Google Pixel Phones on Android 12 Administrator Guidance Documentation

Version 1.0
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1. Document Introduction

This guide includes procedures for configuring Pixel phones running Android 12 into a Common Criteria evaluated configuration and additionally includes guidance to application developers wishing to write applications that leverage the Pixel phone's Common Criteria compliant APIs and features.

1.1 Evaluated Devices

The evaluated devices include the following models and versions:

Product	Model #	Kernel	Android OS Version	Security Patch Level
Google Pixel 6 Pro	GF5KQ, G8V0U, GLU0G	5.10	Android 12.0	November 2021
Google Pixel 6	GR1YH, GB7N6, G9S9B	5.10	Android 12.0	November 2021
Google Pixel 5a-5G	G4S1M	4.19	Android 12.0	November 2021
Google Pixel 5	GD1YQ, GTT9Q, G5NZ6	4.19	Android 12.0	November 2021
Google Pixel 4a-5G	G025E/I/H, G6QU3	4.19	Android 12.0	November 2021
Google Pixel 4a	G025J/M/N	4.14	Android 12.0	November 2021
Google Pixel 4	G020I/M/N	4.14	Android 12.0	November 2021
Google Pixel 4 XL	G020P/Q/J	4.14	Android 12.0	November 2021
Google Pixel 3a	G020E/F/G/H	4.9	Android 12.0	November 2021
Google Pixel 3a XL	G020A/B/C	4.9	Android 12.0	November 2021
Google Pixel 3	G103A/B	4.9	Android 12.0	November 2021
Google Pixel 3 XL	G103C/D	4.9	Android 12.0	November 2021

To verify the OS Version and Security Patch Level on your device:

1. Tap on Settings
2. Tap on About phone
3. Scroll down to Android version and tap on it

1.2 Acronyms

- AE – Android Enterprise
- AES – Advanced Encryption Standard
- API – Application Programming Interface
- BYOD – Bring Your Own Device
- CA – Certificate Authority
- DO – Device Owner
- DPC – Device Policy Controller
- EMM – Enterprise Mobility Management
- MDM – Mobile Device Management
- PKI – Public Key Infrastructure
- TOE – Target of Evaluation

2. Evaluated Capabilities

The Common Criteria configuration adds support for many security capabilities. Some of those capabilities include the following:

- Data Protection
- Lock Screen
- Key Management
- Device Integrity
- Device Management
- Work Profile Separation
- VPN Connectivity
- Audit Logging

2.1 Data Protection

Android uses industry-leading security features to protect user data. The platform creates an application environment that protects the confidentiality, integrity, and availability of user data.

2.1.1 File-Based Encryption

Encryption is the process of encoding user data on an Android device using an encryption key. With encryption, even if an unauthorized party tries to access the data, they won't be able to read it. The device utilizes File-based encryption (FBE) which allows different files to be encrypted with different keys that can be unlocked independently.

Direct Boot allows encrypted devices to boot straight to the lock screen and allows alarms to operate, accessibility services to be available and phones to receive calls before a user has provided their credential.

With file-based encryption and APIs to make apps aware of encryption, it's possible for these apps to operate within a limited context before users have provided their credentials while still protecting private user information.

On a file-based encryption-enabled device, each device user has two storage locations available to apps:

1. Credential Encrypted (CE) storage, which is the default storage location and only available after the user has unlocked the device. CE keys are derived from a combination of user credentials and a hardware secret. It is available after the user has successfully unlocked the device the first time after boot and remains available for active users until the device shuts down, regardless of whether the screen is subsequently locked or not.
2. Device Encrypted (DE) storage, which is a storage location available both before the user has unlocked the device (Direct Boot) and after the user has unlocked the device. DE keys are derived from a hardware secret that's only available after the device has performed a successful Verified Boot.

By default, apps do not run during Direct Boot mode. If an app needs to take action during Direct Boot mode, such as an accessibility service like Talkback or an alarm clock app, the app can register components to run during this mode.

DE and CE keys are unique and distinct - no user's CE or DE key will match another. File-based encryption allows files to be encrypted with different keys, which can be unlocked independently. All encryption is based on AES-256 in XTS mode. Due to the way XTS is defined, it needs two 256-bit keys. In effect, both CE and DE keys are 512-bit keys.

By taking advantage of CE, file-based encryption ensures that a user cannot decrypt another user's data. This is an improvement on full-disk encryption where there's only one encryption key, so all users must know the primary user's passcode to decrypt data. Once decrypted, all data is decrypted.

2.2 Lock screen

Both biometric template matching and passcode verification can only take place on secure hardware with rate limiting (exponentially increasing timeouts) enforced. Android's GateKeeper throttling is also used to prevent brute-force attacks. After a user enters an incorrect password, GateKeeper APIs return a value in milliseconds in which the caller must wait before attempting to validate another password. Any attempts before the defined amount of time has passed will be ignored by GateKeeper. Gatekeeper also keeps a count of the number of failed validation attempts since the last successful attempt. These two values together are used to prevent brute-force attacks of the TOE's password.

For biometric fingerprint authentication (available on Pixel 3, 3 XL, 3a, 3a XL, 4a, 4a-5G, 5, 5a-5G, 6 and 6 Pro phones), the user can attempt 5 failed fingerprint unlocks before fingerprint is locked for 30 seconds. After the 20th cumulative attempt, the device prohibits use of fingerprint until the password is entered.

For biometric face unlock authentication (available on the Pixel 4 and 4 XL), the user can attempt 5 failed face unlocks before the device prohibits use of face unlock until the password is entered.

Android offers APIs that allow apps to use biometrics (fingerprints and face) for authentication, and allows users to authenticate by using their fingerprint scans on supported devices. These APIs are used in conjunction with the Android Keystore system.

2.3 Key Management

2.3.1 KeyStore

The Android KeyStore class lets you manage private keys in secure hardware to make them more difficult to extract from the device. The KeyStore enables apps to generate and store credentials used for authentication, encryption, or signing purposes.

Keystore supports symmetric cryptographic primitives such as AES (Advanced Encryption Standard) and HMAC (Keyed-Hash Message Authentication Code) and asymmetric cryptographic algorithms such as RSA and EC. Access controls are specified during key generation and enforced for the lifetime of the key. Keys can be restricted to be usable only after

the user has authenticated, and only for specified purposes or with specified cryptographic parameters. For more information, see the Authorization Tags and Functions pages.

Additionally, version binding binds keys to an operating system and patch level version. This ensures that an attacker who discovers a weakness in an old version of system or TEE software cannot roll a device back to the vulnerable version and use keys created with the newer version.

On Pixel phones, the KeyStore is implemented in secure hardware. This guarantees that even in the event of a kernel compromise, KeyStore keys are not extractable from the secure hardware. Pixel devices also include StrongBox Keymaster, an implementation of the Keymaster HAL that resides in a Titan M. This module contains its own CPU, secure storage, a true random-number generator and additional mechanisms to resist package tampering and unauthorized sideloading of apps. When checking keys stored in the StrongBox Keymaster, the system corroborates a key's integrity with the Trusted Execution Environment (TEE).

2.3.2 KeyChain

The KeyChain class allows apps to use the system credential storage for private keys and certificate chains. KeyChain is often used by Chrome, Virtual Private Network (VPN) apps, and many enterprise apps to access keys imported by the user or by the mobile device management app.

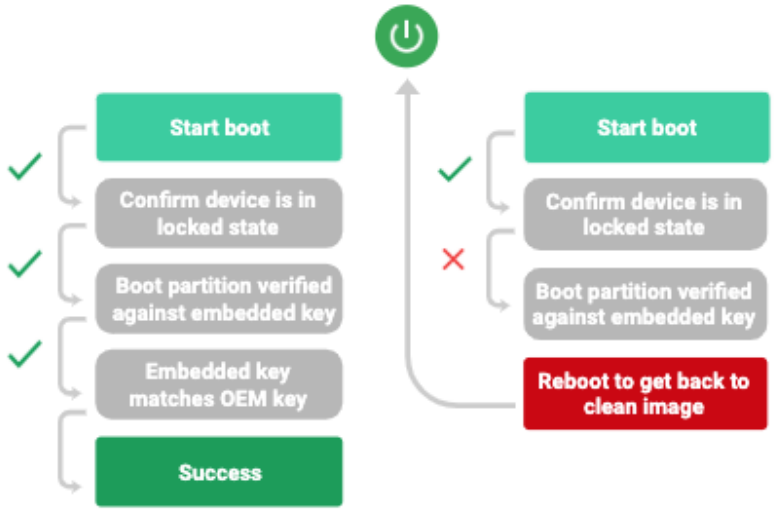
Whereas the KeyStore is for non-shareable app-specific keys, KeyChain is for keys that are meant to be shared across profiles. For example, your mobile device management agent can import a key that Chrome will use for an enterprise website.

2.4 Device Integrity

Device integrity features protect the mobile device from running a tampered operating system. With companies using mobile devices for essential communication and core productivity tasks, keeping the OS secure is essential. Without device integrity, very few security properties can be assured. Android adopts several measures to guarantee device integrity at all times.

2.4.1 Verified Boot

Verified Boot is Android's secure boot process that verifies system software before running it. This makes it more difficult for software attacks to persistent across reboots, and provides users with a safe state at boot time. Each Verified Boot stage is cryptographically signed. Each phase of the boot process verifies the integrity of the subsequent phase, prior to executing that code. Full boot of a compatible device with a locked bootloader proceeds only if the OS satisfies integrity checks. Verification algorithms used must be as strong as current recommendations from NIST for hashing algorithms (SHA-256) and public key sizes (RSA-2048).

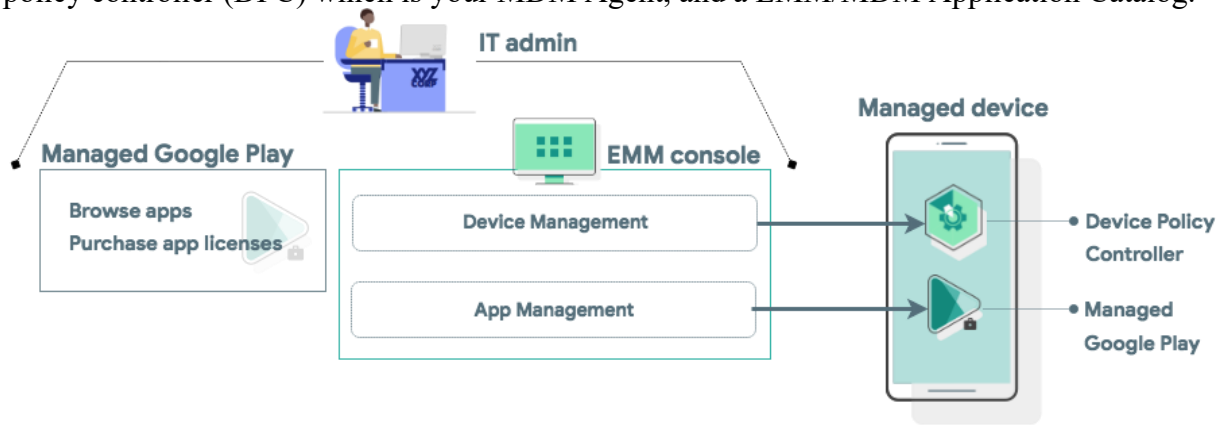


The Verified Boot state is used as an input in the process to derive disk encryption keys. If the Verified Boot state changes (e.g. the user unlocks the bootloader), then the secure hardware prevents access to data used to derive the disk encryption keys that were used when the bootloader was locked.

Find out more about Verified Boot here.

2.5 Device Management

The TOE leverages the device management capabilities that are provided through Android Enterprise which is a combination of three components: your EMM/MDM console, a device policy controller (DPC) which is your MDM Agent, and a EMM/MDM Application Catalog.



Components of an Android Enterprise solution.

2.5.1 EMM/MDM console

EMM solutions typically take the form of an EMM console—a web application you develop that allows IT admins to manage their organization, devices, and apps. To support these functions for

Android, you integrate your console with the APIs and UI components provided by Android Enterprise.

2.5.2 DPC (MDM Agent)

All Android devices that an organization manages through your EMM console must install a DPC app during setup. A DPC is an agent that applies the management policies set in your EMM console to devices. Depending on which development option you choose, you can couple your EMM solution with the EMM solution's DPC, Android's DPC, or with a custom DPC that you develop.

End users can provision a fully managed or dedicated device using a DPC identifier (e.g. "afw#"), according to the implementation guidelines defined in the Play EMM API developer documentation.

- The EMM's DPC must be publicly available on Google Play, and the end user must be able to install the DPC from the device setup wizard by entering a DPC-specific identifier.
- Once installed, the EMM's DPC must guide the user through the process of provisioning a fully managed or dedicated device.

2.6 Work Profile Separation

Fully managed devices with work profiles are for company-owned devices that are used for both work and personal purposes. The organization still manages the entire device. However, the separation of work data and apps into a work profile allows organizations to enforce two separate sets of policies. For example:

- A stronger set of policies for the work profile that applies to all work apps and data.
- A more lightweight set of policies for the personal profile that applies to the user's personal apps and data.

You can learn more about work profile separation in section 7.

2.7 VPN Connectivity

IT admins can specify an Always On VPN to ensure that data from specified managed apps will always go through a configured VPN. **Note:** this feature requires deploying a VPN client that supports both Always On and per-app VPN features. IT admins can specify an arbitrary VPN application (specified by the application package name) to be set as an Always On VPN. IT admins can use managed configurations to specify the VPN settings for an app.

You can read more about VPN configuration options in section 6.

2.8 Audit Logging

IT admins can gather usage data from devices that can be parsed and programmatically evaluated for malicious or risky behavior. Activities logged include Android Debug Bridge (adb) activity, app launches, and screen unlocks.

- IT admins can enable security logging for target devices, and the EMM's DPC must be able to retrieve both security logs and pre-reboot security logs automatically.
- IT admins can review enterprise security logs for a given device and configurable time window, in the EMMs console.
- IT admins can export enterprise security logs from the EMMs console.

IT admins can also capture relevant logging information from Logcat which does not require any additional configuration to be enabled.

You can see a detailed audit logging table in section 9, along with information on how to view and export the different types of audit logs.

3. Security Configuration

The Pixel phones offer a rich built-in interface and MDM callable interface for security configuration. This section identifies the security parameters for configuring your device in Common Criteria mode and for managing its security settings.

3.1 Common Criteria Mode

To configure the device into Common Criteria Mode, you must set the following options:

1. Require a lockscreen password
   - Please review the Password Management items in section 3.4 (Common Criteria Related Settings)
2. Disable Smart Lock
   - Smart Lock can be disabled using KEYGUARD_DISABLE_TRUST_AGENTS()
3. Enable Encryption of Wi-Fi and Bluetooth secrets
   - This can be enabled by using setCommonCriteriaModeEnabled()
4. Disable Debugging Features (Developer options)
   - By default Debugging features are disabled. The system administrator can prevent the user from enabling them by using DISALLOW_DEBUGGING_FEATURES()
5. Disable installation of applications from unknown sources
   - This can be disabled by using DISALLOW_INSTALL_UNKNOWN_SOURCES()
6. Turn off usage & diagnostics
   - Open your device's Settings app
   - Tap Google, then More, then Usage & diagnostics
   - Turn Usage & diagnostics off
7. Enable Audit Logging
   - Audit Logging can be enabled using setSecurityLoggingEnabled.
   - For certain items Logcat can be used which does not require any additional enablement
8. Applications that require PP_MD_V3.1 compliant Sensitive Data Protection, Hostname Checking, Revocation Checking, or TLS Ciphersuite restriction must implement the NIAPSEC library.

No additional configuration is required to ensure key generation, key sizes, hash sizes, and all other cryptographic functions meet NIAP requirements.

3.2 Cryptographic Module Identification

The TOE implements CAVP certified cryptographic algorithms which are provided by the following cryptographic components:

1. BoringSSL Library:
   - BoringCrypto version dcdc7bbc6e59ac0123407a9dc4d1f43dd0d117cd
2. The TOE's LockSettings service
   - Android LockSettings service KBKDF (version 77561fc30db9aedc1f50f5b07504aa65b4268b88)
3. Hardware Cryptography:

- TOE's Wi-FI Chipset provides an AES-CCMP implementation
- The TOE's application processor (Snapdragon 845 [SDM845], Snapdragon 855 [SM8150], Snapdragon 730 [SM7150], Snapdragon 765 [SM7250], Snapdragon 670 [SDM670], and Google Tensor) provides additional cryptographic algorithms. The CAVP certificates correctly identify the specific hardware.

4. Secure Chipset (Titan M):
    - Titan M crypto version H1C2M 57402c8aa (not available on the Pixel 6 and 6 Pro)

The use of other cryptographic components beyond those listed above was neither evaluated nor tested during the TOE's Common Criteria evaluation.

No additional configuration is needed for the cryptographic modules in order to be compliant.

3.3 Permissions Model

Android runs all apps inside sandboxes to prevent malicious or buggy app code from compromising other apps or the rest of the system. Because the application sandbox is enforced in the kernel, this enforcement extends to the entire app regardless of the specific development environment, APIs used, or programming language. A memory corruption error in an app only allows arbitrary code execution in the context of that particular app, with the permissions enforced by the OS.

Similarly, system components run in least-privileged sandboxes in order to prevent compromises in one component from affecting others. For example, externally reachable components, like the media server and WebView, are isolated in their own restricted sandbox.

Android employs several sandboxing techniques, including Security-Enhanced Linux (SELinux), seccomp, and file-system permissions.

The purpose of a *permission* is to protect the privacy of an Android user. Android apps must request permission to access sensitive user data (such as contacts and SMS), as well as certain system features (such as camera and internet). Depending on the feature, the system might grant the permission automatically or might prompt the user to approve the request.
A central design point of the Android security architecture is that no app, by default, has permission to perform any operations that would adversely impact other apps, the operating system, or the user. This includes reading or writing the user's private data (such as contacts or emails), reading or writing another app's files, performing network access, keeping the device awake, and so on.

The DPC can pre-grant or pre-deny specific permissions using PERMISSION_GRANT_STATE API's. In addition the end user can revoke a specific apps permission by:

1. Tapping on Settings>Apps&notifications
2. Tapping on the particular app and then tapping on Permissions
3. From there the user can toggle off any specific permission

You can learn more about Android Permissions on developer.android.com.

3.4 Common Criteria Related Settings

The Common Criteria evaluation requires a range of security settings be available. Those security settings are identified in the table below. In many cases, the administrator or user has to have the ability to configure the setting but no specific value is required.

Security Feature	Setting	Description	Required Value	API	User Interface
Encryption	Device Encryption	Encrypts all internal storage	N/A	Encryption on by default with no way to turn off	
	Wipe Device	Removes all data from device	No required value	wipeData()	To wipe the device go to Settings>System>Reset options and select **Erase all date (factory reset)**
	Wipe Enterprise Data	Remove all enterprise data from device	No required value	wipeData() called from secondary user	
Password Management	Password Length	Minimum number of characters in a password	No required value	setPasswordMinimumLength()	To set a screen lock go to Settings>Security & location>Screen lock and tap on **Password**
	Password Complexity	Specify the type of characters required in a password	No required value	setPasswordQuality()	To set a screen lock go to Settings>Security & location>Screen lock and tap on **Password**
	Password Expiration	Maximum length of time before a password must change	No required value	setPasswordExpirationTimeout()	
	Authentication Failures	Maximum number of authentication failures	10 or less	setMaximumFailedPasswordsForWipe()	
Lockscreen	Inactivity to lockout	Time before lockscreen is engaged	No required value	setMaximumTimeToLock()	To set an inactivity lockout go to Settings>Security & location> and tap on the gear icon next to Screen lock then tap on Automatically lock and select the appropriate value
	Banner	Banner message displayed on the lockscreen	Administrator or user defined text	setDeviceOwnerLockScreenInfo	To set a banner go to Settings>Security & location>Lock screen preferences>Lock screen

					message. Set a message and tap **Save**
	Remote Lock	Looks the device remotely	Function must be available	lockNow()	Tap the power button to turn off the screen which locks the device
	Show Password	Disallows the displaying of the password on the screen of lock-screen password	Disable	This is disabled by default	
	Notifications	Controls whether notifications are displayed on the lockscreen	Enable/Disable are available options	KEYGUARD_DISABLE_SECURE_NOTIFICATIONS() KEYGUARD_DISABLE_UNREDACTED_NOTIFICATIONS	
	Control Biometric Fingerprint	Control the use of Biometric Fingerprint authentication factor	Enable/Disable are available options	KEYGUARD_DISABLE_FINGERPRINT()	
	Control Biometric Face Unlock	Control the use of Biometric Face unlock	Enable/Disable are available options	KEYGUARD_DISABLED_FEATURES_SET	
Certificate Management	Import CA Certificates	Import CA Certificates into the Trust Anchor Database or the credential storage	No required value	installCaCert()	Tap on Settings>Security & location>Advanced>Encryption & credentials and select **Install from storage**
	Remove Certificates	Remove certificates from the Trust Anchor Database or the credential storage	No required value	uninstallCACert()	To clear all user installed certificates tap on Settings>Security & location>Advanced>Ecnryption & credentials and select Clear credentials To remove a specific user installed certificate tap on Settings>Security & location>Advanced>Ecnryption & credentials>Trusted credentials. Switch to the User tab, select the certificate you want to delete and tap on **Remove**
	Import Client Certificates	Import client certificates in to Keychain	No required value	installKeyPair()	Tap on Settings>Security & location>Advanced>Ecnryption & credentials and

	Remove Client Certificates	Remove client certificates from Keychain	No required value	removeKeyPair()	select **Install from storage** To remove a specific user installed client certificate tap on Settings>Security & location>Advanced>Ecnryption & credentials>User credentials. Switch to the User tab, select the certificate you want to delete and tap on **Remove**
Radio Control	Control Wi-Fi	Control access to Wi-Fi	Enable/Disable are available options	DISALLOW_CONFIG_WIFI()	To disable Wi-Fi tap on Settings>Network & internet and toggle Airplane mode to **On**
	Control GPS	Control access to GPS	Enable/Disable are available options	DISALLOW_SHARE_LOCATION() DISALLOW_CONFIG_LOCATION()	
	Control Cellular	Control access to Cellular	Enable/Disable are available options	DISALLOW_CONFIG_MOBILE_NETWORKS()	To disable Cellular tap on Settings>Network & internet>Mobile network and tap on your carrier and toggle to **Off**
	Control NFC	Control access to NFC	Enable/Disable are available options	DISALLOW_OUTGOING_BEAM()	To disable NFC tap on Settings>Connected devices>Connection preferences and toggle NFC to **Off**
	Control Bluetooth	Control access to Bluetooth	Enable/Disable are available options	DISALLOW_BLUETOOTH () DISALLOW_BLUETOOTH_SHARING() DISALLOW_CONFIG_BLUETOOTH()	
	Control Location Service	Control access to Location Service	Enable/Disable are available options	DISALLOW_SHARE_LOCATION() DISALLOW_CONFIG_LOCATION()	
Wi-Fi Settings	Specify Wi-Fi SSIDs	Specify SSID values for connecting to Wi-Fi. Can also create	No required value	WifiEnterpriseConfig()	

		white and black lists for SSIDs.			
	Set WLAN CA Certificate	Select the CA Certificate for the Wi-FI connection	No required value	WifiEnterpriseConfig()	
	Specify security type	Specify the connection security (WEP, WPA2, etc)	No required value	WifiEnterpriseConfig()	
	Select authentication protocol	Specify the EAP-TLS connection values	No required value	WifiEnterpriseConfig()	
	Select client credentials	Specify the client credentials to access a specified WLAN	No required value	WifiEnterpriseConfig()	
	Control Always-on VPN	Control access to Always-on VPN	Enable/Disable are available options	setAlwaysOnVPNPackage()	
Hardware Control	Control Microphone (across device)	Control access to microphone across the device	Enable/Disable are available options	DISALLOW_UNMUTE_MICROPHONE()	
	Control Microphone (per-app basis)	Control access to microphone per application	Enable/Disable are available options		Tap on 'Settings>Apps & notifications>App permissions>Microphone' then de-select the apps to remove permissions
	Control Camera (per-app basis)	Control access to camera per application	Enable/Disable are available options		Tap on 'Settings>Apps & notifications>App permissions>Camera' then de-select the apps to remove permissions
	Control USB Mass Storage	Control access to mounting the device for storage over USB.	Enable/Disable are available options	DISALLOW_MOUNT_PHYSICAL_MEDIA()	
	Control USB Debugging	Control access to USB debugging.	Enable/Disable are available options	DISALLOW_DEBUGGING_FEATURES()	
	Control USB Tethered Connections	Control access to USB tethered connections.	Enable/Disable are available options	DISALLOW_CONFIG_TETHERING()	

	Control Bluetooth Tethered Connections	Control access to Bluetooth tethered connections.	Enable/Disable are available options	DISALLOW_CONFIG_TETHERING()	
	Control Hotspot Connections	Control access to Wi-Fi hotspot connections	Enable/Disable are available options	DISALLOW_CONFIG_TETHERING()	
	Automatic Time	Allows the device to get time from the Wi-Fi connection	Enable/Disable are available options	setAutoTimeRequired()	Tap on 'Settings>System>Date & time' and toggle Automatic date & time to On
Application Control	Install Application	Installs specified application	No required value	PackageInstaller.Session()	
	Uninstall Application	Uninstalls specified application	App to uninstall	uninstall()	To uninstall an application tap on Settings>Applications & notifications>See all. Select the application and tap on Uninstall
	Application Whitelist	Specifies a list of applications that may be installed	No required value	This is done by the EMM/MDM when they setup an application catalog which leverages PackageInstaller.Session()	
	Application Blacklist	Specifies a list of applications that may not be installed	No required value	PackageInstaller.SessionInfo()	
	Application Repository	Specifies the location from which applications may be installed	No required value	DISALLOW_INSTALL_UNKNOWN_SOURCES()	
TOE Management	Enrollment	Enroll TOE in management	No required value		During device setup scan EMM/MDM provided QR code or enter EMM/MDM DPC identifier Refer to section 2.5.2 for more details
	Disallow Unenrollment	Prevent the user from removing the managed profile	Enable/Disable	DISALLOW_REMOVE_MANAGED_PROFILE()	

				DISALLOW_FACTORY_RESET()	
	Unenrollment	Unenroll TOE from management	App to uninstall	uninstall() – this API can be used to uninstall the MDM Agent from the device. Uninstalling the MDM agent from an enterprise profile will delete the entire profile and all its applications.	This API can be used to uninstall enterprise apps. If an admin uninstalls the MDM agent installed on an enterprise profile, the entire profile and all enterprise applications are deleted.
	Allow Developer Mode	Controls Developer Mode access	Enable/Disable are available options	DISALLOW_DEBUGGING_FEATURES()	
	Sharing Data Between Enterprise and Personal Apps	Controls data sharing between enterprise and work apps	Enable/Disable	DISALLOW_CROSS_PROFILE_COPY_PASTE() addCrossProfileIntentFilter()	

3.5 Password Recommendations

When setting a password, you should select a password that:

- Does not use known information about yourself (e.g. pets names, your name, kids names or any information available in the public domain);
- Is significantly different from previous passwords (adding a '1' or "!" to the end of the password is not sufficient); or
- Does not contain a complete word. (Password!).
- Does not contain repeating or sequential numbers and/or letters.

3.6 Bug Reporting Process

Google supports a bug filing system for the Android OS outlined here: https://source.android.com/setup/contribute/report-bugs.

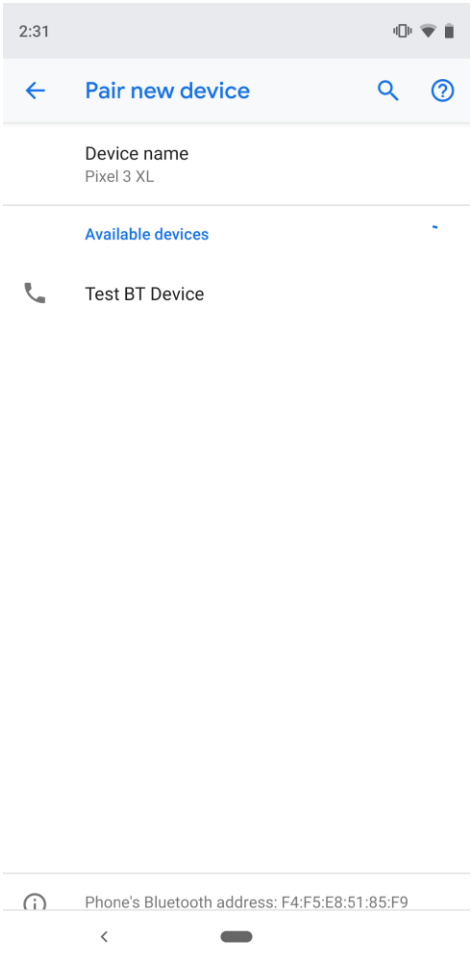
This allows developers or users to search for, file, and vote on bugs that need to be fixed. This helps to ensure that all bugs that affect large numbers of people get pushed up in priority to be fixed.

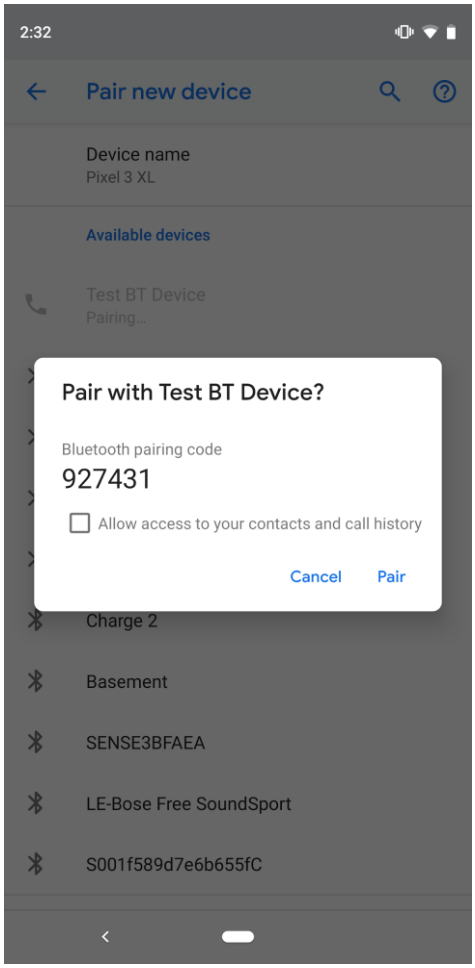
4. Bluetooth Configuration

Follow the below steps to pair and connect using Bluetooth

Pair

1. Open your phone or tablet's Settings app .
2. Tap Connected devices > Connection preferences > Bluetooth. Make sure Bluetooth is turned on.
3. Tap Pair new device.
4. Tap the name of the Bluetooth device you want to pair with your phone or tablet.
5. Follow any on-screen steps.





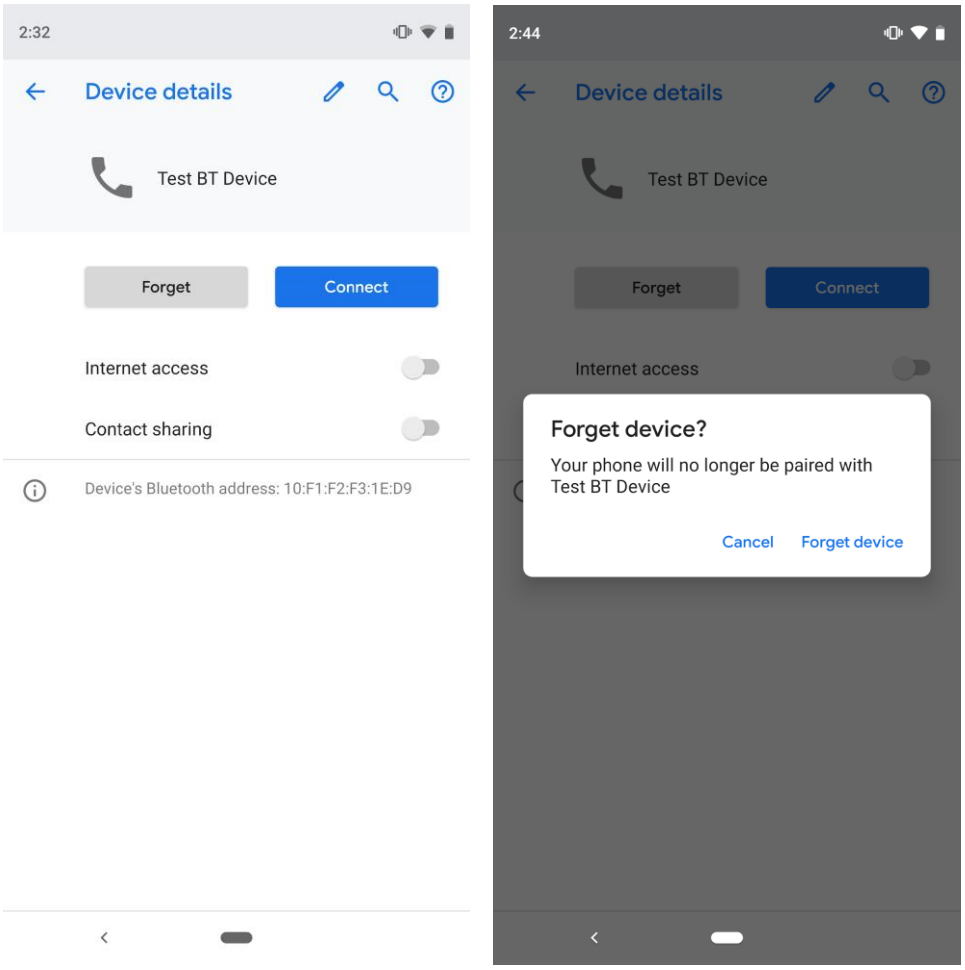
Connect

1. Open your phone or tablet's Settings app .
2. Tap Connected devices > Connection preferences > Bluetooth.
3. Make sure Bluetooth is turned on.
4. In the list of paired devices, tap a paired but unconnected device.
5. When your phone or tablet and the Bluetooth device are connected, the device shows as "Connected" in the list.

Tip: If your phone is connected to something through Bluetooth, at the top of the screen, you'll see a Bluetooth icon .

Remove Previously Paired Device

1. Open your phone or tablet's Settings app .
2. Tap Connected devices > Previously connected devices
3. Tap the gear icon to the right of the device you want to unpair
4. Tap on Forget and confirm in the popup window by tapping on Forget device



For additional support information around Bluetooth please take a look at this support link.

5. Wi-Fi Configuration

Android supports the WPA2-Enterprise (802.11i) protocol, which is specifically designed for enterprise networks and can be integrated into a broad range of Remote Authentication Dial-In User Service (RADIUS) authentication servers.

IT admins can silently provision enterprise Wi-Fi configurations on managed devices, including:

- SSID, via the EMM's DPC
- Password, via the EMM's DPC
- Identity, via the EMM's DPC
- Certificate for clients authorization, via the EMM's DPC
- CA certificate(s), via the EMM's DPC

IT admins can lock down Wi-Fi configurations on managed devices, to prevent users from creating new configurations or modifying corporate configurations.

IT admins can lock down corporate Wi-Fi configurations in either of the following configurations:

- Users cannot modify any Wi-Fi configurations provisioned by the EMM, but may add and modify their own user-configurable networks (for instance personal networks).
- Users cannot add or modify any Wi-Fi network on the device, limiting Wi-Fi connectivity to just those networks provisioned by the EMM.

When the device tries to connect to a Wi-Fi network it performs a standard captive portal check which bypasses the full tunnel VPN configuration. If the administrator wants to turn the captive portal check off they need to do this physically on the device before enrolling it in to the MDM by:

1. Enable Developer Options by tapping on Settings>About phone and tapping on Build number five times until they see that Developer options has been enabled
2. Enable Android Debug Bridge (ADB) over USB by tapping on Settings>System>Advanced>Developer options and scroll down to USB debugging and enable the toggle to On
3. Connect to the device to a workstation that has ADB installed and type in “adb shell settings put global captive_portal_mode 0” and hit enter
4. You can verify the change by typing “adb shell settings get global captive_portal_mode” and the return value should be “0”
5. Turn off Developer options by tapping on Settings>System>Advanced>Developer options and toggling the On option to Off at the top

If a Wi-Fi connection unintentionally terminates, the end user will need to reconnect to re-establish the session.

6. VPN Configuration

Android supports securely connecting to an enterprise network using VPN:

- **Always-on VPN**—The VPN can be configured so that apps don't have access to the network until a VPN connection is established, which prevents apps from sending data across other networks.
    - Always-on VPN supports VPN clients that implement VpnService. The system automatically starts that VPN after the device boots. Device owners and profile owners can direct work apps to always connect through a specified VPN. Additionally, users can manually set Always-on VPN clients that implement VpnService methods using **Settings>More>VPN**. Always-on VPN can also be enabled manually from the settings menu.

7. Work Profile Separation

Work profile mode is initiated when the DPC initiates a managed provisioning flow. The work profile is based on the Android multi-user concept, where the work profile functions as a separate Android user segregated from the primary profile. The work profile shares common UI real estate with the primary profile. Apps, notifications, and widgets from the work profile show up next to their counterparts from the primary profile and are always badged so users have an indication as to what type of app it is.

With the work profile, enterprise data does not intermix with personal application data. The work profile has its own apps, its own downloads folder, its own settings, and its own KeyChain. It is encrypted using its own encryption key, and it can have its own passcode to gate access.

The work profile is provisioned upon installation, and the user can only remove it by removing the entire work profile. Administrators can also remotely instruct the device policy client to remove the work profile, for instance, when a user leaves the organization or a device is lost. Whether the user or an IT administrator removes the work profile, user data in the primary profile remains on the device.

A DPC running in profile owner mode can require users to specify a security challenge for apps running in the work profile. The system shows the security challenge when the user attempts to open any work apps. If the user successfully completes the security challenge, the system unlocks the work profile and decrypts it, if necessary.

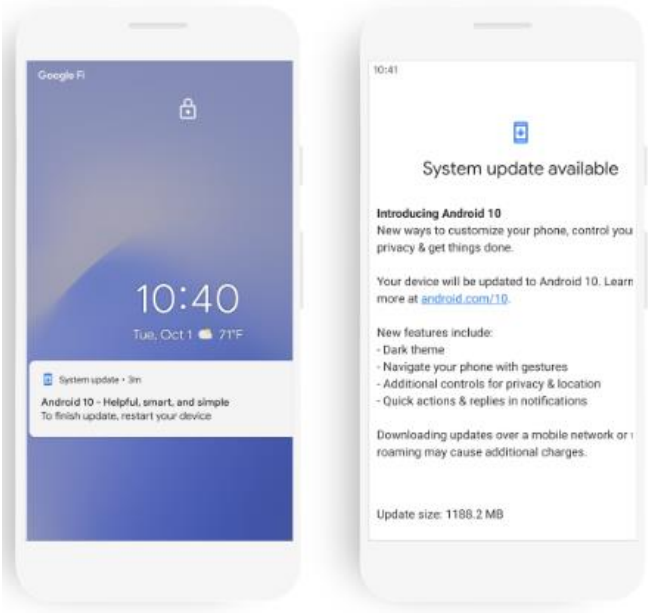
Android also provides support for a separate work challenge to enhance security and control. The work challenge is a separate passcode that protects work apps and data. Admins managing the work profile can choose to set the password policies for the work challenge differently from the policies for other device passwords. Admins managing the work profile set the challenge policies using the usual DevicePolicyManager methods, such as setPasswordQuality() and setPasswordMinimumLength(). These admins can also configure the primary device lock, by using the DevicePolicyManager instance returned by the DevicePolicyManager.getParentProfileInstance() method.

As part of setting up a separate work challenge, users may also elect to enroll fingerprints to unlock the work profile more conveniently. Fingerprints must be enrolled separately from the primary profile as they are not shared across profiles.
As with the primary profile, the work challenge is verified within secure hardware, ensuring that it's difficult to brute-force. The passcode, mixed in with a secret from the secure hardware, is used to derive the disk encryption key for the work profile, which means that an attacker cannot derive the encryption key without either knowing the passcode or breaking the secure hardware.

9. Secure Update Process

Over the Air (OTA) updates (which includes baseband processor updates) using a public key chaining ultimately to the Root Public Key, a hardware protected key whose SHA-256 hash resides inside the application processor. Should this verification fail, the software update will fail and the update will not be installed. Additionally, the Pixel phones also provide roll-back protection for OTA updates to prevent a user from installing a prior/previous version of software by check.

The Pixel phones leverage A/B system updates, also known as seamless updates. This approach ensures that a workable booting system remains on the disk during an over-the-air (OTA) update. This approach reduces the likelihood of an inactive device after an update, which means fewer device replacements and device reflashes at repair and warranty centers. Other commercial-grade operating systems such as ChromeOS also use A/B updates successfully.



The user will get a notification when an update is made available. No special configuration will be required to ensure a secure update process.

8.1 Google Play System Updates

Google Play System Updates offer a simple and fast method to deliver updates. End-user devices receive the components from the Google Play Store or through a partner-provided over-the-air (OTA) mechanism.

The components are delivered as either APK or APEX files — APEX is a new file format which loads earlier in the booting process. Important security and performance improvements that previously needed to be part of full OS updates can be downloaded and installed similarly to an app update. Updates delivered in this way are secured by being cryptographically signed.

Google Play System Updates can also deliver faster security fixes for critical security bugs by modularizing media components, which accounted for nearly 40% of recently patched vulnerabilities, and allowing updates to Conscrypt, the Java Security Provider.

10. Audit Logging

Security Logs:

A MDM agent acting as Device Owner can control the logging with DevicePolicyManager#setSecurityLoggingEnabled. When security logs are enabled, device owner apps receive periodic callbacks from DeviceAdminReceiver#onSecurityLogsAvailable, at which time new batch of logs can be collected viaDevicePolicyManager#retrieveSecurityLogs. SecurityEvent describes the type and format of security logs being collected.

Audit events from the Security Log are those where the "Keyword" field appears first in the format. For example: <Keyword> (<Date><Timestamp>): <message>

Logcat Logs:

Logcat logs can be read by a command issued via an ADB shell running on the phone. Information about reading Logcat logs can be found here. The command to issue a dump of the logcat logs is:

> adb logcat

Logcat logs cannot be exported from the device outside of using the above ADB command to dump to a file, then retrieving the file from the device (which requires developer settings enabled and administrative permissions).

Logcat logs can also be read by an application (for example an MDM agent) granted permission from an ADB shell:

> adb shell pm grant <application_package_name> android.permission.READ_LOGS

Audit events from the Logcat log are those where the "Keyword" field appears after the timestamp field in the format. For example: Date> <Time> <ID> | <Keyword> <Message>

The table below provides audit events:

Requirement	Auditable Events	Additional Audit Record Contents	Log Events & Examples
FAU_GEN.1	Start-up and shutdown of the audit functions		<Keyword> (<Date><Timestamp>): <message> Start-up: LOGGING_STARTED (Thu Sep 24 10:53:19 EDT 2020): Shutdown: All logs are stored in memory. When audit functions are disabled, all memory being used by the audit functions is released by the OS, and so this log cannot be seen.
	All administrative actions	**See Management Function Table**	

	Start-up and shutdown of the Rich OS		<Keyword> (<Date><Timestamp>): <message> Start-up: OS_STARTUP (Thu Sep 24 10:53:18 EDT 2020): orange enforcing Shutdown: All logs are stored in memory. This log is not capturable or persistent through boot, and thus isn't available to an MDM Administrator
FCS_STG_EXT.1	Import or destruction of key.	Identity of key. Role and identity of requestor.	<Keyword> (<Date><Timestamp>): <message> KEY_IMPORTED (Thu Sep 24 12:21:47 EDT 2020): 1 USRPKEY_852acf518726278597463f75999f3e28110a61a9 1000 <Keyword> (<Date><Timestamp>): <message> KEY_DESTROYED (Thu Sep 24 12:22:38 EDT 2020): 1 USRPKEY_852acf518726278597463f75999f3e28110a61a9 1000
FCS_STG_EXT.3	Failure to verify integrity of stored key.	Identity of key being verified.	KEY_INTEGRITY_VIOLATION (Thu Oct 29 16:20:44 EDT 2020): USRPKEY_"corrupt" 1010
FDP_DAR_EXT.2	Failure to encrypt/decrypt data.	No additional information.	<Date> <Time> <ID> | <Keyword> <Message> 01-17 14:16:31.069 9533 9605 E SecureCipher: Failure to decrypt data: Keystore operation failed 01-17 14:15:47.212 12181 12181 E SDPCryptoUtils-Inject: encryptAES256key failed - User not authenticated :android.security.keystore.UserNotAuthenticatedException: User not authenticated
FDP_STG_EXT.1	Addition or removal of certificate from Trust Anchor Database.	Subject name of certificate.	<Keyword> (<Date><Timestamp>): <message> CERT_AUTHORITY_INSTALLED (Thu Sep 24 12:22:17 EDT 2020): 1 cn=rootca-rsa,1.2.840.113549.1.9.1=#161a726f6f7463612d72736140676f7373616d65727365632e636f6d,o=gss,l=catonsville,st=md,c=us 0 CERT_AUTHORITY_REMOVED (Thu Sep 24 12:22:30 EDT 2020): 1 cn=rootca-rsa,1.2.840.113549.1.9.1=#161a726f6f7463612d72736140676f7373616d65727365632e636f6d,o=gss,l=catonsville,st=md,c=us 0

FIA_X509_EXT.1	Failure to validate X.509v3 certificate.	Reason for failure of validation.	<Date> <Time> <ID> | <Keyword> <Message> 01-17 15:15:16.341 2879 2879 I wpa_supplicant: wlan0: CTRL-EVENT-DISCONNECTED bssid=9c:4e:36:87:88:2c reason=23 01-17 15:15:16.341 2879 2879 I wpa_supplicant: wlan0: CTRL-EVENT-SSID-TEMP-DISABLED id=0 ssid="nanoPC-EAP" auth_failures=1 duration=10 reason=AUTH_FAILED 01-17 15:15:20.996 2879 2879 I wpa_supplicant: wlan0: CTRL-EVENT-EAP-FAILURE EAP authentication failed
FMT_SMF_EXT.2	[none].	[none].	
FPT_NOT_EXT.1	[*None*].	[*No additional information*].	
FPT_TST_EXT.1	Initiation of self-test.	[*none*]	<Keyword> (<Date><Timestamp>): <message> CRYPTO_SELF_TEST_COMPLETED (Thu Sep 24 10:53:19 EDT 2020): 1
	Failure of self-test.		<Keyword> (<Date><Timestamp>): <message> CRYPTO_SELF_TEST_COMPLETED (Thu Sep 24 10:53:19 EDT 2020): 0
FPT_TST_EXT.2(1) (Selection is optional)	Start-up of TOE.	No additional information.	<Keyword> (<Date><Timestamp>): <message> OS_STARTUP (Thu Sep 24 10:53:18 EDT 2020): orange enforcing
	[*none*]	No additional information.	
WLAN EP Audit Logs:			
FCS_TLSC_EXT.1/WLAN	Failure to establish an EAP-TLS session.	Reason for failure	<Date> <Time> <ID> | <Keyword> <Message> 10-21 16:58:59.964 25222 25222 I wpa_supplicant: OpenSSL: openssl_handshake - SSL_connect error:1000007d:SSL routines:OPENSSL_internal:CERTIFICATE_VERIFY_FAILED 10-21 16:59:01.025 25222 25222 I wpa_supplicant: wlan0: CTRL-EVENT-EAP-FAILURE EAP authentication failed

			10-21 16:59:01.047 25222 25222 I wpa_supplicant: wlan0: CTRL-EVENT-DISCONNECTED bssid=9c:4e:36:87:88:2c reason=23 10-21 16:59:01.047 25222 25222 I wpa_supplicant: wlan0: CTRL-EVENT-SSID-TEMP-DISABLED id=0 ssid="nanoPC-EAP" auth_failures=1 duration=10 reason=AUTH_FAILED
	Establishment/ termination of an EAP-TLS session.	Non-TOE endpoint of connection	<Date> <Time> <ID> | <Keyword> <Message> Establishment: 10-21 16:54:44.527 24829 24829 I wpa_supplicant: wlan0: CTRL-EVENT-EAP-METHOD EAP vendor 0 method 13 (TLS) selected 10-21 16:54:45.519 24829 24829 I wpa_supplicant: wlan0: CTRL-EVENT-CONNECTED - Connection to 9c:4e:36:87:88:2c completed [id=0 id_str=%7B%22configKey%22%3A%22%5C%22nanoPC-EAP%5C%22WPA_EAP%22%2C%22creatorUid%22%3A%221000%22%7D] Termination: 10-21 16:56:45.396 24829 24829 I wpa_supplicant: wlan0: CTRL-EVENT-DISCONNECTED bssid=9c:4e:36:87:88:2c reason=3 locally_generated=
FPT_TST_EXT.1/ WLAN (note: can be performed by TOE or TOE platform)	Execution of this set of TSF self-tests. [none].	[no additional information].	<Date> <Time> <ID> | <Keyword> <Message> These TSF Self-tests are included in the self-tests.
FTA_WSE_EXT.1	All attempts to connect to access points.		<Date> <Time> <ID> | <Keyword> <Message> 10-21 17:20:45.753 25222 25222 I wpa_supplicant: wlan0: Trying to associate with SSID 'AP144' 10-21 17:20:45.896 25222 25222 I wpa_supplicant: wlan0: Associated with 00:22:75:9f:ea:80
FTP_ITC_EXT.1/ WLAN	All attempts to establish a trusted channel.	Identification of the non-TOE endpoint of the channel.	<Date> <Time> <ID> | <Keyword> <Message> 10-21 17:20:45.753 25222 25222 I wpa_supplicant: wlan0: Trying to associate with SSID 'AP144' 10-21 17:20:45.896 25222 25222 I wpa_supplicant: wlan0: Associated with 00:22:75:9f:ea:80

The below table provides samples management function audits:

REQUIREMENT	FUNCTION	Required Value	AUDIT LOG
FMT_SMF_EXT.1.1 Function 1	Configure password policy		
FMT_SMF_EXT.1.1 Function 1a	a. minimum password length	Greater than or equal to 8	<Keyword> (<Date><Timestamp>): <message> PASSWORD_COMPLEXITY_SET (Thu Jun 18 19:50:21 EDT 2020): com.afwsamples.testdpc 0 0 16 393216 0 0 0 0 0 0
FMT_SMF_EXT.1.1 Function 1b	b. minimum password complexity	No required value	<Keyword> (<Date><Timestamp>): <message> PASSWORD_COMPLEXITY_SET (Sun Jul 05 19:01:57 EDT 2020): com.afwsamples.testdpc 0 0 0 393216 1 0 1 0 0 1
FMT_SMF_EXT.1.1 Function 1c	c. maximum password lifetime		<Keyword> (<Date><Timestamp>): <message> PASSWORD_EXPIRATION_SET (Sun Jul 05 19:03:55 EDT 2020): com.afwsamples.testdpc 0 0 600000
FMT_SMF_EXT.1.1 Function 2	Configure session locking policy		
FMT_SMF_EXT.1.1 Function 2a	a. screen-lock enabled/disabled	Enabled	<Keyword> (<Date><Timestamp>): <message> PASSWORD_COMPLEXITY_SET (Sun Jul 05 19:01:57 EDT 2020): com.afwsamples.testdpc 0 0 0 393216 1 0 1 0 0 1
FMT_SMF_EXT.1.1 Function 2a	a. screen-lock enabled/disabled (after requiring a password above, admin can request the user set a password)	No required value	<Date> <Time> <ID> | <Keyword> <Message> 09-23 13:17:18.528 1499 6482 I ActivityTaskManager: START u0 {act=android.app.action.SET_NEW_PASSWORD cmp=com.android.settings/.password.SetNewPasswordActivity} from uid 10245
FMT_SMF_EXT.1.1 Function 2b	b. screen lock timeout	10 minutes or less	<Keyword> (<Date><Timestamp>): <message> MAX_SCREEN_LOCK_TIMEOUT_SET (Mon Jul 13 21:39:23 EDT 2020): com.afwsamples.testdpc 0 0 120000

FMT_SMF_EXT.1.1 Function 2b	b. screen lock timeout (after setting a max time, the admin can prevent any user changes with this)		<Keyword> (<Date><Timestamp>): <message> USER_RESTRICTION_ADDED (Mon Jul 13 21:42:18 EDT 2020): com.afwsamples.testdpc 0 no_config_screen_timeout
FMT_SMF_EXT.1.1 Function 2c	c. number of authenticati on failures	10 or less	<Keyword> (<Date><Timestamp>): <message> MAX_PASSWORD_ATTEMPTS_SET (Wed Sep 23 13:22:53 EDT 2020): com.afwsamples.testdpc 0 0 10
FMT_SMF_EXT.1.1 Function 8a	Configure application installation policy a. restricting the sources of applications	Enable	<Keyword> (<Date><Timestamp>): <message> USER_RESTRICTION_ADDED (Thu Aug 27 13:34:17 EDT 2020): com.afwsamples.testdpc 0 no_install_unknown_sources
FMT_SMF_EXT.1.1 Function 8c	Configure application installation policy c. denying installation of applications	Enable	<Keyword> (<Date><Timestamp>): <message> USER_RESTRICTION_ADDED (Thu Aug 27 13:34:17 EDT 2020): com.afwsamples.testdpc 0 no_install_unknown_sourcesUSER_RESTRICTION_ ADDED (Wed Jan 15 14:33:38 EST 2020): com.afwsamples.testdpc 0 no_install_apps

11.FDP_DAR_EXT.2 & FCS_CKM.2(2) – Sensitive Data Protection Overview

Using the NIAPSEC library, sensitive data protection including Biometric protections are enabled by default by using the Strong configuration.

To request access to the NIAPSEC library, please reach out to: niapsec@google.com.

The library provides APIs via SecureContextCompat to write files when the device is either locked or unlocked. Reading an encrypted file is only possible when the device is unlocked and authenticated biometrically.

Saving sensitive data files requires a key to be generated in advance. Please see the Key generation section for more information.

Supported Algorithms via SecureConfig.getStrongConfig()
File Encryption Key: AES256 - AES/GCM/NoPadding
Key Encryption Key: RSA4096 - RSA/ECB/OAEPWithSHA-256AndMGF1Padding

Writing Encrypted (Sensitive) Files:
SecureContextCompat opens a FileOutputStream for writing and uses SecureCipher (below) to encrypt the data.
The Key Encryption Key, which is stored in the AndroidKeystore encrypts the File Encryption Key which is encoded with the file data.

Reading Encrypted (Sensitive) Files:
SecureContextCompat opens a FileInputStream for reading and uses SecureCipher (below) to decrypt the data.
The Key Encryption Key, which is stored in the AndroidKeystore decrypts the File Encryption Key which is encoded with the file data.

The File encryption key material is automatically destroyed and removed from memory after each operation. Please see EphemeralSecretKey for more information.

▪ SecureContextCompat

Included in the NIAPSEC library.
Encrypt and decrypt files that require sensitive data protection.

Supported Algorithms:
AES256 - AES/GCM/NoPadding
RSA4096 - RSA/ECB/OAEPWithSHA-256AndMGF1Padding

Public Constructor	
SecureContextCompat	**new SecureContextCompat**(Context, BiometricSupport)

	See BiometricSupport Constructor to create an instance of the SecureContextCompat with Biometric support.
Public Methods	
FileOutputStream	**openEncryptedFileOutput** (String name, **int** mode, String keyPairAlias) Gets an encrypted file output stream using the a*symmetric/ephemeral* algorithms specified by the default configuration, using NIAP standards. -name - The file name -mode - The file mode, usually Context.MODE_PRIVATE -keyPairAlias - Encrypt data with the AndroidKeyStore key referenced - Key Encryption Key
void	**openEncryptedFileInput** (String name, Executor executor, EncryptedFileInputStreamListener listener) Gets an encrypted file input stream using the a*symmetric/ephemeral* algorithms specified by the default configuration, using NIAP standards. -name - The file name -Executor - to handle the threading for BiometricPrompt. Usually Executors.newSingleThreadExecutor() -Listener for the resulting FileInputStream.

Code Examples:

```
SecureContextCompat secureContext = new SecureContextCompat(getApplicationContext(),
SecureConfig.getStrongConfig(biometricSupport));

// Open a sensitive file for writing
FileOutputStream outputStream = secureContext.openEncryptedFileOutput(FILE_NAME,
Context.MODE_PRIVATE, KEY_PAIR_ALIAS);
// Write data to the file, where DATA is a String of sensitive information.
outputStream.write(DATA.getBytes(StandardCharsets.UTF_8));
outputStream.flush();
outputStream.close();

// Read a sensitive data file
 secureContext.openEncryptedFileInput(FILE_NAME, Executors.newSingleThreadExecutor(),
inputStream -> {
   byte[] clearText = new byte[inputStream.available()];
   inputStream.read(encodedData);
   inputStream.close();
  // do something with the decrypted data
});
```

Built using the JCE libraries for more information please see the following resources:
AndroidKeyStore - https://developer.android.com/training/articles/keystore
BiometricPrompt - https://developer.android.com/reference/android/hardware/biometrics/BiometricPrompt

12. API Specification

This section provides a list of the evaluated cryptographic APIs that developers can use when writing their mobile applications.

1. Cryptographic APIs
    - This section lists all the APIs for the algorithms and random number generation
2. Key Management
    - APIs for importing, using, and destroying keys
3. Certificate Validation, TLS, HTTPS
    - API used by applications for configuring the reference identifier
    - APIs for validation checks (should match the test program provided)
    - TLS, HTTPS, Bluetooth BR/EDR (any other protocol available to applications)

▪ Cryptographic APIs

Code samples to do encryption and decryption, including random number generation.

Code examples:

```
// Data to encrypt
byte[] clearText = "Secret Data".getBytes(StandardCharsets.UTF_8);

// Create a Biometric Support object to handle key authentication
BiometricSupport biometricSupport = new BiometricSupportImpl(activity,
getApplicationContext()) {
        …
};

SecureCipher secureCipher = SecureCipher.getDefault(biometricSupport);
secureCipher.encryptSensitiveData("niapKey", clearText, new
SecureCipher.SecureSymmetricEncryptionCallback() {
  @Override
  public void encryptionComplete(byte[] cipherText, byte[] iv) {
    // Do something with the encrypted data
  }
});

// to decrypt
secureCipher.decryptSensitiveData("niapKey", cipherText, iv, new
SecureCipher.SecureDecryptionCallback() {
  @Override
  public void decryptionComplete(byte[] clearText) {
    // do something with the encrypted data
  }
});
```

// Generate ephemeral key (random number generation)

```
int keySize = 256;
SecureRandom secureRandom = SecureRandom.getInstanceStrong();
byte[] key = new byte[keySize / 8];
secureRandom.nextBytes(key);

// Encrypt / decrypt data with the ephemeral key
EphemeralSecretKey ephemeralSecretKey = new EphemeralSecretKey(key,
SecureConfig.getStrongConfig());
Pair<byte[], byte[]> ephemeralCipherText =
secureCipher.encryptEphemeralData(ephemeralSecretKey, clearText);
byte[] ephemeralClearText = secureCipher.decryptEphemeralData(ephemeralSecretKey,
ephemeralCipherText.first, ephemeralCipherText.second);
```

i. SecureCipher

Included in the NIAPSEC library.
Handles low-level cryptographic operations including encryption and decryption. For sensitive data protection this library is not used directly by developers.

Supported Algorithms:
AES256 - AES/GCM/NoPadding
RSA4096 - RSA/ECB/OAEPWithSHA-256AndMGF1Padding

Public Static Accessors	
SecureCipher	**SecureCipher.getDefault**(BiometricSupport) *See BiometricSupport* API to get an instance of the SecureCipher with Biometric support.
Public Methods	
void	**encryptSensitiveData** (String keyAlias, **byte**[] clearData, SecureSymmetricEncryptionCallback callback) Encrypt sensitive data using the *symmetric* algorithm specified by the default configuration, using NIAP standards. *See SecureConfig.getStrongConfig() - Default is AES256 GCM.* -keyAlias - Encrypt data with the AndroidKeyStore key referenced -clearData - the data to be encrypted -callback, the callback to return the cipherText after encryption is complete.
void	**encryptSensitiveDataAsymmetric** (String keyAlias, **byte**[] clearData, SecureAsymmetricEncryptionCallback callback) Encrypt sensitive data using the *asymmetric* algorithm specified by the default configuration, using NIAP standards. *See SecureConfig.getStrongConfig() - Default is RSA4096 with OAEP.*

	-keyAlias - Encrypt data with the AndroidKeyStore key referenced -clearData - the data to be encrypted -callback, the callback to return the cipherText after encryption is complete.
Pair<**byte**[], **byte**[]>	**encryptEphemeralData** (EphemeralSecretKey ephemeralSecretKey, byte[] clearData) Encrypt data with an Ephemeral AES 256 GCM key, used for encrypting file data for SDP. -The Ephemeral key to use -clearData, the data to be encrypted Returns a Pair of the cipherText, and IV byte arrays respectively.
void	**decryptSensitiveData** (String keyAlias, **byte**[] encryptedData, **byte**[] initializationVector, SecureDecryptionCallback callback) Decrypt sensitive data using the *symmetric* algorithm specified by the default configuration, using NIAP standards. *See SecureConfig.getStrongConfig() - Default is AES256 GCM.* -keyAlias - Encrypt data with the AndroidKeyStore key referenced -encryptedData - the data to be decrypted -initializationVector - the IV used for encryption -callback, the callback to return the clearText after decryption is complete.
void	**decryptSensitiveData** (String keyAlias, **byte**[] encryptedData, SecureDecryptionCallback callback) Decrypt sensitive data using the a*symmetric* algorithm specified by the default configuration, using NIAP standards. *See SecureConfig.getStrongConfig() - Default is RSA4096 with OAEP.* -keyAlias - Encrypt data with the AndroidKeyStore key referenced -encryptedData - the data to be decrypted -callback, the callback to return the clearText after decryption is complete.
byte[]	**decryptEphemeralData** (EphemeralSecretKey ephemeralSecretKey, **byte**[] encryptedData, **byte**[] initializationVector) Decrypt data with an Ephemeral AES 256 GCM key, used for encrypting file data for SDP. -The Ephemeral key to use -encryptedData - the data to be decrypted -initializationVector - the IV used for encryption Returns a byte array of the clear text.

Built using the JCE libraries for more information please see the following resources:

AndroidKeyStore - https://developer.android.com/training/articles/keystore
Cipher - https://developer.android.com/reference/javax/crypto/Cipher
SecretKey - https://developer.android.com/reference/javax/crypto/SecretKey
SecureRandom - https://developer.android.com/reference/java/security/SecureRandom
BiometricPrompt - https://developer.android.com/reference/android/hardware/biometrics/BiometricPrompt

ii. FCS_CKM.2(1) – Key Establishment (RSA)

Assume that Alice knows a private key and Bob knows Alice's public key. Bob sent a key encrypted by the public key. This example shows how Alice gets a plain key sent by Bob. Alice needs her own private key to decrypt an encrypted key.

```
KeyPairGenerator keyGen = KeyPairGenerator.getInstance("RSA", "AndroidOpenSSL");
keyGen.initialize(keySize);
KeyPair keyPair = keyGen.generateKeyPair();
RSAPublicKey pub = (RSAPublicKey) keyPair.getPublic();
RSAPrivateCrtKey priv = (RSAPrivateCrtKey) keyPair.getPrivate();

// Encrypt
Cipher cipher = Cipher.getInstance("RSA/ECB/OAEPWithSHA-256AndMGF1Padding");
cipher.init(Cipher.ENCRYPT_MODE, publicKey, new OAEPParameterSpec("SHA-256",
    "MGF1", new MGF1ParameterSpec("SHA-1"), PSource.PSpecified.DEFAULT));
byte[] cipherText = cipher.doFinal(data.getBytes(StandardCharsets.UTF_8));

// Decrypt
Cipher cipher = Cipher.getInstance("RSA/ECB/OAEPWithSHA-256AndMGF1Padding");
cipher.init(Cipher.DECRYPT_MODE, privateKey, new OAEPParameterSpec("SHA-256",
    "MGF1", new MGF1ParameterSpec("SHA-1"), PSource.PSpecified.DEFAULT));
Byte[] plainText = cipher.doFinal(cipherText);
```

Algorithms::
RSA/ECB/OAEPWithSHA-256AndMGF1Padding

Reference:
Cipher - https://developer.android.com/reference/javax/crypto/Cipher

iii. FCS_CKM.2(1) – Key Establishment (ECDSA) & FCS_COP.1(3) – Signature Algorithms (ECDSA)

Assume that Alice knows a private key and Bob's public key. Bob knows his private key and Alice's public key. Then Alice and Bob can sign/verify the contents of a message.

```
KeyPairGenerator keyGen = KeyPairGenerator.getInstance("EC", "AndroidOpenSSL");
ECGenParameterSpec ecParams = new ECGenParameterSpec(spec);
```

```
keyGen.initialize(ecParams);
KeyPair keyPair = keyGen.generateKeyPair();
ECPublicKey pubKey = (ECPublicKey) keyPair.getPublic();
ECPrivateKey privKey = (ECPrivateKey) keyPair.getPrivate();

// Sign
Signature signature = Signature.getInstance(algorithm);
signature.initSign(privateKey);
signature.update(data.getBytes(StandardCharsets.UTF_8));
byte[] signature =  signature.sign();

// Verify
Signature signature = Signature.getInstance(algorithm);
signature.initVerify(publicKey);
signature.update(data.getBytes(StandardCharsets.UTF_8));
boolean verified =  signature.verify(sig);
```

Algorithms:
"SHA256withECDSA", "secp256r1"
"SHA384withECDSA", "secp384r1"
"SHA512withECDSA", "secp521r1"

Reference:
Signature - https://developer.android.com/reference/java/security/Signature

iv. FCS_CKM.1 – Key Generation (ECDSA)

Assume that Alice knows a private key and Bob's public key. Bob knows his private key and Alice's public key.

```
KeyPairGenerator keyGen = KeyPairGenerator.getInstance("EC", "AndroidOpenSSL");
ECGenParameterSpec ecParams = new ECGenParameterSpec(spec);
keyGen.initialize(ecParams);
KeyPair keyPair = keyGen.generateKeyPair();
ECPublicKey pubKey = (ECPublicKey) keyPair.getPublic();
ECPrivateKey privKey = (ECPrivateKey) keyPair.getPrivate();
```

Algorithms:
"SHA256withECDSA", "secp256r1"
"SHA384withECDSA", "secp384r1"
"SHA512withECDSA", "secp521r1"

Reference:
Signature - https://developer.android.com/reference/java/security/Signature

v. FCS_COP.1(1) – Encryption/Decryption (AES)

Cipher class encrypts or decrypts a plain text.

```
KeyGenerator keyGenerator = KeyGenerator.getInstance("AES", "AndroidOpenSSL");
keyGenerator.init(keySize);
SecretKey key = keyGenerator.generateKey();

// Encrypt
Cipher cipher = Cipher.getInstance(transformation);
cipher.init(Cipher.ENCRYPT_MODE, secretKey);
byte[] iv = cipher.getIV();
byte[] clearData = data.getBytes(UTF_8);
byte[] cipherText = cipher.doFinal(clearData);
Pair<byte[], byte[]> result =  Pair<>(cipherText, iv);

// Decrypt
Cipher cipher = Cipher.getInstance(transformation);
cipher.init(Cipher.DECRYPT_MODE, secretKey, spec);
String plainText =  new String(cipher.doFinal(cipherText), UTF_8);
```

Algorithms:
AES/CBC/NoPadding
AES/GCM/NoPadding

Reference:
Cipher - https://developer.android.com/reference/javax/crypto/Cipher

vi. FCS_COP.1(2) – Hashing (SHA)

You can use MessageDigest class to calculate the hash of plaintext.

```
MessageDigest messageDigest = MessageDigest.getInstance(algorithm);
messageDigest.update(data.getBytes(StandardCharsets.UTF_8));
byte[] digest = messageDigest.digest();
```

Algorithms:
SHA-1
SHA-256
SHA-384
SHA-512

Reference:
MessageDigest - https://developer.android.com/reference/java/security/MessageDigest

vii. FCS_COP.1(3) – RSA (Signature Algorithms)

KeyFactory class generates RSA private key and public key. Signature class signs a plaintext with private key generated above and verifies it with public key

```
KeyPairGenerator keyGen = KeyPairGenerator.getInstance("RSA", "AndroidOpenSSL");
keyGen.initialize(keySize);
KeyPair keyPair = keyGen.generateKeyPair();
RSAPublicKey pub = (RSAPublicKey) keyPair.getPublic();
RSAPrivateCrtKey priv = (RSAPrivateCrtKey) keyPair.getPrivate();

// Sign
Signature signature = Signature.getInstance(algorithm);
signature.initSign(privateKey);
signature.update(data.getBytes(StandardCharsets.UTF_8));
byte[] sig =  signature.sign();

// Verify
Signature signature = Signature.getInstance(algorithm);
signature.initVerify(publicKey);
signature.update(data.getBytes(StandardCharsets.UTF_8));
boolean verified =  signature.verify(sig);
```

Algorithms:
SHA256withRSA
SHA384withRSA

Reference:
Signature - https://developer.android.com/reference/java/security/Signature

viii. FCS_CKM.1 –Key Generation (RSA)

KeyFactory class generates RSA private key and public key.

```
KeyPairGenerator keyGen = KeyPairGenerator.getInstance("RSA", "AndroidOpenSSL");
keyGen.initialize(keySize);
KeyPair keyPair = keyGen.generateKeyPair();
RSAPublicKey pub = (RSAPublicKey) keyPair.getPublic();
RSAPrivateCrtKey priv = (RSAPrivateCrtKey) keyPair.getPrivate();
```

Algorithms:
SHA256withRSA
SHA384withRSA

Reference:
Signature - https://developer.android.com/reference/java/security/Signature

ix. FCS_COP.1(4) - HMAC

Mac class calculates the hash of plaintext with key.

```
KeyGenerator keyGenerator = KeyGenerator.getInstance(
      algorithm, "AndroidOpenSSL");
keyGenerator.init(keySize);
SecretKey key = keyGenerator.generateKey();

// Mac
Mac mac = Mac.getInstance(algorithm);
mac.init(secretKey);
byte[] mac =  mac.doFinal(data.getBytes(StandardCharsets.UTF_8));
```

Algorithms:
HmacSHA1
HmacSHA256
HmacSHA384
HmacSHA512

Reference:
Mac - https://developer.android.com/reference/javax/crypto/Mac

▪ Key Management

Code samples to do key management.

Code examples:

```
SecureKeyGenerator keyGenerator = SecureKeyGenerator.getInstance();
// Generate Keypair
keyGenerator.generateAsymmetricKeyPair(KEY_PAIR_ALIAS);
// Generate Symmetric Key
keyGenerator.generateKey(KEY_ALIAS);

// Generate ephemeral key (random number generation)
keyGenerator.generateEphemeralDataKey();

// To delete a key stored in the Android Keystore
KeyStore keyStore = KeyStore.getInstance("AndroidKeyStore");
keyStore.load(null);
keyStore.deleteEntry("KEY_TO_REMOVE");
```

i. SecureKeyGenerator

Included in the NIAPSEC library.
Handles low-level key generation operations using the AndroidKeyStore. For sensitive data protection this library is not used directly by developers.

Supported Algorithms:
AES256 - AES/GCM/NoPadding
RSA4096 - RSA/ECB/OAEPWithSHA-256AndMGF1Padding

Public Static Accessors	
SecureKeyGenerator	**SecureCipher.getDefault**() API to get an instance of the SecureCipher with NIAP settings.
Public Methods	
boolean	generateKey(String keyAlias) Generate an AES key with NIAP settings that is stored and protected in the AndroidKeyStore. *See SecureConfig.getStrongConfig() - Default is AES256 GCM.* -keyAlias - name for the key
boolean	generateKeyAsymmetricKeyPair(String keyAlias) Generate an RSA key pair with NIAP settings that is stored and protected in the AndroidKeyStore. *See SecureConfig.getStrongConfig() - Default is RSA4096 OAEP.* -keyAlias - name for the key pair
EphemeralSecretKey	**generateEphemeralDataKey()** Generate an AES key with NIAP settings. This key is not stored in the AndroidKeyStore Uses SecureRandom.getInstanceStrong() to generate a random key. *See SecureConfig.getStrongConfig() - Default is AES256 GCM.*

Built using the JCE libraries for more information please see the following resources:
AndroidKeyStore - https://developer.android.com/training/articles/keystore
KeyPairGenerator- https://developer.android.com/reference/java/security/KeyPairGenerator
SecretKey - https://developer.android.com/reference/javax/crypto/SecretKey
SecureRandom - https://developer.android.com/reference/java/security/SecureRandom
KeyGenParameterSpec - https://developer.android.com/reference/android/security/keystore/KeyGenParameterSpec

▪ FCS_TLSC_EXT.1 - Certificate Validation, TLS, HTTPS

Included in the NIAPSEC library.
SecureURL automatically configures TLS and can perform certificate and host validation checking. At construction, SecureURL requires a reference identifier.

Code examples:

```
SecureURL url = new SecureURL(referenceIdentifier, "google_cert");
HttpsURLConnection conn = (HttpsURLConnection) url.openConnection();
conn.setRequestMethod("GET");
conn.setDoInput(true);
conn.connect();

// Manual check
SecureURL url = new SecureURL(referenceIdentifier, "google_cert");
boolean valid = url.isValid(urlConnection);
```

Public Constructors	
SecureURL	**new SecureURL(String referenceIdentifier, String clientCert)** API to create an instance of the SecureURL with NIAP settings. clientCert is optional.
Public Methods	
HttpsURLConnection	openConnection Opens an HttpsUrlConnection using TLS by default and handles OCSP validation checks and does a hostname verification check on initiation of the connection.
boolean	isValid(String hostname, SSLSocket socket) A manual OCSP certificate and hostname check. Based on a hostname and underlying SSLSocket.
boolean	isValid(HttpsURLConnection conn) A manual OCSP certificate and hostname check. Based on an existing HttpsUrlConnection.
boolean	isValid(Certificate cert) A manual OCSP certificate check.

boolean	isValid(List<Certificate> certs) A manual OCSP certificates check.

Built using the networking libraries for more information please see the following resources:
HttpsUrlConnection - https://developer.android.com/reference/javax/net/ssl/HttpsURLConnection
PKIXRevocationChecker - https://developer.android.com/reference/java/security/cert/PKIXRevocationChecker
SSLSocket - https://developer.android.com/reference/javax/net/ssl/SSLSocket

i. Cipher Suites

When applications utilize the NIAPSEC library, no configuration is needed to restrict or allow ciphersuites to be compliant. A list of the ciphersuites supported by Android 12 NIAPSEC can be found below:

For TLS 1.2 with mutual authentication:

Approved Cipher Suites	TLS Version
TLS_RSA_WITH_AES_256_GCM_SHA384 as defined in RFC 5288, TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256 as defined in RFC 5289, TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384 as defined in RFC 5289, TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256 as defined in RFC 5289, TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384 as defined in RFC 5289	TLS v1.2

The device supports TLS versions 1.0, 1.1, and 1.2 for use with EAP-TLS as part of WPA2. The TOE supports the following ciphersuites for this:
TLS_RSA_WITH_AES_128_CBC_SHA as defined in RFC 5246,
TLS_RSA_WITH_AES_256_CBC_SHA as defined in RFC 5246,
TLS_RSA_WITH_AES_128_GCM_SHA256 as defined in RFC 5288,
TLS_RSA_WITH_AES_256_GCM_SHA384 as defined in RFC 5288,
TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256 as defined in RFC 5289,
TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384 as defined in RFC 5289,
TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256 as defined in RFC 5289,
TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384 as defined in RFC 5289

ii. Guidance for Bluetooth Low Energy APIs

Provides classes that manage Bluetooth functionality, such as scanning for devices, connecting with devices, and managing data transfer between devices. The Bluetooth API supports both "Classic Bluetooth" and Bluetooth Low Energy.
For more information about Classic Bluetooth, see the Bluetooth guide. For more information about Bluetooth Low Energy, see the Bluetooth Low Energy (BLE) guide.
The Bluetooth APIs let applications:

- Scan for other Bluetooth devices (including BLE devices).
- Query the local Bluetooth adapter for paired Bluetooth devices.
- Establish RFCOMM channels/sockets.
- Connect to specified sockets on other devices.
- Transfer data to and from other devices.
- Communicate with BLE devices, such as proximity sensors, heart rate monitors, fitness devices, and so on.
- Act as a GATT client or a GATT server (BLE).

To perform Bluetooth communication using these APIs, an application must declare the BLUETOOTH permission. Some additional functionality, such as requesting device discovery, also requires the BLUETOOTH_ADMIN permission.

Interfaces

BluetoothAdapter.LeScanCallback	Callback interface used to deliver LE scan results.
BluetoothProfile	Public APIs for the Bluetooth Profiles.
BluetoothProfile.ServiceListener	An interface for notifying BluetoothProfile IPC clients when they have been connected or disconnected to the service.

Classes

BluetoothA2dp	This class provides the public APIs to control the Bluetooth A2DP profile.
BluetoothAdapter	Represents the local device Bluetooth adapter.
BluetoothAssignedNumbers	Bluetooth Assigned Numbers.
BluetoothClass	Represents a Bluetooth class, which describes general characteristics and capabilities of a device.

BluetoothClass.Device	Defines all device class constants.
BluetoothClass.Device.Major	Defines all major device class constants.
BluetoothClass.Service	Defines all service class constants.
BluetoothDevice	Represents a remote Bluetooth device.
BluetoothGatt	Public API for the Bluetooth GATT Profile.
BluetoothGattCallback	This abstract class is used to implement BluetoothGatt callbacks.
BluetoothGattCharacteristic	Represents a Bluetooth GATT Characteristic A GATT characteristic is a basic data element used to construct a GATT service,BluetoothGattService.
BluetoothGattDescriptor	Represents a Bluetooth GATT Descriptor GATT Descriptors contain additional information and attributes of a GATT characteristic, BluetoothGattCharacteristic.
BluetoothGattServer	Public API for the Bluetooth GATT Profile server role.
BluetoothGattServerCallback	This abstract class is used to implement BluetoothGattServer callbacks.
BluetoothGattService	Represents a Bluetooth GATT Service Gatt Service contains a collection of BluetoothGattCharacteristic, as well as referenced services.
BluetoothHeadset	Public API for controlling the Bluetooth Headset Service.

BluetoothHealth	*This class was deprecated in API level 29. Health Device Profile (HDP) and MCAP protocol are no longer used. New apps should use Bluetooth Low Energy based solutions such as* BluetoothGatt,BluetoothAdapter#listenUsingL2capChannel(), *or*BluetoothDevice#createL2capChannel(int)
BluetoothHealthAppConfiguration	*This class was deprecated in API level 29. Health Device Profile (HDP) and MCAP protocol are no longer used. New apps should use Bluetooth Low Energy based solutions such as* BluetoothGatt,BluetoothAdapter#listenUsingL2capChannel(), *or*BluetoothDevice#createL2capChannel(int)
BluetoothHealthCallback	*This class was deprecated in API level 29. Health Device Profile (HDP) and MCAP protocol are no longer used. New apps should use Bluetooth Low Energy based solutions such as* BluetoothGatt,BluetoothAdapter#listenUsingL2capChannel(), *or*BluetoothDevice#createL2capChannel(int)
BluetoothHearingAid	This class provides the public APIs to control the Hearing Aid profile.
BluetoothHidDevice	Provides the public APIs to control the Bluetooth HID Device profile.
BluetoothHidDevice.Callback	The template class that applications use to call callback functions on events from the HID host.
BluetoothHidDeviceAppQosSettings	Represents the Quality of Service (QoS) settings for a Bluetooth HID Device application.
BluetoothHidDeviceAppSdpSettings	Represents the Service Discovery Protocol (SDP) settings for a Bluetooth HID Device application.
BluetoothManager	High level manager used to obtain an instance of an BluetoothAdapter and to conduct overall Bluetooth Management.
BluetoothServerSocket	A listening Bluetooth socket.

BluetoothSocket	A connected or connecting Bluetooth socket.

https://developer.android.com/reference/android/bluetooth/package-summary.html

How to connect and pair with a bluetooth device:

```
// get bluetooth adapter
BluetoothAdapter bluetoothAdapter = BluetoothAdapter.getDefaultAdapter();
if (bluetoothAdapter == null) {
    // Device doesn't support Bluetooth
}

// make sure bluetooth is enabled
if (!bluetoothAdapter.isEnabled()) {
    Intent enableBtIntent = new Intent(BluetoothAdapter.ACTION_REQUEST_ENABLE);
    startActivityForResult(enableBtIntent, REQUEST_ENABLE_BT);
}

// query for devices
Set<BluetoothDevice> pairedDevices = bluetoothAdapter.getBondedDevices();
if (pairedDevices.size() > 0) {
    // There are paired devices. Get the name and address of each paired device.
    for (BluetoothDevice device : pairedDevices) {
        String deviceName = device.getName();
        String deviceHardwareAddress = device.getAddress(); // MAC address
    }
}

// Connect to devices.
private class AcceptThread extends Thread {
    private final BluetoothServerSocket mmServerSocket;

    public AcceptThread() {
        // Use a temporary object that is later assigned to mmServerSocket
        // because mmServerSocket is final.
        BluetoothServerSocket tmp = null;
        try {
            // MY_UUID is the app's UUID string, also used by the client code.
            tmp = bluetoothAdapter.listenUsingRfcommWithServiceRecord(NAME, MY_UUID);
        } catch (IOException e) {
            Log.e(TAG, "Socket's listen() method failed", e);
        }
        mmServerSocket = tmp;
    }
```

```
    public void run() {
        BluetoothSocket socket = null;
        // Keep listening until exception occurs or a socket is returned.
        while (true) {
            try {
                socket = mmServerSocket.accept();
            } catch (IOException e) {
                Log.e(TAG, "Socket's accept() method failed", e);
                break;
            }

            if (socket != null) {
                // A connection was accepted. Perform work associated with
                // the connection in a separate thread.
                manageMyConnectedSocket(socket);
                mmServerSocket.close();
                break;
            }
        }
    }

    // Closes the connect socket and causes the thread to finish.
    public void cancel() {
        try {
            mmServerSocket.close();
        } catch (IOException e) {
            Log.e(TAG, "Could not close the connect socket", e);
        }
    }
}
```

More information here
https://developer.android.com/guide/topics/connectivity/bluetooth.html#SettingUp

Sample service to interact with a bluetooth APIs.

```
// A service that interacts with the BLE device via the Android BLE API.
public class BLEService extends Service {
    private final static String TAG = "BLEService";
    private BluetoothManager mBluetoothManager;
    private BluetoothAdapter mBluetoothAdapter;
    private String mBluetoothDeviceAddress;
    private BluetoothGatt mBluetoothGatt;
    private int mConnectionState = STATE_DISCONNECTED;
    private static final int STATE_DISCONNECTED = 0;
    private static final int STATE_CONNECTING = 1;
    private static final int STATE_CONNECTED = 2;
```

```
public final static String ACTION_GATT_CONNECTED =
        "com.niap.ble.ACTION_GATT_CONNECTED";
public final static String ACTION_GATT_DISCONNECTED =
        "com.niap.ble.ACTION_GATT_DISCONNECTED";
public final static String ACTION_GATT_SERVICES_DISCOVERED =
        "com.niap.ble.ACTION_GATT_SERVICES_DISCOVERED";
public final static String ACTION_DATA_AVAILABLE =
        "com.niap.ble.ACTION_DATA_AVAILABLE";
public final static String EXTRA_DATA =
        "com.niap.ble.EXTRA_DATA";

// Various callback methods defined by the BLE API.
private final BluetoothGattCallback mGattCallback =
        new BluetoothGattCallback() {
            @Override
            public void onConnectionStateChange(BluetoothGatt gatt, int status,
                                                int newState) {
                String intentAction;
                if (newState == BluetoothProfile.STATE_CONNECTED) {
                    intentAction = ACTION_GATT_CONNECTED;
                    mConnectionState = STATE_CONNECTED;
                    broadcastUpdate(intentAction);
                    Log.i(TAG, "Connected to GATT server.");
                    Log.i(TAG, "Attempting to start service discovery:" +
                            mBluetoothGatt.discoverServices());
                } else if (newState == BluetoothProfile.STATE_DISCONNECTED) {
                    intentAction = ACTION_GATT_DISCONNECTED;
                    mConnectionState = STATE_DISCONNECTED;
                    Log.i(TAG, "Disconnected from GATT server.");
                    broadcastUpdate(intentAction);
                }
            }

            @Override
            // New services discovered
            public void onServicesDiscovered(BluetoothGatt gatt, int status) {
                if (status == BluetoothGatt.GATT_SUCCESS) {
                    broadcastUpdate(ACTION_GATT_SERVICES_DISCOVERED);
                } else {
                    Log.w(TAG, "onServicesDiscovered received: " + status);
                }
            }

            @Override
            // Result of a characteristic read operation
            public void onCharacteristicRead(BluetoothGatt gatt,
```

```
                                    BluetoothGattCharacteristic characteristic,
                                    int status) {
                            if (status == BluetoothGatt.GATT_SUCCESS) {
                                broadcastUpdate(ACTION_DATA_AVAILABLE, characteristic);
                            }
                        }
                    };
}
```