible by h, the evaluator shall generate 20 test vectors for it.

For each test vector, the evaluator shall supply this data to the TOE in order to produce the keying material output. The results from each test may either be obtained by the evaluator directly or by supplying the inputs to the implementer and receiving the results in response. To determine correctness, the evaluator shall compare the resulting values to those obtained by submitting the same inputs to a known good implementation.

FCS_CKM_EXT.4 Extended: Key Destruction

FCS_CKM_EXT.4.1 The TSF shall destroy cryptographic keys in accordance with the specified cryptographic key destruction methods:
- by clearing the KEK encrypting the target key

- in accordance with the following rules
  - For volatile memory, the destruction shall be executed by a single direct overwrite [**selection**: *consisting of a pseudo-random pattern using the TSF's RBG*, *consisting of zeroes*].
  - For non-volatile EEPROM, the destruction shall be executed by a single direct overwrite consisting of a pseudo random pattern using the TSF's RBG (as specified in FCS_RBG_EXT.1), followed by a read-verify.
  - For non-volatile flash memory, that is not wear-leveled, the destruction shall be executed [**selection**: *by a single direct overwrite consisting of zeros followed by a read-verify*, *by a block erase that erases the reference to memory that stores data as well as the data itself*].
  - For non-volatile flash memory, that is wear-leveled, the destruction shall be executed [**selection**: *by a single direct overwrite consisting of zeros*, *by a block erase*].
  - For non-volatile memory other than EEPROM and flash, the destruction shall be executed by a single direct overwrite with a random pattern that is changed before each write.

Application Note: The clearing indicated above applies to each intermediate storage area for plaintext key/cryptographic critical security parameter (i.e. any storage, such as memory buffers, that is included in the path of such data) upon the transfer of the key/cryptographic critical security parameter to another location.

Because plaintext key material is not allowed to be written to non-volatile memory (FPT_KST_EXT.1), the second selection only applies to key material written to volatile memory.

FCS_CKM_EXT.4.2 The TSF shall destroy all plaintext keying material and critical security parameters when no longer needed.

Application Note: For the purposes of this requirement, plaintext keying material refers to authentication data, passwords, secret/private symmetric keys, private asymmetric keys, data used to derive keys, values derived from passwords, etc. If a BAF is selected in FIA_UAU.5.1 the enrollment or authentication templates are not subject to this requirement, since templates are not suitable for deriving keying material. However, source biometric data (i.e. fingerprint image or friction ridge pattern), the features an algorithm uses to perform biometric authentication for enrollment or verification (e.g. location of minutia), threshold values used in making the match adjudication, intermediate values calculated while building an enrollment or authentication template (i.e. direction maps, minutia counts, binarized and skeletonized representations of friction ridge patterns, etc.), and final match scores are examples of critical security parameters that must be destroyed when no longer needed.

Key destruction procedures are performed in accordance with FCS_CKM_EXT.4.1.

There are multiple situations in which plaintext keying material is no longer necessary, including when the TOE is powered off, when the wipe function is performed, when trusted channels are disconnected, when keying material is no longer needed by the trusted channel per the protocol, and when transitioning to the locked state (for those values derived from the Password Authentication Factor or that key material which is protected by the password-derived or biometric-unlocked KEK according to FCS_STG_EXT.2 – see Figure 3). For keys (or key material used to derive those keys) protecting sensitive data received in the locked state, "no longer needed" includes "while in the locked state."

Trusted channels may include TLS, HTTPS, DTLS, IPsec VPNs, Bluetooth BR/EDR, and Bluetooth LE. The plaintext keying material for these channels includes (but is not limited to) master secrets, and Security Associations (SAs).

If REK(s) are processed in a separate execution environment on the same Application Processor as the Rich OS, REK key material must be cleared from RAM immediately after use, and at least, must be wiped when the device is locked, as the REK is part of the key hierarchy protecting sensitive data.

Evaluation Activity

TSS
The evaluator shall check to ensure the TSS lists each type of plaintext key material (DEKs, software-based key storage, KEKs, trusted channel keys, passwords, etc.) and its generation and storage location.

The evaluator shall verify that the TSS describes when each type of key material is cleared (for example, on system power off, on wipe function, on disconnection of trusted channels, when no longer needed by the trusted channel per the protocol, when transitioning to the locked state, and possibly including immediately after use, while in the locked state, etc.).

The evaluator shall also verify that, for each type of key, the type of clearing procedure that is performed (cryptographic erase, overwrite with zeros, overwrite with random pattern, or block erase) is listed. If different types of memory are used to store the materials to be protected, the evaluator shall check to ensure that the TSS describes the

clearing procedure in terms of the memory in which the data are stored.

Tests
Assurance Activity Note:*The following tests require the developer to provide access to a test platform that provides the evaluator with tools that are typically not found on factory products.*

For each software and firmware key clearing situation (including on system power off, on wipe function, on disconnection of trusted channels, when no longer needed by the trusted channel per the protocol, when transitioning to the locked state, and possibly including immediately after use, while in the locked state) the evaluator shall repeat the following tests.

For these tests the evaluator shall utilize appropriate development environment (e.g. a Virtual Machine) and development tools (debuggers, simulators, etc.) to test that keys are cleared, including all copies of the key that may have been created internally by the TOE during normal cryptographic processing with that key.

- ***Test 1:*** *Applied to each key held as plaintext in volatile memory and subject to destruction by overwrite by the TOE (whether or not the plaintext value is subsequently encrypted for storage in volatile or non-volatile memory). In the case where the only selection made for the destruction method key was removal of power, then this test is unnecessary. The evaluator shall:*
  1. *Record the value of the key in theTOE subject to clearing.*
  2. *Cause the TOE to perform a normal cryptographic processing with the key from Step #1.*
  3. *Cause the TOE to clear the key.*
  4. *Cause the TOE to stop the execution but not exit.*
  5. *Cause the TOE to dump the entire memory of theTOE into a binary file.*
  6. *Search the content of the binary file created in Step #5 for instances of the known key value from Step #1.*
  7. *Break the key value from Step #1 into 3 similar sized pieces and perform a search using each piece.*

  Steps 1-6 ensure that the complete key does not exist anywhere in volatile memory. If a copy is found, then the test fails.

  Step 7 ensures that partial key fragments do not remain in memory. If a fragment is found, there is a minuscule chance that it is not within the context of a key (e.g., some random bits that happen to match). If this is the case the test should be repeated with a different key in Step #1. If a fragment is found the test fails.

- ***Test 2:*** *Applied to each key held in non-volatile memory and subject to destruction by overwrite by the TOE. The evaluator shall use special tools (as needed), provided by the TOE developer if necessary, to view the key storage location:*
  1. *Record the value of the key in theTOE subject to clearing.*
  2. *Cause the TOE to perform a normal cryptographic processing with the key from Step #1.*
  3. *Cause the TOE to clear the key.*
  4. *Search the non-volatile memory the key was stored in for instances of the known key value from Step #1. If a copy is found, then the test fails.*
  5. *Break the key value from Step #1 into 3 similar sized pieces and perform a search using each piece. If a fragment is found then the test is repeated (as described for test 1 above), and if a fragment is found in the repeated test then the test fails.*

- ***Test 3:*** *Applied to each key held as non-volatile memory and subject to destruction by overwrite by the TOE. The evaluator shall use special tools (as needed), provided by the TOE developer if necessary, to view the key storage location:*
  1. *Record the storage location of the key in theTOE subject to clearing.*
  2. *Cause the TOE to perform a normal cryptographic processing with the key from Step #1.*
  3. *Cause the TOE to clear the key.*
  4. *Read the storage location in Step #1 of non-volatile memory to ensure the appropriate pattern is utilized.*

  The test succeeds if correct pattern is used to overwrite the key in the memory location. If the pattern is not found the test fails.

FCS_CKM_EXT.5 Extended: TSF Wipe

FCS_CKM_EXT.5.1 The TSF shall wipe all protected data by [**selection**:

- *Cryptographically erasing the encrypted DEKs and/or the KEKs in non-volatile memory by following the requirements in FCS_CKM_EXT.4.1*,
- *Overwriting all according to the following rules:*
  - *For EEPROM, the destruction shall be executed by a single direct overwrite consisting of a pseudo random pattern using the TSF's RBG (as specified in*

FCS_RBG_EXT.1, followed by a read-verify.
- *For flash memory, that is not wear-leveled, the destruction shall be executed [**selection**: by a single direct overwrite consisting of zeros followed by a read-verify, by a block erase that erases the reference to memory that stores data as well as the data itself].*
- *For flash memory, that is wear-leveled, the destruction shall be executed [**selection**: by a single direct overwrite consisting of zeros, by a block erase].*
- *For non-volatile memory other than EEPROM and flash, the destruction shall be executed by a single direct overwrite with a random pattern that is changed before each write.*

].

Application Note: Protected data is all non-TSF data, including all user or enterprise data. Some or all of this data may be considered sensitive data as well.

FCS_CKM_EXT.5.2 The TSF shall perform a power cycle on conclusion of the wipe procedure.

Application Note: The ST author shall select which method of wipe the TSF performs.

Evaluation Activity

TSS
The evaluator shall check to ensure the TSS describes how the device is wiped; and the type of clearing procedure that is performed (cryptographic erase or overwrite) and, if overwrite is performed, the overwrite procedure (overwrite with zeros, overwrite three or more times by a different alternating pattern, overwrite with random pattern, or block erase). If different types of memory are used to store the data to be protected, the evaluator shall check to ensure that the TSS describes the clearing procedure in terms of the memory in which the data are stored (for example, data stored on flash are cleared by overwriting once with zeros, while data stored on the internal persistent storage device are cleared by overwriting three times with a random pattern that is changed before each write).

Tests
Assurance Activity Note: *The following test may require the developer to provide access to a test platform that provides the evaluator with tools that are typically not found on consumer Mobile Device products.*

- ***Test 1:*** *The evaluator shall perform one of the following tests. The test before and after the wipe command shall be identical. This test shall be repeated for each type of memory used to store the data to be protected.*
  - ***Test 1.1: For File-based Methods:***
    The evaluator shall enable encryption according to the AGD guidance. The evaluator shall create a user data (protected data or sensitive data) file, for example, by using an application. The evaluator shall use a tool provided by the developer to examine this data stored in memory (for example, by examining a decrypted files). The evaluator shall initiate the wipe command according to the AGD guidance provided for FMT_SMF_EXT.1. The evaluator shall use a tool provided by the developer to examine the same data location in memory to verify that the data has been wiped according to the method described in the TSS (for example, the files are still encrypted and cannot be accessed).
  - ***Test 1.2: For Volume-based Methods:***
    The evaluator shall enable encryption according to the AGD guidance. The evaluator shall create a unique data string, for example, by using an application. The evaluator shall use a tool provided by the developer to search decrypted data for the unique string. The evaluator shall initiate the wipe command according to the AGD guidance provided for FMT_SMF_EXT.1. The evaluator shall use a tool provided by the developer to search for the same unique string in decrypted memory to verify that the data has been wiped according to the method described in the TSS (for example, the files are still encrypted and cannot be accessed).
- ***Test 2:*** *The evaluator shall cause the device to wipe and verify that the wipe concludes with a power cycle.*

FCS_CKM_EXT.6 Extended: Salt Generation

FCS_CKM_EXT.6.1 The TSF shall generate all salts using a RBG that meets FCS_RBG_EXT.1.

Application Note: This requirement refers only to salt generation. In the examples given, a salt may be used as part of the scheme/algorithm. Requirements on nonces and/or ephemeral keys are provided elsewhere, if needed. The list below is provided for clarity, in order to give examples of where the TSF may be generating cryptographic salts; it is not exhaustive nor is it intended to mandate implementation of all of these schemes/algorithms. Cryptographic salts are generated for various uses including:

- RSASSA-PSS signature generation

- DSA signature generation
- ECDSA signature generation
- DH static key agreement scheme
- PBKDF
- Key Agreement Scheme in NIST SP 800-56B
- AES GCM

Evaluation Activity

> ***TSS***
> *The evaluator shall verify that the TSS contains a description regarding the salt generation, including which algorithms on the TOE require salts. The evaluator shall confirm that the salt is generated using an RBG described in FCS_RBG_EXT.1. For PBKDF derivation of KEKs, this assurance activity may be performed in conjunction with FCS_CKM_EXT.3.2.*

FCS_CKM_EXT.7 Extended: Cryptographic Key Support (REK)

> ***This is a selection-based component. Its inclusion depends upon selection from FCS_CKM_EXT.1.1.***

FCS_CKM_EXT.7.1 A REK shall not be able to be read from or exported from the hardware.

Application Note: If "mutable-hardware" is selected in FCS_CKM_EXT.1.1, FCS_CKM_EXT.7 must be included in the ST. Note that if "immutable-hardware" is selected in FCS_CKM_EXT.1.1 it implicitly meets FCS_CKM_EXT.7.

The lack of a public/documented API for importing or exporting, when a private/undocumented API exists, is not sufficient to meet this requirement.

Evaluation Activity

> ***Tests***
> *The assurance activity for this element is performed in conjunction with the assurance activity for FCS_CKM_EXT.1.*

FCS_COP.1/ENCRYPT Cryptographic operation

FCS_COP.1.1/ENCRYPT The TSF shall perform encryption/decryption in accordance with a specified cryptographic algorithm:

- AES-CBC (as defined in FIPS PUB 197, and NIST SP 800-38A) mode
- AES-CCMP (as defined in FIPS PUB 197, NIST SP 800-38C and IEEE 802.11-2012), and
- [**selection**:
  - *AES Key Wrap (KW) (as defined in NIST SP 800-38F)*,
  - *AES Key Wrap with Padding (KWP) (as defined in NIST SP 800-38F)*,
  - *AES-GCM (as defined in NIST SP 800-38D)*,
  - *AES-CCM (as defined in NIST SP 800-38C)*,
  - *AES-XTS (as defined in NIST SP 800-38E) mode*,
  - *AES-CCMP-256 (as defined in NIST SP800-38C and IEEE 802.11ac-2013)*,
  - *AES-GCMP-256 (as defined in NIST SP800-38D and IEEE 802.11ac-2013)*,
  - *no other modes*

  ]

and cryptographic key sizes 128-bit key sizes and [**selection**: *256-bit key sizes*, *no other key sizes*].

Application Note: For the first selection, the ST author should choose the mode or modes in which AES operates. For the second selection, the ST author should choose the key sizes that are supported by this functionality. 128-bit CBC and CCMP are required in order to comply with WLAN Client Extended Package.

Note that to comply with the WLAN Client EP, AES CCMP (which uses AES in CCM as specified in SP 800-38C) with cryptographic key size of 128 bits must be implemented. If CCM is only implemented to support CCMP for WLAN, AES-CCM does not need be selected. Optionally, AES-CCMP-256 or AES-GCMP-256 with cryptographic key size of 256 bits may be implemented.

Evaluation Activity

> ***Tests***
> ***Assurance Activity Note:*** *The following tests require the developer to provide access to a test platform that provides the evaluator with tools that are typically not found on factory products.*
>
> ***AES-CBC Tests***

- ***Test 1:*** *AES-CBC Known Answer Tests*

  There are four Known Answer Tests (KATs), described below. In all KATs, the plaintext, ciphertext, and IV values shall be 128-bit blocks. The results from each test may either be obtained by the evaluator directly or by supplying the inputs to the implementer and receiving the results in response. To determine correctness, the evaluator shall compare the resulting values to those obtained by submitting the same inputs to a known good implementation.

  - ***Test 1.1:*** *KAT-1. To test the encrypt functionality ofAES-CBC, the evaluator shall supply a set of 10 plaintext values and obtain the ciphertext value that results from AES-CBC encryption of the given plaintext using a key value of all zeros and an IV of all zeros. Five plaintext values shall be encrypted with a 128-bit all-zeros key, and the other five shall be encrypted with a 256-bit all-zeros key.*

    To test the decrypt functionality of AES-CBC, the evaluator shall perform the same test as for encrypt, using 10 ciphertext values as input and AES-CBC decryption.

  - ***Test 1.2:*** *KAT-2. To test the encrypt functionality ofAES-CBC, the evaluator shall supply a set of 10 key values and obtain the ciphertext value that results from AES-CBC encryption of an all-zeros plaintext using the given key value and an IV of all zeros. Five of the keys shall be 128-bit keys, and the other five shall be 256-bit keys.*

    To test the decrypt functionality of AES-CBC, the evaluator shall perform the same test as for encrypt, using an all-zero ciphertext value as input and AES-CBC decryption.

  - ***Test 1.3:*** *KAT-3. To test the encrypt functionality ofAES-CBC, the evaluator shall supply the two sets of key values described below and obtain the ciphertext value that results from AES encryption of an all-zeros plaintext using the given key value and an IV of all zeros. The first set of keys shall have 128 128-bit keys, and the second set shall have 256 256-bit keys. Key i in each set shall have the leftmost i bits be ones and the rightmost N-i bits be zeros, for i in [1,N].*

    To test the decrypt functionality of AES-CBC, the evaluator shall supply the two sets of key and ciphertext value pairs described below and obtain the plaintext value that results from AES-CBC decryption of the given ciphertext using the given key and an IV of all zeros. The first set of key/ciphertext pairs shall have 128 128-bit key/ciphertext pairs, and the second set of key/ciphertext pairs shall have 256 256-bit key/ciphertext pairs. Key i in each set shall have the leftmost i bits be ones and the rightmost N-i bits be zeros, for i in [1,N]. The ciphertext value in each pair shall be the value that results in an all-zeros plaintext when decrypted with its corresponding key.

  - ***Test 1.4:*** *KAT-4. To test the encrypt functionality ofAES-CBC, the evaluator shall supply the set of 128 plaintext values described below and obtain the two ciphertext values that result from AES-CBC encryption of the given plaintext using a 128-bit key value of all zeros with an IV of all zeros and using a 256-bit key value of all zeros with an IV of all zeros, respectively. Plaintext value i in each set shall have the leftmost i bits be ones and the rightmost 128-i bits be zeros, for i in [1,128].*

    To test the decrypt functionality of AES-CBC, the evaluator shall perform the same test as for encrypt, using ciphertext values of the same form as the plaintext in the encrypt test as input and AES-CBC decryption.

- ***Test 2:*** *AES-CBC Multi-Block Message Test*

  The evaluator shall test the encrypt functionality by encrypting an i-block message where 1 < i <= 10. The evaluator shall choose a key, an IV and plaintext message of length i blocks and encrypt the message, using the mode to be tested, with the chosen key and IV. The ciphertext shall be compared to the result of encrypting the same plaintext message with the same key and IV using a known good implementation.

  The evaluator shall also test the decrypt functionality for each mode by decrypting an i-block message where 1 < i <= 10. The evaluator shall choose a key, an IV and a ciphertext message of length i blocks and decrypt the message, using the mode to be tested, with the chosen key and IV. The plaintext shall be compared to the result of decrypting the same ciphertext message with the same key and IV using a known good implementation.

- ***Test 3:*** *AES-CBC Monte Carlo Tests*

  The evaluator shall test the encrypt functionality using a set of 200 plaintext, IV,

and key 3-tuples. 100 of these shall use 128 bit keys, and 100 shall use 256 bit keys. The plaintext and IV values shall be 128-bit blocks. For each 3-tuple, 1000 iterations shall be run as follows:

```
# Input: PT, IV, Key for i = 1 to 1000: if i == 1: CT[1] =
        AES-CBC-Encrypt(Key, IV, PT) PT = IV else: CT[i] = AES-CBC-Encrypt(Key, PT) PT
        = CT[i-1]
```

The ciphertext computed in the 1000th iteration (i.e. CT[1000]) is the result for that trial. This result shall be compared to the result of running 1000 iterations with the same values using a known good implementation.

The evaluator shall test the decrypt functionality using the same test as for encrypt, exchanging CT and PT and replacing AES-CBC-Encrypt with AES-CBC-Decrypt.

AES-CCM Tests

- ***Test 1:*** *The evaluator shall test the generation-encryption and decryption-verification functionality of AES-CCM for the following input parameter and tag lengths:*

  128 bit and 256 bit keys

  Two payload lengths. *One payload length shall be the shortest supported payload length, greater than or equal to zero bytes. The other payload length shall be the longest supported payload length, less than or equal to 32 bytes (256 bits).*

  Two or three associated data lengths. *One associated data length shall be 0, if supported. One associated data length shall be the shortest supported payload length, greater than or equal to zero bytes. One associated data length shall be the longest supported payload length, less than or equal to 32 bytes (256 bits). If the implementation supports an associated data length of 2^{16} bytes, an associated data length of 2^{16} bytes shall be tested.*

  Nonce lengths. *All supported nonce lengths between 7 and 13 bytes, inclusive, shall be tested.*

  Tag lengths. *All supported tag lengths of 4, 6, 8, 10, 12, 14 and 16 bytes shall be tested.*

  To test the generation-encryption functionality of AES-CCM, the evaluator shall perform the following four tests:

  - ***Test 1.1:*** *For EACH supported key and associated data length and ANY supported payload, nonce and tag length, the evaluator shall supply one key value, one nonce value and 10 pairs of associated data and payload values and obtain the resulting ciphertext.*

  - ***Test 1.2:*** *For EACH supported key and payload length and ANY supported associated data, nonce and tag length, the evaluator shall supply one key value, one nonce value and 10 pairs of associated data and payload values and obtain the resulting ciphertext.*

  - ***Test 1.3:*** *For EACH supported key and nonce length and ANY supported associated data, payload and tag length, the evaluator shall supply one key value and 10 associated data, payload and nonce value 3-tuples and obtain the resulting ciphertext.*

  - ***Test 1.4:*** *For EACH supported key and tag length and ANY supported associated data, payload and nonce length, the evaluator shall supply one key value, one nonce value and 10 pairs of associated data and payload values and obtain the resulting ciphertext.*

  To determine correctness in each of the above tests, the evaluator shall compare the ciphertext with the result of generation-encryption of the same inputs with a known good implementation.

  To test the decryption-verification functionality of AES-CCM, for EACH combination of supported associated data length, payload length, nonce length and tag length, the evaluator shall supply a key value and 15 nonce, associated data and ciphertext 3-tuples and obtain either a FAIL result or a PASS result with the decrypted payload. The evaluator shall supply 10 tuples that should FAIL and 5 that should PASS per set of 15.

AES-GCM Test

The evaluator shall test the authenticated encrypt functionality of AES-GCM for each combination of the following input parameter lengths:

128 bit and 256 bit keys

Two plaintext lengths. *One of the plaintext lengths shall be a non-zero integer multiple of 128 bits, if supported. The other plaintext length shall not be an integer multiple of 128 bits, if supported.*

Three AAD lengths. *One AAD length shall be 0, if supported. One AAD length shall be a non-zero integer multiple of 128 bits, if supported. One AAD length shall not be an integer multiple of 128 bits, if supported.*

Two IV lengths. *If 96 bit IV is supported, 96 bits shall be one of the two IV lengths tested.*

- ***Test 1:*** *The evaluator shall test the encrypt functionality using a set of 10 key, plaintext, AAD, and IV tuples for each combination of parameter lengths above and obtain the ciphertext value and tag that results from AES-GCM authenticated encrypt. Each supported tag length shall be tested at least once per set of 10. The IV value may be supplied by the evaluator or the implementation being tested, as long as it is known.*

- ***Test 2:*** *The evaluator shall test the decrypt functionality using a set of 10 key, ciphertext, tag, AAD, and IV 5-tuples for each combination of parameter lengths above and obtain a Pass/Fail result on authentication and the decrypted plaintext if Pass. The set shall include five tuples that Pass and five that Fail.*

The results from each test may either be obtained by the evaluator directly or by supplying the inputs to the implementer and receiving the results in response. To determine correctness, the evaluator shall compare the resulting values to those obtained by submitting the same inputs to a known good implementation.

XTS-AES Test

- ***Test 1:*** *The evaluator shall test the encrypt functionality ofXTS-AES for each combination of the following input parameter lengths:*

256 bit (for AES-128) and 512 bit (for AES-256) keys

Three data unit (i.e. plaintext) lengths. *One of the data unit lengths shall be a non-zero integer multiple of 128 bits, if supported. One of the data unit lengths shall be an integer multiple of 128 bits, if supported. The third data unit length shall be either the longest supported data unit length or 216 bits, whichever is smaller.*

using a set of 100 (key, plaintext and 128-bit random tweak value) 3-tuples and obtain the ciphertext that results from XTS-AES encrypt.

The evaluator may supply a data unit sequence number instead of the tweak value if the implementation supports it. The data unit sequence number is a base-10 number ranging between 0 and 255 that implementations convert to a tweak value internally.

- ***Test 2:*** *The evaluator shall test the decrypt functionality ofXTS-AES using the same test as for encrypt, replacing plaintext values with ciphertext values and XTS-AES encrypt with XTS-AES decrypt.*

AES Key Wrap (AES-KW) and Key Wrap with Padding (AES-KWP) Test

- ***Test 1:*** *The evaluator shall test the authenticated encryption functionality of AES-KW for EACH combination of the following input parameter lengths:*

128 and 256 bit key encryption keys (KEKs)

Three plaintext lengths. *One of the plaintext lengths shall be two semi-blocks (128 bits). One of the plaintext lengths shall be three semi-blocks (192 bits). The third data unit length shall be the longest supported plaintext length less than or equal to 64 semi-blocks (4096 bits).*

using a set of 100 key and plaintext pairs and obtain the ciphertext that results from AES-KW authenticated encryption. To determine correctness, the evaluator shall use the AES-KW authenticated-encryption function of a known good implementation.

- ***Test 2:*** *The evaluator shall test the authenticated-decryption functionality of AES-KW using the same test as for authenticated-encryption, replacing plaintext values with ciphertext values and AES-KW authenticated-encryption with AES-KW authenticated-decryption.*

- ***Test 3:*** *The evaluator shall test the authenticated-encryption functionality of AES-KWP using the same test as for AES-KW authenticated-encryption with the following change in the three plaintext lengths:*
  - *One plaintext length shall be one octet. One plaintext length shall be 20 octets (160 bits).*

- *One plaintext length shall be the longest supported plaintext length less than or equal to 512 octets (4096 bits).*

- ***Test 4:*** *The evaluator shall test the authenticated-decryption functionality of AES-KWP using the same test as for AES-KWP authenticated-encryption, replacing plaintext values with ciphertext values and AES-KWP authenticated-encryption with AES-KWP authenticated-decryption.*

FCS_COP.1/HASH Cryptographic operation

FCS_COP.1.1/HASH The TSF shall perform cryptographic hashing in accordance with a specified cryptographic algorithm SHA-1 and [**selection**: *SHA-256, SHA-384, SHA-512, no other algorithms*] and message digest sizes 160 and [**selection**: *256, 384, 512 bits, no other message digest sizes*] that meet the following: FIPS Pub 180-4.

Application Note: Per NIST SP 800-131A, SHA-1 for generating digital signatures is no longer allowed, and SHA-1 for verification of digital signatures is strongly discouraged as there may be risk in accepting these signatures. It is expected that vendors will implement SHA-2 algorithms in accordance with SP 800-131A.

SHA-1 is currently required in order to comply with the WLAN Client Extended Package. Vendors are strongly encouraged to implement updated protocols that support the SHA-2 family; until updated protocols are supported, this PP allows support for SHA-1 implementations in compliance with SP 800-131A.

The intent of this requirement is to specify the hashing function. The hash selection must support the message digest size selection. The hash selection should be consistent with the overall strength of the algorithm used (for example, SHA 256 for 128-bit keys).

The TSF hashing functions can be implemented in one of two modes. The first mode is the byteoriented mode. In this mode the TSF only hashes messages that are an integral number of bytes in length; i.e. the length (in bits) of the message to be hashed is divisible by 8. The second mode is the bitoriented mode. In this mode the TSF hashes messages of arbitrary length. The TSF may implement either bit-oriented or byte-oriented; both implementations are not required.

Evaluation Activity

TSS
The evaluator shall check that the association of the hash function with other TSF cryptographic functions (for example, the digital signature verification function) is documented in the TSS. The evalutator shall check that the TSS indicates if the hashing function is implemented in bit-oriented and/or byte-oriented mode.

Guidance
The evaluator checks the AGD documents to determine that any configuration that is required to be done to configure the functionality for the required hash sizes is present.

Tests
Assurance Activity Note: *The following tests require the developer to provide access to a test platform that provides the evaluator with tools that are typically not found on factory products.*

The evaluator shall perform all of the following tests for each hash algorithm implemented by the TSF and used to satisfy the requirements of this PP. As there are different tests for each mode, an indication is given in the following sections for the bit-oriented vs. the byteoriented testmacs.

- ***Test 1:*** *Short Messages Test: Bit-oriented Mode*
  The evaluators devise an input set consisting of m+1 messages, where m is the block length of the hash algorithm. The length of the messages ranges sequentially from 0 to m bits. The message text shall be pseudorandomly generated. The evaluators compute the message digest for each of the messages and ensure that the correct result is produced when the messages are provided to the TSF.

- ***Test 2:*** *Short Messages Test: Byte-oriented Mode*
  The evaluators devise an input set consisting of m/8+1 messages, where m is the block length of the hash algorithm. The length of the messages range sequentially from 0 to m/8 bytes, with each message being an integral number of bytes. The message text shall be pseudorandomly generated. The evaluators compute the message digest for each of the messages and ensure that the correct result is produced when the messages are provided to the TSF.

- ***Test 3:*** *Selected Long Messages Test: Bit-oriented Mode*
  *The evaluators devise an input set consisting of m messages, where m is the block length of the hash algorithm. The length of the ith message is 512 + 99*i,*

where 1 ≤ i ≤ m. The message text shall be pseudorandomly generated. The evaluators compute the message digest for each of the messages and ensure that the correct result is produced when the messages are provided to the TSF.

- ***Test 4:*** *Selected Long Messages Test: Byte-oriented Mode*
  *The evaluators devise an input set consisting of m/8 messages, where m is the block length of the hash algorithm. The length of the ith message is 512 + 8*99*i, where 1 ≤ i ≤ m/8. The message text shall be pseudorandomly generated. The evaluators compute the message digest for each of the messages and ensure that the correct result is produced when the messages are provided to the TSF.*

- ***Test 5:*** *Pseudorandomly Generated Messages Test: Byte-oriented Mode*
  This test is for byteoriented implementations only. The evaluators randomly generate a seed that is n bits long, where n is the length of the message digest produced by the hash function to be tested. The evaluators then formulate a set of 100 messages and associated digests by following the algorithm provided in Figure 1 of SHAVS. The evaluators then ensure that the correct result is produced when the messages are provided to the TSF.

FCS_COP.1/SIGN Cryptographic operation

FCS_COP.1.1/SIGN The TSF shall perform cryptographic signature services (generation and verification) in accordance with a specified cryptographic algorithm[**selection**:

- *RSA schemes using cryptographic key sizes of 2048-bit or greater that meet the following: FIPS PUB 186-4, "Digital Signature Standard (DSS)", Section 4*,
- *ECDSA schemes using "NIST curves" P-384 and [**selection**: P-256, P-521, no other curves] that meet the following: FIPS PUB 186-4, "Digital Signature Standard (DSS)", Section 5*,
- *No other algorithms*

].

Application Note: The ST Author should choose the algorithm implemented to perform digital signatures; if more than one algorithm is available, this requirement should be iterated to specify the functionality. For the algorithm chosen, the ST author should make the appropriate assignments/selections to specify the parameters that are implemented for that algorithm.

Evaluation Activity

Tests
Assurance Activity Note: *The following tests require the developer to provide access to a test platform that provides the evaluator with tools that are typically not found on factory products.*

- ***Test 1: ECDSA Algorithm Tests***
  - ***Test 1.1: ECDSA FIPS 186-4 Signature Generation Test***
    For each supported NIST curve (i.e. P-256, P-384 and P-521) and SHA function pair, the evaluator shall generate 10 1024-bit long messages and obtain for each message a public key and the resulting signature values R and S. To determine correctness, the evaluator shall use the signature verification function of a known good implementation.

  - ***Test 1.2: ECDSA FIPS 186-4 Signature Verification Test***
    For each supported NIST curve (i.e. P-256, P-384 and P-521) and SHA function pair, the evaluator shall generate a set of 10 1024-bit message, public key and signature tuples and modify one of the values (message, public key or signature) in five of the 10 tuples. The evaluator shall obtain in response a set of 10 PASS/FAIL values.
- ***Test 2: RSA Signature Algorithm Tests***
  - ***Test 2.1: Signature Generation Test***
    The evaluator shall verify the implementation of RSA Signature Generation by the TOE using the Signature Generation Test. To conduct this test the evaluator must generate or obtain 10 messages from a trusted reference implementation for each modulus size/SHA combination supported by the TSF. The evaluator shall have the TOE use their private key and modulus value to sign these messages.

    The evaluator shall verify the correctness of the TSF's signature using a known good implementation and the associated public keys to verify the signatures.

  - ***Test 2.2: Signature Verification Test***
    The evaluator shall perform the Signature Verification test to verify the ability of the TOE to recognize another party's valid and invalid signatures. The evaluator shall inject errors into the test vectors produced during the Signature Verification Test by introducing errors in some of the public keys e,

messages, IR format, and/or signatures. The TOE attempts to verify the signatures and returns success or failure.

The evaluator shall use these test vectors to emulate the signature verification test using the corresponding parameters and verify that the TOE detects these errors.

FCS_COP.1/KEYHMAC Cryptographic operation

FCS_COP.1.1/KEYHMAC The TSF shall perform keyed-hash message authentication in accordance with a specified cryptographic algorithm HMAC-SHA-1 and [**selection**: *HMAC-SHA-256, HMAC-SHA-384, HMAC-SHA-512, no other algorithms*] and cryptographic key sizes [**assignment**: *key size (in bits) used in HMAC*] and message digest sizes 160 and [**selection**: *256, 384, 512, no other*] bits that meet the following: FIPS Pub 198-1, "The Keyed-Hash Message Authentication Code", and FIPS Pub 180-4, "Secure Hash Standard".

Application Note: The selection in this requirement must be consistent with the key size specified for the size of the keys used in conjunction with the keyed-hash message authentication. HMAC-SHA-1 is currently required in order to comply with the WLAN Client EP.

Evaluation Activity

TSS
The evaluator shall examine the TSS to ensure that it specifies the following values used by the HMAC function: key length, hash function used, block size, and output MAC length used.

Tests
Assurance Activity Note: *The following tests require the developer to provide access to a test platform that provides the evaluator with tools that are typically not found on factory products.*

For each of the supported parameter sets, the evaluator shall compose 15 sets of test data. Each set shall consist of a key and message data. The evaluator shall have the TSF generate HMAC tags for these sets of test data. The resulting MAC tags shall be compared to the result of generating HMAC tags with the same key and IV using a known good implementation.

FCS_COP.1/CONDITION Cryptographic operation

FCS_COP.1.1/CONDITION The TSF shall perform conditioning in accordance with a specified cryptographic algorithm HMAC-[**selection**: *SHA-256, SHA-384, SHA-512*] using a salt, and [**selection**: *PBKDF2 with [**assignment**: number of iterations] iterations, [**assignment**: key stretching funtion], no other function*] and output cryptographic key sizes [**selection**: *128, 256*] that meet the following: [**selection**: *NIST SP 800-132, no standard*].

Application Note: The key cryptographic key sizes in the third selection should be made to correspond to the KEK key sizes selected in FCS_CKM_EXT.3.

This password must be conditioned into a string of bits that forms the submask to be used as input into the KEK. Conditioning can be performed using one of the identified hash functions and may include a key stretching function; the method used is selected by the ST Author. If selected, NIST SP 800-132 requires the use of a pseudo-random function (PRF) consisting of HMAC with an approved hash function. The ST author selects the hash function used, also includes the appropriate requirements for HMAC and the hash function.

Appendix A of NIST SP 800-132 recommends setting the iteration count in order to increase the computation needed to derive a key from a password and, therefore, increase the workload of performing a dictionary attack.

Evaluation Activity

TSS
The evaluator shall check that the TSS describes the method by which the password is first encoded and then fed to the SHA algorithm and verify the SHA algorithm matches the first selection.

If a key stretching function, such as PBKDF2, is selected the settings for the algorithm (padding, blocking, etc.) shall be described. The evaluator shall verify that the TSS contains a description of how the output of the hash function or key stretching function is used to form the submask that will be input into the function and is the same length as the KEK as specified in FCS_CKM_EXT.3.

If any manipulation of the key is performed in forming the submask that will be used to form the KEK, that process shall be described in the TSS.

No explicit testing of the formation of the submask from the input password is required.

FCS_HTTPS_EXT.1 Extended: HTTPS Protocol

FCS_HTTPS_EXT.1.1 The TSF shall implement the HTTPS protocol that complies with RFC 2818.

FCS_HTTPS_EXT.1.2 The TSF shall implement HTTPS using TLS as defined in the Package for Transport Layer Security.

Application Note: The Package for Transport Layer Security shall be included in the ST, with the following selections made:

- FCS_TLS_EXT.1:
  - TLS shall be selected
  - Client shall be selected

FCS_HTTPS_EXT.1.3 The TSF shall notify the application and [**selection**: *not establish the connection*, *request application authorization to establish the connection*, *no other action*] if the peer certificate is deemed invalid.

Application Note: Validity is determined by the certificate path, the expiration date, and the revocation status in accordance with RFC 5280.

If "not establish the connection" is selected then "with no exceptions" shall be selected for FCS_TLSC_EXT.1.3 in the Package for Transport Layer Security. If "request application authorization to establish the connection" is selected then "except when override is authorized" shall be selected for FCS_TLSC_EXT.1.3 in the Package for Transport Layer Security. If "no other action" is selected either selection can be made in FCS_TLSC_EXT.1.3.

FMT_SMF_EXT.1 Function 23 configures whether to allow/disallow the establishment of a trusted channel if the peer certificate is deemed invalid.

Evaluation Activity

Tests

- ***Test 1:*** *The evaluator shall attempt to establish an HTTPS connection with a webserver, observe the traffic with a packet analyzer, and verify that the connection succeeds and that the traffic is identified as TLS or HTTPS.*

  Other tests are performed in conjunction with testing in the Package for Transport Layer Security.

  Certificate validity shall be tested in accordance with testing performed for FIA_X509_EXT.1, and the evaluator shall perform the following test:

- ***Test 2:*** *The evaluator shall demonstrate that using a certificate without a valid certification path results in an application notification. Using the administrative guidance, the evaluator shall then load a certificate or certificates to the Trust Anchor Database needed to validate the certificate to be used in the function, and demonstrate that the function succeeds. The evaluator then shall delete one of the certificates, and show that the application is notified of the validation failure.*

FCS_IV_EXT.1 Extended: Initialization Vector Generation

FCS_IV_EXT.1.1 The TSF shall generate IVs in accordance with Table 12: References and IV Requirements for NIST-approved Cipher Modes.

Application Note: Table 12 lists the requirements for composition of IVs according to the NIST Special Publications for each cipher mode. The composition of IVs generated for encryption according to a cryptographic protocol is addressed by the protocol. Thus, this requirement addresses only IVs generated for key storage and data storage encryption.

Evaluation Activity

TSS

The evaluator shall examine the key hierarchy section of the TSS to ensure that the encryption of all keys is described and the formation of the IVs for each key encrypted by the same KEK meets FCS_IV_EXT.1.

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

FCS_RBG_EXT.1.1 The TSF shall perform all deterministic random bit generation services in accordance with NIST Special Publication 800-90A using [**selection**: *Hash_DRBG (any)*, *HMAC_DRBG (any)*, *CTR_DRBG (AES)*].

FCS_RBG_EXT.1.2 The deterministic RBG shall be seeded by an entropy source that accumulates entropy from [**selection**: *a software-based noise source*, *TSF-hardware-based noise source*] with a

minimum of [**selection**: *128 bits*, *256 bits*] of entropy at least equal to the greatest security strength (according to NIST SP 800-57) of the keys and hashes that it will generate.

FCS_RBG_EXT.1.3 The TSF shall be capable of providing output of theRBG to applications running on the TSF that request random bits.

Application Note: SP 800-90A contains 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 or in the TSS. While any of the identified hash functions (SHA-224, SHA-256, SHA-384, SHA-512) are allowed for Hash_DRBG or HMAC_DRBG, only AES-based implementations for CTR_DRBG are allowed.

The ST author must also ensure that any underlying functions are included in the baseline requirements for the TOE.

Health testing of the DRBGs is performed in conjunction with the self-tests required in FPT_TST_EXT.1.1.

For the selection in FCS_RBG_EXT.1.2, the ST author selects the appropriate number of bits of entropy that corresponds to the greatest security strength of the algorithms included in the ST. Security strength is defined in Tables 2 and 3 of NIST SP 800-57A. For example, if the implementation includes 2048-bit RSA (security strength of 112 bits), AES 128 (security strength 128 bits), and HMAC-SHA-256 (security strength 256 bits), then the ST author would select 256 bits.

The ST author may select either software or hardware noise sources. A hardware noise source is a component that produces data that cannot be explained by a deterministic rule, due to its physical nature. In other words, a hardware based noise source generates sequences of random numbers from a physical process that cannot be predicted. For example, a sampled ring oscillator consists of an odd number of inverter gates chained into a loop, with an electrical pulse traveling from inverter to inverter around the loop. The inverters are not clocked, so the precise time required for a complete circuit around the loop varies slightly as various physical effects modify the small delay time at each inverter on the line to the next inverter. This variance results in an approximate natural frequency that contains drift and jitter over time. The output of the ring oscillator consists of the oscillating binary value sampled at a constant rate from one of the inverters – a rate that is significantly slower than the oscillator's natural frequency.

Evaluation Activity

Documentation shall be produced and the evaluator shall perform the activities in accordance with Appendix B - Entropy Documentation And Assessment, the "Clarification to the Entropy Documentation and Assessment".

The evaluator shall verify that the API documentation provided according to Section 5.2.2 Class ADV: Development, includes the security functions described in FCS_RBG_EXT.1.3.

Guidance
The evaluator shall also confirm that the operational guidance contains appropriate instructions for configuring the RNG functionality.

Tests
Assurance Activity Note: *The following tests require the developer to provide access to a test platform that provides the evaluator with tools that are typically not found on factory products.*

The evaluator shall perform 15 trials for the RNG implementation. If the RNG is configurable, the evaluator shall perform 15 trials for each configuration.

If the RNG has prediction resistance enabled, each trial consists of (1) instantiate DRBG, (2) generate the first block of random bits (3) generate a second block of random bits (4) uninstantiate. The evaluator verifies that the second block of random bits is the expected value. The evaluator shall generate eight input values for each trial. The first is a count (0 – 14). The next three are entropy input, nonce, and personalization string for the instantiate operation. The next two are additional input and entropy input for the first call to generate. The final two are additional input and entropy input for the second call to generate. These values are randomly generated. "generate one block of random bits" means to generate random bits with number of returned bits equal to the Output Block Length (as defined in NIST SP800-90A).

If the RNG does not have prediction resistance, each trial consists of (1) instantiate DRBG, (2) generate the first block of random bits (3) reseed, (4) generate a second block of random bits (5) uninstantiate. The evaluator verifies that the second block of random bits is the expected value. The evaluator shall generate eight input values for each trial. The first is a count (0 – 14). The next three are entropy input, nonce, and personalization string for the instantiate operation. The fifth value is additional input to the first call to generate. The sixth and seventh are additional input and entropy input to

the call to reseed. The final value is additional input to the second generate call.

The following paragraphs contain more information on some of the input values to be generated/selected by the evaluator.

> ***Entropy input:*** *the length of the entropy input value must equal the seed length.*
> ***Nonce:*** *If a nonce is supported (CTR_DRBG with no Derivation Function does not use a nonce), the nonce bit length is one-half the seed length.*
> ***Personalization string:*** *The length of the personalization string must be seed length. If the implementation only supports one personalization string length, then the same length can be used for both values. If more than one string length is support, the evaluator shall use personalization strings of two different lengths. If the implementation does not use a personalization string, no value needs to be supplied.*
> ***Additional input:*** *the additional input bit lengths have the same defaults and restrictions as the personalization string lengths.*

FCS_RBG_EXT.2 Extended: Cryptographic Operation (Random Bit Generation)

This is an objective component.

FCS_RBG_EXT.2.1 The TSF shall save the state of the deterministic RBG at power-off, and shall use this state as input to the deterministic RBG at startup.

Application Note: The capability to add the state saved at power-off as input to the RBG prevents an RBG that is slow to gather entropy from producing the same output regularly and across reboots. Since there is no guarantee of the protections provided when the state is stored (or a requirement for any such protection), it is assumed that the state is 'known', and therefore cannot contribute entropy to the RBG, but can introduce enough variation that the initial RBG values are not predictable and exploitable.

Evaluation Activity

> ***TSS***
> *The evaluation activity for this requirement is captured in the RBG documentation for Appendix B - Entropy Documentation And Assessment. The evaluator shall verify that the documentation describes how the state is generated so as to be available for the next startup, how the state is used as input to the DRBG, and any protection measures used for the state while the TOE is powered off.*

FCS_RBG_EXT.3 Extended: Cryptographic Operation (Random Bit Generation)

This is an objective component.

FCS_RBG_EXT.3.1 The TSF shall allow applications to add data to the deterministic RBG using the Personalization String as defined in SP 800-90A.

Application Note: As specified in SP 800-90A the TSF shall not count data input from an application towards the entropy required by FCS_RBG_EXT.1. Thus, the TSF shall not allow the only input to the RBG seed to be from an application.

Evaluation Activity

> *The evaluator shall verify that this function is included as an interface to the RBG in the documentation required by Appendix B - Entropy Documentation And Assessment and that the behavior of the RBG following a call to this interface is described. The evaluator shall also verify that the documentation of the RBG describes the conditions of use and possible values for the Personalization String input to the SP 800-90A specified DRBG.*
> ***Tests***
> - ***Test 1:*** *The evaluator shall write, or the developer shall provide, an application that adds data to the RBG via the Personalization String. The evaluator shall verify that the request succeeds.*

FCS_SRV_EXT.1 Extended: Cryptographic Algorithm Services

FCS_SRV_EXT.1.1 The TSF shall provide a mechanism for applications to request the TSF to perform the following cryptographic operations:

- All mandatory and [**selection**: *selected algorithms*, *selected algorithms with the exception of ECC over curve 25519-based algorithms*] in FCS_CKM.2/LOCKED
- The following algorithms in FCS_COP.1/ENCRYPT: AES-CBC, [**selection**: *AES Key Wrap*, *AES Key Wrap with Padding*, *AES-GCM*, *AES-CCM*, *no other modes*]
- All mandatory and selected algorithms in FCS_COP.1/SIGN

- All mandatory and selected algorithms in FCS_COP.1/HASH
- All mandatory and selected algorithms in FCS_COP.1/KEYHMAC
- [**selection**:
  - *All mandatory and [**selection**: selected algorithms, selected algorithms with the exception of ECC over curve 25519-based algorithms] in FCS_CKM.1*,
  - *The selected algorithms in FCS_COP.1/CONDITION*,
  - *No other cryptographic operations*

  ]

Application Note: For each of the listed FCS components in the bulleted list, the intent is that the TOE will make available all algorithms specified for that component in theST. For example, if for FCS_COP.1/HASH the ST author selects SHA-256, then the TOE would have to make available an interface to perform SHA-1 (the "mandatory" portion of FCS_COP.1/HASH) and SHA-256 (the "selected" portion of FCS_COP.1/HASH).

The exception is for FCS_COP.1/ENCRYPT. The TOE is not required to make available AES_CCMP, AES_XTS, AES_GCMP-256, or AES_CCMP_256 even though they may be implemented to perform TSF-related functions. It is acceptable for the platform to not provide AES Key Wrap (KW) and AES Key Wrap with Padding (KWP) to applications even if selected in FCS_COP.1/ENCRYPT. However, the ST author is expected to select AES-GCM and/or AES-CCM if it is selected in theST for the FCS_COP.1/ENCRYPT component.

Evaluation Activity

The evaluator shall verify that the API documentation provided according to Section 5.2.2 Class ADV: Development includes the security functions (cryptographic algorithms) described in these requirements.

Tests
The evaluator shall write, or the developer shall provide access to, an application that requests cryptographic operations by the TSF. The evaluator shall verify that the results from the operation match the expected results according to the API documentation. This application may be used to assist in verifying the cryptographic operation assurance activities for the other algorithm services requirements.

FCS_SRV_EXT.2 Extended: Cryptographic Algorithm Services

This is an objective component.

FCS_SRV_EXT.2.1 The TSF shall provide a mechanism for applications to request theTSF to perform the following cryptographic operations:

- Algorithms in FCS_COP.1/ENCRYPT
- Algorithms in FCS_COP.1/SIGN

by keys stored in the secure key storage.

Application Note: The TOE will, therefore, be required to perform cryptographic operations on behalf of applications using the keys stored in the TOE's secure key storage.

Evaluation Activity

The evaluator shall verify that the API documentation for the secure key storage includes the cryptographic operations by the stored keys.

Tests
The evaluator shall write, or the developer shall provide access to, an application that requests cryptographic operations of stored keys by the TSF. The evaluator shall verify that the results from the operation match the expected results according to the API documentation. The evaluator shall use these APIs to test the functionality of the secure key storage according to the Assurance Activities in FCS_STG_EXT.1.

5.1.2.1 Cryptographic Storage (FCS_STG)

The following requirements describe how keys are protected. All keys must ultimately be protected by a REK, and may optionally be protected by the user's authentication factor. Each key's confidentiality and integrity must be protected. This section also describes the secure key storage services to be provided by the Mobile Device for use by applications and users, applying the same level of protection for these keys as keys internal to the OS.

FCS_STG_EXT.1 Extended: Cryptographic Key Storage

FCS_STG_EXT.1.1 The TSF shall provide [**selection**: *mutable hardware*, *software-based*] secure key storage for asymmetric private keys and [**selection**: *symmetric keys*, *persistent secrets*, *no other keys*].

Application Note: A hardware keystore can be exposed to theTSF through a variety of interfaces, including embedded on the motherboard, USB, microSD, and Bluetooth.

Immutable hardware is considered outside of this requirement and will be covered elsewhere.

If the secure key storage is implemented in software that is protected as required by FCS_STG_EXT.2, the ST author shall select "software-based." If "software-based" is selected, the ST author shall select "all software-based key storage" in FCS_STG_EXT.2.

Support for secure key storage for all symmetric keys and persistent secrets will be required in future revisions.

FCS_STG_EXT.1.2 The TSF shall be capable of importing keys/secrets into the secure key storage upon request of [**selection**: *the user*, *the administrator*] and [**selection**: *applications running on the TSF*, *no other subjects*].

Application Note: If the ST Author selects only user, the ST Author shall select function 9 in FMT_MOF_EXT.1.1.

FCS_STG_EXT.1.3 The TSF shall be capable of destroying keys/secrets in the secure key storage upon request of [**selection**: *the user*, *the administrator*].

Application Note: If the ST Author selects only user, the ST Author shall select function 10 in FMT_MOF_EXT.1.1.

FCS_STG_EXT.1.4 The TSF shall have the capability to allow only the application that imported the key/secret the use of the key/secret. Exceptions may only be explicitly authorized by [**selection**: *the user*, *the administrator*, *a common application developer*].

Application Note: If the ST Author selects user or administrator, the ST Author must also select function 34 in FMT_SMF_EXT.1.1. If the ST Author selects only user, the ST Author shall select function 34 in FMT_MOF_EXT.1.1.

FCS_STG_EXT.1.5 The TSF shall allow only the application that imported the key/secret to request that the key/secret be destroyed. Exceptions may only be explicitly authorized by [**selection**: *the user*, *the administrator*, *a common application developer*].

Application Note: If the ST Author selects user or administrator, the ST Author must also select function 35 in FMT_SMF_EXT.1.1. If the ST Author selects only user, the ST Author shall select function 35 in FMT_MOF_EXT.1.1.

Evaluation Activity

The evaluator shall verify that the API documentation provided according to Section 5.2.2 Class ADV: Development includes the security functions (import, use, and destruction) described in these requirements. The API documentation shall include the method by which applications restrict access to their keys/secrets in order to meet FCS_STG_EXT.1.4".

TSS
The evaluator shall review the TSS to determine that the TOE implements the required secure key storage. The evaluator shall ensure that the TSS contains a description of the key storage mechanism that justifies the selection of "mutable hardware" or "software-based".

Guidance
The evaluator shall review the AGD guidance to determine that it describes the steps needed to import or destroy keys/secrets.

Tests
The evaluator shall test the functionality of each security function:

- ***Test 1:*** *The evaluator shall import keys/secrets of each supported type according to the AGD guidance. The evaluator shall write, or the developer shall provide access to, an application that generates a key/secret of each supported type and calls the import functions. The evaluator shall verify that no errors occur during import.*

- ***Test 2:*** *The evaluator shall write, or the developer shall provide access to, an application that uses an imported key/secret:*
  - *For RSA, the secret shall be used to sign data.*
  - *For ECDSA, the secret shall be used to sign data*

  In the future additional types will be required to be tested:
  - *For symmetric algorithms, the secret shall be used to encrypt data.*
  - *For persistent secrets, the secret shall be compared to the imported secret.*

  The evaluator shall repeat this test with the application-imported keys/secrets and a different application's imported keys/secrets. The evaluator shall verify that the TOE requires approval before allowing the application to use the key/secret imported by the user or by a different application:
  - *The evaluator shall deny the approvals to verify that the application is not*

able to use the key/secret as described.
    - *The evaluator shall repeat the test, allowing the approvals to verify that the application is able to use the key/secret as described.*

  If the ST Author has selected "common application developer", this test is performed by either using applications from different developers or appropriately (according to API documentation) not authorizing sharing.
- ***Test 3:*** *The evaluator shall destroy keys/secrets of each supported type according to the AGD guidance. The evaluator shall write, or the developer shall provide access to, an application that destroys an imported key/secret.*

  The evaluator shall repeat this test with the application-imported keys/secrets and a different application's imported keys/secrets. The evaluator shall verify that the TOE requires approval before allowing the application to destroy the key/secret imported by the administrator or by a different application:

    - *The evaluator shall deny the approvals and verify that the application is still able to use the key/secret as described.*
    - *The evaluator shall repeat the test, allowing the approvals and verifying that the application is no longer able to use the key/secret as described.*

  If the ST Author has selected "common application developer", this test is performed by either using applications from different developers or appropriately (according to API documentation) not authorizing sharing.

FCS_STG_EXT.2 Extended: Encrypted Cryptographic Key Storage

FCS_STG_EXT.2.1 The TSF shall encrypt all DEKs, KEKs, [**assignment**: *any long-term trusted channel key material*] and [**selection**: *all software-based key storage*, *no other keys*] by KEKs that are [**selection**:

- *Protected by the REK with [**selection**:*
  - *encryption by a REK,*
  - *encryption by a KEK chaining from a REK,*
  - *encryption by a KEK that is derived from a REK*

  ] ,
- *Protected by the REK and the password with [**selection**:*
  - *encryption by a REK and the password-derived KEK,*
  - *encryption by a KEK chaining to a REK and the password-derived or biometric-unlocked KEK,*
  - *encryption by a KEK that is derived from a REK and the password-derived or biometric-unlocked KEK*

  ]

].

Application Note: The ST author must select "all software-based key storage" if "software-based" is selected in FCS_STG_EXT.1.1. If the ST author selects "mutable hardware" in FCS_STG_EXT.1.1, the secure key storage is not subject to this requirement. REKs are not subject to this requirement.

A REK and the password-derived KEK may be combined to form a combinedKEK (as described in FCS_CKM_EXT.3) in order to meet this requirement.

Sensitive data is protected by the REK and the password or biometric. Sensitive data includes some or all user or enterprise data. Software-based key storage itself shall be considered sensitive data and be protected accordingly, i.e. by the password or biometric and REK.

All keys must ultimately be protected by a REK. Sensitive data must be protected by the password or biometric (selection 2). In particular, Figure 3 has KEKs protected according to these requirements: DEK_1 meets 2a and would be appropriate for sensitive data, DEK_2 meets 1b and would not be appropriate for sensitive data, K_1 meets 1a and is not considered a sensitive key, and K_2 meets 2b and is considered a sensitive key.

Long-term trusted channel key material includes WPA2 (PSKs), IPsec (PSKs and client certificates) and Bluetooth keys. These keys shall not be protected by the password, as they may be necessary in the locked state. For clarity, the ST author must assign any Long-term trusted channel key material supported by the TOE . At a minimum, aTOE must support at least WPA2 and Bluetooth keys.

The documentation of the product's encryption key management should be detailed enough that, after reading, the evaluator will thoroughly understand the product's key management and how it meets the requirements to ensure the keys are adequately protected. This documentation should include an essay and diagram(s). This documentation is not required to be part of the TSS - it can be submitted as a separate document and marked as developer proprietary.

Evaluation Activity

> ***TSS***
> *The evaluator shall review the TSS to determine that the TSS includes key hierarchy description of the protection of each DEK for data-at-rest, of software-based key storage, of long-term trusted channel keys, and of KEK related to the protection of the DEKs, long-term trusted channel keys, and software-based key storage. This description must include a diagram illustrating the key hierarchy implemented by the TOE in order to demonstrate that the implementation meets FCS_STG_EXT.2. The description shall indicate how the functionality described by FCS_RBG_EXT.1 is invoked to generate DEKs (FCS_CKM_EXT.2), the key size (FCS_CKM_EXT.2 and FCS_CKM_EXT.3) for each key, how each KEK is formed (generated, derived, or combined according to FCS_CKM_EXT.3), the integrity protection method for each encrypted key (FCS_STG_EXT.3), and the IV generation for each key encrypted by the same KEK (FCS_IV_EXT.1). More detail for each task follows the corresponding requirement.*

FCS_STG_EXT.2.2 DEKs, KEKs, [**assignment**: *any long-term trusted channel key material*] and [**selection**: *all software-based key storage*, *no other keys*] shall be encrypted using one of the following methods: [**selection**:

- *using a SP800-56B key establishment scheme*,
- *using AES in the [**selection**: Key Wrap (KW) mode, Key Wrap with Padding (KWP) mode, GCM, CCM, CBC mode]*

] .

Application Note: The ST author selects which key encryption schemes are used by the TOE. This requirement refers only to KEKs as defined this PP and does not refer to those KEKs specified in other standards. The ST author must assign the same Long-term trusted channel key material assigned in FCS_STG_EXT.2.1.

Evaluation Activity

> ***TSS***
> *The evaluator shall examine the key hierarchy description in the TSS section to verify that each DEK and software-stored key is encrypted according to FCS_STG_EXT.2.*

FCS_STG_EXT.3 Extended: Integrity of encrypted key storage

FCS_STG_EXT.3.1 The TSF shall protect the integrity of any encrypted DEKs and KEKs and [**selection**: *long-term trusted channel key material*, *all software-based key storage*, *no other keys*] by [**selection**:

- *[**selection**: GCM, CCM, Key Wrap, Key Wrap with Padding] cipher mode for encryption according to FCS_STG_EXT.2*,
- *a hash (FCS_COP.1/HASH) of the stored key that is encrypted by a key protected by FCS_STG_EXT.2*,
- *a keyed hash (FCS_COP.1/KEYHMAC) using a key protected by a key protected by FCS_STG_EXT.2*,
- *a digital signature of the stored key using an asymmetric key protected according to FCS_STG_EXT.2*,
- *an immediate application of the key for decrypting the protected data followed by a successful verification of the decrypted data with previously known information*

].

Application Note: The ST author must assign the same Long-term trusted channel key material assigned in FCS_STG_EXT.2.1.

FCS_STG_EXT.3.2 The TSF shall verify the integrity of the [**selection**: *hash*, *digital signature*, *MAC*] of the stored key prior to use of the key.

Application Note: This requirement is not applicable to derived keys that are not stored. It is not expected that a single key will be protected from corruption by multiple of these methods; however, a product may use one integrity-protection method for one type of key and a different method for other types of keys. The explicit Assurance Activities for each of the options will be addressed in each of the requirements (FCS_COP.1.1/HASH, FCS_COP.1.1/KEYHMAC).

Key Wrapping shall be implemented per SP800-38F.

The documentation of the product's encryption key management should be detailed enough that, after reading, the evaluator will thoroughly understand the product's key management and how it meets the requirements to ensure the keys are adequately protected. This documentation should include an essay and diagram(s). This documentation is not required to be part of the TSS - it can be submitted as a separate document and marked as developer proprietary.

Evaluation Activity

TSS
The evaluator shall examine the key hierarchy description in theTSS section to verify that each encrypted key is integrity protected according to one of the options in FCS_STG_EXT.3.

5.1.3 Class: User Data Protection (FDP)

FDP_ACF_EXT.1 Extended: Security access control

FDP_ACF_EXT.1.1 The TSF shall provide a mechanism to restrict the system services that are accessible to an application.

Application Note: Examples of system services to which this requirement applies include:

- obtain data from camera and microphone input devices
- get current GPS location
- retrieve credentials from system-wide credential store
- retrieve contacts list / address book
- retrieve stored pictures
- retrieve text messages
- retrieve emails
- retrieve device identifier information
- obtain network access

Evaluation Activity

TSS
The evaluator shall ensure the TSS lists all system services available for use by an application. The evaluator shall also ensure that the TSS describes how applications interface with these system services, and means by which these system services are protected by the TSF.

The TSS shall describe which of the following categories each system service falls in:

1. *No applications are allowed access*
2. *Privileged applications are allowed access*
3. *Applications are allowed access by user authorization*
4. *All applications are allowed access*

Privileged applications include any applications developed by the TSF developer. The TSS shall describe how privileges are granted to third-party applications. For both types of privileged applications, the TSS shall describe how and when the privileges are verified and how the TSF prevents unprivileged applications from accessing those services.

For any services for which the user may grant access, the evaluator shall ensure that the TSS identifies whether the user is prompted for authorization when the application is installed, or during runtime. The evaluator shall ensure that the operational user guidance contains instructions for restricting application access to system services.

Tests
Assurance Activity Note: *The following tests require the vendor to provide access to a test platform that provides the evaluator with tools that are typically not found on consumer Mobile Device products.*

The evaluator shall write, or the developer shall provide, applications for the purposes of the following tests.

- ***Test 1:*** *For each system service to which no applications are allowed access, the evaluator shall attempt to access the system service with a test application and verify that the application is not able to access that system service.*
- ***Test 2:*** *For each system service to which only privileged applications are allowed access, the evaluator shall attempt to access the system service with an unprivileged application and verify that the application is not able to access that system service. The evaluator shall attempt to access the system service with a privileged application and verify that the application can access the service.*
- ***Test 3:*** *For each system service to which the user may grant access, the evaluator shall attempt to access the system service with a test application. The evaluator shall ensure that either the system blocks such accesses or prompts for user authorization. The prompt for user authorization may occur at runtime or at installation time, and should be consistent with the behavior described in the TSS.*
- ***Test 4:*** *For each system service listed in the TSS that is accessible by all applications, the evaluator shall test that an application can access that system service.*

FDP_ACF_EXT.1.2 The TSF shall provide an access control policy that prevents [**selection**: *application*, *groups of applications*] from accessing [**selection**: *all*, *private*] data stored by other [**selection**: *application*, *groups of applications*]. Exceptions may only be explicitly authorized for such sharing by [**selection**: *the user*, *the administrator*, *a common application developer*, *no one*].

Application Note: Application groups may be designated Enterprise or Personal. Applications installed by the user default to being in the Personal application group unless otherwise designated by the administrator in function 43 of FMT_SMF_EXT.1.1. Applications installed by the administrator default to being in the Enterprise application group (this category includes applications that the user requests the administrator install, for instance by selecting the application for installation through an enterprise application catalog) unless otherwise designated by the administrator in function 43 of FMT_SMF_EXT.1.1. It is acceptable for the same application to have multiple instances installed, each in different application groups. Private data is defined as data that is accessible only by the application that wrote it. Private data is distinguished from data that an application may, by design, write to shared storage areas.

If "groups of applications" is selected, FDP_ACF_EXT.2 must be included in the ST.

Evaluation Activity

TSS
The evaluator shall examine the TSS to verify that it describes which data sharing is permitted between applications, which data sharing is not permitted, and how disallowed sharing is prevented. It is possible to select both "application" and "groups of application", in which case the TSS is expected to describe the data sharing policies that would be applied in each case.
Tests

- ***Test 1:*** *The evaluator shall write, or the developer shall provide, two applications, one that saves data containing a unique string and the other, which attempts to access that data. If "groups of applications" is selected, the applications shall be placed into different groups. If "application" is selected, the evaluator shall install the two applications. If "private data" is selected, the application shall not write to a designated shared storage area. The evaluator shall verify that the second application is unable to access the stored unique string.*

  If "the user" is selected, the evaluator shall grant access as the user and verify that the second application is able to access the stored unique string.

  If "the administrator" is selected, the evaluator shall grant access as the administrator and verify that the second application is able to access the stored unique string.

  If "a common application developer" is selected, the evaluator shall grant access to an, application with a common application developer to the first, and verify that the application is able to access the stored unique string.

FDP_ACF_EXT.2 Extended: Security access control

This is a selection-based component. Its inclusion depends upon selection from FDP_ACF_EXT.1.2.

FDP_ACF_EXT.2.1 The TSF shall provide a separate [**selection**: *address book*, *calendar*, *keystore*, *account credential database*, [***assignment****: list of additional resources*]] for each application group and only allow applications within that process group to access the resource. Exceptions may only be explicitly authorized for such sharing by [**selection**: *the user*, *the administrator*, *no one*].

Application Note: If "groups of applications" is selected in FDP_ACF_EXT.1.2, FDP_ACF_EXT.2 must be included in the ST.

Evaluation Activity

Tests
For each selected resource, the evaluator shall cause data to be placed into the Enterprise group's instance of that shared resource. The evaluator shall install an application into the Personal group that attempts to access the shared resource information and verify that it cannot access the information.

FDP_ACF_EXT.3 Extended: Security attribute based access control

This is an objective component.

FDP_ACF_EXT.3.1 The TSF shall enforce an access control policy that prohibits an application from granting both write and execute permission to a file on the device except for [**selection**: *files stored in the application's private data folder*, *no exceptions*].

Evaluation Activity

> ***Tests***
> ***Assurance Activity Note:*** *The following tests require the developer to provide access to a test platform that provides the evaluator with tools that are typically not found on consumer Mobile Device products.*
>
> - ***Test 1:*** *The evaluator shall write, or the developer shall provide, an application that attempts to store a file with both write and execute permissions. If the selection is "no exceptions", then the evaluator shall verify that this action fails and that the permissions on the file are not simultaneously write and execute. If the selection is "application's private data folder", then the evaluator shall ensure that the attempt to store the file is outside of the application's private data folder.*
> - ***Test 2:*** *The evaluator shall traverse the file system examining the permission on each TSF file to verify that no file has both write and execute permissions set. If the selection is "application's private data folder", then only files outside of this folder need to be examined by the evaluator for this test.*

FDP_BCK_EXT.1 Extended: Application Backup

> ***This is an objective component.***

FDP_BCK_EXT.1.1 The TSF shall provide a mechanism for applications to mark [**selection**: *all application data*, *selected application data*] to be excluded from device backups.

Application Note: Device backups include any mechanism built into the TOE that allows stored application data to be extracted over a physical port or sent over the network, but does not include any functionality implemented by a specific application itself if the application is not included in the TOE. The lack of a public/documented API for performing backups, when a private/undocumented API exists, is not sufficient to meet this requirement.

Evaluation Activity

> ***Tests***
> *If "all application data" is selected, the evaluator shall install an application that has marked all of its application data to be excluded from backups. The evaluator shall cause data to be placed into the application's storage area. The evaluator shall attempt to back up the application data and verify that the backup fails or that the application's data was not included in the backup.*
>
> *If "selected application data" is selected, the evaluator shall install an application that has marked selected application data to be excluded from backups. The evaluator shall cause data covered by "selected application data" to be placed into the application's storage area. The evaluator shall attempt to backup that selected application data and verify that either the backup fails or that the selected data is excluded from the backup.*

FDP_PBA_EXT.1 Extended: Storage of Critical Biometric Parameters

> ***This is a selection-based component. Its inclusion depends upon selection from FIA_UAU.5.1.***

FDP_PBA_EXT.1.1 The TSF shall protect the authentication template [**selection**: *using a PIN as an additional factor*, *using a password as an additional factor*, [**assignment**: *other circumstances*]].

Application Note: If a BAF or "hybrid" is selected in FIA_UAU.5.1, FDP_PBA_EXT.1.1 must be included in the ST. If "hybrid" is selected in FIA_UAU.5.1, then "using a PIN as an additional factor" or "using a password as an additional factor" shall be selected. If "hybrid" is not selected in FIA_UAU.5.1, then the authentication template shall be secured by other means, which should be specified in the assignment. Since compromised authentication templates can be used in generating presentation/spoof attacks, it is important to utilize secure methods for protecting them.

Evaluation Activity

> ***TSS***
> *The evaluator shall determine that the TSS contains a description of the activities that happen during biometric authentication.*
>
> *The evaluator shall ensure that the authentication template is protected either using a PIN or by other secure means, as specified by the vendor.*

5.1.3.1 Data-At-Rest Protection (FDP_DAR)

Three levels of data-at-rest protection are addressed: TSF data, Protected Data (and keys), and sensitive data. Table 5

addresses the level of protection required for each level of data-at-rest.

Table 5: Protection of Data Levels

Data Level	Protection Required
TSF Data	TSF data does not require confidentiality, but does require integrity protection. (FPT_TST_EXT.2/PREKERNEL)
Protected Data	Protected data is encrypted while powered off. (FDP_DAR_EXT.1)
Sensitive Data	Sensitive data is encrypted while in the locked state, in addition to while powered off. (FDP_DAR_EXT.2)

All keys, protected data, and sensitive data must ultimately be protected by the REK. Sensitive data must be protected by the password in addition to the REK. In particular, Figure 3 has KEKs protected according to these requirements: DEK_1 would be appropriate for sensitive data, DEK_2 would not be appropriate for sensitive data, K_1 is not considered a sensitive key, and K_2 is considered a sensitive key.

These requirements include a capability for encrypting sensitive data received while in the locked state, which may be considered a separate sub-category of sensitive data. This capability may be met by a key transport scheme (RSA) by using a public key to encrypt the DEK while protecting the corresponding private key with a password-derived or biometric-unlocked KEK.

This capability may also be met by a key agreement scheme. To do so, the device generates a device-wide sensitive data asymmetric pair (the private key of which is protected by a password-derived or biometric-unlocked KEK) and an asymmetric pair for the received sensitive data to be stored. In order to store the sensitive data, the device-wide public key and data private key are used to generate a shared secret, which can be used as a KEK or a DEK. The data private key and shared secret are cleared after the data is encrypted and the data public key stored. Thus, no key material is available in the locked state to decrypt the newly stored data. Upon unlock, the device-wide private key is decrypted and is used with each data public key to regenerate the shared secret and decrypt the stored data. Figure 4, below, illustrates this scheme.

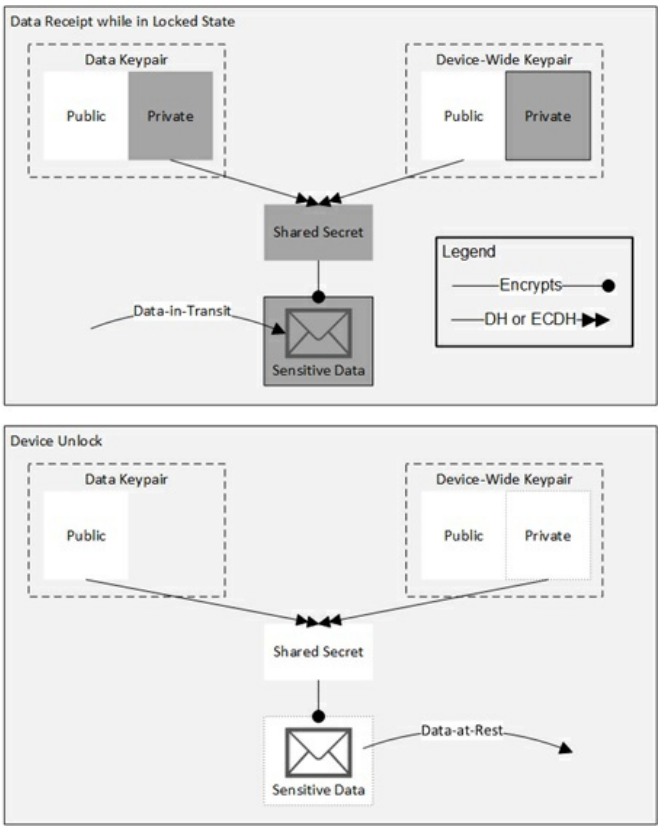

Figure 4: Key Agreement Scheme for Encrypting Received Sensitive Data in the Locked State

FDP_DAR_EXT.1 Extended: Protected Data Encryption

FDP_DAR_EXT.1.1 Encryption shall cover all protected data.

Application Note: Protected data is all non-TSF data, including all user or enterprise data. Some or all of this data may be considered sensitive data as well.

FDP_DAR_EXT.1.2 Encryption shall be performed using DEKs with AES in the [**selection**: *XTS*, *CBC*, *GCM*] mode with key size [**selection**: *128*, *256*] bits.

Application Note: IVs shall be generated in accordance with FCS_IV_EXT.1.1.

Evaluation Activity

TSS
The evaluator shall verify that the TSS section of the ST indicates which data is protected by the DAR implementation and what data is considered TSF data. The evaluator shall ensure that this data includes all protected data.

Guidance
The evaluator shall review the AGD guidance to determine that the description of the configuration and use of the DAR protection does not require the user to perform any actions beyond configuration and providing the authentication credential. The evaluator shall also review the AGD guidance to determine that the configuration does not require the user to identify encryption on a per-file basis.

Tests
Assurance Activity Note: *The following test requires the developer to provide access to a test platform that provides the evaluator with tools that are typically not found on consumer Mobile Device products.*

- ***Test 1:*** *The evaluator shall enable encryption according to the AGD guidance. The evaluator shall create user data (non-system) either by creating a file or by using an application. The evaluator shall use a tool provided by the developer to verify that this data is encrypted when the product is powered off, in conjunction with Test 1 for FIA_UAU_EXT.1.*

FDP_DAR_EXT.2 Extended: Sensitive Data Encryption

FDP_DAR_EXT.2.1 The TSF shall provide a mechanism for applications to mark data and keys as sensitive.

Application Note: Data and keys that have been marked as sensitive will be subject to certain restrictions (through other requirements) in both the locked and unlocked states of the Mobile Device. This mechanism allows an application to choose those data and keys under its control to be subject to those requirements.

In the future, this PP may require that all data and key created by applications will default to the "sensitive" marking, requiring an explicit "non-sensitive" marking rather than an explicit "sensitive" marking.

Evaluation Activity

TSS
The evaluator shall verify that the TSS includes a description of which data stored by the TSF (such as by native applications) is treated as sensitive. This data may include all or some user or enterprise data and must be specific regarding the level of protection of email, contacts, calendar appointments, messages, and documents.

The evaluator shall examine the TSS to determine that it describes the mechanism that is provided for applications to use to mark data and keys as sensitive. This description shall also contain information reflecting how data and keys marked in this manner are distinguished from data and keys that are not (for instance, tagging, segregation in a "special" area of memory or container, etc.).

Tests
- ***Test 1:*** *The evaluator shall enable encryption of sensitive data and require user authentication according to the AGD guidance. The evaluator shall try to access and create sensitive data (as defined in the ST and either by creating a file or using an application to generate sensitive data) in order to verify that no other user interaction is required.*

FDP_DAR_EXT.2.2 The TSF shall use an asymmetric key scheme to encrypt and store sensitive data received while the product is locked.

Application Note: Sensitive data is encrypted according to FDP_DAR_EXT.1.2. The asymmetric key scheme must be performed in accordance with FCS_CKM.2/LOCKED.

The intent of this requirement is to allow the device to receive sensitive data while locked and to store the received data in such a way as to prevent unauthorized parties from decrypting it while in the locked state. If only a subset of sensitive data may be received in the locked state, this subset must be described in the TSS.

Key material must be cleared when no longer needed according to FCS_CKM_EXT.4. For keys (or key material used to derive those keys) protecting sensitive data received in the locked state, "no longer needed" includes "while in the locked state." For example, in the first key scheme, this includes the DEK protecting the received data as soon as the data is

encrypted. In the second key scheme this includes the private key for the data asymmetric pair, the generated shared secret, and any generated DEKs. Of course, both schemes require that a private key of an asymmetric pair (the RSA private key and the device-wide private key, respectively) be cleared when transitioning to the locked state.

Evaluation Activity

TSS
The evaluator shall review the TSS section of the ST to determine that the TSS includes a description of the process of receiving sensitive data while the device is in a locked state. The evaluator shall also verify that the description indicates if sensitive data that may be received in the locked state is treated differently than sensitive data that cannot be received in the locked state. The description shall include the key scheme for encrypting and storing the received data, which must involve an asymmetric key and must prevent the sensitive data-at-rest from being decrypted by wiping all key material used to derive or encrypt the data (as described in the application note). The introduction to this section provides two different schemes that meet the requirements, but other solutions may address this requirement.

Tests
The evaluator shall perform the tests in FCS_CKM_EXT.4 for all key material no longer needed while in the locked state and shall ensure that keys for the asymmetric scheme are addressed in the tests performed when transitioning to the locked state.

FDP_DAR_EXT.2.3 The TSF shall encrypt any stored symmetric key and any stored private key of the asymmetric key(s) used for the protection of sensitive data according to FCS_STG_EXT.2.1 selection 2.

Application Note: Symmetric keys used to encrypt sensitive data while theTSF is in the unlocked state must be encrypted with (or chain to a KEK encrypted with) the REK and password-derived or biometric-unlocked KEK. A stored private key of the asymmetric key scheme for encrypting data in the locked state must be encrypted with (or chain to a KEK encrypted with) the REK and password-derived or biometric-unlocked KEK.

The documentation of the product's encryption key management should be detailed enough that, after reading, the evaluator will thoroughly understand the product's key management and how it meets the requirements to ensure the keys are adequately protected. This documentation should include an essay and diagram(s). This documentation is not required to be part of the TSS - it can be submitted as a separate document and marked as developer proprietary.

Evaluation Activity

TSS
The evaluator shall verify that the key hierarchy section of theTSS required for FCS_STG_EXT.2.1 includes the symmetric encryption keys (DEKs) used to encrypt sensitive data. The evaluator shall ensure that these DEKs are encrypted by a key encrypted with (or chain to a KEK encrypted with) the REK and password-derived or biometric-unlocked KEK.

The evaluator shall verify that the TSS section of the ST that describes the asymmetric key scheme includes the protection of any private keys of the asymmetric pairs. The evaluator shall ensure that any private keys that are not wiped and are stored by the TSF are stored encrypted by a key encrypted with (or chain to a KEK encrypted with) the REK and password-derived or biometric-unlocked KEK.

FDP_DAR_EXT.2.4 The TSF shall decrypt the sensitive data that was received while in the locked state upon transitioning to the unlocked state using the asymmetric key scheme and shall re-encrypt that sensitive data using the symmetric key scheme.

Evaluation Activity

TSS
The evaluator shall verify that the TSS section of the ST that describes the asymmetric key scheme includes a description of the actions taken by the TSF for the purposes of DAR upon transitioning to the unlocked state. These actions shall minimally include decrypting all received data using the asymmetric key scheme and re-encrypting with the symmetric key scheme used to store data while the device is unlocked.

FDP_IFC_EXT.1 Extended: Subset information flow control

FDP_IFC_EXT.1.1 The TSF shall [**selection**:

- *provide an interface which allows aVPN client to protect allIP traffic using IPsec*,
- *provide a VPN client which can protect allIP traffic using IPsec*

] with the exception ofIP traffic required to establish theVPN connection.

Application Note: Typically, the traffic required to establish the VPN connection is referred to as "Control Plane" traffic; whereas, the IP traffic protected by the IPsec VPN is referred to as "Data Plane" traffic. All "Data Plane" traffic must flow through the VPN connection and the VPN must not split-tunnel.

If no native IPsec client is validated or third-party VPN clients may also implement the required Information Flow Control, the first option shall be selected. In these cases, the TOE provides an API to third-party VPN clients that allow them to configure the TOE's network stack to perform the required Information Flow Control.

The ST author shall select the second option if the TSF implements a native VPN client (IPsec is selected in FTP_ITC_EXT.1). Thus the TSF shall be validated against the PP-Module for VPN Client and the ST author shall also include FDP_IFC_EXT from the PP-Module for VPN Client.

It is optional for the VPN client to be configured to be always-on per FMT_SMF_EXT.1 Function 45. Always-on means the establishment of an IPsec trusted channel to allow any communication by the TSF.

Evaluation Activity

TSS
The evaluator shall verify that the TSS section of the ST describes the routing of IP traffic through processes on the TSF when a VPN client is enabled. The evaluator shall ensure that the description indicates which traffic does not go through the VPN and which traffic does and that a configuration exists for each baseband protocol in which only the traffic identified by the ST author as necessary for establishing the VPN connection (IKE traffic and perhaps HTTPS or DNS traffic) is not encapsulated by the VPN protocol (IPsec). The evaluator shall verify that the TSS section describes any differences in the routing of IP traffic when using any supported baseband protocols (e.g. Wi-Fi or, LTE).

Guidance
The evaluator shall verify that one (or more) of the following options is addressed by the documentation:

- *The description above indicates that if a VPN client is enabled, all configurations route all Data Plane traffic through the tunnel interface established by the VPN client.*
- *The AGD guidance describes how the user and/or administrator can configure the TSF to meet this requirement.*
- *The API documentation includes a security function that allows a VPN client to specify this routing.*

Tests

- ***Test 1:*** *If the ST author identifies any differences in the routing between Wi-Fi and cellular protocols, the evaluator shall repeat this test with a base station implementing one of the identified cellular protocols.*

  Step 1: The evaluator shall enable a Wi-Fi configuration as described in the AGD guidance (as required by FTP_ITC_EXT.1). The evaluator shall use a packet sniffing tool between the wireless access point and an Internet-connected network. The evaluator shall turn on the sniffing tool and perform actions with the device such as navigating to websites, using provided applications, and accessing other Internet resources. The evaluator shall verify that the sniffing tool captures the traffic generated by these actions, turn off the sniffing tool, and save the session data.

  Step 2: The evaluator shall configure an IPsec VPN client that supports the routing specified in this requirement, and if necessary, configure the device to perform the routing specified as described in the AGD guidance. The evaluator shall turn on the sniffing tool, establish the VPN connection, and perform the same actions with the device as performed in the first step. The evaluator shall verify that the sniffing tool captures traffic generated by these actions, turn off the sniffing tool, and save the session data.

  Step 3: The evaluator shall examine the traffic from both step one and step two to verify that all Data Plane traffic is encapsulated by IPsec. The evaluator shall examine the Security Parameter Index (SPI) value present in the encapsulated packets captured in Step two from the TOE to the Gateway and shall verify this value is the same for all actions used to generate traffic through the VPN. Note that it is expected that the SPI value for packets from the Gateway to the TOE is different than the SPI value for packets from the TOE to the Gateway. The evaluator shall be aware that IP traffic on the cellular baseband outside of the IPsec tunnel may be emanating from the baseband processor and shall verify with the manufacturer that any identified traffic is not emanating from the application processor.

  Step 4: The evaluator shall perform an ICMP echo from the TOE to the IP address

of another device on the local wireless network and shall verify that no packets are sent using the sniffing tool. The evaluator shall attempt to send packets to the TOE outside the VPN tunnel (i.e. not through the VPN gateway), including from the local wireless network, and shall verify that the TOE discards them.

FDP_STG_EXT.1 Extended: User Data Storage

FDP_STG_EXT.1.1 The TSF shall provide protected storage for the Trust Anchor Database.

Evaluation Activity

TSS
The evaluator shall ensure the TSS describes the Trust Anchor Database implemented that contain certificates used to meet the requirements of this PP. This description shall contain information pertaining to how certificates are loaded into the store, and how the store is protected from unauthorized access (for example, UNIX permissions) in accordance with the permissions established in FMT_SMF_EXT.1 and FMT_MOF_EXT.1.1.

FDP_UPC_EXT.1/NORMAL Extended: Inter-TSF user data transfer protection

FDP_UPC_EXT.1.1/NORMAL The TSF shall provide a means for non-TSF applications executing on theTOE to use

- mutually authenticated TLS as defined in the Package for Transport Layer Security,
- HTTPS,

and [**selection**:

- *mutually authenticated DTLS as defined in the Package for Transport Layer Security*,
- *IPsec in accordance with the PP-Module for VPN Client*,
- *no other protocol*

] to provide a protected communication channel between the non-TSF application and another IT product that is logically distinct from other communication channels, provides assured identification of its end points, protects channel data from disclosure, and detects modification of the channel data.

Application Note: The intent of this requirement is that one of the selected protocols is available for use by user applications running on the device for use in connecting to distant-end services that are not necessarily part of the enterprise infrastructure. It should be noted that the FTP_ITC_EXT.1 requires that all TSF communications be protected using the protocols indicated in that requirement, so the protocols required by this component ride "on top of" those listed in FTP_ITC_EXT.1.

It should also be noted that some applications are part of the TSF, and FTP_ITC_EXT.1 requires that TSF applications be protected by at least one of the protocols in first selection in FTP_ITC_EXT.1. It is not required to have two different implementations of a protocol, or two different protocols, to satisfy both this requirement (for non-TSF apps) and FTP_ITC_EXT.1 (for TSF apps), as long as the services specified are provided.

The ST author shall list which trusted channel protocols are implemented by the Mobile Device for use by non-TSF apps.

The TSF shall be validated against requirements from the Package for Transport Layer Security, with the following selections made:

- FCS_TLS_EXT.1:
  - TLS is selected
  - Client is selected
- FCS_TLSC_EXT.1.1:
  - The cipher suites selected must correspond with the algorithms and hash functions allowed in FCS_COP.1.
  - Mutual authentication must be selected
- FCS_TLSC_EXT.1.3
  - With no exceptions is selected.

If "mutually authenticated DTLS as defined in the Package for Transport Layer Security" is selected, the TSF shall be validated against requirements from the Package for Transport Layer Security, with the following selections made:

- FCS_TLS_EXT.1:
  - DTLS is selected
  - client is selected
- FCS_DTLSC_EXT.1.1:
  - The cipher suites selected must correspond with the algorithms and hash functions allowed in FCS_COP.1.
  - mutual authentication must be selected
- FCS_DTLSC_EXT.1.3

- With no exceptions is selected.

If the ST author selects IPsec, the TSF shall be validated against the PP-Module for Virtual Private Network (VPN) Clients.

FDP_UPC_EXT.1.2/NORMAL The TSF shall permit the non-TSF applications to initiate communication via the trusted channel.

Evaluation Activity

The evaluator shall verify that the API documentation provided according to Section 5.2.2 Class ADV: Development includes the security functions (protection channel) described in these requirements, and verify that the APIs implemented to support this requirement include the appropriate settings/parameters so that the application can both provide and obtain the information needed to assure mutual identification of the endpoints of the communication as required by this component.

TSS
The evaluator shall examine the TSS to determine that it describes that all protocols listed in the TSS are specified and included in the requirements in the ST.

Guidance
The evaluator shall confirm that the operational guidance contains instructions necessary for configuring the protocol(s) selected for use by the applications.

Tests
Assurance Activity Note: *The following test requires the developer to provide access to a test platform that provides the evaluator with tools that are typically not found on consumer Mobile Device products.*

The evaluator shall write, or the developer shall provide access to, an application that requests protected channel services by the TSF. The evaluator shall verify that the results from the protected channel match the expected results according to the API documentation. This application may be used to assist in verifying the protected channel assurance activities for the protocol requirements. The evaluator shall also perform the following tests:

- ***Test 1:*** *The evaluators shall ensure that the application is able to initiate communications with an external IT entity using each protocol specified in the requirement, setting up the connections as described in the operational guidance and ensuring that communication is successful.*
- ***Test 2:*** *The evaluator shall ensure, for each communication channel with an authorized IT entity, the channel data are not sent in plaintext.*

FDP_UPC_EXT.1/BLUETOOTH Extended: Inter-TSF user data transfer protection - Bluetooth

This is an implementation-based component. Its inclusion depends on whether the TOE implements one (or more) of

- ***Bluetooth***

as described in Appendix A: Implementation-based Requirements.

FDP_UPC_EXT.1.1/BLUETOOTH The TSF shall provide a means for non-TSF applications executing on theTOE to use

- Bluetooth BR/EDR in accordance with the PP-Module for Bluetooth,

and [**selection**:

- *Bluetooth LE in accordance with the PP-Module for Bluetooth*,
- *no other protocol*

] to provide a protected communication channel between the non-TSF application and another IT product that is logically distinct from other communication channels, provides assured identification of its end points, protects channel data from disclosure, and detects modification of the channel data.

Application Note: If the TOE includes Bluetooth hardware this requirement shall be included in the ST. The intent of this requirement is that Bluetooth BR/EDR and optionally Bluetooth LE is available for use by user applications running on the device for use in connecting to distant-end services that are not necessarily part of the enterprise infrastructure. The ST author shall list which trusted channel protocols are implemented by the Mobile Device for use by non-TSF apps.

The TSF shall be validated against requirements from the PP-Module for Bluetooth. It should be noted that the FTP_ITC_EXT.1 requires that all TSF communications be protected using the protocols indicated in that requirement, so the protocols required by this component ride "on top of" those listed in FTP_ITC_EXT.1.

FDP_UPC_EXT.1.2/BLUETOOTH The TSF shall permit the non-TSF applications to initiate communication via the trusted channel.

Evaluation Activity

The evaluator shall verify that the API documentation provided according to Section 5.2.2 Class ADV: Development includes the security functions (protection channel) described in these requirements, and verify that the APIs implemented to support this requirement include the appropriate settings/parameters so that the application can both provide and obtain the information needed to assure mutual identification of the endpoints of the communication as required by this component.

TSS
The evaluator shall examine the TSS to determine that it describes that all protocols listed in the TSS are specified and included in the requirements in the ST.

Guidance
The evaluator shall confirm that the operational guidance contains instructions necessary for configuring the protocol(s) selected for use by the applications.

Tests
Assurance Activity Note: *The following test requires the developer to provide access to a test platform that provides the evaluator with tools that are typically not found on consumer Mobile Device products.*

The evaluator shall write, or the developer shall provide access to, an application that requests protected channel services by the TSF. The evaluator shall verify that the results from the protected channel match the expected results according to the API documentation. This application may be used to assist in verifying the protected channel assurance activities for the protocol requirements. The evaluator shall also perform the following tests:

- ***Test 1:*** *The evaluators shall ensure that the application is able to initiate communications with an external IT entity using each protocol specified in the requirement, setting up the connections as described in the operational guidance and ensuring that communication is successful.*
- ***Test 2:*** *The evaluator shall ensure, for each communication channel with an authorized IT entity, the channel data are not sent in plaintext.*

5.1.4 Class: Identification and Authentication (FIA)

FIA_AFL_EXT.1 Extended: Authentication failure handling

FIA_AFL_EXT.1.1 The TSF shall consider password and [**selection**: *fingerprint*, *iris*, *face*, *voice*, *vein*, *hybrid*, *no other*] as critical authentication mechanisms.

Application Note: A critical authentication mechanism is one in which countermeasures are triggered (i.e. wipe of the device) when the maximum number of unsuccessful authentication attempts is exceeded, rendering the other factors unavailable.

If no additional authentication mechanisms are selected in FIA_UAU.5.1, then 'no other' shall be selected. If an additional authentication mechanism is selected in FIA_UAU.5.1, then it shall only be selected in FIA_AFL_EXT.1.1 if surpassing the authentication failure threshold for biometric data causes a countermeasure to be triggered regardless of the failure status of the other authentication mechanisms.

If the TOE implements multiple Authentication Factor interfaces (for example, a DAR decryption interface, a lockscreen interface, an auxiliary boot mode interface), this component applies to all available interfaces. For example, a password is a critical authentication mechanism regardless of if it is being entered at the DAR decryption interface or at a lockscreen interface.

FIA_AFL_EXT.1.2 The TSF shall detect when a configurable positive integer within [**assignment**: *range of acceptable values for each authentication mechanism*] of [**selection**: *unique*, *non-unique*] unsuccessful authentication attempts occur related to last successful authentication for each authentication mechanism.

Application Note: The positive integer(s) is configured according to FMT_SMF_EXT.1.1 function 2.

An unique authentication attempt is defined as any attempt to verify a password or biometric sample, in which the input is different from a previous attempt. 'Unique' shall be selected if the authentication system increments the counter only for unique unsuccessful authentication attempts. For example, if the same incorrect password is attempted twice the authentication system increments the counter once. 'Non-unique' shall be selected if the authentication system increments the counter for each unsuccessful authentication attempt, regardless of if the input is unique. For example, if the same incorrect password is attempted twice the authentication system increments the counter twice.

If hybrid authentication (i.e. a combination of biometric and pin/password) is supported, a failed authentication attempt can be counted as a single attempt, even if both the biometric and pin/password were incorrect.

If the TOE supports multiple authentication mechanisms per FIA_UAU.5.1, this component applies to all authentication mechanisms. It is acceptable for each authentication mechanism to utilize an independent counter or for multiple authentication mechanisms to utilize a shared counter. The interaction between the authentication factors in regards to the authentication counter shall be in accordance with FIA_UAU.5.2.

If the TOE implements multiple Authentication Factor interfaces (for example, aDAR decryption interface, a lockscreen interface, an auxiliary boot mode interface), this component applies to all available interfaces. However, it is acceptable for each Authentication Factor interface to be configurable with a different number of unsuccessful authentication attempts.

FIA_AFL_EXT.1.3 The TSF shall maintain the number of unsuccessful authentication attempts that have occurred upon power off.

Application Note: The TOE may implement an Authentication Factor interface that precedes another Authentication Factor interface in the boot sequence (for example, a volume DAR decryption interface which precedes the lockscreen interface) before the user can access the device. In this situation, because the user must successfully authenticate to the first interface to access the second, the number of unsuccessful authentication attempts need not be maintained for the second interface.

FIA_AFL_EXT.1.4 When the defined number of unsuccessful authentication attempts has exceeded the maximum allowed for a given authentication mechanism, all future authentication attempts will be limited to other available authentication mechanisms, unless the given mechanism is designated as a critical authentication mechanism.

Application Note: In accordance with FIA_AFL_EXT.1.3, this requirement also applies after the TOE is powered off and powered back on.

FIA_AFL_EXT.1.5 When the defined number of unsuccessful authentication attempts for the last available authentication mechanism or single critical authentication mechanism has been surpassed, the TSF shall perform a wipe of all protected data.

Application Note: Wipe is performed in accordance with FCS_CKM_EXT.5. Protected data is all non-TSF data, including all user or enterprise data. Some or all of this data may be considered sensitive data as well.

If the TOE implements multiple Authentication Factor interfaces (for example, a DAR decryption interface, a lockscreen interface, an auxiliary boot mode interface), this component applies to all available interfaces.

FIA_AFL_EXT.1.6 The TSF shall increment the number of unsuccessful authentication attempts prior to notifying the user that the authentication was unsuccessful.

Application Note: This requirement is to ensure that if power is cut to the device directly after an authentication attempt, the counter will be incremented to reflect that attempt.

Evaluation Activity

TSS
The evaluator shall ensure that the TSS describes that a value corresponding to the number of unsuccessful authentication attempts since the last successful authentication is kept for each Authentication Factor interface. The evaluator shall ensure that this description also includes if and how this value is maintained when the TOE loses power, either through a graceful powered off or an ungraceful loss of power. The evaluator shall ensure that if the value is not maintained, the interface is after another interface in the boot sequence for which the value is maintained.

If the TOE supports multiple authentication mechanisms, the evaluator shall ensure that this description also includes how the unsuccessful authentication attempts for each mechanism selected in FIA_UAU.5.1 is handled. The evaluator shall verify that the TSS describes if each authentication mechanism utilizes its own counter or if multiple authentication mechanisms utilize a shared counter. If multiple authentication mechanisms utilize a shared counter, the evaluator shall verify that the TSS describes this interaction.

The evaluator shall confirm that the TSS describes how the process used to determine if the authentication attempt was successful. The evaluator shall ensure that the counter would be updated even if power to the device is cut immediately following notifying the TOE user if the authentication attempt was successful or not.

Guidance
The evaluator shall verify that the AGD guidance describes how the administrator configures the maximum number of unique unsuccessful authentication attempts.

Tests

- ***Test 1:*** *The evaluator shall configure the device with all authentication mechanisms selected in FIA_UAU.5.1. The evaluator shall perform the following tests for each available authentication interface:*

  Test 1a: The evaluator shall configure the TOE, according to the AGD guidance, with a maximum number of unsuccessful authentication attempts. The evaluator shall enter the locked state and enter incorrect passwords until the wipe occurs. The evaluator shall verify that the number of password entries corresponds to the configured maximum and that the wipe is implemented.

  Test 1b: [conditional] If the TOE supports multiple authentication mechanisms the previous test shall be repeated using a combination of authentication mechanisms confirming that the critical authentication mechanisms will cause the device to wipe and that when the maximum number of unsuccessful authentication attempts for a non-critical authentication mechanism is exceeded, the device limits authentication attempts to other available authentication mechanisms. If multiple authentication mechanisms utilize a shared counter, then the evaluator shall verify that the maximum number of unsuccessful authentication attempts can be reached by using each individual authentication mechanism and a combination of all authentication mechanisms that share the counter.

- ***Test 2:*** *The evaluator shall repeat test one, but shall power off (by removing the battery, if possible) the TOE between unsuccessful authentication attempts. The evaluator shall verify that the total number of unsuccessful authentication attempts for each authentication mechanism corresponds to the configured maximum and that the critical authentication mechanisms cause the device to wipe. Alternatively, if the number of authentication failures is not maintained for the interface under test, the evaluator shall verify that upon booting the TOE between unsuccessful authentication attempts another authentication factor interface is presented before the interface under test.*

FIA_BMG_EXT.1 Extended: Accuracy of Biometric Authentication

This is a selection-based component. Its inclusion depends upon selection from FIA_UAU.5.1.

FIA_BMG_EXT.1.1 The one-attempt BAF False Accept Rate (FAR) for [**assignment**: *biometric modality selected in FIA_UAU.5.1*]shall not exceed [**assignment**: *claimed FAR no greater than 1:100*] with a one-attempt BAF False Reject Rate (FRR) not to exceed 1 in [**assignment**: *claimed FRR no greater than 1:10*].

Application Note: If a BAF or "hybrid" is selected in FIA_UAU.5.1, FIA_BMG_EXT.1.1 must be included in the ST. The assignment shall be completed for each biometric modality selected in FIA_UAU.5.1. If multiple biometric modalities are selected in FIA_UAU.5.1, it is acceptable for each modality to have a different FAR and FRR.

The False Accept Rate (FAR) is the measure of the likelihood that the biometric will incorrectly accept an authentication attempt by an unauthorized user. A system's FAR typically is stated as the proportion of verification transactions with wrongful claims of identity that are incorrectly confirmed.

The False Reject Rate (FRR) is the measure of the likelihood that the biometric security system will incorrectly reject an authentication attempt by an authorized user. A system's FRR typically is stated as the proportion of verification transactions with truthful claims of identity that are incorrectly denied.

Please note that without the use of hybrid authentication, multiple authentication attempts for a BAF that is claimed to have a one-attempt FAR between 1:100 and 1:500 inclusive will not produce an acceptable SAFAR in meeting FIA_BMG_EXT.1.2. More generally, depending on the number of authentication attempts allowed for the BAF, the claimed FAR must be strong (or equivalently, low) enough so that the SAFAR chosen in FIA_BMG_EXT.1.2 can be met within the 1% margin mandated.

Generally testing environments for a biometric system in a mobile device are based on a single legitimate user enrolling and test subjects attempt to authenticate. Since a thorough evaluation for FAR and FRR meeting all the conditions of statistical independence is not feasible in the timeframe of CC evaluations and in agreement with ISO/IEC 19795, the use of offline testing is acceptable even if this causes the biometric system to deviate slightly from the evaluated configuration. Additionally, full cross-comparison (i.e. all test subjects are compared to non-self) is acceptable.

Detailed explanations corresponding to the testing environments that are acceptable, to include the number of trials needed, can be found in F.1 Experimental Setups And Error Bars In Testing FAR And FRR.

Evaluation Activity

TSS
The evaluator shall verify that the TSS contains evidence supporting the testing and calculations completed to determine the FAR and FRR. Appendix F - Biometric Derivation and Examples provides guidance to how this testing could be completed and to what error bars are expected when the Rule of 3 is applied. The evaluator shall consult Appendix F - Biometric Derivation and Examples as a reference, but should not treat it as a mandate. The evaluator shall verify that the TSS contains evidence of whether online or offline testing was used. If offline testing was completed, evidence describing the differences between the biometric system used for testing and the TOE in the evaluated configuration, if any must be included.

The following documentation is not required to be part of the TSS - it may be submitted as a separate proprietary document. The evaluator shall verify the evidence includes how many imposters were used for testing and that the testing describes how imposters are compared to enrolled users, for example, if multiple devices for online testing or full cross-comparison for offline testing was used. Adequate documentation is required to demonstrate that testing was completed to support the claimed FAR and FRR.

FIA_BMG_EXT.1.2 The overall System Authentication False Accept Rate (SAFAR) shall be no greater than 1 in [**assignment**: *a SAFAR no greater than 1:500*] within a 1% margin.

Application Note: If a BAF or "hybrid" is selected in FIA_UAU.5.1, FIA_BMG_EXT.1.2 must be included in the ST.

System Authentication False Accept Rate (SAFAR) is defined by the combination of individual error rates for each authentication factor and attempts used for access to a single session on the device.

Accessing a single session may involve a single authentication factor, in which case the SAFAR for a single attempt will be equal to the false accept rate (FAR) of that authentication factor and the SAFAR for n attempts will be $1-(1-FAR)^n$, assuming independence.

Accessing a single session on the device may involve the ability to use multiple authentication factors. It may be the case that only one authentication factor is needed to access a single session on the device (i.e. both a password and a BAF can be used, but only one is needed) or that both authentication factors are needed to access a single session on the device (i.e. both the BAF and a PIN must be entered). The full equations for calculating the SAFAR can be found in F.3 SAFAR Calculation Equations. A fully worked-out example that applies the equations in F.3 SAFAR Calculation Equations for calculating the SAFAR can be found in F.4 SAFAR Calculation Example.

The worst-case scenario shall be used to calculate the SAFAR. Thus the authentication factor with the highest FAR shall be used for the maximum number of authentication attempts allowed for that factor. If any authentication attempts remain, then the authentication factor with the second highest FAR is used for the maximum number of authentication attempts allowed for that factor and so on. For example, the TOE supports a password and a BAF, the FAR for the BAF is higher than the FAR for the password and each authentication factor utilizes a shared counter per FIA_AFL_EXT.1. Then the worst-case scenario is the BAF is utilized for the maximum number of authentication attempts allowed for the BAF. For any remaining authentication attempts allowed the password is utilized.

Another example is the TOE supports a password and two BAFs, where the BAFs have different FARs, with both FARs being higher than the password FAR. Then the worst-case scenario is that the BAF with the highest FAR is used for the maximum number of authentication attempts allowed for that BAF, followed by the second BAF if any authentication attempts are allowed for that BAF. If any authentication attempts remain, then the password is utilized for those attempts.

The 1% margin is included for cases where a BAF is not a critical authentication factor and thus both BAF and password can be used in a session without exceeding the declared SAFAR.

Evaluation Activity

TSS
The evaluator shall verify that the TSS indicates which SAFAR the TOE is targeting and contains evidence supporting the calculations, per F.3 SAFAR Calculation Equations, completed to determine the SAFAR. The evaluator shall verify that the TSS contains evidence of how the authentication factors interact, per FIA_UAU.5.2 and FIA_AFL_EXT.1. The evaluator shall verify that the TSS, contains the combination(s) of authentication factors needed to meet the SAFAR, and the number of attempts for each authentication factor the TOE is configured to allow. Adequate documentation is required to demonstrate the calculations completed to support the claimed SAFAR.

FIA_BMG_EXT.2 Extended: Biometric Enrollment

This is an objective component.

FIA_BMG_EXT.2.1 The TSF shall only use biometric samples of sufficient quality for enrollment. Sample data shall have [**assignment**: *quality metrics corresponding to each biometric modality*].

Application Note: Different biometric modalities utilize different quality standards. The quality standard for the each BAF selected in FIA_UAU.5 should be listed in the assignment. For example, fingerprint may utilize the NFIQ standard where NFIQ 1.0 scores of 1, 2, or 3 are required for use in hardware PIV, where 1 is the highest quality standard. NFIQ 2.0 is a newer version of the NFIQ standard that has not seen widespread adoption as of the publication of this PP but is being considered by the scientific community as well as by industry. Samples used to create the authentication template/profile at enrollment shall be mutually consistent. After the authentication template has been created, it shall be tested to determine whether or not it is of sufficient quality and if not, more quality samples shall be added until it is of sufficient quality.

Evaluation Activity

TSS
The evaluator shall verify that the TSS describes how the quality of samples used to create the authentication template at enrollment are verified. As well as the quality standard that the validation method uses to perform the assessment.

Guidance
The evaluator shall verify that the AGD guidance describes how to enroll a user for each biometric modality supported.

Tests
The evaluator shall input biometric samples for enrollment. Upon inputting biometric samples a fixed number of times as specified in the prompts, one or more authentication templates will be generated. The evaluator shall verify that the device only accepts samples of sufficient quality or requests additional samples if the authentication template is not of sufficient quality. For all quality metrics, the evaluator shall ensure that biometric samples achieving a worse quality score than the prescribed threshold are rejected.

FIA_BMG_EXT.3 Extended: Biometric Verification

This is an objective component.

FIA_BMG_EXT.3.1 The TSF shall only use biometric samples of sufficient quality for verification. As such, sample data shall have [**assignment**: *quality metrics corresponding to each biometric modality*].

Application Note: Different biometric modalities utilize different quality standards. The quality standard for the each BAF selected in FIA_UAU.5 should be listed in the assignment. For example, fingerprint may utilize the NFIQ standard where NFIQ 1.0 scores of 1, 2, or 3 are required for use in hardware PIV, where 1 is the highest quality standard. NFIQ 2.0 is a newer version of the NFIQ standard that has not seen widespread adoption as of the publication of this PP but is being considered by the scientific community as well as by industry.

Evaluation Activity

TSS
The evaluator shall verify that the TSS describes how the quality of samples used to verify authentication are verified. As well as the quality standard that the validation method uses to perform the assessment. The evaluator shall enroll a user for each biometric modality supported. The evaluator will then input biometric samples for verification and ensure that the device only accepts samples of sufficient quality. The evaluator shall ensure that biometric samples achieving a worse quality score than the prescribed threshold are rejected.

FIA_BMG_EXT.4 Extended: Biometric Templates

This is an objective component.

FIA_BMG_EXT.4.1 The TSF shall only generate and use enrollment templates and/or authentication templates of sufficient quality for any subsequent authentication functions.

Application Note: If the vendor needs to develop an authentication template using multiple enrollment samples, they shall all be mutually consistent and correspond to the biometric characteristics of a single user and source. For the purposes of this requirement, enrollment templates are templates constructed from sample data, while authentication templates are generated based on sample data and/or enrollment templates and stored for

matching/biometric verification purposes. One or more templates could be generated during enrollment without the user knowing how many.

Authentication templates may not have standard quality metrics, but vendor and/or labs still need to ensure that such templates have a sufficient feature set available to provide a desired identity assurance level. Examples include minimum number of fingerprint minutiae.

Evaluation Activity

> ***TSS***
> *The evaluator shall verify that the TSS describes how the samples used to create the authentication template at enrollment are mutually consistent and how the mutual consistency is validated, both in terms of the method of validation as well as the quality standard that the validation method uses to perform the assessment.*
>
> *The evaluator shall input biometric samples for enrollment. In doing so, the evaluator shall verify the enrollment templates generated are of sufficient quality. Upon inputting biometric samples a fixed number of times as specified in the prompts, the evaluator shall additionally verify that any enrollment and authentication templates generated are of sufficient quality. That is, they shall all be mutually consistent and correspond to the biometric characteristics of a single user and source (e.g. the same finger from the same person).*

FIA_BMG_EXT.5 Extended: Handling Unusual Biometric Templates

> ***This is an objective component.***

FIA_BMG_EXT.5.1 The matching algorithm shall handle properly formatted enrollment templates and/or authentication templates, especially those with unusual data properties, appropriately. If such templates contain incorrect syntax, are of low quality, or contain enrollment data considered unrealistic for a given modality, then they shall be rejected by the matching algorithm and an error code shall be reported.

Application Note: While it is important to have properly formatted enrollment or authentication templates, it is equally important for the matching algorithm to correctly handle enrollment and/or authentication templates that have unusual data properties or are of low quality. If the matching algorithm detects templates that are of low quality, have low numbers of bits of complexity, or maintain unusual data properties, it shall return an error code or other indication in order to protect the system from possible spoofing or denial-of-service attacks. For the purposes of this requirement, enrollment templates are templates constructed from sample data, while authentication templates are stored for matching/biometric verification purposes.

Examples of unusual data properties that may cause fingerprint enrollment template rejection include, but are not limited to, minutia counts that are too high or too low, direction field maps that do not correspond to real fingerprint ridge flow maps, all detected minutia crowded to the extreme edges of the image area, and ridge widths that are too wide or too narrow.

Accordingly, if an enrollment template and/or authentication template meets the structural requirements but without proper syntax, the matching algorithm shall similarly return an error code or other indication to similar effect.

Evaluation Activity

> ***TSS***
> *The evaluator shall verify that the TSS how the matching algorithm addresses properly formatted templates with unusual data properties, incorrect syntax, or low quality. The evaluator shall ensure that these claims are sound through appropriate testing based on test programs provided by the vendor.*

FIA_BMG_EXT.6 Extended: Spoof Detections for Biometrics

> ***This is an objective component.***

FIA_BMG_EXT.6.1 The TSF shall perform Presentation Attack Detection testing up to the attack potential of [**selection**: *basic*, *intermediate*, *advanced*] attacks, for each biometric modalities selected in FIA_UAU.5.1 on each enrollment and authentication attempt, rejecting detected spoofs. When an authentication attempt fails due to PAD testing, the TSF shall not indicate to the user the reason for failure to authenticate.

Application Note: Presentation Attack Detection (PAD) is also known as liveness detection or spoof detection. If multiple modalities are selected in FIA_UAU.5.1, then this SFR shall be iterated for each modality. For each modality, only one attack strength shall be selected.

Because Presentation Attack Detection (PAD) is an open-ended problem much like

vulnerability testing, it is neither cost-effective nor feasible to create a complete list of attack vectors and perform testing on all of them during the timeframe for CC evaluations. Such a list would be ever-changing, and unlike code vulnerabilities (i.e. CVEs), the equipment, skill, time, and cost required to test highly sophisticated attacks is highly infeasible for a testing lab given the current timeframe for CC evaluations. Nevertheless, it is a known risk that has been documented by researchers for years.

Therefore, vendors are responsible for providing their own documentation specifying the measures the TSF takes to mitigate presentation attacks and the appropriate pen-testing (for example, red teaming and blue teaming) performed as proof.

To be specific, basic attacks (including basic and enhanced-basic [IBPC]) refer to attacks in literature of low skill that can be performed on a limited budget. This includes, but is not limited to, playback attacks of a spoken utterance using a different mobile device for voice authentication, taking a photograph of a fingerprint or facial and submitting it to the sensor, among other examples.

Intermediate (or moderate [IBPC]) attacks can include, but are not limited to, creating a foam finger to thwart fingerprint detection and using a higher quality playback device to thwart liveness detection.

Advanced (including high and beyond high [IBPC]) attacks can include, but are not limited to, creating a synthetic hand with the given fingerprint using an expensive 3D-printer and forcing someone to reveal one's credentials through coercion or threats that may cause harm (where detection of duress is required). Many of these attack techniques may be sensitive or government classified.

Evaluation Activity

TSS
The testing methodology specified in ISO 19989 Information technology — Security evaluation of presentation attack detection for biometrics [ISO 19989] is to be used to determine the efficacy of the PAD for the selected attack potential.

Assurance Activity Note: *ISO 19989 is in draft status at the time of publication of this PP. Once the ISO standard is published, it shall be used to meet the assurance activity for this requirement. Henniger, Scheuermann, and Kniess [IBPC], provide a description of attack potential calculation with examples. Until such time as ISO 19989 is published, the vendor shall provide to the lab a description of the PAD processing implemented in the TSF, test procedures used to validate successful operation of PAD, and test data with results of the PAD validation testing. The lab may analyze the test procedures and data to validate vendor test results or, optionally, may conduct its own testing.*

Tests
If the lab performs its own testing, it is highly recommended that the vendor provides spoof testing tools, as it is not expected for the lab to create a test procedure for modalities outside of established standards and easily implemented procedures. Labs can also expedite the testing process by purchasing the appropriate spoof kits and recipes from specialized biometrics testing labs.

FIA_PMG_EXT.1 Extended: Password Management

FIA_PMG_EXT.1.1 The TSF shall support the following for the Password Authentication Factor:

1. Passwords shall be able to be composed of any combination of [**selection**: *upper and lower case letters*, *[**assignment**: a character set of at least 52 characters]*], numbers, and special characters: [**selection**: *"!"*, *"@"*, *"#"*, *"$"*, *"%"*, *"^"*, *"&"*, *"*"*, *"("*, *")"*, *[**assignment**: other characters]*] ;
2. Password length up to [**assignment**: *an integer greater than or equal to 14*] characters shall be supported.

Application Note: While some corporate policies require passwords of 14 characters or better, the use of a REK for DAR protection and key storage protection and the anti-hammer requirement (FIA_TRT_EXT.1) addresses the threat of attackers with physical access using much smaller and less complex passwords.

The ST author selects the character set: either the upper and lower case Basic Latin letters or another assigned character set containing at least 52 characters. The assigned character set must be well defined: either according to an international encoding standard (such as Unicode) or defined in the assignment by the ST author. The ST author also selects the special characters that are supported by TOE; they may optionally list additional special characters supported using the assignment.

Evaluation Activity

Guidance
The evaluator shall examine the operational guidance to determine that it provides guidance to security administrators on the composition of strong passwords, and that it

provides instructions on setting the minimum password length. The evaluator shall also perform the following tests. Note that one or more of these tests can be performed with a single test case.

Tests

- ***Test 1:*** *The evaluator shall compose passwords that either meet the requirements, or fail to meet the requirements, in some way. For each password, the evaluator shall verify that the TOE supports the password. While the evaluator is not required (nor is it feasible) to test all possible compositions of passwords, the evaluator shall ensure that all characters, rule characteristics, and a minimum length listed in the requirement are supported, and justify the subset of those characters chosen for testing.*

FIA_TRT_EXT.1 Extended: Authentication Throttling

FIA_TRT_EXT.1.1 The TSF shall limit automated user authentication attempts by [**selection**: *preventing authentication via an external port*, *enforcing a delay between incorrect authentication attempts*] for all authentication mechanisms selected in FIA_UAU.5.1. The minimum delay shall be such that no more than 10 attempts can be attempted per 500 milliseconds.

Application Note: The authentication throttling applies to all authentication mechanisms selected in FIA_UAU.5.1. The user authentication attempts in this requirement are attempts to guess the Authentication Factor. The developer can implement the timing of the delays in the requirements using unequal or equal timing of delays. The minimum delay specified in this requirement provides defense against brute forcing.

Evaluation Activity

TSS

The evaluator shall verify that the TSS describes the method by which authentication attempts are not able to be automated. The evaluator shall ensure that the TSS describes either how the TSF disables authentication via external interfaces (other than the ordinary user interface) or how authentication attempts are delayed in order to slow automated entry and shall ensure that this delay totals at least 500 milliseconds over 10 attempts for all authentication mechanisms selected in FIA_UAU.5.1.

FIA_UAU.5 Multiple Authentication Mechanisms

FIA_UAU.5.1 The TSF shall provide password and [**selection**: *fingerprint*, *iris*, *face*, *voice*, *vein*, *hybrid*, *no other mechanism*] to support user authentication.

Application Note: The TSF must support a Password Authentication Factor and may optionally implement a BAF, in the form of a fingerprint, iris, face, voice and (finger/palm) vein. A hybrid authentication factor is where a user has to submit a combination of PIN/password and biometric sample where both have to pass and if either fails the user is not made aware of which factor failed.

If "hybrid" is selected, a biometric modality does not need to be selected, but should be selected if the biometric authentication can be used independent of the hybrid authentication, i.e. without having to enter a PIN/password.

If a biometric modality or "hybrid" is selected, then FIA_BMG_EXT.1 and FDP_PBA_EXT.1 must be included in the ST.

If "using a PIN as an additional factor" or "using a password as an additional factor" is selected in FDP_PBA_EXT.1.1, then "hybrid" shall be selected.

The Password Authentication Factor is configured according to FIA_PMG_EXT.1.

FIA_UAU.5.2 The TSF shall authenticate any user's claimed identity according to the [**assignment**: *rules describing how each authentication mechanism provides authentication*].

Application Note: For all authentication mechanisms specified in FIA_UAU.5.1, the TSS shall describe the rules as to how each authentication mechanism is used. Example rules are how the authentication mechanism authenticates the user (i.e. how does the TSF verify that the correct password or biometric sample was entered), the result of a successful authentication (i.e. is the user input used to derive or unlock a key) and which authentication mechanism can be used at which authentication factor interfaces (i.e. if there are times, for example, after a reboot, that only specific authentication mechanisms can be used). If multiple BAFs are supported per FIA_UAU.5.1, the interaction between the BAFs, shall be described. For example, if the multiple BAFs can be enabled at the same time. Rules regarding how the authentication factors interact in terms of unsuccessful authentication are covered in FIA_AFL_EXT.1.

Evaluation Activity

TSS

The evaluator shall ensure that the TSS describes each mechanism provided to support

user authentication and the rules describing how the authentication mechanism(s) provide authentication.

Guidance
The evaluator shall verify that configuration guidance for each authentication mechanism is addressed in the AGD guidance.
Tests

- ***Test 1:*** *For each authentication mechanism selected, the evaluator shall enable that mechanism and verify that it can be used to authenticate the user at the specified authentication factor interfaces.*
- ***Test 2:*** *For each authentication mechanism rule, the evaluator shall ensure that the authentication mechanism(s) behave accordingly.*

FIA_UAU.6 Re-Authentication

FIA_UAU.6.1 The TSF shall re-authenticate the user via the Password Authentication Factor under the conditions attempted change to any supported authentication mechanisms.

Application Note: The password authentication factor must be entered before either the password or biometric authentication factor, if selected in FIA_UAU.5.1, can be changed.

Evaluation Activity

Tests

- ***Test 1:*** *The evaluator shall configure the TSF to use the Password Authentication Factor according to the AGD guidance. The evaluator shall change Password Authentication Factor according to the AGD guidance and verify that the TSF requires the entry of the Password Authentication Factor before allowing the factor to be changed.*
- ***Test 2:*** *[conditional] For each BAF selected in FIA_UAU.5.1, the evaluator shall configure the TSF to use the BAF, which includes configuring the Password Authentication Factor, according to the AGD guidance. The evaluator shall change the BAF according to the AGD guidance and verify that the TSF requires the entry of the Password Authentication Factor before allowing the BAF to be changed.*
- ***Test 3:*** *[conditional] If "hybrid" is selected in FIA_UAU.5.1, the evaluator shall configure the TSF to use the BAF and PIN or password, which includes configuring the Password Authentication Factor, according to the AGD guidance. The evaluator shall change the BAF and PIN according to the AGD guidance and verify that the TSF requires the entry of the Password Authentication Factor before allowing the factor to be changed.*

FIA_UAU.6.2 The TSF shall re-authenticate the user via an authentication factor defined in FIA_UAU.5.1 under the conditions TSF-initiated lock, user-initiated lock, [**assignment**: *other conditions*].

Application Note: Depending on the selections made in FIA_UAU.5.1, either the password (at a minimum), biometric authentication or hybrid authentication mechanisms can be used to unlock the device. TSF- and user-initiated locking is described in FTA_SSL_EXT.1.

Evaluation Activity

Tests

- ***Test 1:*** *The evaluator shall configure the TSF to transition to the locked state after a time of inactivity (FMT_SMF_EXT.1) according to the AGD guidance. The evaluator shall wait until the TSF locks and then verify that the TSF requires the entry of the Password Authentication Factor before transitioning to the unlocked state.*
- ***Test 2:*** *[conditional] For each BAF selected in FIA_UAU.5.1, the evaluator shall repeat Test 1 verifying that the TSF requires the entry of the BAF before transitioning to the unlocked state.*
- ***Test 3:*** *[conditional] If "hybrid" is selected in FIA_UAU.5.1, the evaluator shall repeat Test 1 verifying that the TSF requires the entry of the BAF and PIN/password before transitioning to the unlocked state.*
- ***Test 4:*** *The evaluator shall configure user-initiated locking according to the AGD guidance. The evaluator shall lock the TSF and then verify that the TSF requires the entry of the Password Authentication Factor before transitioning to the unlocked state.*
- ***Test 5:*** *[conditional] For each BAF selected in FIA_UAU.5.1, the evaluator shall repeat Test 4 verifying that the TSF requires the entry of the BAF before transitioning to the unlocked state.*
- ***Test 6:*** *[conditional] If "hybrid" is selected in FIA_UAU.5.1, the evaluator shall repeat Test 4 verifying that the TSF requires the entry of the BAF and PIN/password before transitioning to the unlocked state.*

FIA_UAU.7 Protected Authentication Feedback

FIA_UAU.7.1 The TSF shall provide only obscured feedback to the device's display to the user while the authentication is in progress.

Application Note: This applies to all authentication methods specified in FIA_UAU.5.1. The TSF may briefly (1 second or less) display each character or provide an option to allow the user to unmask the password; however, the password must be obscured by default.

If a BAF is selected in FIA_UAU.5.1, the TSF shall not display sensitive information regarding the biometric that could aid an adversary in identifying and/or spoofing the respective biometric characteristics of a given human user. While it is true that biometric samples, by themselves, are not secret, the analysis performed by the respective biometric algorithms, as well as output data from these biometric algorithms, is considered sensitive and shall be kept secret. Where applicable, the TSF shall not reveal or make public the reason(s) for authentication failure.

Evaluation Activity

TSS
The evaluator shall ensure that the TSS describes the means of obscuring the authentication entry, for all authentication methods specified in FIA_UAU.5.1.
Guidance
The evaluator shall verify that any configuration of this requirement is addressed in the AGD guidance and that the password is obscured by default.
Tests

- ***Test 1:*** *The evaluator shall enter passwords on the device, including at least the Password Authentication Factor at lockscreen, and verify that the password is not displayed on the device.*
- ***Test 2:*** *[conditional] For each BAF selected in FIA_UAU.5.1, the evaluator shall authenticate by producing a biometric sample at lockscreen. As the biometric algorithms are performed, the evaluator shall verify that sensitive images, audio, or other information identifying the user are kept secret and are not revealed to the user. Additionally, the evaluator shall produce a biometric sample that fails to authenticate and verify that the reason(s) for authentication failure (user mismatch, low sample quality, etc.) are not revealed to the user. It is acceptable for the BAF to state that it was unable to physically read the biometric sample, for example, if the sensor is unclean or the biometric sample was removed too quickly. However, specifics regarding why the presented biometric sample failed authentication shall not be revealed to the user.*

FIA_UAU_EXT.1 Extended: Authentication for Cryptographic Operation

FIA_UAU_EXT.1.1 The TSF shall require the user to present the Password Authentication Factor prior to decryption of protected data and encrypted DEKs, KEKs and [**selection**: *long-term trusted channel key material*, *all software-based key storage*, *no other keys*] at startup.

Application Note: The intent of this requirement is to prevent decryption of protected data before the user has authorized to the device using the Password Authentication Factor. The Password Authentication Factor is also required in order derive the key used to decrypt sensitive data, which includes software-based secure key storage.

Evaluation Activity

TSS
The evaluator shall verify that the TSS section of the ST describes the process for decrypting protected data and keys. The evaluator shall ensure that this process requires the user to enter a Password Authentication Factor and, in accordance with FCS_CKM_EXT.3, derives a KEK, which is used to protect the software-based secure key storage and (optionally) DEK(s) for sensitive data, in accordance with FCS_STG_EXT.2.

Tests
The following tests may be performed in conjunction with FDP_DAR_EXT.1 and FDP_DAR_EXT.2.

Assurance Activity Note: *The following test require the developer to provide access to a test platform that provides the evaluator with tools that are typically not found on consumer Mobile Device products.*

- ***Test 1:*** *The evaluator shall enable encryption of protected data and require user authentication according to the AGD guidance. The evaluator shall write, or the developer shall provide access to, an application that includes a unique string treated as protected data.*

  The evaluator shall reboot the device, use a tool provided by developer to search for the unique string amongst the application data, and verify that the unique string cannot be found. The evaluator shall enter the Password Authentication Factor to access full device functionality, use a tool provided by the developer to access the

unique string amongst the application data, and verify that the unique string can be found.

- ***Test 2:*** *[conditional] The evaluator shall require user authentication according to the AGD guidance. The evaluator shall store a key in the software-based secure key storage.*

  The evaluator shall lock the device, use a tool provided by developer to access the key amongst the stored data, and verify that the key cannot be retrieved or accessed. The evaluator shall enter the Password Authentication Factor to access full device functionality, use a tool provided by developer to access the key, and verify that the key can be retrieved or accessed.

- ***Test 3:*** *[conditional] The evaluator shall enable encryption of sensitive data and require user authentication according to the AGD guidance. The evaluator shall write, or the developer shall provide access to, an application that includes a unique string treated as sensitive data.*

  The evaluator shall lock the device, use a tool provided by developer to attempt to access the unique string amongst the application data, and verify that the unique string cannot be found. The evaluator shall enter the Password Authentication Factor to access full device functionality, use a tool provided by developer to access the unique string amongst the application data, and verify that the unique string can be retrieved.

FIA_UAU_EXT.2 Extended: Timing of Authentication

FIA_UAU_EXT.2.1 The TSF shall allow [**selection**: *[**assignment**: list of actions]*, *no actions*] on behalf of the user to be performed before the user is authenticated.

FIA_UAU_EXT.2.2 The TSF shall require each user to be successfully authenticated before allowing any other TSF-mediated actions on behalf of that user.

Application Note: The security relevant actions allowed by unauthorized users in locked state must be listed. At a minimum the actions that correspond to the functions available to the user in FMT_SMF_EXT.1 and are allowed by unauthorized users in locked state should be listed. For example, if the user can enable/disable the camera per function 5 of FMT_SMF_EXT.1 and unauthorized users can take a picture when the device is in locked state, this action must be listed.

Evaluation Activity

TSS
The evaluator shall verify that the TSS describes the actions allowed by unauthorized users in the locked state.
Tests
The evaluator shall attempt to perform some actions not listed in the selection while the device is in the locked state and verify that those actions do not succeed.

FIA_UAU_EXT.4 Extended: Secondary User Authentication

FIA_UAU_EXT.4.1 The TSF shall provide a secondary authentication mechanism for accessing Enterprise applications and resources. The secondary authentication mechanism shall control access to the Enterprise application and shared resources and shall be incorporated into the encryption of protected and sensitive data belonging to Enterprise applications and shared resources.

Application Note: For the BYOD use case, Enterprise applications and data shall be protected using a different password than the user authentication to gain access to the personal applications and data, if configured.

This requirement shall be included in the ST if the TOE implements a container solution, in which there is a separate authentication, to separate user and Enterprise applications and resources.

Evaluation Activity

Tests
The assurance activities for any selected requirements related to device authentication must be separately performed for the secondary authentication mechanism (in addition to activities performed for the primary authentication mechanism). The requirements are: FIA_UAU.6, FIA_PMG_EXT.1, FIA_TRT_EXT.1, FIA_UAU.7, FIA_UAU_EXT.2, FTA_SSL_EXT.1, FCS_STG_EXT.2, FMT_SMF_EXT.1/FMT_MOF_EXT.1 #1, #2, #8, #21, and #36.

Additionally, FIA_AFL_EXT.1 must be met, except that in FIA_AFL_EXT.1.2 the separate test is performed with the text "wipe of all protected data" changed to "wipe of all Enterprise application data and all Enterprise shared resource data."

FIA_UAU_EXT.4.2 The TSF shall require the user to present the secondary authentication factor prior to decryption of Enterprise application data and Enterprise shared resource data.

Application Note: This requirement must be selected if FIA_UAU_EXT.4.1 is selected. The intent of this requirement is to prevent decryption of protected Enterprise application data and Enterprise shared resource data before the user has authenticated to the device using the secondary authentication factor. Enterprise shared resource data consists of the FDP_ACF_EXT.2.1 selections.

Evaluation Activity

TSS
The evaluator shall verify that the TSS section of the ST describes the process for decrypting Enterprise application data and shared resource data. The evaluator shall ensure that this process requires the user to enter an Authentication Factor and, in accordance with FCS_CKM_EXT.3, derives a KEK which is used to protect the software-based secure key storage and (optionally) DEK(s) for sensitive data, in accordance with FCS_STG_EXT.2.

FIA_X509_EXT.1 Extended: X.509 Validation of certificates

FIA_X509_EXT.1.1 The TSF shall validate certificates in accordance with the following rules:

- RFC 5280 certificate validation and certificate path validation
- The certificate path must terminate with a certificate in the Trust Anchor Database
- The TSF shall validate a certificate path by ensuring the presence of the basicConstraints extension and that the CA flag is set to TRUE for all CA certificates
- The TSF shall validate the revocation status of the certificate using **selection**: *the Online Certificate Status Protocol (OCSP) as specified in RFC 2560*, *a Certificate Revocation List (CRL) as specified in RFC 5759*]
- The TSF shall validate the extendedKeyUsage field according to the following rules:
  - Certificates used for trusted updates and executable code integrity verification shall have the Code Signing purpose (id-kp 3 with OID 1.3.6.1.5.5.7.3.3) in the extendedKeyUsage field
  - Server certificates presented for TLS shall have the Server Authentication purpose (id-kp 1 with OID 1.3.6.1.5.5.7.3.1) in the extendedKeyUsage field
  - (Conditional) Server certificates presented for EST shall have the CMC Registration Authority (RA) purpose (id-kp-cmcRA with OID 1.3.6.1.5.5.7.3.28) in the extendedKeyUsage field

Application Note: FIA_X509_EXT.1.1 lists the rules for validating certificates. The ST author shall select whether revocation status is verified using OCSP or CRLs. The WLAN Client EP to which a MDF TOE must also conform requires that certificates are used for EAP-TLS; this use requires that the extendedKeyUsage rules are verified. Certificates may optionally be used for trusted updates of system software and applications (FPT_TUD_EXT.2) and for integrity verification (FPT_TST_EXT.2/PREKERNEL) and, if implemented, must be validated to contain the Code Signing purpose extendedKeyUsage.

While FIA_X509_EXT.1.1 requires that the TOE perform certain checks on the certificate presented by a TLS server, there are corresponding checks that the authentication server will have to perform on the certificate presented by the client; namely that the extendedKeyUsage field of the client certificate includes "Client Authentication" and that the key agreement bit (for the Diffie-Hellman ciphersuites) or the key encipherment bit (for RSA ciphersuites) be set. Certificates obtained for use by the TOE will have to conform to these requirements in order to be used in the enterprise. This check is required to support EAP-TLS for the WLAN Client EP.

FIA_X509_EXT.1.2 The TSF shall only treat a certificate as a CA certificate if the basicConstraints extension is present and the CA flag is set to TRUE.

Application Note: This requirement applies to certificates that are used and processed by the TSF and restricts the certificates that may be added to the Trust Anchor Database.

Evaluation Activity

TSS
The evaluator shall ensure the TSS describes where the check of validity of the certificates takes place. The evaluator ensures the TSS also provides a description of the certificate path validation algorithm.

Tests
The tests described must be performed in conjunction with the other Certificate Services assurance activities, including the use cases in FIA_X509_EXT.2.1 and FIA_X509_EXT.3. The tests for the extendedKeyUsage rules are performed in conjunction with the uses that require those rules. The evaluator shall create a chain of at least four certificates: the node certificate to be tested, two Intermediate CAs, and the self-signed Root CA.

- ***Test 1:*** *The evaluator shall then load a certificate or certificates to the Trust Anchor Database needed to validate the certificate to be used in the function (e.g. application validation, trusted channel setup, or trusted software update), and demonstrate that the function succeeds. The evaluator then shall delete one of the certificates, and show that the function fails.*

- ***Test 2:*** *The evaluator shall demonstrate that validating an expired certificate results in the function failing.*

- ***Test 3:*** *The evaluator shall test that the TOE can properly handle revoked certificates-conditional on whether CRL or OCSP is selected; if both are selected, then a test shall be performed for each method. The evaluator shall test revocation of the node certificate and revocation of the intermediate CA certificate (i.e. the intermediate CA certificate should be revoked by the root CA). For the test of the WLAN use case, only pre-stored CRLs are used. The evaluator shall ensure that a valid certificate is used, and that the validation function succeeds. The evaluator then attempts the test with a certificate that has been revoked (for each method chosen in the selection) to ensure when the certificate is no longer valid that the validation function fails.*

- ***Test 4:*** *The evaluator shall construct a certificate path, such that the certificate of the CA issuing the TOE's certificate does not contain the basicConstraints extension. The validation of the certificate path fails.*

- ***Test 5:*** *The evaluator shall construct a certificate path, such that the certificate of the CA issuing the TOE's certificate has the cA flag in the basicConstraints extension not set. The validation of the certificate path fails.*

- ***Test 6:*** *The evaluator shall construct a certificate path, such that the certificate of the CA issuing the TOE's certificate has the cA flag in the basicConstraints extension set to TRUE. The validation of the certificate path succeeds.*

- ***Test 7:*** *The evaluator shall modify any byte in the first eight bytes of the certificate and demonstrate that the certificate fails to validate (the certificate will fail to parse correctly).*

- ***Test 8:*** *The evaluator shall modify any bit in the last byte of the signature algorithm of the certificate and demonstrate that the certificate fails to validate (the signature on the certificate will not validate).*

- ***Test 9:*** *The evaluator shall modify any byte in the public key of the certificate and demonstrate that the certificate fails to validate (the signature on the certificate will not validate).*

FIA_X509_EXT.2 Extended: X.509 certificate authentication

FIA_X509_EXT.2.1 The TSF shall use X.509v3 certificates as defined by RFC 5280 to support authentication for mutually authenticated TLS as defined in the Package for Transport Layer Security, HTTPS [**selection**: *IPsec in accordance with the PP-Module for VPN Client*, *mutually authenticated DTLS as defined in the Package for Transport Layer Security*], and [**selection**: *code signing for system software updates*, *code signing for mobile applications*, *code signing for integrity verification*, *[**assignment**: other uses]*, *no additional uses*].

Application Note: The ST author's first selection shall match the selection of FDP_UPC_EXT.1.1/NORMAL and FTP_ITC_EXT.1.1.

Certificates may optionally be used for trusted updates of system software (FPT_TUD_EXT.2.3) and mobile applications (FPT_TUD_EXT.4.1) and for integrity verification (FPT_TST_EXT.2/PREKERNEL). If "code signing for system software updates" or "code signing for mobile applications" is selected FPT_TUD_EXT.3.1 shall be included in the ST.

If FPT_TUD_EXT.4.1 is included in the ST, "code signing for mobile applications" must be included in the selection.

FIA_X509_EXT.2.2 When the TSF cannot establish a connection to determine the revocation status of a certificate, the TSF shall [**selection**: *allow the administrator to choose whether to accept the certificate in these cases*, *allow the user to choose whether to accept the certificate in these cases*, *accept the certificate*, *not accept the certificate*].

Application Note: The TOE must not accept the certificate if it fails any of the other validation rules in FIA_X509_EXT.1. However, often a connection must be established to perform a verification of the revocation status of a certificate - either to download a CRL or to perform OCSP. The selection is used to describe the behavior in the event that such a connection cannot be established (for example, due to a network error). If the TOE has determined the certificate valid according to all other rules in FIA_X509_EXT.1, the behavior indicated in the selection shall determine the validity. If the administrator-configured or user-configured option is selected, the ST Author must also select function 30 in FMT_SMF_EXT.1.

The TOE may behave differently depending on the trusted channel; for example, in the case of WLAN where connections are unlikely to be established, the TOE may accept the certificate even though certificates are not accepted for other channels. The ST author should select all applicable behaviors.

Evaluation Activity

TSS
The evaluator shall check the TSS to ensure that it describes how the TOE chooses which certificates to use, and any necessary instructions in the administrative guidance for configuring the operating environment so that the TOE can use the certificates.

The evaluator shall examine the TSS to confirm that it describes the behavior of the TOE when a connection cannot be established during the validity check of a certificate used in establishing a trusted channel. The evaluator shall verify that any distinctions between trusted channels are described.
Guidance
If the requirement that the administrator is able to specify the default action, then the evaluator shall ensure that the operational guidance contains instructions on how this configuration action is performed.

Tests
The evaluator shall perform the following test for each trusted channel:

- ***Test 1:*** *The evaluator shall demonstrate that using a valid certificate that requires certificate validation checking to be performed in at least some part by communicating with a non-TOE IT entity. The evaluator shall then manipulate the environment so that the TOE is unable to verify the validity of the certificate, and observe that the action selected in FIA_X509_EXT.2.2 is performed. If the selected action is administrator-configurable, then the evaluator shall follow the operational guidance to determine that all supported administrator-configurable options behave in their documented manner.*

FIA_X509_EXT.3 Extended: Request Validation of certificates

FIA_X509_EXT.3.1 The TSF shall provide a certificate validation service to applications.

FIA_X509_EXT.3.2 The TSF shall respond to the requesting application with the success or failure of the validation.

Application Note: In order to comply with all of the rules in FIA_X509_EXT.1, multiple API calls may be required; all of these calls should be clearly documented

Evaluation Activity

The evaluator shall verify that the API documentation provided according to Section 5.2.2 Class ADV: Development includes the security function (certificate validation) described in this requirement. This documentation shall be clear as to which results indicate success and failure.

Tests
The evaluator shall write, or the developer shall provide access to, an application that requests certificate validation by the TSF. The evaluator shall verify that the results from the validation match the expected results according to the API documentation. This application may be used to verify that import, removal, modification, and validation are performed correctly according to the tests required by FDP_STG_EXT.1, FTP_ITC_EXT.1, FMT_SMF_EXT.1.1, and FIA_X509_EXT.1.

FIA_X509_EXT.4 Extended: X509 certificate enrollment

This is an objective component.

FIA_X509_EXT.4.1 The TSF shall use the Enrollment over Secure Transport (EST) protocol as specified in RFC 7030 to request certificate enrollment using the simple enrollment method described in RFC 7030 Section 4.2.

FIA_X509_EXT.4.2 The TSF shall be capable of authenticating EST requests using an existing certificate and corresponding private key as specified by RFC 7030 Section 3.3.2.

FIA_X509_EXT.4.3 The TSF shall be capable of authenticating EST requests using HTTP Basic Authentication with a username and password as specified by RFC 7030 Section 3.2.3.

FIA_X509_EXT.4.4 The TSF shall perform authentication of the EST server using an Explicit Trust Anchor following the rules described in RFC 7030, section 3.6.1.

Application Note: EST also uses HTTPS as specified in FCS_HTTPS_EXT.1 to establish a secure connection to an EST server. The separate Trust Anchor Database dedicated to EST operations is described as Explicit Trust Anchors in RFC 7030.

FIA_X509_EXT.4.5 The TSF shall be capable of requesting server-provided private keys as specified in RFC 7030 Section 4.4.

FIA_X509_EXT.4.6 The TSF shall be capable of updating its EST-specific Trust Anchor Database using the "Root CA Key Update" process described in RFC 7030 Section 4.1.3.

FIA_X509_EXT.4.7 The TSF shall generate a Certificate Request Message for EST as specified in RFC 2986 and be able to provide the following information in the request: public key and [**selection**: *device-specific information*, *Common Name*, *Organization*, *Organizational Unit*, *Country*].

Application Note: The public key referenced is the public key portion of the public-private key pair generated by the TOE as specified in FCS_CKM.1.

FIA_X509_EXT.4.8 The TSF shall validate the chain of certificates from the RootCA certificate in the Trust Anchor Database to the EST Server CA certificate upon receiving a CA Certificates Response.

Evaluation Activity

Guidance
The evaluator shall check to ensure that the operational guidance contains instructions on requesting certificates from an EST server, including generating a Certificate Request Message.

Tests
The evaluator shall also perform the following tests. Other tests are performed in conjunction with the Assurance Activity listed in the Package for Transport Layer Security.

- ***Test 1:*** *The evaluator shall use the operational guidance to cause the TOE to request certificate enrollment from an EST server using the simple enrollment method described in RFC 7030 Section 4.2, authenticating the certificate request to the server using an existing certificate and private key as described by RFC 7030 Section 3.3.2. The evaluator shall confirm that the resulting certificate is successfully obtained and installed in the TOE key store.*

- ***Test 2:*** *The evaluator shall use the operational guidance to cause the TOE to request certificate enrollment from an EST server using the simple enrollment method described in RFC 7030 Section 4.2, authenticating the certificate request to the server using a username and password as described by RFC 7030 Section 3.2.3. The evaluator shall confirm that the resulting certificate is successfully obtained and installed in the TOE key store.*

- ***Test 3:*** *The evaluator shall modify the EST server to return a certificate containing a different public key than the key included in the TOE's certificate request. The evaluator shall use the operational guidance to cause the TOE to request certificate enrollment from an EST server. The evaluator shall confirm that the TOE does not accept the resulting certificate since the public key in the issued certificate does not match the public key in the certificate request.*

- ***Test 4:*** *The evaluator shall configure the EST server or use a man-in-the-middle tool to present a server certificate to the TOE that is present in the TOE general Trust Anchor Database but not its EST-specific Trust Anchor Database. The evaluator shall cause the TOE to request certificate enrollment from the EST server. The evaluator shall verify that the request is not successful.*

- ***Test 5:*** *The evaluator shall configure the EST server or use a man-in-the-middle tool to present an invalid certificate. The evaluator shall cause the TOE to request certificate enrollment from the EST server. The evaluator shall verify that the request is not successful The evaluator shall configure the EST server or use a man-in-the-middle tool to present a certificate that does not have the CMC RA purpose and verify that requests to the EST server fail. The tester shall repeat the test using a valid certificate and a certificate that contains the CMC RA purpose and verify that the certificate enrollment requests succeed.*

- ***Test 6:*** *The evaluator shall use a packet sniffing tool between the TOE and an EST server. The evaluator shall turn on the sniffing tool and cause the TOE to request certificate enrollment from an EST server. The evaluator shall verify that the EST protocol interaction occurs over a Transport Layer Security (TLS) protected connection. The evaluator is not expected to decrypt the connection but rather observe that the packets conform to the TLS protocol format.*

- ***Test 7:*** *The evaluator shall use the operational guidance to cause the TOE to request a server-provided private key and certificate from an EST server. The evaluator shall confirm that the resulting private key and certificate are successfully obtained and installed in the TOE key store.*

- ***Test 8:*** *The evaluator shall modify the EST server to, in response to a server-provided private key and certificate request, return a private key that does not correspond with the public key in the returned certificate. The evaluator shall use the operational guidance to cause the TOE to request a server-provided private key and certificate. The evaluator shall confirm that the TOE does not accept the resulting private key and certificate since the private key and public key do not correspond.*

- ***Test 9:*** *The evaluator shall configure the EST server to provide a "RootCA Key Update" as described in RFC 7030 Section 4.1.3. The evaluator shall cause the TOE to request CA certificates from the EST server and shall confirm that the EST-specific Trust Anchor Database is updated with the new trust anchor.*

- ***Test 10:*** *The evaluator shall configure the EST server to provide a "RootCA Key Update" as described in RFC 7030 Section 4.1.3, but shall modify part of the NewWithOld certificate's generated signature. The evaluator shall cause the TOE to request CA certificates from the EST server and shall confirm that the EST-specific Trust Anchor Database is not updated with the new trust anchor since the signature did not verify.*

- ***Test 11:*** *The evaluator shall use the operational guidance to cause the TOE to generate a certificate request message. The evaluator shall capture the generated message and ensure that it conforms to the format specified by RFC 2986. The evaluator shall confirm that the certificate request provides the public key and other required information, including any necessary user-input information.*

FIA_X509_EXT.5 Extended: X509 certificate enrollment

This is an objective component.

FIA_X509_EXT.5.1 The TSF shall generate a Certificate Request Message as specified in RFC 2986 and be able to provide the following information in the request: public key and [**selection**: *device-specific information*, *Common Name*, *Organization*, *Organizational Unit*, *Country*].

Application Note: The public key referenced in FIA_X509_EXT.5.1 is the public key portion of the public-private key pair generated by the TOE as specified in FCS_CKM.1. The trusted channel requirements do not apply to communication with the CA for the certificate request/response messages.

As Enrollment over Secure Transport (EST) is a new standard that has not yet been widely adopted, this requirement is included as an interim objective requirement in order to allow developers to distinguish those products which have do have the ability to generate Certificate Request Messages but do not yet implement EST.

FIA_X509_EXT.5.2 The TSF shall validate the chain of certificates from the RootCA upon receiving the CA Certificate Response.

Evaluation Activity

TSS
If the ST author selects "device-specific information", the evaluator shall verify that the TSS contains a description of the device-specific fields used in certificate requests.

Guidance
The evaluator shall check to ensure that the operational guidance contains instructions on generating a Certificate Request Message. If the ST author selects "Common Name", "Organization", "Organizational Unit", or "Country", the evaluator shall ensure that this guidance includes instructions for establishing these fields before creating the certificate request message.

Tests
The evaluator shall also perform the following tests:

- ***Test 1:*** *The evaluator shall use the operational guidance to cause the TOE to generate a certificate request message. The evaluator shall capture the generated message and ensure that it conforms to the format specified. The evaluator shall confirm that the certificate request provides the public key and other required information, including any necessary user-input information.*

- ***Test 2:*** *The evaluator shall demonstrate that validating a certificate response message without a valid certification path results in the function failing. The evaluator shall then load a certificate or certificates as trusted CAs needed to validate the certificate response message, and demonstrate that the function succeeds. The evaluator shall then delete one of the certificates, and show that the function fails.*

5.1.5 Class: Security Management (FMT)

Both the user and the administrator may manage the TOE. This administrator is likely to be acting remotely and could be the Mobile Device Management (MDM) Administrator acting through an MDM Agent.

The Administrator is responsible for management activities, including setting the policy that is applied by the enterprise on the Mobile Device. These management functions are likely to be a different set than those management functions provided to the user. Management functions that are provided to the user and not the administrator are listed in FMT_MOF_EXT.1.1. Management functions for which the administrator may adopt a policy that restricts the user from performing that function are listed in FMT_MOF_EXT.1.2.

Table 6 compares the management functions required by this Protection Profile in the following three requirements (FMT_MOF_EXT.1.1, FMT_MOF_EXT.1.2, and FMT_SMF_EXT.1).

FMT_MOF_EXT.1 Extended: Management of security functions behavior

FMT_MOF_EXT.1.1 The TSF shall restrict the ability to perform the functions in column 3 of Table 6 to the user.

Application Note: The functions that have an "M" in the third column are mandatory for this component, thus are restricted to the user, meaning that the administrator cannot manage those functions. The functions that have an "O" in the third column are optional and may be selected; and those functions with a "-" in the third are not applicable and may not be selected. The ST author should select those security management functions that only the user may perform (i.e. the ones the administrator may not perform).

The ST author may not select the same function in both FMT_MOF_EXT.1.1 and FMT_MOF_EXT.1.2. A function cannot contain an "M" in both column 3 and column 5.

The ST author may use a table in the ST, indicating with clear demarcations (to be accompanied by an index) those functions that are restricted to the user (column 3). The ST author should iterate a row to indicate any variations in the selectable sub-functions or assigned values with respect to the values in the columns.

For functions that are mandatory, any sub-functions not in a selection are also mandatory and any assignments must contain at least one assigned value. For non-selectable sub-functions in an optional function, all sub-functions outside a selection must be implemented in order for the function to be listed.

Evaluation Activity

> ***TSS***
> *The evaluator shall verify that the TSS describes those management functions that may only be performed by the user and confirm that the TSS does not include an Administrator API for any of these management functions. This activity will be performed in conjunction with FMT_SMF_EXT.1.*

FMT_MOF_EXT.1.2 The TSF shall restrict the ability to perform the functions in column 5 of Table 6 to the administrator when the device is enrolled and according to the administrator-configured policy.

Application Note: As long as the device is enrolled in management, the administrator (of the enterprise) must be guaranteed that minimum security functions of the enterprise policy are enforced. Further restrictive policies can be applied at any time by the user on behalf of the user or other administrators.

The functions that have an "M" in the fifth column are mandatory for this component; the functions that have an "O" in the fifth column are optional and may be selected; and those functions with a "-" in the fifth are not applicable and may not be selected.

The ST author may not select the same function in both FMT_MOF_EXT.1.1 and FMT_MOF_EXT.1.2.

The ST author should select those security management functions that the administrator may restrict. The ST author may use a table in the ST, indicating with clear demarcations (to be accompanied by an index) those functions that are and are not implemented with APIs for the administrator (as in column 4). Additionally, the ST author should demarcate which functions the user is prevented from accessing or performing (as in column 5). The ST author should iterate a row to indicate any variations in the selectable sub-functions or assigned values with respect to the values in the columns.

For functions that are mandatory, any sub-functions not in a selection are also mandatory and any assignments must contain at least one assigned value. For non-selectable sub-functions in an optional function, all sub-functions outside the selection must be implemented in order for the function to be listed.

Evaluation Activity

> ***TSS***
> *The evaluator shall verify that the TSS describes those management functions that may*

be performed by the Administrator, to include how the user is prevented from accessing, performing, or relaxing the function (if applicable), and how applications/APIs are prevented from modifying the Administrator configuration. The TSS also describes any functionality that is affected by administrator-configured policy and how. This activity will be performed in conjunction with FMT_SMF_EXT.1.

Tests

- ***Test 1:*** *The evaluator shall use the test environment to deploy policies to Mobile Devices.*
- ***Test 2:*** *The evaluator shall create policies which collectively include all management functions which are controlled by the (enterprise) administrator and cannot be overridden/relaxed by the user as defined in FMT_MOF_EXT.1.2. The evaluator shall apply these policies to devices, attempt to override/relax each setting both as the user (if a setting is available) and as an application (if an API is available), and ensure that the TSF does not permit it. Note that the user may still apply a more restrictive policy than that of the administrator.*
- ***Test 3:*** *Additional testing of functions provided to the administrator are performed in conjunction with the testing activities for FMT_SMF_EXT.1.1.*

FMT_SMF_EXT.1 Extended: Specification of Management Functions

FMT_SMF_EXT.1.1 The TSF shall be capable of performing the following management functions:

Table 6: Management Functions

Status Markers:
M - Mandatory
O - Optional/Objective

Management Function	Impl.	User Only	Admin	Admin Only
1. configure password policy: a. minimum password length b. minimum password complexity c. maximum password lifetime	X	-	X	X
2. configure session locking policy: a. screen-lock enabled/disabled b. screen lock timeout c. number of authentication failures	X	-	X	X
3. enable/disable the VPN protection: a. across device [**selection**: • *b. on a per-app basis*, • *c. on a per-group of applications processes basis*, • *d. no other method*]	X	O	O	O
4. enable/disable [**assignment**: *list of all radios*]	X	O	O	O
5. enable/disable [**assignment**: *list of audio or visual collection devices*]: a. across device [**selection**: • *b. on a per-app basis*, • *c. on a per-group of applications processes basis*, • *d. no other method*]	X	O	O	O
6. transition to the locked state	X	-	X	-
7.TSF wipe of protected data	X	-	X	-
8.configure application installation policy by [**selection**:	X	-	X	X

- *a. restricting the sources of applications*,
- *b. specifying a set of allowed applications based on [**assignment**: application characteristics] (an application whitelist)*,
- *c. denying installation of applications*

]

9.import keys/secrets into the secure key storage	X	O	O	-
10. destroy imported keys/secrets and [**selection**: *no other keys/secrets*, *[**assignment**: list of other categories of keys/secrets]*] in the secure key storage	X	O	O	-
11.import X.509v3 certificates into the Trust Anchor Database	X	-	X	O
12.remove imported X.509v3 certificates and [**selection**: *no other X.509v3 certificates*, *[**assignment**: list of other categories of X.509v3 certificates]*] in the Trust Anchor Database	X	O	O	-
13. enroll the TOE in management	X	X	-	-
14. remove applications	X	-	X	O
15. update system software	X	-	X	O
16. install applications	X	-	X	O
17. remove Enterprise applications	X	-	X	-
18. enable/disable display notification in the locked state of: [**selection**: • *a. email notifications*, • *b. calendar appointments*, • *c. contact associated with phone call notification*, • *d. text message notification*, • *e. other application-based notifications*, • *f. all notifications*]	X	O	O	O
19. enable data-at rest protection	X	O	O	O
20.enable removable media's data-at-rest protection	X	O	O	O
21. enable/disable location services: a. across device [**selection**: • *b. on a per-app basis*, • *c. on a per-group of applications processes basis*, • *d. no other method*]	X	O	O	O
22. Enable/disable the use of [**selection**: *Biometric Authentication Factor*, *Hybrid Authentication Factor*]	X	O	O	O
23. configure whether to allow/disallow establishment of a trusted channel if the peer/server certificate is deemed invalid.	X	O	O	O
24. enable/disable all data signaling over [**assignment**: *list of externally accessible hardware ports*]	O	O	O	O
25. enable/disable [**assignment**: *list of protocols where the device acts as a server*]	O	O	O	O
26. enable/disable developer modes	O	O	O	O
27. enable/disable bypass of local user authentication	O	O	O	O
28. wipe Enterprise data	O	O	O	-
29. approve [**selection**: *import*, *removal*] by applications of X.509v3 certificates in the Trust Anchor Database	O	O	O	O
30. configure whether to allow/disallow establishment of a trusted channel if the TSF cannot establish a connection	O	O	O	O

to determine the validity of a certificate				
31. enable/disable the cellular protocols used to connect to cellular network base stations	O	O	O	O
32. read audit logs kept by the TSF	O	O	O	-
33. configure [**selection**: *certificate*, *public-key*] used to validate digital signature on applications	O	O	O	O
34. approve exceptions for shared use of keys/secrets by multiple applications	O	O	O	O
35. approve exceptions for destruction of keys/secrets by applications that did not import the key/secret	O	O	O	O
36. configure the unlock banner	O	-	O	O
37. configure the auditable items	O	-	O	O
38. retrieve TSF-software integrity verification values	O	O	O	O
39. enable/disable [**selection**: • *USB mass storage mode*, • *USB data transfer without user authentication*, • *USB data transfer without authentication of the connecting system*]	O	O	O	O
40. enable/disable backup of [**selection**: *all applications*, *selected applications*, *selected groups of applications*, *configuration data*] to [**selection**: *locally connected system*, *remote system*]	O	O	O	O
41. enable/disable [**selection**: • *Hotspot functionality authenticated by [**selection**: pre-shared key, passcode, no authentication]*, • *USB tethering authenticated by [**selection**: pre-shared key, passcode, no authentication]*]	O	O	O	O
42. approve exceptions for sharing data between [**selection**: *application*, *groups of application*]	O	O	O	O
43. place applications into application groups based on [**assignment**: *enterprise configuration settings*]	O	O	O	O
44. unenroll the TOE from management	O	O	O	O
45. enable/disable the Always On VPN protection	O	O	O	O
46. revoke Biometric template	O	O	O	O
47. [**assignment**: *list of other management functions to be provided by the TSF*]	O	O	O	O

Application Note: Table 6 compares the management functions required by this Protection Profile.

The first column lists the management functions identified in the PP.

In the following columns:

- ‘M’ means Mandatory
- ‘O’ means Optional/Objective

The second column (FMT_SMF_EXT.1) indicates whether the function is to be implemented. The ST author should select which Optional functions are implemented.

The third column (FMT_MOF_EXT.1.1) indicates functions that are to be restricted to the user (i.e. not available to the administrator).

The fourth column (Administrator) indicates functions that are available to the administrator. The functions restricted to the user (column 3) cannot also be available to the administrator. Functions available to the administrator can still be available to the user, as long as the function is not restricted to the administrator (column 5). Thus, if the TOE must offer these functions to the administrator to perform the fourth column shall be selected.

The fifth column (FMT_MOF_EXT.1.2) indicates whether the function is to be restricted to the

administrator when the device is enrolled and the administrator applies the indicated policy. If the function is restricted to the administrator the function is not available to the user. This does not prevent the user from modifying a setting to make the function stricter, but the user cannot undo the configuration enforced by the administrator.

The ST author may use a table in theST, listing only those functions that are implemented. For functions that are mandatory, any sub-functions not in a selection are also mandatory and any assignments must contain at least one assigned value. For functions that are optional and contain an assignment or selection, at least one value must be assigned/selected to be included in the ST. For non-selectable sub-functions in an optional function, all sub-functions must be implemented in order for the function to be included. For functions with a "per-app basis" sub function and an assignment, the ST author must indicate which assigned features are manageable on a per-app basis and which are not by iterating the row.

Function-specific Application Notes:

For functions 3, 5 and 21, the function must be implemented on a device-wide basis but may also be implemented on a per-app basis or on a per-group of applications basis in which the configuration includes the list of applications or groups of applications to which the enable/disable applies.

Function 3 addresses enabling and disabling the IPsec VPN only. The configuration of the VPN Client itself (with information such as VPN Gateway, certificates, and algorithms) is addressed by the PP-Module for VPN Client. The administrator options should only be listed if the administrator can remotely enable/disable the VPN connection.

Function 3 optionally allows the VPN to be configured per-app or per-groups of apps. If this configuration is selected, it does not void FDP_IFC_EXT.1. Instead FDP_IFC_EXT.1 is applied to the application or group of applications the VPN is applied to. In other words, all traffic destined for the VPN-enabled application or group of applications, must travel through the VPN, but traffic not destined for that application or group of applications can travel outside the VPN. When the VPN is configured across the device FDP_IFC_EXT.1 applies to all traffic and the VPN must not split tunnel.

The assignment in function 4 consists of all radios present on the TSF, such as Wi-Fi, GPS, cellular, NFC, Bluetooth BR/EDR, and Bluetooth LE, which can be enabled and disabled. In the future, if both Bluetooth BR/EDR and Bluetooth LE are supported, they will be required to be enabled and disabled separately. Disablement of the cellular radio does not imply that the radio may not be enabled in order to place emergency phone calls; however, it is not expected that a device in "airplane mode", where all radios are disabled, will automatically (without authorization) turn on the cellular radio to place emergency calls.

The assignment in function 5 consists of at least one audio and/or visual device, such as camera and microphone, which can be enabled and disabled by either the user or administrator. Disablement of the microphone does not imply that the microphone may not be enabled in order to place emergency phone calls. If certain devices are able to be restricted to the enterprise (either device-wide, per-app or per-group of applications) and others are able to be restricted to users, then this function should be iterated in the table with the appropriate table entries.

Regarding functions 4 and 5, disablement of a particular radio or audio/visual device must be effective as soon as the TOE has power. Disablement must also apply when the TOE is booted into auxiliary boot modes, for example, associated with updates or backup. If the TOE supports states in which security management policy is inaccessible, for example, due to data-at-rest protection, it is acceptable to meet this requirement by ensuring that these devices are disabled by default while in these states. That these devices are disabled during auxiliary boot modes does not imply that the device (particularly the cellular radio) may not be enabled in order to perform emergency phone calls.

Wipe of the TSF (function 7) is performed according to FCS_CKM_EXT.5. Protected data is all non-TSF data, including all user or enterprise data. Some or all of this data may be considered sensitive data as well.

The selection in function 8 allows the ST author to select which mechanisms are available to the administrator through the MDM Agent to restrict the applications which the user may install. The ST author shall state if application whitelisting is applied device-wide or if it can be specified to apply to either the Enterprise and/or Personal applications.

- If the administrator can restrict the sources from which applications can be installed, the ST author selects option a.
- If the administrator can specify a whitelist of allowed applications, theST author selects option b. The ST author should list any application characteristics (e.g. name, version, or developer) based on which the whitelist can be formed.
- If the administrator can prevent the user from installing additional applications, the ST author selects c.

In the future, function 12 may require destruction or disabling of any default trusted CA certificates, excepting those CA certificates necessary for continued operation of the TSF, such as the developer’s certificate. At this time, the ST author shall indicate in the assignment

whether pre-installed or any other category of X.509v3 certificates may be removed from the Trust Anchor Database.

For function 13, the enrollment function may be installing an MDM agent and includes the policies to be applied to the device. It is acceptable for the user approval notice to require the user to intentionally opt to view the policies (for example, by "tapping" on a "View" icon) rather than listing the policies in full in the notice.

For function 15, the administrator capability to update the system software may be limited to causing a prompt to the user to update rather than the ability to initiate the update itself. As the administrator is likely to be acting remotely, he/she would be unaware of inopportune situations, such as low power, which may cause the update to fail and the device to become inoperable. The user can refuse to accept the update in such situations. It is expected that system architects will be cognizant of this limitation and will enforce network access controls in order to enforce enterprise-critical updates.

Function 16 addresses both installation and update. This protection profile does not distinguish between installation and update of applications because mobile devices typically completely overwrite the previous installation with a new installation during an application update.

For function 17, "Enterprise applications" are those applications that belong to the Enterprise application group. Applications installed by the enterprise administrator (including automatic installation by the administrator after being requested by the user from a catalog of enterprise applications) are by default placed in the Enterprise application group unless an exception has been made in function 43 of FMT_SMF_EXT.1.1.

If the display of notifications in the locked state is supported, the configuration of these notifications (function 18) must be included in the selection.

Function 19 must be included in the selection if data-at-rest protection is not natively enabled.

Function 20 is implicitly met if the TSF does not support removable media.

For function 21, location services include location information gathered from GPS, cellular, and Wi-Fi.

Function 22 is implicitly met if the TOE does not contain a BAF. This selection shall correspond with the selection made in FIA_UAU.5.1. If a BAF is selected in FIA_UAU.5.1, "Biometric Authentication Factor" shall be selected and the user or admin shall have the option to disable the use of it. If multiple BAFs are selected in FIA_UAU.5.1, this applies to all different modalities. If "hybrid" is selected in FIA_UAU.5.1 it shall be selected and the user or admin shall have the option to disable the use of it.

For function 23, the configuration can be different depending on the specific trusted channel.

The assignment in function 24 consists of all externally accessible hardware ports, such as USB, the SD card, and HDMI, whose data transfer capabilities can be enabled and disabled by either the user or administrator. Disablement of data transfer over an external port must be effective during and after boot into the normal operative mode of the device. If the TOE supports states in which configured security management policy is inaccessible, for example, due to data-at-rest protection, it is acceptable to meet this requirement by ensuring that data transfer is disabled by default while in these states. Each of the ports may be enabled or disabled separately. The configuration policy need not disable all ports together. In the case of USB, chagrining is still allowed if data transfer capabilities have been disabled.

The assignment in function 25 consists of all protocols where the TSF acts as a server, which can be enabled and disabled by either the user or administrator.

Function 26 must be included in the selection if developer modes are supported by the TSF.

Function 27 must be included in the selection if bypass of local user authentication, such as a "Forgot Password", password hint, or remote authentication feature, is supported.

Function 29 must be included in the selection if the TSF allows applications, other than the MDM Agents, to import or remove X.509v3 certificates from the Trust Anchor Database. The MDM Agent is considered the administrator. This function does not apply to applications trusting a certificate for its own validations. The function only applies to situations where the application modifies the device-wide Trust Anchor Database, affecting the validations performed by the TSF for other applications. The user or administrator may be provided the ability to globally allow or deny any application requests in order to meet this requirement.

Function 30 must be included in the ST if "administrator-configured option" is selection in FIA_X509_EXT.2.2.

Function 33 should be included in the selection if FPT_TUD_EXT.4.1 is included in the ST and the configurable option is selected.

Function 34 should be included in the selection if user or administrator is selected in FCS_STG_EXT.1.4.

Function 35 should be included in the selection if user or administrator is selected in FCS_STG_EXT.1.5.

Function 36 must be included in the selection if FTA_TAB.1 is included in the ST.

Function 37 must be included in the selection if FAU_SEL.1 is included in the ST.

For function 41, hotspot functionality refers to the condition in which the mobile device is serving as an access point to other devices, not the connection of the TOE to external hotspots.

Functions 42 and 43 correspond to FDP_ACF_EXT.1.2.

For function 44, FMT_SMF_EXT.2.1 specifies actions to be performed when the TOE is unenrolled from management.

For function 45, shall be included in the ST if IPsec is selected in FTP_ITC_EXT.1 and the native IPsec VPN client can be configured to be Always-On. Always-On is defined as when the TOE has a network connection the VPN attempts to connect, all data leaving the device uses the VPN when the VPN is connected and no data leaves that device when the VPN is disconnected. The configuration of the VPN Client itself (with information such as VPN Gateway, certificates, and algorithms) is addressed by the PP-Module for VPN Client.

Evaluation Activity

TSS
The evaluator shall verify that the TSS describes all management functions, what role(s) can perform each function, and how these functions are (or can be) restricted to the roles identified by FMT_MOF_EXT.1.

The following activities are organized according to the function number in the table. These activities include TSS assurance activities, AGD assurance activities, and test activities.

Test activities specified below shall take place in the test environment described in the Assurance Activity for FPT_TUD_EXT.1.1, FPT_TUD_EXT.1.2, and FPT_TUD_EXT.1.3.
Guidance
The evaluator shall consult the AGD guidance to perform each of the specified tests, iterating each test as necessary if both the user and administrator may perform the function. The evaluator shall verify that the AGD guidance describes how to perform each management function, including any configuration details. For each specified management function tested, the evaluator shall confirm that the underlying mechanism exhibits the configured setting.

Tests

Function 1
The evaluator shall verify the TSS defines the allowable policy options: the range of values for both password length and lifetime, and a description of complexity to include character set and complexity policies (e.g., configuration and enforcement of number of uppercase, lowercase, and special characters per password).

- ***Test 1:*** *The evaluator shall exercise the TSF configuration as the administrator and perform positive and negative tests, with at least two values set for each variable setting, for each of the following:*
  - *minimum password length*
  - *minimum password complexity*
  - *maximum password lifetime*

Function 2
The evaluator shall verify the TSS defines the range of values for both timeout period and number of authentication failures for all supported authentication mechanisms.

- ***Test 2:*** *The evaluator shall exercise the TSF configuration as the administrator. The evaluator shall perform positive and negative tests, with at least two values set for each variable setting, for each of the following:*
  - *screen-lock enabled/disabled*
  - *screen lock timeout*
  - *number of authentication failures (may be combined with test for FIA_AFL_EXT.1)*

Function 3
- ***Test 3:*** *The evaluator shall perform the following tests:*
  a. *The evaluator shall exercise the TSF configuration to enable the VPN protection. These configuration actions must be used for the testing of the FDP_IFC_EXT.1.1 requirement.*
  b. *[conditional] If "per-app basis" is selected, the evaluator shall create two*

applications and enable one to use the VPN and the other to not use the VPN. The evaluator shall exercise each application (attempting to access network resources; for example, by browsing different websites) individually while capturing packets from the TOE. The evaluator shall verify from the packet capture that the traffic from the VPN-enabled application is encapsulated in IPsec and that the traffic from the VPN-disabled application is not encapsulated in IPsec.

c. *[conditional] If "per-groups of application basis" is selected, the evaluator shall create two applications and the applications shall be placed into different groups. Enable one application group to use the VPN and the other to not use the VPN. The evaluator shall exercise each application (attempting to access network resources; for example, by browsing different websites) individually while capturing packets from the TOE. The evaluator shall verify from the packet capture that the traffic from the application in the VPN-enabled group is encapsulated in IPsec and that the traffic from the application in the VPN-disabled group is not encapsulated in IPsec.*

Function 4
The evaluator shall verify that the TSS includes a description of each radio and an indication of if the radio can be enabled/disabled along with what role can do so. In addition the evaluator shall verify that the frequency ranges at which each radio operates is included in the TSS. The evaluator shall confirm that the AGD guidance describes how to perform the enable/disable function for each radio.

The evaluator shall ensure that minimal signal leakage enters the RF shielded enclosure (i.e. Faraday bag, Faraday box, RF shielded room) by performing the following steps:

Step 1: Place the antenna of the spectrum analyzer inside the RF shielded enclosure.

Step 2: Enable "Max Hold" on the spectrum analyzer and perform a spectrum sweep of the frequency range between 300MHz – 6000MHz, in I KHz steps (this range should encompass 802.11, 802.15, GSM, UMTS, LTE and GPS). This range will not address NFC 13.56MHz, another test should be set up with similar constraints to address NFC.

If power above -90 dBm is observed, the Faraday box has too great of signal leakage and shall not be used to complete the test for Function 4.

- ***Test 4:*** *The evaluator shall exercise the TSF configuration as the administrator and, if not restricted to the administrator, the user, to enable and disable the state of each radio (e.g. Wi-Fi, GPS, cellular, NFC, Bluetooth). Additionally, the evaluator shall repeat the steps below, booting into any auxiliary boot mode supported by the device. For each radio, the evaluator shall:*

  Step 1: Place the antenna of the spectrum analyzer inside the RF shielded enclosure. Configure the spectrum analyzer to sweep desired frequency range for the radio to be tested (based on range provided in the TSS)). The ambient noise floor shall be set to -110dBm. Place the TOE into the RF shielded enclosure to isolate them from all other RF traffic.

  Step 2: The evaluator shall create a baseline of the expected behavior of RF signals. The evaluator shall power on the device, ensure the radio in question is enabled, power off the device, enable "Max Hold" on the spectrum analyzer and power on the device. The evaluator shall wait 2 minutes at each Authentication Factor interface prior to entering the necessary password to complete the boot process, waiting 5 minutes after the device is fully booted. The evaluator shall observe that RF spikes are present at the expected uplink channel frequency. The evaluator shall clear the "Max Hold" on the spectrum analyzer.

  Step 3: The evaluator shall verify the absence of RF activity for the uplink channel when the radio in question is disabled. The evaluator shall complete the following test five times. The evaluator shall power on the device, ensure the radio in question is disabled, power off the device, enable "Max Hold" on the spectrum analyzer and power on the device. The evaluator shall wait 2 minutes at each Authentication Factor interface prior to entering the necessary password to complete the boot process, waiting 5 minutes after the device is fully booted. The evaluator shall clear the "Max Hold" on the spectrum analyzer. If a spike of RF activity for the uplink channel of the specific radio frequency band is observed at any time (either at an Authentication Factor interface or when the device is fully booted) it is deemed that the radio is enabled.

Function 5
The evaluator shall verify that the TSS includes a description of each collection device and an indication of if it can be enabled/disabled along with what role can do so. The evaluator shall confirm that the AGD guidance describes how to perform the enable/disable function.

- ***Test 5:*** *The evaluator shall perform the following test(s):*

a. *The evaluator shall exercise the TSF configuration as the administrator and, if not restricted to the administrator, the user, to enable and disable the state of each audio or visual collection devices (e.g. camera, microphone) listed by the ST author. For each collection device, the evaluator shall disable the device and then attempt to use its functionality. The evaluator shall reboot the TOE and verify that disabled collection devices may not be used during or early in the boot process. Additionally, the evaluator shall boot the device into each available auxiliary boot mode and verify that the collection device cannot be used.*
b. *[conditional] If "per-app basis" is selected, the evaluator shall create two applications and enable one to use access the A/V device and the other to not access the A/V device. The evaluator shall exercise each application attempting to access the A/V device individually. The evaluator shall verify that the enabled application is able to access the A/V device and the disabled application is not able to access the A/V device.*
c. *[conditional] If "per-groups of application basis" is selected, the evaluator shall create two applications and the applications shall be placed into different groups. Enable one group to access the A/V device and the other to not access the A/V device. The evaluator shall exercise each application attempting to access the A/V device individually. The evaluator shall verify that the application in the enabled group is able to access the A/V device and the application in the disabled group is not able to access the A/V device.*

Function 6

- ***Test 6:*** *The evaluator shall use the test environment to instruct the TSF, both as a user and as the administrator, to command the device to transition to a locked state, and verify that the device transitions to the locked state upon command.*

Function 7

- ***Test 7:*** *The evaluator shall use the test environment to instruct the TSF, both as a user and as the administrator, to command the device to perform a wipe of protected data. The evaluator must ensure that this management setup is used when conducting the assurance activities in FCS_CKM_EXT.5.*

Function 8

The evaluator shall verify the TSS describes the allowable application installation policy options based on the selection included in the ST. If the application whitelist is selected, the evaluator shall verify that the TSS includes a description of each application characteristic upon which the whitelist may be based.

- ***Test 8:*** *The evaluator shall exercise the TSF configuration as the administrator to restrict particular applications, sources of applications, or application installation according to the AGD guidance. The evaluator shall attempt to install unauthorized applications and ensure that this is not possible. The evaluator shall, in conjunction, perform the following specific tests:*
  a. *[conditional] The evaluator shall attempt to connect to an unauthorized repository in order to install applications.*
  b. *[conditional] The evaluator shall attempt to install two applications (one whitelisted, and one not) from a known allowed repository and verify that the application not on the whitelist is rejected. The evaluator shall also attempt to side-load executables or installation packages via USB connections to determine that the white list is still adhered to*

Function 9 & Function 10

The evaluator shall verify that the TSS describes each category of keys/secrets that can be imported into the TSF's secure key storage.

- ***Test 9:*** *The test of these functions is performed in association with FCS_STG_EXT.1.*

- ***Test 10:*** *The test of these functions is performed in association with FCS_STG_EXT.1.*

Function 11

The evaluator shall review the AGD guidance to determine that it describes the steps needed to import, modify, or remove certificates in the Trust Anchor database, and that the users that have authority to import those certificates (e.g., only administrator, or both administrators and users) are identified.

- ***Test 11:*** *The evaluator shall import certificates according to the AGD guidance as the user and/or as the administrator, as determined by the administrative guidance. The evaluator shall verify that no errors occur during import. The evaluator should perform an action requiring use of the X.509v3 certificate to provide assurance that installation was completed properly.*

Function 12

The evaluator shall verify that the TSS describes each additional category of X.509 certificates and their use within the TSF.

- ***Test 12:*** *The evaluator shall remove an administrator-imported certificate and any*

other categories of certificates included in the assignment of function 14 from the Trust Anchor Database according to the AGD guidance as the user and as the administrator.

Function 13
The evaluator shall examine the TSS to ensure that it contains a description of each management function that will be enforced by the enterprise once the device is enrolled. The evaluator shall examine the AGD guidance to determine that this same information is present.

- ***Test 13:*** *The evaluator shall verify that user approval is required to enroll the device into management.*

Function 14
The evaluator shall verify that the TSS includes an indication of what applications (e.g., user-installed applications, Administrator-installed applications, or Enterprise applications) can be removed along with what role can do so. The evaluator shall examine the AGD guidance to determine that it details, for each type of application that can be removed, the procedures necessary to remove those applications and their associated data. For the purposes of this assurance activity, "associated data" refers to data that are created by the app during its operation that do not exist independent of the app's existence, for instance, configuration data, or e-mail information that's part of an e-mail client. It does not, on the other hand, refer to data such as word processing documents (for a word processing app) or photos (for a photo or camera app).

- ***Test 14:*** *The evaluator shall attempt to remove applications according to the AGD guidance and verify that the TOE no longer permits users to access those applications or their associated data.*

Function 15
- ***Test 15:*** *The evaluator shall attempt to update the TSF system software following the procedures in the AGD guidance and verify that updates correctly install and that the version numbers of the system software increase.*

Function 16
- ***Test 16:*** *The evaluator shall attempt to install an application following the procedures in the AGD guidance and verify that the application is installed and available on the TOE.*

Function ove
- ***Test 17:*** *The evaluator shall attempt to remove any Enterprise applications from the device by following the administrator guidance. The evaluator shall verify that the TOE no longer permits users to access those applications or their associated data.*

Function 18
The evaluator shall examine the AGD Guidance to determine that it specifies, for at least each category of information selected for Function 18, how to enable and disable display information for that type of information in the locked state.

- ***Test 18:*** *For each category of information listed in the AGD guidance, the evaluator shall verify that when that TSF is configured to limit the information according to the AGD, the information is no longer displayed in the locked state.*

Function 19
- ***Test 19:*** *The evaluator shall exercise the TSF configuration as the administrator and, if not restricted to the administrator, the user, to enable system-wide data-at-rest protection according to the AGD guidance. The evaluator shall ensure that all assurance activities for DAR (FDP_DAR) are conducted with the device in this configuration.*

Function 20
- ***Test 20:*** *The evaluator shall exercise the TSF configuration as the administrator and, if not restricted to the administrator, the user, to enable removable media's data-at-rest protection according to the AGD guidance. The evaluator shall ensure that all assurance activities for DAR (FDP_DAR) are conducted with the device in this configuration.*

Function 21
- ***Test 21:*** *The evaluator shall perform the following tests.*
  a. *The evaluator shall enable location services device-wide and shall verify that an application (such as a mapping application) is able to access the TOE's location information. The evaluator shall disable location services device-wide and shall verify that an application (such as a mapping application) is unable to access the TOE's location information.*
  b. *[conditional] If "per-app basis" is selected, the evaluator shall create two applications and enable one to use access the location services and the other to not access the location services. The evaluator shall exercise each application attempting to access location services individually. The evaluator*

shall verify that the enabled application is able to access the location services and the disabled application is not able to access the location services.

Function 22

- ***Test 22:*** *The evaluator shall verify that the TSS states if the TOE supports a BAF and/or hybrid authentication. If the TOE does not include a BAF and/or hybrid authentication this test is implicitly met.*
  a. *[conditional] If a BAF is selected the evaluator shall verify that the TSS describes the procedure to enable/disable the BAF. If the TOE includes multiple BAFs, the evaluator shall verify that the TSS describes how to enable/disable each BAF, specifically if the different modalities can be individually enabled/disabled. The evaluator shall configure the TOE to allow each supported BAF to authenticate and verify that successful authentication can be achieved using the BAF. The evaluator shall configure the TOE to disable the use of each supported BAF for authentication and confirm that the BAF cannot be used to authenticate.*
  b. *[conditional] If "Hybrid" is selected the evaluator shall verify that the TSS describes the procedure to enable/disable the hybrid (biometric credential and PIN/password) authentication. The evaluator shall configure the TOE to allow hybrid authentication to authenticate and confirm that successful authentication can be achieved using the hybrid authentication. The evaluator shall configure the TOE to disable the use of hybrid authentication and confirm that the hybrid authentication cannot be used to authenticate.*

Assurance Activity Note: *It should be noted that the following functions are optional capabilities, if the function is implemented, then the following assurance activities shall be performed. The notation of "[conditional] beside the function number indicates that if the function is not included in the ST, then there is no expectation that the assurance activity be performed.*

Function 23 [conditional]

- ***Test 23:*** *The test of this function is performed in conjunction with FIA_X509_EXT.2.2, FCS_TLSC_EXT.1.3 in the Package for Transport Layer Security.*

Function 24 [conditional]

The evaluator shall verify that the TSS includes a list of each externally accessible hardware port and an indication of if data transfer over that port can be enabled/disabled. AGD guidance will describe how to perform the enable/disable function.

- ***Test 24:*** *The evaluator shall exercise the TSF configuration to enable and disable data transfer capabilities over each externally accessible hardware ports (e.g. USB, SD card, HDMI) listed by the ST author. The evaluator shall use test equipment for the particular interface to ensure that no low-level signaling is occurring on all pins used for data transfer when they are disabled. For each disabled data transfer capability, the evaluator shall repeat this test by rebooting the device into the normal operational mode and verifying that the capability is disabled throughout the boot and early execution stage of the device.*

Function 25 [conditional]

The evaluator shall verify that the TSS describes how the TSF acts as a server in each of the protocols listed in the ST, and the reason for acting as a server.

- ***Test 25:*** *The evaluator shall attempt to disable each listed protocol in the assignment. The evaluator shall verify that remote devices can no longer access the TOE or TOE resources using any disabled protocols.*

Function 26 [conditional]

- ***Test 26:*** *The evaluator shall exercise the TSF configuration as the administrator and, if not restricted to the administrator, the user, to enable and disable any developer mode. The evaluator shall test that developer mode access is not available when its configuration is disabled. The evaluator shall verify the developer mode remains disabled during device reboot.*

Function 27 [conditional]

The evaluator shall examine the AGD guidance to determine that it describes how to enable and disable any "Forgot Password", password hint, or remote authentication (to bypass local authentication mechanisms) capability.

- ***Test 27:*** *For each mechanism listed in the AGD guidance that provides a "Forgot Password" feature or other means where the local authentication process can be bypassed, the evaluator shall disable the feature and ensure that they are not able to bypass the local authentication process.*

Function 28 [conditional]

- ***Test 28:*** *The evaluator shall attempt to wipe Enterprise data resident on the device according to the administrator guidance. The evaluator shall verify that the data is no longer accessible by the user.*

Function 29 [conditional]
The evaluator shall verify that the TSS describes how approval for an application to perform the selected action (import, removal) with respect to certificates in the Trust Anchor Database is accomplished (e.g., a pop-up, policy setting, etc.).

The evaluator shall also verify that the API documentation provided according to Section 5.2.2 Class ADV: Development includes any security functions (import, modification, or destruction of the Trust Anchor Database) allowed by applications.

- ***Test 29:*** *The evaluator shall perform one of the following tests:*
  a. *[conditional] If applications may import certificates to the Trust Anchor Database, the evaluator shall write, or the developer shall provide access to, an application that imports a certificate into the Trust Anchor Database. The evaluator shall verify that the TOE requires approval before allowing the application to import the certificate:*
     - *The evaluator shall deny the approvals to verify that the application is not able to import the certificate. Failure of import shall be tested by attempting to validate a certificate that chains to the certificate whose import was attempted (as described in the Assurance Activity for FIA_X509_EXT.1).*
     - *The evaluator shall repeat the test, allowing the approval to verify that the application is able to import the certificate and that validation occurs.*
  b. *[conditional] If applications may remove certificates in the Trust Anchor Database, the evaluator shall write, or the developer shall provide access to, an application that removes certificates from the Trust Anchor Database. The evaluator shall verify that the TOE requires approval before allowing the application to remove the certificate:*
     - *The evaluator shall deny the approvals to verify that the application is not able to remove the certificate. Failure of removal shall be tested by attempting to validate a certificate that chains to the certificate whose removal was attempted (as described in the Assurance Activity for FIA_X509_EXT.1).*

  The evaluator shall repeat the test, allowing the approval to verify that the application is able to remove/modify the certificate and that validation no longer occurs.

Function 30 [conditional]
- ***Test 30:*** *The test of this function is performed in conjunction with FIA_X509_EXT.2.2.*

Function 31 [conditional]
The evaluator shall ensure that the TSS describes which cellular protocols can be disabled. The evaluator shall confirm that the AGD guidance describes the procedure for disabling each cellular protocol identified in the TSS.

- ***Test 31:*** *The evaluator shall attempt to disable each cellular protocol according to the administrator guidance. The evaluator shall attempt to connect the device to a cellular network and, using network analysis tools, verify that the device does not allow negotiation of the disabled protocols.*

Function 32 [conditional]
- ***Test 32:*** *The evaluator shall attempt to read any device audit logs according to the administrator guidance and verify that the logs may be read. This test may be performed in conjunction with the assurance activity of FAU_GEN.1.*

Function 33 [conditional]
- ***Test 33:*** *The test of this function is performed in conjunction with FPT_TUD_EXT.4.1.*

Function 34 [conditional]
The evaluator shall verify that the TSS describes how the approval for exceptions for shared use of keys/secrets by multiple applications is accomplished (e.g., a pop-up, policy setting, etc.).

- ***Test 34:*** *The test of this function is performed in conjunction with FCS_STG_EXT.1.*

Function 35 [conditional]
The evaluator shall verify that the TSS describes how the approval for exceptions for destruction of keys/secrets by applications that did not import the key/secret is accomplished (e.g., a pop-up, policy setting, etc.).

- ***Test 35:*** *The test of this function is performed in conjunction with FCS_STG_EXT.1.*

Function 36 [conditional]

The evaluator shall verify that the TSS describes any restrictions in banner settings (e.g., character limitations).

- ***Test 36:*** *The test of this function is performed in conjunction with FTA_TAB.1.*

Function 37 [conditional]

- ***Test 37:*** *The test of this function is performed in conjunction with FAU_SEL.1.*

Function 38 [conditional]

- ***Test 38:*** *The test of this function is performed in conjunction with FPT_NOT_EXT.2.1.*

Function 39 [conditional]
The evaluator shall verify that the TSS includes a description of how data transfers can be managed over USB.

- ***Test 39:*** *The evaluator shall perform the following tests based on the selections made in the table:*
  a. *[conditional] The evaluator shall disable USB mass storage mode, attach the device to a computer, and verify that the computer cannot mount the TOE as a drive. The evaluator shall reboot the TOE and repeat this test with other supported auxiliary boot modes.*
  b. *[conditional] The evaluator shall disable USB data transfer without user authentication, attach the device to a computer, and verify that the TOE requires user authentication before the computer can access TOE data. The evaluator shall reboot the TOE and repeat this test with other supported auxiliary boot modes.*
  c. *[conditional] The evaluator shall disable USB data transfer without connecting system authentication, attach the device to a computer, and verify that the TOE requires connecting system authentication before the computer can access TOE data. The evaluator shall then connect the TOE to another computer and verify that the computer cannot access TOE data. The evaluator shall then connect the TOE to the original computer and verify that the computer can access TOE data.*

Function 40 [conditional]
The evaluator shall verify that the TSS includes a description of available backup methods that can be enabled/disabled. If "selected applications or selected groups of applications are selected the TSS shall include which applications of groups of applications backup can be enabled/disabled.

- ***Test 40:*** *If "all applications" is selected, the evaluator shall disable each selected backup location in turn and verify that the TOE cannot complete a backup. The evaluator shall then enable each selected backup location in turn and verify that the TOE can perform a backup.*

  If "selected applications" is selected, the evaluator shall disable each selected backup location in turn and verify that for the selected application the TOE prevents backup from occurring. The evaluator shall then enable each selected backup location in turn and verify that for the selected application the TOE can perform a backup.

  If "selected groups of applications" is selected, the evaluator shall disable each selected backup location in turn and verify that for a group of applications the TOE prevents the backup from occurring. The evaluator shall then enable each selected backup location in turn and verify for the group of application the TOE can perform a backup.

  If "configuration data" is selected, the evaluator shall disable each selected backup location in turn and verify that the TOE prevents the backup of configuration data from occurring. The evaluator shall then enable each selected backup location in turn and verify that the TOE can perform a backup of configuration data.

Function 41 [conditional]
The evaluator shall verify that the TSS includes a description of Hotspot functionality and USB tethering to include any authentication for these.

- ***Test 41:*** *The evaluator shall perform the following tests based on the selections in 0.*
  a. *[conditional] The evaluator shall enable hotspot functionality with each of the of the support authentication methods. The evaluator shall connect to the hotspot with another device and verify that the hotspot functionality requires the configured authentication method.*
  b. *[conditional] The evaluator shall enable USB tethering functionality with each of the of the support authentication methods. The evaluator shall connect to the TOE over USB with another device and verify that the tethering functionality requires the configured authentication method.*

Function 42 [conditional]

- ***Test 42:*** *The test of this function is performed in conjunction with*

FDP_ACF_EXT.1.2.

Function 43 [conditional]

- ***Test 43:*** *The evaluator shall set a policy to cause a designated application to be placed into a particular application group. The evaluator shall then install the designated application and verify that it was placed into the correct group.*

Function 44 [conditional]

- ***Test 44:*** *The evaluator shall attempt to unenroll the device from management and verify that the steps described in FMT_SMF_EXT.2.1 are performed. This test should be performed in conjunction with the FMT_SMF_EXT.2.1 assurance activity.*

Function 45 [conditional]

- ***Test 45:*** *The evaluator shall verify that the TSS contains guidance to configure the VPN as Always-On. The evaluator shall configure the VPN as Always-On and perform the following test.*
  a. *The evaluator shall verify that when the VPN is connected all traffic is routed through the VPN. This test is performed in conjunction with FDP_IFC_EXT.1.1.*
  b. *The evaluator shall verify that when the VPN is not established, that no traffic leaves the device. The evaluator shall ensure that the TOE has network connectivity and that the VPN is established. The evaluator shall use a packet sniffing tool to capture the traffic leaving the TOE. The evaluator shall disable the VPN connection on the server side. The evaluator shall perform actions with the device such as navigating to websites, using provided applications, and accessing other Internet resources and verify that no traffic leaves the device.*
  c. *The evaluator shall verify that the TOE has network connectivity and that the VPN is established. The evaluator shall disable network connectivity (i.e. Airplane Mode) and verify that the VPN disconnects. The evaluator shall re-establish network connectivity and verify that the VPN automatically reconnects.*

Function 46 [conditional]

- ***Test 46:*** *The evaluator shall verify that the TSS describes the procedure to revoke a biometric credential stored on the TOE. The evaluator shall configure the TOE to use BAF and confirm that the biometric can be used to authenticate to the device. The evaluator shall revoke the biometric credential's ability to authenticate to the TOE and confirm that the same BAF cannot be used to authenticate to the device.*

Function 47

The evaluator shall verify that the TSS describes all assigned security management functions and their intended behavior.

- ***Test 47:*** *The evaluator shall design and perform tests to demonstrate that the function may be configured and that the intended behavior of the function is enacted by the TOE.*

FMT_SMF_EXT.2 Extended: Specification of Remediation Actions

FMT_SMF_EXT.2.1 The TSF shall offer [**selection**: *wipe of protected data*, *wipe of sensitive data*, *remove Enterprise applications*, *remove all device-stored Enterprise resource data*, *remove Enterprise secondary authentication data*, *[**assignment**: list other available remediation actions]*] upon un-enrollment and [**selection**: *[**assignment**: other administrator-configured triggers]*, *no other triggers*].

Application Note: Un-enrollment may consist of removing the MDM agent or removing the administrator's policies. The functions in the selection are remediation actions that TOE provides (perhaps via APIs) to the administrator (perhaps via an MDM agent) that are performed upon un-enrollment. "Enterprise applications" refers to applications that are in the Enterprise application group. "Enterprise resource data" refers to all stored Enterprise data and the separate resources that are available to the Enterprise application group, per FDP_ACF_EXT.2.1. If FDP_ACF_EXT.2.1 is included in the ST, then "remove all device-stored Enterprise resource data" must be selected, and is defined to be all resources selected in FDP_ACF_EXT.2.1. If FIA_UAU_EXT.4.1 is included in the ST, then "remove Enterprise secondary authentication data" must be selected. If FIA_UAU_EXT.4.1 is not included in the ST, then "remove Enterprise secondary authentication data" cannot be selected. Enterprise secondary authentication data only refers to any data stored on the TOE that is specifically used as part of a secondary authentication mechanism to authenticate access to Enterprise applications and shared resources. Material that is used for the TOE's primary authentication mechanism or other purposes not related to authentication to or protection of Enterprise applications or shared resources should not be removed.

Protected data is all non-TSF data, including all user or enterprise data. Some or all of this data may be considered sensitive data as well. If "wipe of protected data" is selected it is assumed that the sensitive data is wiped as well. However, if "wipe of sensitive data" is selected, it does not imply that all non-TSF data (protected data) is wiped. If "wipe of

protected data" or "wipe of sensitive data" is selected the wipe shall be in accordance with FCS_CKM_EXT.5.1. Thus cryptographically wiping the device is an acceptable remediation action.

Evaluation Activity

TSS
The evaluator shall verify that the TSS describes all available remediation actions, when they are available for use, and any other administrator-configured triggers. The evaluator shall verify that the TSS describes how the remediation actions are provided to the administrator.

Tests
The evaluator shall use the test environment to iteratively configure the device to perform each remediation action in the selection. The evaluator shall configure the remediation action per how the TSS states it is provided to the administrator. The test environment could be a MDM agent application, but can also be an application with administrator access.

FMT_SMF_EXT.3 Extended: Current Administrator

This is an objective component.

FMT_SMF_EXT.3.1 The TSF shall provide a mechanism that allows users to view a list of currently authorized administrators and the management functions that each administrator is authorized to perform.

Evaluation Activity

Tests
The evaluator shall cause the TOE to be enrolled into management. The evaluator shall then invoke this mechanism and verify the ability to view that the device has been enrolled, and view the management functions that the administrator is authorized to perform.

5.1.6 Class: Protection of the TSF (FPT)

FPT_AEX_EXT.1 Extended: Anti-Exploitation Services (ASLR)

FPT_AEX_EXT.1.1 The TSF shall provide address space layout randomization ASLR to applications.

FPT_AEX_EXT.1.2 The base address of any user-space memory mapping will consist of at least 8 unpredictable bits.

Application Note: The 8 unpredictable bits may be provided by the TSF RBG (as specified in FCS_RBG_EXT.1) but is not required.

Evaluation Activity

TSS
The evaluator shall ensure that the TSS section of the ST describes how the 8 bits are generated and provides a justification as to why those bits are unpredictable.

Assurance Activity Note: *The following test require the developer to provide access to a test platform that provides the evaluator with tools that are typically not found on consumer Mobile Device products.*
Tests

- ***Test 1:*** *The evaluator shall select 3 apps included with the TSF. These must include any web browser or mail client included with the TSF. For each of these apps, the evaluator shall launch the same app on two separate Mobile Devices of the same type and compare all memory mapping locations. The evaluator must ensure that no memory mappings are placed in the same location on both devices.*

  If the rare (at most 1/256) chance occurs that two mappings are the same for a single app and not the same for the other two apps, the evaluator shall repeat the test with that app to verify that in the second test the mappings are different.

FPT_AEX_EXT.2 Extended: Anti-Exploitation Services (Memory Page Permissions)

FPT_AEX_EXT.2.1 The TSF shall be able to enforce read, write, and execute permissions on every page of physical memory.

Evaluation Activity

TSS
The evaluator shall ensure that the TSS describes of the memory management unit (MMU), and ensures that this description documents the ability of the MMU to enforce read, write, and execute permissions on all pages of virtual memory.

FPT_AEX_EXT.3 Extended: Anti-Exploitation Services (Overflow Protection)

FPT_AEX_EXT.3.1 TSF processes that execute in a non-privileged execution domain on the application processor shall implement stack-based buffer overflow protection.

Application Note: A "non-privileged execution domain" refers to the user mode (as opposed to kernel mode, for instance) of the processor. While not all TSF processes must implement such protection, it is expected that most of the processes (to include libraries used by TSF processes) do implement buffer overflow protections.

Evaluation Activity

TSS
The evaluator shall determine that the TSS contains a description of stack-based buffer overflow protections implemented in the TSF software which runs in the non-privileged execution mode of the application processor. The exact implementation of stack-based buffer overflow protection will vary by platform. Example implementations may be activated through compiler options such as "-fstack-protector-all", "-fstack-protector", and "/GS" flags. The evaluator shall ensure that the TSS contains an inventory of TSF binaries and libraries, indicating those that implement stack-based buffer overflow protections as well as those that do not. The TSS must provide a rationale for those binaries and libraries that are not protected in this manner.

FPT_AEX_EXT.4 Extended: Domain Isolation

FPT_AEX_EXT.4.1 The TSF shall protect itself from modification by untrusted subjects.

FPT_AEX_EXT.4.2 The TSF shall enforce isolation of address space between applications.

Application Note: In addition to the TSF software (e.g., kernel image, device drivers, trusted applications) that resides in storage, the execution context (e.g., address space, processor registers, per-process environment variables) of the software operating in a privileged mode of the processor (e.g., kernel), as well as the context of the trusted applications is to be protected. In addition to the software, any configuration information that controls or influences the behavior of the TSF is also to be protected from modification by untrusted subjects.

Configuration information includes, but is not limited to, user and administrative management function settings, WLAN profiles, and Bluetooth data such as the service-level security requirements database.

Untrusted subjects include untrusted applications; unauthorized users who have access to the device while powered off, in a screen-locked state, or when booted into auxiliary boot modes; and, unauthorized users or untrusted software or hardware which may have access to the device over a wired interface, either when the device is in a screen-locked state or booted into auxiliary boot modes.

Evaluation Activity

TSS
The evaluator shall ensure that the TSS describes the mechanisms that are in place that prevents non-TSF software from modifying the TSF software or TSF data that governs the behavior of the TSF. These mechanisms could range from hardware-based means (e.g. "execution rings" and memory management functionality); to software-based means (e.g. boundary checking of inputs to APIs). The evaluator determines that the described mechanisms appear reasonable to protect the TSF from modification.

The evaluator shall ensure the TSS describes how the TSF ensures that the address spaces of applications are kept separate from one another.

The evaluator shall ensure the TSS details the USSD and MMI codes available from the dialer at the locked state or during auxiliary boot modes that may alter the behavior of the TSF. The evaluator shall ensure that this description includes the code, the action performed by the TSF, and a justification that the actions performed do not modify user or TSF data. If no USSD or MMI codes are available, the evaluator shall ensure that the TSS provides a description of the method by which actions prescribed by these codes are prevented.

The evaluator shall ensure the TSS documents any TSF data (including software, execution context, configuration information, and audit logs) which may be accessed and modified over a wired interface in auxiliary boot modes. The evaluator shall ensure that the description includes data, which is modified in support of update or restore of the device. The evaluator shall ensure that this documentation includes the auxiliary boot

modes in which the data may be modified, the methods for entering the auxiliary boot modes, the location of the data, the manner in which data may be modified, the data format and packaging necessary to support modification, and software and/or hardware tools, if any, which are necessary for modifying the data.

The evaluator shall ensure that the TSS provides a description of the means by which unauthorized and undetected modification (that is, excluding cryptographically verified updates per FPT_TUD_EXT.2) of the TSF data over the wired interface in auxiliary boots modes is prevented. The lack of publicly available tools is not sufficient justification. Examples of sufficient justification include auditing of changes, cryptographic verification in the form of a digital signature or hash, disabling the auxiliary boot modes, and access control mechanisms that prevent writing to files or flashing partitions.

Tests
Assurance Activity Note: *The following tests require the vendor to provide access to a test platform that provides the evaluator with tools that are typically not found on consumer Mobile Device products. In addition, the vendor provides a list of files (e.g., system files, libraries, configuration files, audit logs) that make up the TSF data. This list could be organized by folders/directories (e.g., /usr/sbin, /etc), as well as individual files that may exist outside of the identified directories.*

- ***Test 1:*** *The evaluator shall create and load an app onto the Mobile Device. This app shall attempt to traverse over all file systems and report any locations to which data can be written or overwritten. The evaluator must ensure that none of these locations are part of the OS software, device drivers, system and security configuration files, key material, or another untrusted application's image/data. For example, it is acceptable for a trusted photo editor app to have access to the data created by the camera app, but a calculator application shall not have access to the pictures.*

- ***Test 2:*** *For each available auxiliary boot mode, the evaluator shall attempt to modify a TSF file of their choosing using the software and/or hardware tools described in the TSS. The evaluator shall verify that the modification fails.*

FPT_AEX_EXT.5 Extended: Anti-Exploitation Services (ASLR)

This is an objective component.

FPT_AEX_EXT.5.1 The TSF shall provide address space layout randomization (ASLR) to the kernel.

FPT_AEX_EXT.5.2 The base address of any kernel-space memory mapping will consist of at least 4 unpredictable bits.

Application Note: The 4 unpredictable bits may be provided by the TSF RBG (as specified in FCS_RBG_EXT.1).

Evaluation Activity

TSS
The evaluator shall ensure that the TSS section of the ST describes how the 4 bits are generated and provides a justification as to why those bits are unpredictable.

Tests
Assurance Activity Note: *The following test require the developer to provide access to a test platform that provides the evaluator with tools that are typically not found on consumer Mobile Device products.*

- ***Test 1:*** *The evaluator shall reboot the TOE at least five times. For each of these reboots, the evaluator shall examine memory mapping locations of the kernel. The evaluator must ensure that no memory mappings are placed in the same location on both devices.*

FPT_AEX_EXT.6 Extended: Anti-Exploitation Services (Memory Page Permissions)

This is an objective component.

FPT_AEX_EXT.6.1 The TSF shall prevent write and execute permissions from being simultaneously granted to any page of physical memory [**selection**: *with no exceptions*, *[**assignment**: specific exceptions]*].

Application Note: Memory used for just-in-time (JIT) compilation is anticipated as an exception in this requirement; if so, the ST author must address how this exception is permitted. It is expected that the memory management unit will transition the system to a non-operational state if any violation is detected in kernel memory space.

Evaluation Activity

TSS
The evaluator shall ensure that the TSS describes how the operating system of the application processor prevents all processes executing in a non-privileged execution domain from achieving write and execute permissions on any page of memory (with only specified exceptions). The evaluator shall ensure that the TSS describes how such processes are unable to request pages of memory with such permissions, and how they are unable to change permissions to both write and execute on any pages already allocated to them.

FPT_AEX_EXT.7 Extended: Anti-Exploitation Services (Overflow Protection)

This is an objective component.

FPT_AEX_EXT.7.1 The TSF shall include heap-based buffer overflow protections in the runtime environment it provides to processes that execute on the application processor.

Application Note: These heap-based buffer overflow protections are expected to ensure the integrity of heap metadata such as memory addresses or offsets recorded by the heap implementation to manage memory blocks. This includes chunk headers, look-aside lists, and other data structures used to track the state and location of memory blocks managed by the heap.

Evaluation Activity

TSS
The evaluator shall verify that the TSS enumerates the heap implementations provided to userspace processes. The evaluator shall ensure that the TSS lists all types of heap metadata and identifies how the integrity of each type of metadata is ensured. The evaluator shall ensure that the TSS identifies all fields within each type of metadata and identifies how the integrity of these fields is ensured. The evaluator shall verify that the TSS identifies the manner in which an error condition is entered when a heap overflow is detected and the resulting actions taken by the TSF.

Tests
For each heap implementation, the evaluator shall write, or the developer shall provide access to, an application, which allocates memory from the heap and then writes arbitrary data significantly beyond the end of the allocated buffer. The evaluator shall attempt to execute this application and verify that the write is not allowed.

FPT_BBD_EXT.1 Extended: Application Processor Mediation

This is an objective component.

FPT_BBD_EXT.1.1 The TSF shall prevent code executing on any baseband processor (BP) from accessing application processor (AP) resources except when mediated by the AP.

Application Note: These resources include:

- Volatile and non-volatile memory
- Control of and data from integrated and non-integrated peripherals (e.g. USB controllers, touch screen controllers, LCD controller, codecs)
- Control of and data from integrated and non-integrated I/O sensors (e.g. camera, light, microphone, GPS, accelerometers, geomagnetic field sensors)

Mobile devices are becoming increasingly complex having an application processor that runs a rich operating system and user applications and separate baseband processor(s) that handle cellular and other wireless network connectivity.

- The application processor within most modern Mobile Devices is a system on a chip (SoC) that integrates, for example, CPU/GPU cores and memory interface electronics into a single, power-efficient package.
- Baseband processors are becoming increasingly complex themselves delivering voice encoding alongside multiple independent radios (LTE, Wi-Fi, Bluetooth, FM, GPS) in a single package containing multiple CPUs and DSPs.

Thus, the baseband processor(s) in these requirements include such integrated SoCs and include any radio processors (integrated or not) on the Mobile Device.

All other requirements mostly, except where noted, apply to firmware/software on the application processor, but future requirements (notably, all Integrity, Access Control, and Anti-Exploitation requirements) will apply to application processors and baseband processors.

Evaluation Activity

TSS
The evaluator shall ensure that the TSS section of the ST describes at a high level how the processors on the Mobile Device interact, including which bus protocols they use to communicate, any other devices operating on that bus (peripherals and sensors), and identification of any shared resources. The evaluator shall verify that the design described in the TSS does not permit any BPs from accessing any of the peripherals and sensors or from accessing main memory (volatile and non-volatile) used by the AP. In particular, the evaluator shall ensure that the design prevents modification of executable memory of the AP by the BP.

FPT_BLT_EXT.1 Extended: Limitation of Bluetooth Profile Support

This is an objective component.

FPT_BLT_EXT.1.1 The TSF shall disable support for [**assignment**: *list of Bluetooth profiles*] Bluetooth profiles when they are not currently being used by an application on the Mobile Device, and shall require explicit user action to enable them.

Application Note: Some Bluetooth services incur more serious consequences if unauthorized remote devices gain access to them. Such services should be protected by measures like disabling support for the associated Bluetooth profile unless it is actively being used by an application on the Mobile Device (in order to prevent discovery by a Service Discovery Protocol search), and then requiring explicit user action to enable those profiles in order to use the services. It may be further appropriate to require additional user action before granting a remote device access to that service.

For example, it may be appropriate to disable the OBEX Push Profile until a user on the Mobile Device pushes a button in an application indicating readiness to transfer an object. After completion of the object transfer, support for the OBEX profile should be suspended until the next time the user requests its use.

The ST author shall list all Bluetooth profiles which are disabled while not in use by an application and which need explicit user action in order to become enabled.

Evaluation Activity

Tests
The evaluator shall perform the following tests:

- ***Test 1:*** *While the service is not in active use by an application on theTOE, the evaluator shall attempt to discover a service associated with a "protected" Bluetooth profile (as specified by the requirement) on the TOE via a Service Discovery Protocol search. The evaluator shall verify that the service does not appear in the Service Discovery Protocol search results. Next, the evaluator shall attempt to gain remote access to the service from a device that does not currently have a trusted device relationship with the TOE. The evaluator shall verify that this attempt fails due to the unavailability of the service and profile.*
- ***Test 2:*** *The evaluator shall repeat Test 1 with a device that currently has a trusted device relationship with the TOE and verify that the same behavior is exhibited.*

FPT_JTA_EXT.1 Extended: JTAG Disablement

FPT_JTA_EXT.1.1 The TSF shall [**selection**: *disable access through hardware*, *control access by a signing key*] to JTAG.

Application Note: This requirement means that access to JTAG shall be disabled either through hardware and/or restricted through the use of a signing key.

Evaluation Activity

TSS
If "disable access through hardware" is selected:
The evaluator shall examine the TSS to determine the location of the JTAG ports on the TSF, to include the order of the ports (i.e. Data In, Data Out, Clock, etc.).

If "control access by a signing key" is selected:
The evaluator shall examine the TSS to determine how access to the JTAG is controlled by a signing key. The evaluator shall examine the TSS to determine when the JTAG can be accessed, i.e. what has the access to the signing key.

Tests
Assurance Activity Note: *The following test requires the developer to provide access to a test platform that provides the evaluator with chip level access.*

If "disable access through hardware" is selected:
The evaluator shall connect a packet analyzer to the JTAG ports. The evaluator shall query the JTAG port for its device ID and confirm that the device ID cannot be retrieved.

FPT_KST_EXT.1 Extended: Key Storage

FPT_KST_EXT.1.1 The TSF shall not store any plaintext key material in readable non-volatile memory.

Application Note: The intention of this requirement is that the TOE will not write plaintext keying material to persistent storage. For the purposes of this requirement, keying material refers to authentication data, passwords, secret/private symmetric keys, private asymmetric keys, data used to derive keys, etc. These values must be stored encrypted.

This requirement also applies to any value derived from passwords. Thus, the TOE cannot store plaintext password hashes for comparison purposes before protected data is decrypted, and the TOE should use key derivation and decryption to verify the Password Authentication Factor.

If a BAF is selected in FIA_UAU.5.1, keying material also refers to source biometric data (i.e. fingerprint), enrollment and authentication templates, the features an algorithm uses to perform biometric authentication for enrollment or verification (i.e. location of minutia), threshold values used in making the match adjudication, intermediate calculations generated while building an enrollment or authentication template (i.e. direction maps, minutia counts, binarized and skeletonized representations of friction ridge patterns, etc.), and final match scores. Any images or metadata identifying the user for authentication shall be stored encrypted.

If "hybrid" is selected in FIA_UAU.5.1, in addition to the keying material included for the BAF, mentioned in the previous paragraph, keying material also refers to the PIN/password used as part of the hybrid authentication.

Evaluation Activity

TSS
The evaluator shall consult the TSS section of the ST in performing the assurance activities for this requirement.

In performing their review, the evaluator shall determine that the TSS contains a description of the activities that happen on power-up and password authentication relating to the decryption of DEKs, stored keys, and data.

The evaluator shall ensure that the description also covers how the cryptographic functions in the FCS requirements are being used to perform the encryption functions, including how the KEKs, DEKs, and stored keys are unwrapped, saved, and used by the TOE so as to prevent plaintext from being written to non-volatile storage. The evaluator shall ensure that the TSS describes, for each power-down scenario how the TOE ensures that all keys in non-volatile storage are not stored in plaintext.

The evaluator shall ensure that the TSS describes how other functions available in the system (e.g., regeneration of the keys) ensure that no unencrypted key material is present in persistent storage.

The evaluator shall review the TSS to determine that it makes a case that key material is not written unencrypted to the persistent storage.

For each BAF selected in FIA_UAU.5.1:

The evaluator shall determine that the TSS also contains a description of the activities that happen on biometric authentication, relating to the decryption of DEKs, stored keys, and data. In addition how the system ensures that the biometric keying material is not stored unencrypted in persistent storage.

FPT_KST_EXT.2 Extended: No Key Transmission

FPT_KST_EXT.2.1 The TSF shall not transmit any plaintext key material outside the security boundary of the TOE.

Application Note: The intention of this requirement is to prevent the logging of plaintext key information to a service that transmits the information off-device. For the purposes of this requirement, key material refers to keys, passwords, and other material that is used to derive keys.

If a BAF is selected in FIA_UAU.5.1, keying material also refers to source biometric data (i.e. fingerprint), enrollment and authentication templates, the features an algorithm uses to perform biometric authentication for enrollment or verification (i.e. location of minutia), threshold values used in making the match adjudication, intermediate calculations generated while building an enrollment or authentication template (i.e. direction maps, minutia counts,

binarized and skeletonized representations of friction ridge patterns), and final match scores.

If "hybrid" is selected in FIA_UAU.5.1, in addition to the keying material included for theBAF, mentioned in the previous paragraph, keying material also refers to the PIN/password used as part of the hybrid authentication.

In the future, this requirement will apply to symmetric and asymmetric private keys stored in the TOE secure key storage where applications are outside the boundary of the TOE. Thus, the TSF will be required to provide cryptographic key operations (signature, encryption, and decryption) on behalf of applications (FCS_SRV_EXT.2.1) that have access to those keys.

Evaluation Activity

TSS
The evaluator shall consult the TSS section of the ST in performing the assurance activities for this requirement. The evaluator shall ensure that the TSS describes the TOE security boundary. The cryptographic module may very well be a particular kernel module, the Operating System, the Application Processor, or up to the entire Mobile Device.

In performing their review, the evaluator shall determine that the TSS contains a description of the activities that happen on power-up and password authentication relating to the decryption of DEKs, stored keys, and data.

The evaluator shall ensure that the TSS describes how other functions available in the system (e.g., regeneration of the keys) ensure that no unencrypted key material is transmitted outside the security boundary of the TOE.

The evaluator shall review the TSS to determine that it makes a case that key material is not transmitted outside the security boundary of the TOE.

For each BAF selected in FIA_UAU.5.1:

In performing their review, the evaluator shall determine that the TSS contains a description of the activities that happen on biometric authentication, including how any plaintext material, including critical security parameters and results of biometric algorithms, are protected and accessed.

The evaluator shall ensure that the TSS describes how functions available in the biometric algorithms ensure that no unencrypted plaintext material, including critical security parameters and intermediate results, is transmitted outside the security boundary of the TOE or to other functions or systems that transmit information outside the security boundary of the TOE.

FPT_KST_EXT.3 Extended: No Plaintext Key Export

FPT_KST_EXT.3.1 The TSF shall ensure it is not possible for the TOE user(s) to export plaintext keys.

Application Note: Plaintext keys include DEKs, KEKs, and all keys stored in the secure key storage (FCS_STG_EXT.1). The intent of this requirement is to prevent the plaintext keys from being exported during a backup authorized by the TOE user or administrator.

Evaluation Activity

TSS
The ST author will provide a statement of their policy for handling and protecting keys. The evaluator shall check to ensure the TSS describes a policy in line with not exporting either plaintext DEKs, KEKs, or keys stored in the secure key storage.

FPT_NOT_EXT.1 Extended: Self-Test Notification

FPT_NOT_EXT.1.1 The TSF shall transition to non-operational mode and [**selection**: *log failures in the audit record*, *notify the administrator*, *[**assignment**: other actions]*, *no other actions*] when the following types of failures occur:

- failures of the self-test(s)
- TSF software integrity verification failures
- [**selection**: *no other failures*, *[**assignment**: other failures]*]

Evaluation Activity

TSS
The evaluator shall verify that the TSS describes critical failures that may occur and the actions to be taken upon these critical failures.

Tests
Assurance Activity Note: *The following test require the developer to provide access to*

a test platform that provides the evaluator with tools that are typically not found on consumer Mobile Device products.

- ***Test 1:*** *The evaluator shall use a tool provided by the developer to modify files and processes in the system that correspond to critical failures specified in the second list. The evaluator shall verify that creating these critical failures causes the device to take the remediation actions specified in the first list.*

FPT_NOT_EXT.2 Extended: Self-Test Notification

This is an objective component.

FPT_NOT_EXT.2.1 The TSF shall [**selection**: *audit*, *provide the administrator with*] TSF-software integrity verification values.

Application Note: These notifications are typically called remote attestation and these integrity values are typically called measurements. The integrity values are calculated from hashes of critical memory and values, including executable code. The ST author shall select whether these values are logged as a part of FAU_GEN.1.1 or are provided to the administrator.

Evaluation Activity

TSS
The evaluator shall verify that the TSS describes which critical memory is measured for these integrity values and how the measurement is performed (including which TOE software performs these generates these values, how that software accesses the critical memory, and which algorithms are used).

Guidance
If the integrity values are provided to the administrator, the evaluator shall verify that the AGD guidance contains instructions for retrieving these values and information for interpreting them. For example, if multiple measurements are taken, what those measurements are and how changes to those values relate to changes in the device state.

Tests
Assurance Activity Note: *The following test may require the developer to provide access to a test platform that provides the evaluator with tools that are typically not found on consumer Mobile Device products.*

The evaluator shall repeat the following test for each measurement:

- ***Test 1:*** *The evaluator shall boot the device in an approved state and record the measurement taken (either from the log or by using the administrative guidance to retrieve the value via an MDM Agent). The evaluator shall modify the critical memory or value that is measured. The evaluator shall boot the device and verify that the measurement changed.*

FPT_NOT_EXT.2.2 The TSF shall cryptographically sign all integrity verification values.

Application Note: The intent of this requirement is to provide assurance to the administrator that the responses provided are from the TOE and have not been modified or spoofed by a man-in-the-middle such as a network-based adversary or a malicious MDM Agent.

Evaluation Activity

TSS
The evaluator shall verify that the TSS describes which key the TSF uses to sign the responses to queries and the certificate used to prove ownership of the key, and the method of associating the certificate with a particular device manufacturer and model.
Tests
The evaluator shall perform the following test:

- ***Test 1:*** *The evaluator shall write, or the developer shall provide, a management application that queries either the audit logs or the measurements. The evaluator shall verify that the responses to these queries are signed and verify the signatures against the TOE's certificate.*

FPT_STM.1 Reliable time stamps

FPT_STM.1.1 The TSF shall be able to provide reliable time stamps for its own use.

Evaluation Activity

TSS

The evaluator shall examine the TSS to ensure that it lists each security function that makes use of time. The TSS provides a description of how the time is maintained and considered reliable in the context of each of the time related functions. This documentation must identify whether the TSF uses a NTP server or the carrier's network time as the primary time sources.

Guidance
The evaluator examines the operational guidance to ensure it describes how to set the time.
Tests

- ***Test 1:*** *The evaluator uses the operational guide to set the time. The evaluator shall then use an available interface to observe that the time was set correctly.*

FPT_TST_EXT.1 Extended: TSF Cryptographic Functionality Testing

FPT_TST_EXT.1.1 The TSF shall run a suite of self-tests during initial start-up (on power on) to demonstrate the correct operation of all cryptographic functionality.

Application Note: This requirement may be met by performing known answer tests and/or pair-wise consistency tests. The self-tests must be performed before the cryptographic functionality is exercised (for example, during the initialization of a process that utilizes the functionality).

The cryptographic functionality includes the cryptographic operations in FCS_COP, the key generation functions in FCS_CKM, and the random bit generation in FCS_RBG_EXT.

Evaluation Activity

TSS
The evaluator shall examine the TSS to ensure that it specifies the self-tests that are performed at start-up. This description must include an outline of the test procedures conducted by the TSF (e.g., rather than saying "memory is tested", a description similar to "memory is tested by writing a value to each memory location and reading it back to ensure it is identical to what was written" shall be used). The TSS must include any error states that they TSF may enter when self-tests fail, and the conditions and actions necessary to exit the error states and resume normal operation. The evaluator shall verify that the TSS indicates these self-tests are run at start-up automatically, and do not involve any inputs from or actions by the user or operator.

The evaluator shall inspect the list of self-tests in the TSS and verify that it includes algorithm self-tests. The algorithm self-tests will typically be conducted using known answer tests.

FPT_TST_EXT.2/PREKERNEL Extended: TSF Integrity Checking

FPT_TST_EXT.2.1/PREKERNEL The TSF shall verify the integrity of the bootchain up through the Application Processor OS kernel stored in mutable media prior to its execution through the use of [**selection**: *a digital signature using an immutable hardware asymmetric key*, *an immutable hardware hash of an asymmetric key*, *an immutable hardware hash*, *a digital signature using a hardware-protected asymmetric key*].

Application Note: The bootchain of the TSF is the sequence of firmware and software, including ROM, bootloader(s), and kernel, which ultimately result in loading the kernel on the Application Processor, regardless of which processor executes that code. Executable code that would be loaded after the kernel is covered in FPT_TST_EXT.2/POSTKERNEL.

In order to meet this requirement, the hardware protection may be transitive in nature: a hardware-protected public key, hash of an asymmetric key, or hash may be used to verify the mutable bootloader code which contains a key or hash used by the bootloader to verify the mutable OS kernel code, which contains a key or hash to verify the next layer of executable code, and so on.

The cryptographic mechanism used to verify the (initial) mutable executable code must be protected, such as being implemented in hardware or in read-only memory (ROM).

Evaluation Activity

TSS
The evaluator shall verify that the TSS section of the ST includes a description of the boot procedures, including a description of the entire bootchain, of the software for the TSF's Application Processor. The evaluator shall ensure that before loading the bootloader(s) for the operating system and the kernel, all bootloaders and the kernel software itself is cryptographically verified. For each additional category of executable code verified before execution, the evaluator shall verify that the description in the TSS describes how that software is cryptographically verified.

The evaluator shall verify that the TSS contains a justification for the protection of the

cryptographic key or hash, preventing it from being modified by unverified or unauthenticated software. The evaluator shall verify that the TSS contains a description of the protection afforded to the mechanism performing the cryptographic verification.

The evaluator shall verify that the TSS describes each auxiliary boot mode available on the TOE during the boot procedures. The evaluator shall verify that, for each auxiliary boot mode, a description of the cryptographic integrity of the executed code through the kernel is verified before each execution.

Tests
Assurance Activity Note: *The following tests require the vendor to provide access to a test platform that provides the evaluator with tools that are typically not found on consumer Mobile Device products.*

The evaluator shall perform the following tests:

- ***Test 1:*** *The evaluator shall perform actions to cause TSF software to load and observe that the integrity mechanism does not flag any executables as containing integrity errors and that the TOE properly boots.*
- ***Test 2:*** *The evaluator shall modify a TSF executable that is integrity protected and cause that executable to be successfully loaded by the TSF. The evaluator observes that an integrity violation is triggered and the TOE does not boot. (Care must be taken so that the integrity violation is determined to be the cause of the failure to load the module, and not the fact that the module was modified so that it was rendered unable to run because its format was corrupt).*
- ***Test 3:*** *[conditional] If the ST author indicates that the integrity verification is performed using a public key, the evaluator shall verify that the update mechanism includes a certificate validation according to FIA_X509_EXT.1. The evaluator shall digitally sign the TSF executable with a certificate that does not have the Code Signing purpose in the extendedKeyUsage field and verify that an integrity violation is triggered. The evaluator shall repeat the test using a certificate that contains the Code Signing purpose and verify that the integrity verification succeeds. Ideally, the two certificates should be identical except for the extendedKeyUsage field.*

FPT_TST_EXT.2/POSTKERNEL Extended: TSF Integrity Checking

This is an objective component.

FPT_TST_EXT.2.1/POSTKERNEL The TSF shall verify the integrity of [**selection**: *all executable code stored in mutable media*, [***assignment****: list of other executable code*]], stored in mutable media prior to its execution through the use of [**selection**: *a digital signature using an immutable hardware asymmetric key*, *an immutable hardware hash of an asymmetric key*, *an immutable hardware hash*, *a digital signature using a hardware-protected asymmetric key*, *hardware-protected hash*].

Application Note: All executable code covered in this requirement is executed after the kernel is loaded.

If "all executable code in mutable media" is verified, implementation in hardware or in read-only memory is a natural logical consequence.

At this time, the verification of software executed on other processors stored in mutable media is not required; however, it may be added in the first assignment. If all executable code (including bootloader(s), kernel, device drivers, pre-loaded applications, user-loaded applications, and libraries) is verified, "all executable code stored in mutable media" should be selected.

Evaluation Activity

Tests
The assurance activity shall be completed in conjunction with FPT_TST_EXT.2/PREKERNEL for all executable code specified.

FPT_TST_EXT.3 Extended: TSF Integrity Testing

This is a selection-based component. Its inclusion depends upon selection from FIA_X509_EXT.2.1.

FPT_TST_EXT.3.1 The TSF shall not execute code if the code signing certificate is deemed invalid.

Application Note: Certificates may optionally be used for code signing for integrity verification (FPT_TST_EXT.2.1/PREKERNEL). If "code signing for integrity verification" is selected in FIA_X509_EXT.2.1, FPT_TST_EXT.3.1 must be included in the ST.

Validity is determined by the certificate path, the expiration date, and the revocation status in

accordance with RFC 5280.

Evaluation Activity

> ***Tests***
> *Testing for this element is performed in conjunction with the assurance activities for FPT_TST_EXT.2.1/PREKERNEL.*

FPT_TUD_EXT.1 Extended: Trusted Update: TSF version query

FPT_TUD_EXT.1.1 The TSF shall provide authorized users the ability to query the current version of the TOE firmware/software.

FPT_TUD_EXT.1.2 The TSF shall provide authorized users the ability to query the current version of the hardware model of the device.

Application Note: The current version of the hardware model of the device is an identifier that is sufficient to indicate (in tandem with manufacturer documentation) the hardware which comprises the device.

FPT_TUD_EXT.1.3 The TSF shall provide authorized users the ability to query the current version of installed mobile applications.

Application Note: The current version of mobile applications is the name and published version number of each installed mobile application.

Evaluation Activity

> *The evaluator shall establish a test environment consisting of the Mobile Device and any supporting software that demonstrates usage of the management functions. This can be test software from the developer, a reference implementation of management software from the developer, or other commercially available software. The evaluator shall set up the Mobile Device and the other software to exercise the management functions according to the provided guidance documentation.*
> ***Tests***
> - ***Test 1:*** *: Using the AGD guidance provided, the evaluator shall test that the administrator and user can query:*
> - *the current version of the TSF operating system and any firmware that can be updated separately*
> - *the hardware model of the TSF*
> - *the current version of all installed mobile applications*
>
> *The evaluator must review manufacturer documentation to ensure that the hardware model identifier is sufficient to identify the hardware which comprises the device.*

FPT_TUD_EXT.2 Extended: TSF Update Verification

FPT_TUD_EXT.2.1 The TSF shall verify software updates to the Application Processor system software and [**selection**: *[**assignment**: other processor system software]*, *no other processor system software*] using a digital signature verified by the manufacturer trusted key prior to installing those updates

Application Note: The digital signature mechanism is implemented in accordance with FCS_COP.1.1/SIGN.

At this time, this requirement does not required verification of software updates to the software operating outside the Application Processor.

Any change, via a supported mechanism, to software residing in non-volatile storage is deemed a software update. Thus, this requirement applies to TSF software updates regardless of how the software arrives or is delivered to the device. This includes over-the-air (OTA) updates as well as partition images containing software which may be delivered to the device over a wired interface.

FPT_TUD_EXT.2.2 The TSF shall [**selection**: *never update*, *update only by verified software*] the TSF boot integrity [**selection**: *key*, *hash*].

Application Note: The key or hash updated via this requirement is used for verifying software before execution in FPT_TST_EXT.2/PREKERNEL. The key or hash is verified as a part of the digital signature on an update, and the software which performs the update of the key or hash is verified by FPT_TST_EXT.2/PREKERNEL.

FPT_TUD_EXT.2.3 The TSF shall verify that the digital signature verification key used for TSF updates [**selection**: *is validated to a public key in the Trust Anchor Database*, *matches an immutable hardware public key*].

Application Note: The ST author shall indicate the method by which the signing key for system software updates is limited and, if selected in FPT_TUD_EXT.2.3, shall indicate how

this signing key is protected by the hardware.

If certificates are used, certificates are validated for the purpose of software updates in accordance with FIA_X509_EXT.1 and should be selected in FIA_X509_EXT.2.1. Additionally, FPT_TUD_EXT.3.1 must be included in the ST.

Evaluation Activity

TSS
The evaluator shall verify that the TSS section of the ST describes all TSF software update mechanisms for updating the system software. The evaluator shall verify that the description includes a digital signature verification of the software before installation and that installation fails if the verification fails. The evaluator shall verify that all software and firmware involved in updating the TSF is described and, if multiple stages and software are indicated, that the software/firmware responsible for each stage is indicated and that the stage(s) which perform signature verification of the update are identified.

The evaluator shall verify that the TSS describes the method by which the digital signature is verified and that the public key used to verify the signature is either hardware-protected or is validated to chain to a public key in the Trust Anchor Database. If hardware-protection is selected, the evaluator shall verify that the method of hardware-protection is described and that the ST author has justified why the public key may not be modified by unauthorized parties.

[conditional] If the ST author indicates that software updates to system software running on other processors is verified, the evaluator shall verify that these other processors are listed in the TSS and that the description includes the software update mechanism for these processors, if different than the update mechanism for the software executing on the Application Processor.

[conditional] If the ST author indicates that the public key is used for software update digital signature verification, the evaluator shall verify that the update mechanism includes a certificate validation according to FIA_X509_EXT.1 and a check for the Code Signing purpose in the extendedKeyUsage.

Tests
The evaluator shall verify that the developer has provided evidence that the following tests were performed for each available update mechanism:

- ***Test 1:*** *The tester shall try to install an update without the digital signature and shall verify that installation fails. The tester shall attempt to install an update with digital signature, and verify that installation succeeds.*
- ***Test 2:*** *The tester shall digitally sign the update with a key disallowed by the device and verify that installation fails. The tester shall digitally sign the update with the allowed key and verify that installation succeeds.*
- ***Test 3:*** *[conditional] The tester shall digitally sign the update with an invalid certificate and verify that update installation fails. The tester shall repeat the test using a valid certificate and a certificate that contains the purpose and verify that the update installation succeeds.*
- ***Test 4:*** *[conditional] The tester shall digitally sign the application with a certificate that does not have the Code Signing purpose and verify that application installation fails. The tester shall repeat the test using a valid certificate and a certificate that contains the Code Signing purpose and verify that the application installation succeeds.*
- ***Test 5:*** *[conditional] The tester shall repeat this test for the software executing on each processor listed in the first selection. The tester shall attempt to install an update without the digital signature and shall verify that installation fails. The tester shall attempt to install an update with digital signature, and verify that installation succeeds.*

FPT_TUD_EXT.2.4 The TSF shall verify mobile application software using a digital signature mechanism prior to installation.

Application Note: This requirement does not necessitate an X.509v3 certificate or certificate validation. X.509v3 certificates and certificate validation are addressed in FPT_TUD_EXT.4.1.

Evaluation Activity

Assurance Activity Note: *The following test does not have to be tested using the commercial application store.*

TSS
The evaluator shall verify that the TSS describes how mobile application software is verified at installation. The evaluator shall ensure that this method uses a digital

signature.
Tests

- ***Test 1:*** *The evaluator shall write, or the developer shall provide access to, an application. The evaluator shall try to install this application without a digitally signature and shall verify that installation fails. The evaluator shall attempt to install a digitally signed application, and verify that installation succeeds.*

FPT_TUD_EXT.3 Extended: Trusted Update Verification

This is a selection-based component. Its inclusion depends upon selection from FIA_X509_EXT.2.1.

FPT_TUD_EXT.3.1 The TSF shall not install code if the code signing certificate is deemed invalid.

Application Note: Certificates may optionally be used for code signing of system software updates (FPT_TUD_EXT.2.3) and of mobile applications (FPT_TUD_EXT.4.1). This element must be included in the ST if certificates are used for either update element. If either "code signing for system software updates" or "code signing for mobile applications" is selected in FIA_X509_EXT.2.1, FPT_TUD_EXT.3.1 must be included in the ST.

Validity is determined by the certificate path, the expiration date, and the revocation status in accordance with RFC 5280.

Evaluation Activity

Tests
Testing for this element is performed in conjunction with the assurance activities for FPT_TUD_EXT.2.3 and FPT_TUD_EXT.4.1.

FPT_TUD_EXT.4 Extended: Application Verification

This is an objective component.

FPT_TUD_EXT.4.1 The TSF shall by default only install mobile applications cryptographically verified by [**selection**: *a built-in X.509v3 certificate*, *a configured X.509v3 certificate*].

Application Note: The built-in certificate is installed by the manufacturer either at time of manufacture or as a part of system updates. The configured certificate used to verify the signature is set according to FMT_SMF_EXT.1 function 33.

Evaluation Activity

TSS
The evaluator shall verify that the TSS describes how mobile application software is verified at installation. The evaluator shall ensure that this method uses a digital signature by a code signing certificate.
Tests

- ***Test 1:*** *The evaluator shall write, or the developer shall provide access to, an application. The evaluator shall try to install this application without a digitally signature and shall verify that installation fails. The evaluator shall attempt to install an application digitally signed with an appropriate certificate, and verify that installation succeeds.*

- ***Test 2:*** *The evaluator shall digitally sign the application with an invalid certificate and verify that application installation fails. The evaluator shall digitally sign the application with a certificate that does not have the Code Signing purpose and verify that application installation fails. This test may be performed in conjunction with the assurance activities for FIA_X509_EXT.1.*

- ***Test 3:*** *If necessary, the evaluator shall configure the device to limit the public keys that can sign application software according to the AGD guidance. The evaluator shall digitally sign the application with a certificate disallowed by the device or configuration and verify that application installation fails. The evaluator shall attempt to install an application digitally signed with an authorized certificate and verify that application installation succeeds.*

FPT_TUD_EXT.5 Extended: Trusted Update Verification

This is an objective component.

FPT_TUD_EXT.5.1 The TSF shall verify that software updates to theTSF are a current or later version than the current version of the TSF.

Application Note: A later version has a larger version number. The method for distinguishing newer software versions from older versions is determined by the manufacturer.

Evaluation Activity

TSS
The evaluator shall verify that the TSS describes the mechanism that prevents the TSF from installing software updates that are an older version that the currently installed version.

Tests
The evaluator shall repeat the following tests to cover all allowed software update mechanisms as described in the TSS. For example, if the update mechanism replaces an entire partition containing many separate code files, the evaluator does not need to repeat the test for each individual file.

- ***Test 1:*** *The evaluator shall attempt to install an earlier version of software (as determined by the manufacturer). The evaluator shall verify that this attempt fails by checking the version identifiers or cryptographic hashes of the privileged software against those previously recorded and checking that the values have not changed.*
- ***Test 2:*** *The evaluator shall attempt to install a current or later version and shall verify that the update succeeds.*

5.1.7 Class: TOE Access (FTA)

FTA_SSL_EXT.1 Extended: TSF- and User-initiated Locked State

FTA_SSL_EXT.1.1 The TSF shall transition to a locked state after a time interval of inactivity.

FTA_SSL_EXT.1.2 The TSF shall transition to a locked state after initiation by either the user or the administrator.

FTA_SSL_EXT.1.3 The TSF shall, upon transitioning to the locked state, perform the following operations:

a. clearing or overwriting display devices, obscuring the previous contents;
b. [**assignment**: *other actions performed upon transitioning to the locked state*].

Application Note: The time interval of inactivity is configured using FMT_SMF_EXT.1 function 2. The user/administrator-initiated lock is specified inFMT_SMF_EXT.1 function 6.

Evaluation Activity

TSS
The evaluator shall verify the TSS describes the actions performed upon transitioning to the locked state.
Guidance
The evaluation shall verify that the AGD guidance describes the method of setting the inactivity interval and of commanding a lock. The evaluator shall verify that the TSS describes the information allowed to be displayed to unauthorized users.
Tests

- ***Test 1:*** *The evaluator shall configure the TSF to transition to the locked state after a time of inactivity (FMT_SMF_EXT.1) according to the AGD guidance. The evaluator shall wait until the TSF locks and verify that the display is cleared or overwritten and that the only actions allowed in the locked state are unlocking the session and those actions specified in FIA_UAU_EXT.2.*
- ***Test 2:*** *The evaluator shall command the TSF to transition to the locked state according to the AGD guidance as both the user and the administrator. The evaluator shall wait until the TSF locks and verify that the display is cleared or overwritten and that the only actions allowed in the locked state are unlocking the session and those actions specified in FIA_UAU_EXT.2.*

FTA_TAB.1 Default TOE Access Banners

This is an objective component.

FTA_TAB.1.1 Before establishing a user session, the TSF shall display an advisory warning message regarding unauthorized use of the TOE.

Application Note: This requirement may be met with the configuration of either text or an image containing the text of the desired message. The TSF shall minimally display this information at startup, but may also display the information at every unlock. The banner is configured according to FMT_SMF_EXT.1 function 36.

Evaluation Activity

TSS
The TSS shall describe when the banner is displayed.
Tests
The evaluator shall also perform the following test:

- ***Test 1:*** *The evaluator follows the operational guidance to configure a notice and consent warning message. The evaluator shall then start up or unlock the TSF. The evaluator shall verify that the notice and consent warning message is displayed in each instance described in the TSS.*

5.1.8 Class: Trusted Path/Channels (FTP)

FTP_ITC_EXT.1 Extended: Trusted Channel Communication

FTP_ITC_EXT.1.1 The TSF shall use

- 802.11-2012 in accordance with the Extended Package for WLAN Clients,
- 802.1X in accordance with the Extended Package for WLAN Clients,
- EAP-TLS in accordance with the Extended Package for WLAN Clients,
- mutually authenticated TLS as defined in the Package for Transport Layer Security

and [**selection**:

- *IPsec in accordance with the PP-Module for VPN Client*,
- *mutually authenticated DTLS as defined in the Package for Transport Layer Security*,
- *HTTPS*

] protocol to provide a communication channel between itself and another trusted IT product that is logically distinct from other communication channels, provides assured identification of its end points, protects channel data from disclosure, and detects modification of the channel data.

Application Note: The intent of the mandatory portion of the above requirement is to use the cryptographic protocols identified in the requirement to establish and maintain a trusted channel between the TOE and an access point, VPN Gateway, or other trusted IT product.

The ST author shall list which trusted channel protocols are implemented by the Mobile Device.

The TSF shall be validated against the Extended Package for WLAN Clients to satisfy the mandatory trusted channels of 802.11-2012, 802.1X, and EAP-TLS.

To satisfy the mandatory trusted channel of TLS and if "mutually authenticated DTLS as defined in the Package for Transport Layer Security" is selected, the TSF shall be validated against the TLS Functional Package, with the following selections made:

- FCS_TLS_EXT.1:
  - either TLS or DTLS is selected as appropriate
  - client is selected
- FCS_TLSC_EXT.1.1 or FCS_DTLSC_EXT.1.1 (as appropriate):
  - The cipher suites selected must correspond with the algorithms and hash functions allowed in FCS_COP.1.
  - Mutual authentication must be selected
- FCS_TLSC_EXT.1.3 or FCS_DTLSC_EXT.1.3 (as appropriate):
  - With no exceptions is selected.

If the ST author selects IPsec, the TSF shall be validated against the PP-Module for VPN Client.

The ST author must include the security functional requirements for the trusted channel protocol selected in FTP_ITC_EXT.1 in the main body of the ST.

Assured identification of endpoints is performed according to the authentication mechanisms used by the listed trusted channel protocols.

FTP_ITC_EXT.1.2 The TSF shall permit the TSF to initiate communication via the trusted channel.

FTP_ITC_EXT.1.3 The TSF shall initiate communication via the trusted channel for wireless access point connections, administrative communication, configured enterprise connections, and [**selection**: *OTA updates*, *no other connections*].

Evaluation Activity

TSS
The evaluator shall examine the TSS to determine that it describes the details of the TOE connecting to access points, VPN Gateways, and other trusted IT products in terms of the cryptographic protocols specified in the requirement, along with TOE-specific options or procedures that might not be reflected in the specifications. The evaluator shall also confirm that all protocols listed in the TSS are specified and included in the

requirements in the ST.

If OTA updates are selected, the TSS shall describe which trusted channel protocol is initiated by the TOE and is used for updates.

Guidance
The evaluator shall confirm that the operational guidance contains instructions for establishing the connection to access points, VPN Gateways, and other trusted IT products.

Tests
The evaluator shall also perform the following tests for each protocol listed:

- ***Test 1:*** *The evaluator shall ensure, for each communication channel with an authorized IT entity, the channel data are not sent in plaintext and that a protocol analyzer identifies the traffic as the protocol under testing.*
- ***Test 2:*** *[conditional] If IPsec is selected (and the TSF includes a native VPN client), the evaluator shall ensure that the TOE is able to initiate communications with a VPN Gateway, setting up the connections as described in the operational guidance and ensuring that communication is successful.*
- ***Test 3:*** *[conditional]If OTA updates are selected, the evaluator shall trigger an update request according to the operational guidance and shall ensure that the communication is successful.*
- ***Test 4:*** *For any other selected protocol (not tested in Test 1, 2, or 3), the evaluator shall ensure that the TOE is able to initiate communications with a trusted IT product using the protocol, setting up the connection as described in the operational guidance and ensuring that the communication is successful.*

5.2 Security Assurance Requirements

The Security Objectives in Section 4 Security Objectives were constructed to address threats identified in Section 3 Security Problem Definition. The Security Functional Requirements (SFRs) in Section 5.1 Security Fundamental Requirements are a formal instantiation of the Security Objectives. The PP identifies the Security Assurance Requirements (SARs) to frame the extent to which the evaluator assesses the documentation applicable for the evaluation and performs independent testing.

This section lists the set of SARs from CC part 3 that are required in evaluations against this PP. Individual Assurance Activities to be performed are specified both in Section 5.1 Security Fundamental Requirements as well as in this section.

The general model for evaluation of TOEs against STs written to conform to this PP is as follows:

After the ST has been approved for evaluation, the ITSEF will obtain the TOE, supporting environmental IT, and the administrative/user guides for the TOE. The ITSEF is expected to perform actions mandated by the Common Evaluation Methodology (CEM) for the ASE and ALC SARs. The ITSEF also performs the Assurance Activities contained within Section 5.1 Security Fundamental Requirements, which are intended to be an interpretation of the other CEM assurance requirements as they apply to the specific technology instantiated in the TOE. The Assurance Activities that are captured in Section 5.1 Security Fundamental Requirements also provide clarification as to what the developer needs to provide to demonstrate the TOE is compliant with the PP.

The TOE security assurance requirements are identified in Table 7. Table 7: Security Assurance Requirements

Assurance Class	Assurance Components
Security Target (ASE)	Conformance claims (ASE_CCL.1)
	Extended components definition (ASE_ECD.1)
	ST introduction (ASE_INT.1)
	Security objectives for the operational environment (ASE_OBJ.1)
	Stated security requirements (ASE_REQ.1)
	Security Problem Definition (ASE_SPD.1)
	TOE summary specification (ASE_TSS.1)
Development (ADV)	Basic functional specification (ADV_FSP.1)
Guidance Documents (AGD)	Operational user guidance (AGD_OPE.1)
	Preparative procedures (AGD_PRE.1)
Life Cycle Support (ALC)	Labeling of the TOE (ALC_CMC.1)
	TOE CM coverage (ALC_CMS.1)

	Timely Security Updates (ALC_TSU_EXT)
Tests (ATE)	Independent testing – sample (ATE_IND.1)
Vulnerability Assessment (AVA)	Vulnerability survey (AVA_VAN.1)

5.2.1 Class ASE: Security Target

The ST is evaluated as per ASE activities defined in the CEM for ASE_CCL.1, ASE_ECD.1, ASE_INT.1, ASE_OBJ.2, ASE_REQ.2, ASE_SPD.1, and ASE_TSS.1. In addition, there may be Assurance Activities specified within Section 5.1 Security Fundamental Requirements that call for necessary descriptions to be included in theTSS that are specific to the TOE technology type.

5.2.2 Class ADV: Development

The design information about the TOE is contained in the guidance documentation available to the end user as well as the TSS portion of the ST, and any additional information required by thisPP that is not to be made public.

ADV_FSP.1 Basic Functional Specification

Developer action elements:

ADV_FSP.1.1 The developer shall provide a functional specification.

ADV_FSP.1.2 The developer shall provide a tracing from the functional specification to the SFRs.

Application Note: As indicated in the introduction to this section, the functional specification is comprised of the information contained in the AGD_OPE, AGD_PRE, and the API information that is provided to application developers, including the APIs that require privilege to invoke.

The developer may reference a website accessible to application developers and the evaluator. The API documentation shall include those interfaces required in this profile. The API documentation shall clearly indicate to which products and versions each available function applies.

The assurance activities in the functional requirements point to evidence that should exist in the documentation and TSS section; since these are directly associated with the SFRs, the tracing in element ADV_FSP.1.2D is implicitly already done and no additional documentation is necessary.

Content and presentation elements:

ADV_FSP.1.3 The functional specification shall describe the purpose and method of use for each SFR-enforcing and SFR-supporting TSFI.

ADV_FSP.1.4 The functional specification shall identify all parameters associated with each SFR-enforcing and SFR-supporting TSFI.

ADV_FSP.1.5 The functional specification shall provide rationale for the implicit categorization of interfaces as SFR-non-interfering.

ADV_FSP.1.6 The tracing shall demonstrate that the SFRs trace to TSFIs in the functional specification.

Evaluator action elements:

ADV_FSP.1.7 The evaluator shall confirm that the information provided meets all requirements for content and presentation of evidence.

ADV_FSP.1.8 The evaluator shall determine that the functional specification is an accurate and complete instantiation of the SFRs.

Evaluation Activity

There are no specific assurance activities associated with these SARs, except ensuring the information is provided. The functional specification documentation is provided to support the evaluation activities described in Section 5.1 Security Fundamental Requirements, and other activities described for AGD, ATE, and AVA SARs. The requirements on the content of the functional specification information is implicitly assessed by virtue of the other assurance activities being performed; if the evaluator is unable to perform an activity because there is insufficient interface information, then an adequate functional specification has not been provided.

5.2.3 Class AGD: Guidance Documentation

The guidance documents will be provided with the ST. Guidance must include a description of how the IT personnel verifies that the Operational Environment can fulfill its role for the security functionality. The documentation should be in an informal style and readable by the IT personnel.

Guidance must be provided for every operational environment that the product supports as claimed in the ST. This guidance includes:

- instructions to successfully install the TSF in that environment
- instructions to manage the security of the TSF as a product and as a component of the larger operational environment
- instructions to provide a protected administrative capability

Guidance pertaining to particular security functionality is also provided; requirements on such guidance are contained in the assurance activities specified with each requirement.

AGD_OPE.1 Operational User Guidance

Developer action elements:

AGD_OPE.1.1 The developer shall provide operational user guidance.

Application Note: The operational user guidance does not have to be contained in a single document. Guidance to users, administrators and application developers can be spread among documents or web pages. Where appropriate, the guidance documentation is expressed in the eXtensible Configuration Checklist Description Format (XCCDF) to support security automation.

Rather than repeat information here, the developer should review the assurance activities for this component to ascertain the specifics of the guidance that the evaluator will be checking for. This will provide the necessary information for the preparation of acceptable guidance.

Content and presentation elements:

AGD_OPE.1.2 The operational user guidance shall describe, for each user role, the user-accessible functions and privileges that should be controlled in a secure processing environment, including appropriate warnings.

Application Note: User and administrator (e.g., MDM agent), and application developer are to be considered in the definition of user role.

AGD_OPE.1.3 The operational user guidance shall describe, for each user role, how to use the available interfaces provided by the TOE in a secure manner.

AGD_OPE.1.4 The operational user guidance shall describe, for each user role, the available functions and interfaces, in particular all security parameters under the control of the user, indicating secure values as appropriate.

AGD_OPE.1.5 The operational user guidance shall, for each user role, clearly present each type of security-relevant event relative to the user-accessible functions that need to be performed, including changing the security characteristics of entities under the control of the TSF.

AGD_OPE.1.6 The operational user guidance shall identify all possible modes of operation of the OS (including operation following failure or operational error), their consequences, and implications for maintaining secure operation.

AGD_OPE.1.7 The operational user guidance shall, for each user role, describe the security measures to be followed in order to fulfill the security objectives for the operational environment as described in the ST.

AGD_OPE.1.8 The operational user guidance shall be clear and reasonable.

Evaluator action elements:

AGD_OPE.1.9 The evaluator shall confirm that the information provided meets all requirements for content and presentation of evidence.

Evaluation Activity

Some of the contents of the operational guidance are verified by the assurance activities in Section 5.1 Security Fundamental Requirements and evaluation of the TOE according to the [CEM]. The following additional information is also required.

The operational guidance shall contain a list of natively installed applications and any relevant version numbers. If any third party vendors are permitted to install applications before purchase by the end user or enterprise, these applications shall also be listed.

The operational guidance shall contain instructions for configuring the cryptographic engine associated with the evaluated configuration of the TOE. It shall provide a warning to the administrator that use of other cryptographic engines was not evaluated nor tested during the CC evaluation of the TOE.

The documentation must describe the process for verifying updates to the TOE by verifying a digital signature. The evaluator shall verify that this process includes the following steps:

- *Instructions for obtaining the update itself. This should include instructions for making the update accessible to the TOE (e.g., placement in a specific directory).*

- *Instructions for initiating the update process, as well as discerning whether the process was successful or unsuccessful. This includes generation of the hash/digital signature.*

The TOE will likely contain security functionality that does not fall in the scope of evaluation under this PP. The operational guidance shall make it clear to an administrator which security functionality is covered by the evaluation activities.

AGD_PRE.1 Preparative Procedures

Developer action elements:

AGD_PRE.1.1 The developer shall provide the TOE, including its preparative procedures.

Application Note: As with the operational guidance, the developer should look to the assurance activities to determine the required content with respect to preparative procedures.

Content and presentation elements:

AGD_PRE.1.2 The preparative procedures shall describe all the steps necessary for secure acceptance of the delivered TOE in accordance with the developer's delivery procedures.

AGD_PRE.1.3 The preparative procedures shall describe all the steps necessary for secure installation of the TOE and for the secure preparation of the operational environment in accordance with the security objectives for the operational environment as described in the ST.

Evaluator action elements:

AGD_PRE.1.4 The evaluator shall confirm that the information provided meets all requirements for content and presentation of evidence.

AGD_PRE.1.5 The evaluator shall apply the preparative procedures to confirm that the OS can be prepared securely for operation.

Evaluation Activity

As indicated in the introduction above, there are significant expectations with respect to the documentation—especially when configuring the operational environment to support TOE functional requirements. The evaluator shall check to ensure that the guidance provided for the TOE adequately addresses all platforms claimed for the TOE in the ST.

5.2.4 Class ALC: Life-cycle Support

At the assurance level provided for TOEs conformant to this PP, life-cycle support is limited to end-user-visible aspects of the life-cycle, rather than an examination of the TOE vendor’s development and configuration management process. This is not meant to diminish the critical role that a developer’s practices play in contributing to the overall trustworthiness of a product; rather, it is a reflection on the information to be made available for evaluation at this assurance level.

ALC_CMC.1 Labeling of the TOE

Developer action elements:

ALC_CMC.1.1 The developer shall provide the TOE and a reference for the TOE.

Content and presentation elements:

ALC_CMC.1.2 The TOE shall be labeled with a unique reference.

Evaluator action elements:

ALC_CMC.1.3 The evaluator shall confirm that the information provided meets all requirements for content and presentation of evidence.

Evaluation Activity

The evaluator shall check the ST to ensure that it contains an identifier (such as a product name/version number) that specifically identifies the version that meets the requirements of the ST. Further, the evaluator shall check the AGD guidance and TOE samples received for testing to ensure that the version number is consistent with that in the ST. If the vendor maintains a web site advertising theTOE, the evaluator shall examine the information on the web site to ensure that the information in the ST is sufficient to distinguish the product.

ALC_CMS.1 TOE CM Coverage

Developer action elements:

ALC_CMS.1.1 The developer shall provide a configuration list for the TOE.

Content and presentation elements:

ALC_CMS.1.2 The configuration list shall include the following: the TOE itself; and the evaluation evidence required by the SARs.

ALC_CMS.1.3 The configuration list shall uniquely identify the configuration items.

Evaluator action elements:

ALC_CMS.1.4 The evaluator shall confirm that the information provided meets all requirements for content and presentation of evidence.

Application Note: The "evaluation evidence required by the SARs" in this PP is limited to the information in the ST coupled with the guidance provided to administrators and users under the AGD requirements. By ensuring that the TOE is specifically identified and that this identification is consistent in the ST and in the AGD guidance (as done in the assurance activity for ALC_CMC.1), the evaluator implicitly confirms the information required by this component.

Life-cycle support is targeted aspects of the developer's life-cycle and instructions to providers of applications for the developer's devices, rather than an in-depth examination of the TSF manufacturer's development and configuration management process. This is not meant to diminish the critical role that a developer's practices play in contributing to the overall trustworthiness of a product; rather, it's a reflection on the information to be made available for evaluation.

Evaluation Activity

The evaluator shall ensure that the developer has identified (in public-facing development guidance for their platform) one or more development environments appropriate for use in developing applications for the developer's platform. For each of these development environments, the developer shall provide information on how to configure the environment to ensure that buffer overflow protection mechanisms in the environment(s) are invoked (e.g., compiler and linker flags). The evaluator shall ensure that this documentation also includes an indication of whether such protections are on by default, or have to be specifically enabled.

The evaluator shall ensure that the TSF is uniquely identified (with respect to other products from the TSF vendor), and that documentation provided by the developer in association with the requirements in the ST is associated with the TSF using this unique identification.

ALC_TSU_EXT Timely Security Updates

Developer action elements:

ALC_TSU_EXT.1 The developer shall provide a description in the TSS of how timely security updates are made to the TOE.

Content and presentation elements:

ALC_TSU_EXT.2 The description shall include the process for creating and deploying security updates for the TOE software.

Note: The software to be described includes the operating systems of the application processor and the baseband processor, as well as any firmware and applications. The process description includes the TOE developer processes as well as any third-party (carrier) processes. The process description includes each deployment mechanism (e.g., over-the-air updates, per-carrier updates, downloaded updates).

ALC_TSU_EXT.3 The description shall express the time window as the length of time, in days, between public disclosure of a vulnerability and the public availability of security updates to the TOE.

Note: The total length of time may be presented as a summation of the periods of time that each party (e.g., TOE developer, mobile carrier) on the critical path consumes. The time period until public availability per deployment mechanism may differ; each is described.

ALC_TSU_EXT.4 The description shall include the mechanisms publicly available for reporting security issues pertaining to the TOE.

Note: The reporting mechanism could include web sites, email addresses, as well as a means to protect the sensitive nature of the report (e.g., public keys that could be used to encrypt the details of a proof-of-concept exploit).

ALC_TSU_EXT.5 The description shall include where users can seek information about the availability of new updates including details (e.g. CVE identifiers) of the specific public vulnerabilities corrected by each update.

Note: The purpose of providing this information is so that users and enterprises can determine which devices are susceptible to publicly known vulnerabilities so that they can

make appropriate risk decisions, such as limiting access to enterprise resources until updates are installed.

Evaluator action elements:

ALC_TSU_EXT.6 The evaluator shall confirm that the information provided meets all requirements for content and presentation of evidence.

Evaluation Activity

The evaluator shall verify that the TSS contains a description of the timely security update process used by the developer to create and deploy security updates. The evaluator shall verify that this description addresses the TOE OS, the firmware, and bundled applications, each. The evaluator shall also verify that, in addition to the TOE developer's process, any carrier or other third-party processes are also addressed in the description. The evaluator shall also verify that each mechanism for deployment of security updates is described.

The evaluator shall verify that, for each deployment mechanism described for the update process, the TSS lists a time between public disclosure of a vulnerability and public availability of the security update to the TOE patching this vulnerability, to include any third-party or carrier delays in deployment. The evaluator shall verify that this time is expressed in a number or range of days.

The evaluator shall verify that this description includes the publicly available mechanisms (including either an email address or website) for reporting security issues related to the TOE. The evaluator shall verify that the description of this mechanism includes a method for protecting the report either using a public key for encrypting email or a trusted channel for a website.

The evaluator shall verify that the description includes where users can seek information about the availability of new security updates including details of the specific public vulnerabilities corrected by each update. The evaluator shall verify that the description includes the minimum amount of time that the TOE is expected to be supported with security updates, and the process by which users can seek information about when the TOE is no longer expected to receive security updates.

5.2.5 Class ATE: Tests

Testing is specified for functional aspects of the system as well as aspects that take advantage of design or implementation weaknesses. The former is done through the ATE_IND family, while the latter is through the AVA_VAN family. At the assurance level specified in this PP, testing is based on advertised functionality and interfaces with dependency on the availability of design information. One of the primary outputs of the evaluation process is the test report as specified in the following requirements.

Since many of the APIs are not exposed at the user interface (e.g., touch screen), the ability to stimulate the necessary interfaces requires a developer's test environment. This test environment will allow the evaluator, for example, to access APIs and view file system information that is not available on consumer Mobile Devices.

ATE_IND.1 Independent Testing – Conformance

Developer action elements:

ATE_IND.1.1 The developer shall provide the TOE for testing.

Content and presentation elements:

ATE_IND.1.2 The TOE shall be suitable for testing.

Evaluator action elements:

ATE_IND.1.3 The evaluator *shall confirm* that the information provided meets all requirements for content and presentation of evidence.

ATE_IND.1.4 The evaluator shall test a subset of the TSF to confirm that the TSF operates as specified.

Evaluation Activity

The evaluator shall prepare a test plan and report documenting the testing aspects of the system. The test plan covers all of the testing actions contained in the [CEM] and the body of this PP's Assurance Activities. While it is not necessary to have one test case per test listed in an Assurance Activity, the evaluator must document in the test plan that each applicable testing requirement in the ST is covered.

The test plan identifies the platforms to be tested, and for those platforms not included in the test plan but included in the ST, the test plan provides a justification for not testing the platforms. This justification must address the differences between the tested platforms and the untested platforms, and make an argument that the differences do not affect the testing to be performed. It is not sufficient to merely assert that the differences

have no affect; rationale must be provided. If all platforms claimed in the ST are tested, then no rationale is necessary.

The test plan describes the composition of each platform to be tested, and any setup that is necessary beyond what is contained in the AGD documentation. It should be noted that the evaluator is expected to follow the AGD documentation for installation and setup of each platform either as part of a test or as a standard pre-test condition. This may include special test drivers or tools. For each driver or tool, an argument (not just an assertion) should be provided that the driver or tool will not adversely affect the performance of the functionality by the TOE and its platform. This also includes the configuration of the cryptographic engine to be used. The cryptographic algorithms implemented by this engine are those specified by this PP and used by the cryptographic protocols being evaluated (IPsec, TLS/HTTPS, SSH).

The test plan identifies high-level test objectives as well as the test procedures to be followed to achieve those objectives. These procedures include expected results. The test report (which could just be an annotated version of the test plan) details the activities that took place when the test procedures were executed, and includes the actual results of the tests. This shall be a cumulative account, so if there was a test run that resulted in a failure; a fix installed; and then a successful re-run of the test, the report would show a "fail" and "pass" result (and the supporting details), and not just the "pass" result.

5.2.6 Class AVA: Vulnerability Assessment

For the current generation of this protection profile, the evaluation lab is expected to survey open sources to discover what vulnerabilities have been discovered in these types of products. In most cases, these vulnerabilities will require sophistication beyond that of a basic attacker. Until penetration tools are created and uniformly distributed to the evaluation labs, the evaluator will not be expected to test for these vulnerabilities in the TOE. The labs will be expected to comment on the likelihood of these vulnerabilities given the documentation provided by the vendor. This information will be used in the development of penetration testing tools and for the development of future protection profiles.

AVA_VAN.1 Vulnerability Survey

Developer action elements:

AVA_VAN.1.1 The developer shall provide the TOE for testing.

Content and presentation elements:

AVA_VAN.1.2 The TOE shall be suitable for testing.

Evaluator action elements:

AVA_VAN.1.3 The evaluator shall confirm that the information provided meets all requirements for content and presentation of evidence.

AVA_VAN.1.4 The evaluator shall perform a search of public domain sources to identify potential vulnerabilities in the TOE.

Application Note: Public domain sources include the Common Vulnerabilities and Exposures (CVE) dictionary for publicly-known vulnerabilities.

AVA_VAN.1.5 The evaluator shall conduct penetration testing, based on the identified potential vulnerabilities, to determine that the TOE is resistant to attacks performed by an attacker possessing Basic attack potential.

Evaluation Activity

The evaluator shall generate a report to document their findings with respect to this requirement. This report could physically be part of the overall test report mentioned in ATE_IND, or a separate document. The evaluator performs a search of public information to find vulnerabilities that have been found in mobile devices and the implemented communication protocols in general, as well as those that pertain to the particular TOE. The evaluator documents the sources consulted and the vulnerabilities found in the report.

For each vulnerability found, the evaluator either provides a rationale with respect to its non-applicability, or the evaluator formulates a test (using the guidelines provided in ATE_IND) to confirm the vulnerability, if suitable. Suitability is determined by assessing the attack vector needed to take advantage of the vulnerability. If exploiting the vulnerability requires expert skills and an electron microscope, for instance, then a test would not be suitable and an appropriate justification would be formulated.

Appendix A - Implementation-Dependent Requirements

This appendix enumerates requirements are dependent on the TOE implementing a particular function. If theTOE fulfills any of these requirements, the vendor must either add the related SFR or disable the functionality for the evaluated configuration.

A.1 Bluetooth

If the TOE includes Bluetooth hardware, the following SFRs must be all claimed:

- fdp_upc_ext.1/BLUETOOTH

Appendix B - Entropy Documentation And Assessment

The documentation of the entropy source should be detailed enough that, after reading, the evaluator will thoroughly understand the entropy source and why it can be relied upon to provide entropy. This documentation should include multiple detailed sections: design description, entropy justification, operating conditions, and health testing. This documentation is not required to be part of the TSS.

B.1 Design Description

Documentation shall include the design of the entropy source as a whole, including the interaction of all entropy source components. It will describe the operation of the entropy source to include how it works, how entropy is produced, and how unprocessed (raw) data can be obtained from within the entropy source for testing purposes. The documentation should walk through the entropy source design indicating where the random comes from, where it is passed next, any post-processing of the raw outputs (hash, XOR, etc.), if/where it is stored, and finally, how it is output from the entropy source. Any conditions placed on the process (e.g., blocking) should also be described in the entropy source design. Diagrams and examples are encouraged.

This design must also include a description of the content of the security boundary of the entropy source and a description of how the security boundary ensures that an adversary outside the boundary cannot affect the entropy rate.

If implemented, the design description shall include a description of how third-party applications can add entropy to the RBG. A description of any RBG state saving between power-off and power-on shall be included.

B.2 Entropy Justification

There should be a technical argument for where the unpredictability in the source comes from and why there is confidence in the entropy source exhibiting probabilistic behavior (an explanation of the probability distribution and justification for that distribution given the particular source is one way to describe this). This argument will include a description of the expected entropy rate and explain how you ensure that sufficient entropy is going into the TOE randomizer seeding process. This discussion will be part of a justification for why the entropy source can be relied upon to produce bits with entropy.

The entropy justification shall not include any data added from any third-party application or from any state saving between restarts.

B.3 Operating Conditions

Documentation will also include the range of operating conditions under which the entropy source is expected to generate random data. It will clearly describe the measures that have been taken in the system design to ensure the entropy source continues to operate under those conditions. Similarly, documentation shall describe the conditions under which the entropy source is known to malfunction or become inconsistent. Methods used to detect failure or degradation of the source shall be included.

B.4 Health Testing

More specifically, all entropy source health tests and their rationale will be documented. This will include a description of the health tests, the rate and conditions under which each health test is performed (e.g., at startup, continuously, or on-demand), the expected results for each health test, and rationale indicating why each test is believed to be appropriate for detecting one or more failures in the entropy source.

Appendix C - Acronyms

Table 8: Acronyms

Acronym	Meaning
AEAD	Authenticated Encryption with Associated Data
AES	Advanced Encryption Standard
ANSI	American National Standards Institute
AP	Application Processor
API	Application Programming Interface
ASLR	Address Space Layout Randomization
ASLR	Address Space Layout Randomization
BAF	Biometric Authentication Factor
BP	Baseband Processor
BR/EDR	(Bluetooth) Basic Rate/Enhanced Data Rate
CA	Certificate Authority
CBC	Cipher Block Chaining
CC	Common Criteria
CCM	Counter with CBC-Message Authentication Code
CCMP	CCM Protocol
CEM	Common Evaluation Methodology
CMC	Certificate Management over Cryptographic Message Syntax (CMS)
CPU	Central Processing Unit
CRL	Certificate Revocation List
CSP	Critical Security Parameters
CSP	Critical Security Parameter
DAR	Data At Rest
DEK	Data Encryption Key
DEK	Data Encryption Key
DEP	Data Execution Prevention
DH	Diffie-Hellman
DNS	Domain Name System
DSA	Digital Signature Algorithm
DTLS	Datagram Transport Layer Security
EAP	Extensible Authentication Protocol
EAPOL	EAP Over LAN
ECDH	Elliptic Curve Diffie Hellman
ECDSA	Elliptic Curve Digital Signature Algorithm
EEPROM	Electrically Erasable Programmable Read-Only Memory
EST	Enrollment over Secure Transport
FAR	False Accept Rate
FEK	File Encryption Key
FIPS	Federal Information Processing Standards

FM	Frequency Modulation
FQDN	Fully Qualified Domain Name
FRR	False Reject Rate
GCM	Galois Counter Mode
GPS	Global Positioning System
GPU	Graphics Processing Unit
HDMI	High Definition Multimedia Interface
HMAC	Keyed-Hash Message Authentication Code
HTTPS	HyperText Transfer Protocol Secure
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
IPC	Inter-Process Communication
IPsec	Internet Protocol Security
KEK	Key Encryption Key
LE	(Bluetooth) Low Energy
LTE	Long Term Evolution
MD	Mobile Device
MDM	Mobile Device Management
MMI	Man-Machine Interface
MMS	Multimedia Messaging Service
NFC	Near Field Communication
NFIQ	NIST Fingerprint Image Quality
NIST	National Institute of Standards and Technology
NX	Never Execute
OCSP	Online Certificate Status Protocol
OID	Object Identifier
OS	Operating System
OTA	Over the Air
PAD	Presentation Attack Detection
PAE	Port Access Entity
PBKDF	Password-Based Key Derivation Function
PD	Protected Data
PMK	Pairwise Master Key
PP	Protection Profile
PP-Module	Protection Profile Module
PTK	Pairwise Temporal Key
RA	Registration Authority
RBG	Random Bit Generator
REK	Root Encryption Key
ROM	Read-only memory
RSA	Rivest Shamir Adleman Algorithm
SAR	Security Assurance Requirement

SFR	Security Functional Requirement
SHA	Secure Hash Algorithm
SMS	Short Messaging Service
SPI	Security Parameter Index
SSH	Secure Shell
SSID	Service Set Identifier
ST	Security Target
ST	Security Target
TLS	Transport Layer Security
TOE	Target of Evaluation
TSF	TOE Security Functionality
TSF	TOE Security Functionality
TSS	TOE Summary Specification
TSS	TOE Summary Specification
URI	Uniform Resource Identifier
USB	Universal Serial Bus
USSD	Unstructured Supplementary Service Data
VPN	Virtual Private Network
Wi-Fi	Wireless Fidelity
XCCDF	eXtensible Configuration Checklist Description Format
XTS	XEX (XOR Encrypt XOR) Tweakable Block Cipher with Ciphertext Stealing

Appendix D - Use Case Templates

The following use case templates list those selections, assignments, and objective requirements that best support the use cases identified by this Protection Profile. Note that the templates assume that all SFRs listed in Section 5.1 Security Fundamental Requirements are included in the ST, not just those listed in the templates. These templates and deviations from the template should be identified in the Security Target to assist customers with making risk-based purchasing decisions. Products that do not meet these templates are not precluded from use in the scenarios identified by this Protection Profile.

Several of the use cases templates include objective requirements that are strongly desired for the indicated use cases. Readers can expect those requirements to be made mandatory in the next revision of this protection profile, and industry should aim to include that security functionality in products in the near-term.

Where selections for a particular requirement are not identified in a use case template, all available selections are equally applicable to the use case.

D.1 [USE CASE 1] Enterprise-owned device for general-purpose enterprise use

Table 9: Enterprise-Owned Template

Requirement	Action
FCS_STG_EXT.1.4	Do not select "the user."
FMT_MOF_EXT.1.2 Function 4	Assign GPS.
FMT_MOF_EXT.1.2 Function 25	Include in ST. Assign personal Hotspot connections (if feature exists).
FMT_MOF_EXT.1.2 Function 36	Include in ST.
FMT_MOF_EXT.1.2 Function 39	Include in ST. Select "USB Mass storage mode."
FMT_MOF_EXT.1.2 Function 41	Include in ST. Select "USB tethering."
FMT_SMF_EXT.1.1 Function 4	Assign GPS.
FMT_SMF_EXT.1.1 Function 25	Include in ST. Assign personal Hotspot connections (if feature exists).
FMT_SMF_EXT.1.1 Function 36	Include in ST.
FMT_SMF_EXT.1.1 Function 39	Include in ST. Select "USB Mass storage mode."
FMT_SMF_EXT.1.1 Function 41	Include in ST. Select both options.
FPT_BBD_EXT.1.1	Include in ST.
FPT_TST_EXT.2.1/POSTKERNEL	Include in STand Select "all executable code stored in mutable media."
FPT_TUD_EXT.4.1	Include in ST.
FTA_TAB.1.1	Include in ST.

D.2 [USE CASE 2] Enterprise-owned device for specialized, high-security use

Table 10: High Security Template

Requirement	Action
FCS_CKM.1.1	Select RSA with key size of 3072 or select ECC schemes.
FCS_CKM.2.1/UNLOCKED	Select ECC schemes, if ECC schemes are selected inFCS_CKM.1.1.
FCS_CKM.2.1/LOCKED	Select "RSA schemes" or select "ECC schemes that meetNIST SP 800-56A Revision 3".
FCS_CKM_EXT.1.1	If "symmetric" is selected then "256 bits" must be selected. If "asymmetric" is selected and RSA scheme is selected in FCS_CKM.1.1 then "128 bits" can be selected. If "asymmetric" is selected and ECC scheme is selected in FCS_CKM.1.1, then "192 bits" can be selected.
FCS_CKM_EXT.2.1	Select 256 bits.
FCS_CKM_EXT.3.1	If asymmetric KEKs is selected and RSA scheme is selected in FCS_CKM.1.1 then assign 128 bits security strength. If asymmetric KEKs is selected and ECC scheme is selected in FCS_CKM.1.1 then assign 192 bits security strength. If symmetric KEKs is selected, select 256 bit security strength.
FCS_COP.1.1/ENCRYPT	Select 256 bits.

FCS_COP.1.1/HASH	Select SHA-384.
FCS_COP.1.1/SIGN	Assign a key size of 3072 for RSA or select ECDSA schemes.
FCS_COP.1.1/CONDITION	Select 256 bits.
FCS_RBG_EXT.1.2	Select 256 bits.
FCS_TLSC_EXT.1.1 (TLS Package)	Select TLS_RSA_WITH_AES_256_GCM_SHA384 or TLS_ECDHE_ECDSA_WITH AES_256_GCM_SHA384.
FCS_TLSC_EXT.2.1 (TLS Package)	Select secp384r1, if included in ST (if ECC schemes are selected in FCS_CKM.1.1).
FDP_DAR_EXT.1.2	Select 256 bits.
FIA_X509_EXT.2.2	Select either "allow the administrator to choose..." or "not accept the certificate".
FMT_MOF_EXT.1.2 Function 3	Include in ST.
FMT_MOF_EXT.1.2 Function 4	Assign all radios on TSF.
FMT_MOF_EXT.1.2 Function 5	Assign all audio or visual collection devices on TSF.
FMT_MOF_EXT.1.2 Function 19	Include in ST.
FMT_MOF_EXT.1.2 Function 21	Include in ST.
FMT_MOF_EXT.1.2 Function 44	Include in ST.
FMT_MOF_EXT.1.2 Function 45	Include in ST (if IPsec is selected in FTP_ITC_EXT.1).
FMT_SMF_EXT.1.1 Function 12	Assign all X.509v3 certificates in the Trust Anchor Database.
FMT_SMF_EXT.1.1 Function 18	Select "f. all notifications".
FMT_SMF_EXT.1.1 Function 24	Include in ST. Assign at least USB.
FMT_SMF_EXT.1.1 Function 25	Include in ST. Assign all protocols where the TSF acts as a server.
FMT_SMF_EXT.1.1 Function 36	Include in ST.
FMT_SMF_EXT.2.1	Select "wipe of protected data" and "wipe of sensitive data".
FAU_SAR.1.1	Include in ST.
FAU_SAR.1.2	Include in ST.
FAU_SEL.1.1	Include in ST. Select "event type", "success of auditable security events", and "failure of auditable security events".
FCS_SRV_EXT.2.1	Include in ST.
FPT_AEX_EXT.5.1	Include in ST.
FPT_AEX_EXT.5.2	Include in ST.
FPT_BBD_EXT.1.1	Include in ST.
FTA_TAB.1.1	Include in ST.

D.3 [USE CASE 3] Personally-owned device for personal and enterprise use

Table 11: BYOD Template

Requirement	Action
FMT_SMF_EXT.1.1 Function 3	Select "b. on a per-app basis", "c. on a per-groups of application basis" or

	both
FMT_SMF_EXT.1.1 Function 5	Select "b. on a per-app basis", "c. on a per-groups of application basis" or both
FMT_SMF_EXT.1.1 Function 17	Include in ST.
FMT_SMF_EXT.1.1 Function 28	Include in ST.
FMT_SMF_EXT.1.1 Function 44	Include in ST (M-M-)
FMT_SMF_EXT.2.1	Select "Remove Enterprise Applications"
FDP_ACF_EXT.1.2	Select "Groups of Applications"
FDP_ACF_EXT.2.1	Include in ST.

D.4 [USE CASE 4] Personally-owned device for personal and limited enterprise use

At this time no requirements or selections are recommended for this use case.

Appendix E - Initialization Vector Requirements for NIST-Approved Cipher Modes

Table 12: References and IV Requirements for NIST-approved Cipher Modes

Cipher Mode	Reference	IV Requirements
Electronic Codebook (ECB)	SP 800-38A	No IV
Counter (CTR)	SP 800-38A	"Initial Counter" shall be non-repeating. No counter value shall be repeated across multiple messages with the same secret key.
Cipher Block Chaining (CBC)	SP 800-38A	IVs shall be unpredictable. Repeating IVs leak information about whether the first one or more blocks are shared between two messages, so IVs should be non-repeating in such situations.
Output Feedback (OFB)	SP 800-38A	IVs shall be non-repeating and shall not be generated by invoking the cipher on another IV.
Cipher Feedback (CFB)	SP 800-38A	IVs should be non-repeating as repeating IVs leak information about the first plaintext block and about common shared prefixes in messages.
XEX (XOR Encrypt XOR) Tweakable Block Cipher with Ciphertext Stealing (XTS)	SP 800-38E	No IV. Tweak values shall be non-negative integers, assigned consecutively, and starting at an arbitrary non-negative integer.
Cipher-based Message Authentication Code (CMAC)	SP 800-38B	No IV
Key Wrap and Key Wrap with Padding	SP 800-38F	No IV
Counter with CBC-Message Authentication Code (CCM)	SP 800-38C	No IV. Nonces shall be non-repeating.
Galois Counter Mode (GCM)	SP 800-38D	IV shall be non-repeating. The number of invocations ofGCM shall not exceed 2^{32} for a given secret key unless an implementation only uses 96-bit IVs (default length).

Appendix F - Biometric Derivation and Examples

F.1 Experimental Setups And Error Bars In Testing FAR And FRR

F.1.1 Introduction

For the purposes of this PP, FIA_BMG_EXT.1 requires testing for FAR, FRR and SAFAR if a BAF is included in the TOE. In this version of the PP it is expected that the vendor will provide evidence to the evaluator of the testing completed to support the claimed FAR and FRR. This Appendix provides a guide to how this testing could be done and to what error bars are expected when the Rule of 3 is applied. This guide should be treated as a reference and not as a NIAP mandate, requirement, or set of mandates or requirements.

F.1.2 Testing environment that could meet FIA_BMG_EXT.1.1

In performing tests for FAR and FRR, ISO/IEC 19795-1 recommends that vendors or testing labs use the largest test population that can be reasonably managed. Generally, testing environments for mobile devices are based upon individual devices with their own local authentication templates/profiles where the submitted biometric samples are destroyed after submission. It is infeasible to meet the given timeframe for CC evaluations of mobile devices if offline testing is not supported. Either online or offline testing is acceptable. The number of test subjects needed to support a claimed FAR and FRR, will depend on if online or offline testing is used due to how the subjects are compared.

If online testing is utilized, it is expected that the testing is conducted directly on the TOE. The legitimate user will enroll on the TOE and all test subjects will be compared to only the legitimate user. Thus if the target FAR is 1:100, at least 300 independent samples shall be used corresponding to 300 users and at least 300 independent trials are required in testing this FAR. It is acceptable that multiple TOEs, each with a different legitimate user, could be used to reduce the number of test subjects needed for online testing. With the assumption that the test subjects are compared against all legitimate users and no legitimate users are counted as test subjects, if N_D devices are used, the number of test subjects needed can be divided by N_D.

If offline testing is used, it is expected that the biometric system used for testing will not be in the evaluated configuration of the TOE to allow for a full cross-comparison, in which the biometric sample from the test subjects is compared with every non-self template. It is expected, that the biometric system used for testing will collect samples and generate templates exactly the same as the biometric system in the TOE. However, even though the comparison to determine if a valid sample is provided (i.e. matching algorithm) should remain the same, it is acceptable if the biometric system is modified to complete a full cross-comparison. Per ISO/IEC 19795, these comparisons will not be statistically independent, but this approach is statistically unbiased. Additionally, offline testing with a full cross-comparison greatly reduces the number of test subjects needed. If there are N_U users, the number of available individual independent comparisons will be $N_U*(N_U-1)/2$. Thus if the target FAR is 1:10000, only 246 test subjects are needed if offline testing of a full cross-comparison is used.

F.1.3 Deriving False Accept Rate

To expedite approval while maintaining a statistically valid result, it is required for the vendor or independent lab to perform testing using *three* times the sample size, at a minimum, i.e. the "Rule of 3" for the number of trials.

Three times the sample size corresponds to 90% confidence and c = 0.95 (rounded, worst-case), where c is a percentage/fraction of the intended false error rate (either FAR or FRR) for which the error bar is calculated.

The parameters associated with the Rule of 3 are derived by treating a biometric test, consisting of many comparisons, as a series of Bernoulli trials.

As shown in the tables below, the error bar may be large if a higher false error rate is declared.

The table below assumes online testing using a single device, thus a single legitimate user.

Table 13: Comparison of false error rates, number of errors, and number of test subjects needed for online testing, given Rule of 3

False Error Rate	False error rates, 90% confidence, c = 0.95	Number of errors (rounded)	Number of test subjects needed
1% (1:100)	1% ± 0.95%	3	297
0.1% (1:1000)	0.1% ± 0.095%	3	2995
0.01% (1:10000)	0.01% ± 0.0095%	3	29977
0.001% (1:100000)	0.001% ± 0.00095%	3	299797
0.0001% (1:1000000)	0.0001% ± 0.000095%	3	2997998

The table below assumes that N_D devices are used for online testing.

Table 14: Comparison of false error rates, number of errors, and number of test subjects needed for online testing with N_D devices, given Rule of 3

False Error Rate	False error rates, 90% confidence, *c* = 0.95	Number of errors (rounded)	Number of test subjects needed
1% (1:100)	1% ± 0.95%	3	297/N_D
0.1% (1:1000)	0.1% ± 0.095%	3	2995/N_D
0.01% (1:10000)	0.01% ± 0.0095%	3	29977/N_D
0.001% (1:100000)	0.001% ± 0.00095%	3	299797/N_D
0.0001% (1:1000000)	0.0001% ± 0.000095%	3	2997998/N_D

The table below assumes offline testing using a full cross-comparison.

Table 15: Comparison of false error rates, number of errors, and number of test subjects needed for offline testing and full cross-comparison, given Rule of 3

False Error Rate	False error rates, 90% confidence, *c* = 0.95	Number of errors (rounded)	Number of test subjects needed
1% (1:100)	1% ± 0.95%	3	25
0.1% (1:1000)	0.1% ± 0.095%	3	78
0.01% (1:10000)	0.01% ± 0.0095%	3	246
0.001% (1:100000)	0.001% ± 0.00095%	3	776
0.0001% (1:1000000)	0.0001% ± 0.000095%	3	2450

F.1.4 Deriving False Reject Rate

As with False Accept Rate, it is required for the vendor or lab to perform testing using *three* times the sample size, at a minimum, i.e. the "Rule of 3". Three times the sample size corresponds to 90% confidence and *c* = 0.95 (rounded, worst-case), where *c* is a percentage/fraction of the intended false error rate (either FAR or FRR) for which the error bar is calculated.

As shown in the table below, the error bar may be large if a higher false error rate is declared:

Table 16: Comparison of false error rates, number of errors, and number of test subjects needed, given Rule of 3

False Error Rate	False error rates, 90% confidence, *c* = 0.95	Number of errors (rounded)	Number of test subjects needed
10% (1:10)	10% ± 9.5%	3	27
5% (1:20)	5% ± 4.75%	3	57
2% (1:50)	2% ± 1.9%	3	147
1% (1:100)	1% ± 0.95%	3	297

F.2 Derivation of the Rule of 3 (and similar rules, for completeness)

A biometric test can be treated as a series of Bernoulli trials for which a binomial distribution of the number of successes and failures is assumed. When calculating an error interval for which a binomial distribution is assumed, one confidence interval (denoted I_{conf}) that is widely used is the standard Wald interval, expressed in Equation (1) as:

$$\left(p - z_{\alpha/2}\sqrt{\frac{p(1-p)}{n}}\right) \leq I_{conf} \leq \left(p + z_{\alpha/2}\sqrt{\frac{p(1-p)}{n}}\right) \qquad (1)$$

where $p = X/n$ is the sample proportion of successes (or error in this case), $z_{\alpha/2}$ is the 100(1 – α/2)th percentile of the standard normal distribution, and *n* is the number of trials.

Although intervals such as the Wilson, Agresti-Coull, and Jeffreys intervals are recommended by Brown et al., biometrics testing in practice rests on the derivation of the Rule of 30 based on the Wald distribution [BROWN]. However, because of the large sample size, number of test subjects, and number of trials required for the Rule of 30, this PP mandates the Rule of 3 to make testing more feasible.

In simpler form, this refers to a confidence interval with error *E* expressed as:

$$E = z_{\alpha/2}\sqrt{\frac{p(1-p)}{n}} \qquad (2)$$

Rearranging the equation to express the number of trials, *n*, in terms of error *E*, this expression becomes:

$$n = \left(\frac{z_{\alpha/2}}{E}\right)^2 p(1-p) \qquad (3)$$

In practice, *E* is expressed as a proportion of the error probability as:

$$E = cp \qquad (4)$$

Thus, *n* finally becomes:

$$n = \left(\frac{z_{\alpha/2}}{c}\right)^2 \frac{(1-p)}{p} \qquad (5)$$

For a 90% confidence interval, $z_{\alpha/2}$ = 1.6449, while for a 95% confidence interval, $z_{\alpha/2}$ = 1.96.

Thus it is easy to see that for a 90% confidence interval with *c* = 0.95:

$$\left(\frac{1.6449}{0.95}\right)^2 = 2.998 \approx 3 \qquad (6)$$

which confirms the rule of 3 and completes our derivation.

F.3 SAFAR Calculation Equations

A number of equations can be used in calculating SAFAR. A fully-worked example that applies the equations below can be found in F.4 SAFAR Calculation Example.

The SAFAR for a single authentication factor is calculated as $SAFAR = 1-(1-FAR)^{attemptsallowed}$.

Thus let $SAFAR_i$ be the SAFAR for the ith authentication factor where n_i is the number of authentication attempts allowed for the given factor, treated individually as a separate authentication system, which can be expressed as

$$SAFAR_i = 1-(1-FAR_i)^{ni}, \qquad (1)$$

assuming each attempt is independent.

If multiple authentication factors are required (with all to pass), i.e. password plus biometric factor, the SAFAR for a single attempt will be the product of each individual factor's false accept rate, assuming each attempt is independent.

Thus, for a hybrid combination of *m* PIN/password and biometric factors (denoted with index*j*) with n_i attempts allowed, treated collectively as an individual authentication factor in a separate authentication system, the SAFAR can be expressed as:

$$SAFAR_i = 1-\left(1-\prod_{j=1}^{m} FAR_j\right)^{ni}, \qquad (2)$$

assuming each attempt is independent. Because this is currently associated with a PIN/password and biometrics, *m* = 2 in this case.

When ordered, let $SAFAR_{(k)}$ be the SAFAR for the authentication factor with the largest SAFAR, and $SAFAR_{(1)}$ be the SAFAR for the authentication factor with the smallest SAFAR, i.e. $SAFAR_{(1)} \le SAFAR_{(s)} \le \ldots \le SAFAR_{(k-1)} \le SAFAR_{(k)}$.

As such, the following equations for SAFAR utilizing multiple factors follow (using the worst SAFARs):

If the user has a choice of multiple authentication factors with a choice of only one authentication factor in a given session (i.e. all authentication factors are considered critical and a user cannot switch between authentication factors), the overall SAFAR will be equal to $SAFAR_{(k)}$, assuming each attempt is independent.

If the user has a choice of multiple authentication factors and can choose to attempt authentication using more than one factor with success requiring any factor to pass and n_i attempts allowed per factor) for a given session, the SAFAR for *k* available authentication factors will be

$$SAFAR_{any} = 1 - \prod_{i=1}^{k} (1 - SAFAR_i) \qquad (3)$$

assuming each attempt is independent. If there are *critical factors*, the highest SAFAR corresponding to the *worst-case* set of choices shall be reported.

If the user has the choice of a number of authentication factors from which the user must choose *m* factors, all of which must pass with *n* attempts per factor allowed, the SAFAR for a single combination of *m* factors will be

$$SAFAR_{mfactors} = \prod_{i=1}^{m} (SAFAR_i) \qquad (4)$$

assuming each attempt is independent. If *m* < *k* available factors, the worst-case of all $\binom{k}{m}$ combinations of factors becomes the overall SAFAR.

F.4 SAFAR Calculation Example

Password and fingerprint authentication example:

Suppose the overall authentication system consists of two authentication factors: a four character password factor allowing for ten attempts and a fingerprint biometric factor with an FAR of 1:1000 allowing for five attempts.

Passwords utilize the minimum character set of 63 characters, plus one additional accepted character, making it 64. Assume each attempt is independent.

a. What is the SAFAR of each individual authentication factor, treated separately?
b. If the user can only authenticate using a single authentication factor, assuming all authentication factors available are critical and there is no possibility for the user to switch between authentication factors, what is the overall SAFAR?
c. If the user can authenticate using any authentication factor in an authentication session, and none are considered critical factors, what is the overall SAFAR?
d. If the conditions are the same as in c) but password is now a *critical* authentication factor that will cause a device wipe, what is the overall SAFAR?
e. If the password factor and fingerprint biometric factor are both required with the number of attempts for fingerprint increased to ten, what is the overall SAFAR? What is the risk if authentication feedback is provided for each modality (i.e. fingerprint failed or password failed)?
f. f) If the password/PIN factor and fingerprint biometric factor are both combined into a hybrid factor (both must be used and the only authentication feedback allowed is valid login or invalid login) for entry with ten attempts allowed for the hybrid factor, what is the overall SAFAR? Why is this scenario more secure than e)?

Solution:

a. The SAFAR for a four-character password allowing for ten attempts, utilizing a 64 character set, is:

$$SAFAR_{(password|10attempts)} = 1 - \left(1 - Characterset^{length}\right)^{attemptsallowed}$$
$$SAFAR_{(password|10attempts)} = 1 - \left(1 - 64^4\right)^{10} = 5.960 * 10^{-7}\ (rounded)$$

The SAFAR for a fingerprint biometric factor with an FAR of 1:1000, allowing for five attempts, is:

$$SAFAR_{\left(fingerprint|5\ attempts\right)} = 1 - \left(1 - FAR\right)^{attempts}$$

$$SAFAR_{\left(fingerprint|5\ attempts\right)} = 1 - \left(1 - 10^{-3}\right)^{5}=4.990 * 10^{-3} \left(rounded\right)$$

b. If the user is only allowed to pick one factor, the overall SAFAR is that of the weakest one, which is

$$SAFAR_{(fingerprint|5attempts)} = 4.990 * 10^{-3}$$

c. If the user can authenticate using any authentication factor in an authentication session, the overall SAFAR is:

$$SAFAR_{any} = 1 - \left(1 - \left(5.96 * 10^{-7}\right)\right) * \left(1 - \left(4.99 * 10^{-3}\right)\right)$$
$$= 4.991 * 10{-}3(rounded)$$

d. If the conditions are the same as in c) but with password as a critical factor, the worst-case scenario is the same as in c) in that the password factor is picked last, thus

$$SAFAR_{anypasswordcritical} = 4.991 * 10^{-3}\ (rounded)$$

e. If password and fingerprint are now required factors, the SAFAR for fingerprint has to be recalculated for ten attempts:

$$SAFAR_{fingerprint|10attempts} = 1 - \left(1 - 10^{-3}\right)^{10} = 9.955 * 10^{-3}\ (rounded)$$

Since the SAFAR for password with ten attempts allowed is known, it then follows that:

$$SAFAR_{fingerprint+password} = \left(5.960 * 10^{-7}\right) * \left(9.955 * 10^{-3}\right) = 5.933 * 10^{-9}\ (rounded)$$

The risk of providing authentication feedback is that if either authentication factor is compromised, the same sample can then be used by the adversary for every authentication after, thus reducing the SAFAR for the system to that of the other authentication factor.

f. If password/PIN and fingerprint are now combined into a single hybrid factor, the SAFAR is as follows:

$$SAFAR_{fingerprint+password|10attempts} = 1 - \left(1 - 2^{-6*4} * 10^{-3}\right)^{10}$$
$$= 5.960 * 10^{-10}\ (rounded)$$

This is more secure than e) because not only are there less attempts overall before the maximum count is exceeded (10 instead of 20), the adversary would not know if a sample submitted for either factor results in authentication unless the presentation of both factors results in successful authentication.

Appendix G - References

Identifier	Title
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Appendix H - Acknowledgements

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