WV Modular DRM Security Integration Guide for Common Encryption (CENC)

Android Supplement

Version 13

Revision History

Version	Date	Description	Author
1	3/4/2013	Initial revision	Jeff Tinker, Fred Gylys-Colwell, Edwin Wong, Rahul Frias, John Bruce
2	3/14/2013	Added RSA Certificate Provisioning	Jeff Tinker, Fred Gylys-Colwell
4	4/2/2013	Added Generic Modular DRM	Jeff Tinker, Fred Gylys-Colwell
5	4/3/2013	Updated Testing section	Edwin Wong
6	4/5/2013	Refactored common information into *Widevine Modular DRM Security Integration Guide for CENC.* This document is now the *Android Supplement*.	Jeff Tinker
7-9		skipped so version number matches main doc.	
10	4/1/2015	Update info about optional features and unit tests	Fred Gylys-Colwell
10.1	4/21/2015	Add section on keybox requests	Fred Gylys-Colwell
11	11/1/2015	Updated for OEMCrypto API v11.	Fred Gylys-Colwell
12	9/9/2016	Update for OEMCrypto API v12 -- Provisioning 3.0	Fred Gylys-Colwell
13	5/19/2017	Update path for liboemcrypto.so	Fred Gylys-Colwell

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Terms and Definitions

Device Id — A null-terminated C-string uniquely identifying the device. 32 character maximum, including NULL termination.

Device Key — 128-bit AES key assigned by Widevine and used to secure entitlements.

Keybox — Widevine structure containing keys and other information used to establish a root of trust on a device. The keybox is either installed during manufacture or in the field. Factory provisioned devices have a higher level of security and may be approved for access to higher quality content.

Provision — Install a Keybox that has been uniquely constructed for a specific device.

Trusted Execution Environment (TEE) — The portion of the device that contains security hardware and prevents access by non secure system resources.

References

Widevine Security Integration Guide for Android-based Devices

Widevine Modular DRM Security Integration Guide for Common Encryption (CENC)

WVDN Getting Started Guide

Android DRM API for DASH

DASH - 23009-1 MPD and Segment Formats

DASH - 14496-12 ISO BMFF Amendment

DASH - 23001-7 ISO BMFF Common Encryption

Audience

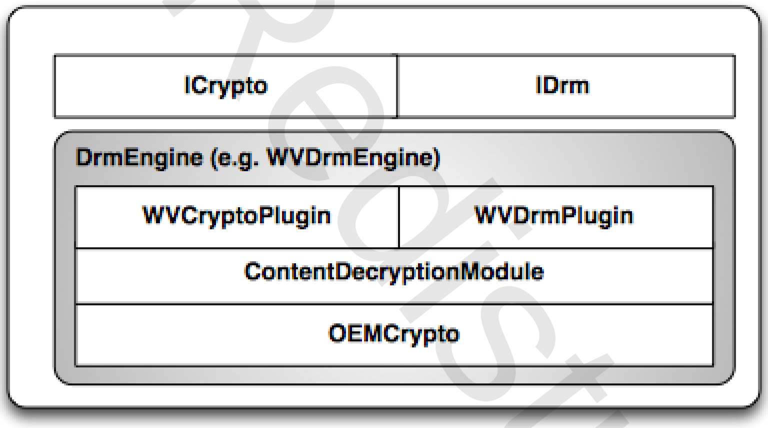
This document is intended for SOC and OEM device manufacturers to integrate with Widevine content protection on android devices.

Purpose

This document defines steps required to build a Widevine DrmEngine component for an android device, and the required functionality of the OEM-provided OEMCrypto library. It contains Android-specific supplemental information for the common document *Widevine Modular DRM Security Integration Guide for Common Encryption (CENC).*

Widevine DrmEngine

The Widevine DrmEngine implements the MediaDrm and Crypto APIs to support content decryption in support of the Android MediaCodec and MediaCrypto APIs. Refer to the “Android DRM API for DASH” document to learn more about how the DrmEngine interacts with these higher level APIs.



The OEMCrypto API defines a hardware abstraction layer to enable the Widevine DrmEngine functionality to be adapted to the underlying hardware feature set.

The remainder of this document defines the OEMCrypto APIs and steps required to build and test the vendor-supplied OEMCrypto implementation library liboemcrypto.so required by the Widevine DrmEngine component on android devices.

Deliverables

The OEMCrypto API implementation should be performed by the vendor. The API is to be implemented in the shared library liboemcrypto.so, which should be placed in /vendor/lib on the device. Alternately, the library may also be placed in one of these directories:

- /system/lib/liboemcrypto.so
- /system/lib64/liboemcrypto.so
- /vendor/lib/liboemcrypto.so
- /vendor/lib64/liboemcrypto.so
- /odm/lib/liboemcrypto.so
- /odm/lib64/liboemcrypto.so

Additional Requirements

In the document **Widevine Modular DRM Security Integration Guide for Common Encryption (CENC),** several features are listed as optional. All android devices must be provisioned with a production keybox. The Session Usage Table is not optional for Android devices. An Android device will not pass GTS testing as a Level 1 device unless it can support the Session Usage Table API. The Generic Crypto API functions are not optional. These functions must be implemented in the secure processor such that keys are not visible to the unsecure OS. Certificate functionality is not optional. Devices must be able to load a different “app specific” RSA certificate in each session.

The only functions described in **Widevine Modular DRM Security Integration Guide for CENC** that are optional are:

- **OEMCrypto_WrapKeybox** - not used by CDM code. OEMs may wish to implement this to facilitate provisioning the device.
- **OEMCrypto_InstallKeybox** - used in unit tests. OEMCrypto_LoadTestKeybox is preferred for unit tests. OEMs may wish to implement this to facilitate provisioning the device -- in particular, at initialization, if IsKeyboxValid() returns false, the widevine code will look for a file called /factory/wv.keys and call OEMCrypto_InstallKeybox with that file.
- **OEMCrypto_LoadRSATestKey** - used in unit tests. OEMCrypto_LoadTestKeybox is preferred.

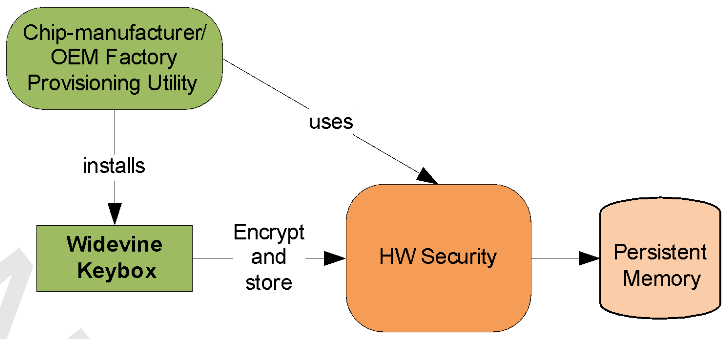
Keybox Requests and Installation Process

Factory Provisioning 3.0

Level 1 Android devices are required to be either factory provisioned with a keybox or factory provisioned with on OEM certificate. For a complete description of OEM certificates, please see the document “Widevine Provisioning 3.0 Design”.

Keybox Factory Provisioning

In Keybox Factory provisioning, the manufacturer obtains keyboxes from Widevine, which are then installed on devices during manufacturing. The keybox must be installed in a partition or region of persistent memory that cannot be erased due to a factory reset or other software operation.



Keybox Requests and Installation Process

Keybox Requests

If you currently work with the Android team directly and have an Android TAM, please use APFE through the partner.android.com portal for managing your Android devices and keyboxes.

If you are not working with and Android TAM, you may use the Widevine Developer Network to request keyboxes. See the document “WVDN Getting Started Guide” for details. You may contact Widevine support through https://support.google.com/widevine/contact/wv_oemcf.

Keybox XML File Format

An example keybox file is shown below:

```
<?xml version="1.0"?>
<Widevine>
<NumberOfKeyboxes>2</NumberOfKeyboxes>
<Keybox DeviceID="mfg_mod123_0000001"><Key>c5f5cf3c2cb2ce175f2f5337a2f8f8ab</Key>
<ID>9d56e4931762b52aa21e4e590df477b5c81c683e0579f041ffa21f875c4c5e4a1cd4c2331e27e3f4a4
9352fb432557336f63b1cb62549fddc9224b84d0c0364c827365fc217d9cb0</ID>
<Magic>6b626f78</Magic>
<CRC>0b11b841</CRC>
</Keybox>
<Keybox DeviceID="mfg_mod123_0000002"><Key>73e38eb4f313e4fce8a5ab547cc7e2c0</Key>
<ID>215a40a9d13da3a9648335081a182869cbe78f607ce3ceb7506f351a22f411ae3f324ab5f5bfb7c542
ffcd38ec09438e7f92855149b02921463153c441332d7a21f875c4c5e4a1cd</ID>
<Magic>6b626f78</Magic>
<CRC>2b4c5e9f</CRC>
</Keybox>
</Widevine>
```

Keybox Installation

The utility for installing a keybox on the device during manufacturing needs to be defined and implemented by the manufacturer. To assist with this process, Widevine provides sample source code for translating a keybox in XML file format into a byte sequence that can be installed on the device.

The keybox must be encrypted with an OEM root key, sometimes called a “key encryption key” using AES-128 or stronger encryption. Once encrypted, the keybox must be stored in a non-erasable persistent memory region or file on the device. The keybox is accessed using the OEMCrypto Keybox Access APIs.

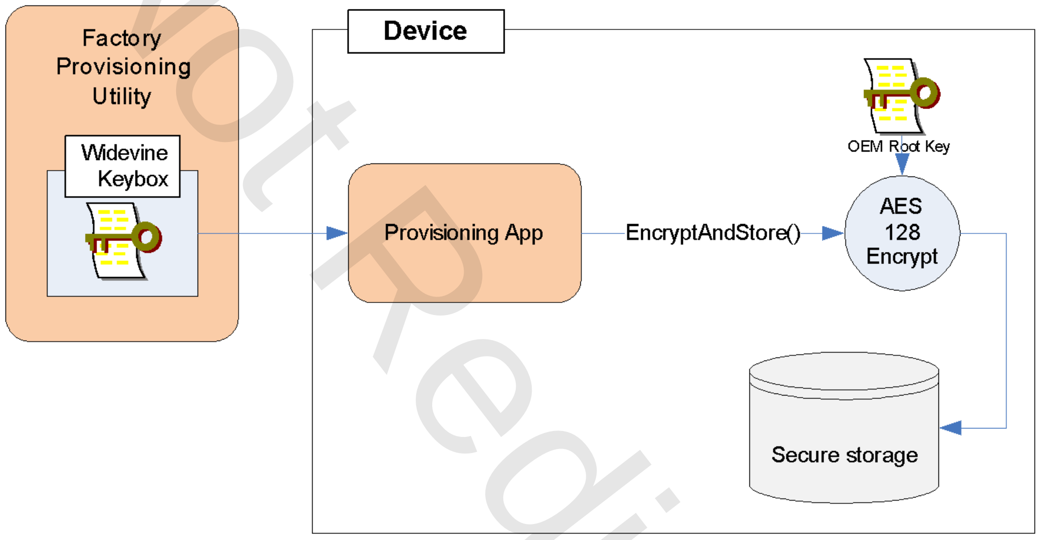


FIGURE 1. FACTORY PROVISIONING KEYBOX INSTALLATION

If the facilities of the secure environment on the device are not available at the time of factory provisioning, the manufacturer may implement the two-stage WrapKeybox and InstallKeybox method of provisioning described in more detail in the main document in the section titled “Provisioning API”.

Destroy keybox file after installation

The clear keybox file must be destroyed after installation using PGP shredder.

Unit and Integration Testing

A unit test validates a single piece of functionality, in isolation from the rest of the system. The unit test class typically contains unit tests for all of the methods of a single C++ source file. An integration test combines various components and tests the system as a whole.

A number of unit and integration tests are provided for vendors to verify the basic functions of their implementation. The tests utilize Google C++ Testing Framework, which can be found in the Android tree under external/gtest. It can also be downloaded from Google C++ Testing Framework.

Unit tests for OEMCrypto are found in the android source tree, in the directory
`$ANDROID_BUILD_TOP/vendor/widevine/libwvdrmengine/`

Setting Up the Build Environment

Before building any tests, please setup the build environment in the local branch

```
. build/envsetup.sh
lunch <Your TARGET>
```

The unit tests depend on several libraries, it is best to build the entire tree at least once:

```
make -j 12
```

Reference Implementation

The reference implementation is sample code for all the features for OEMCrypto. You can build this and install it on the device to debug or test code, but it does not have a production keybox, and does not have level 1 security. It should not be included in a production device. Build the reference implementation of oemcrypto.so:

```
cd $ANDROID_BUILD_TOP/vendor/widevine/libwvdrmengine/oemcrypto/mock
mm
adb root
adb remount
adb push $OUT/system/vendor/lib/liboemcrypto.so/system/vendor/lib
```

Make sure to remove the reference version, and clean your source tree before installing your version of liboemcrypto.so. If the unit tests say you have system ID 0x1019, then you are running with a test keybox, and might have the reference implementation still installed. If the command “mm” fails because of missing dependencies, try the command “mma”. The command “mma” takes longer, but it scans all the makefiles in the tree and attempts to make all dependencies.

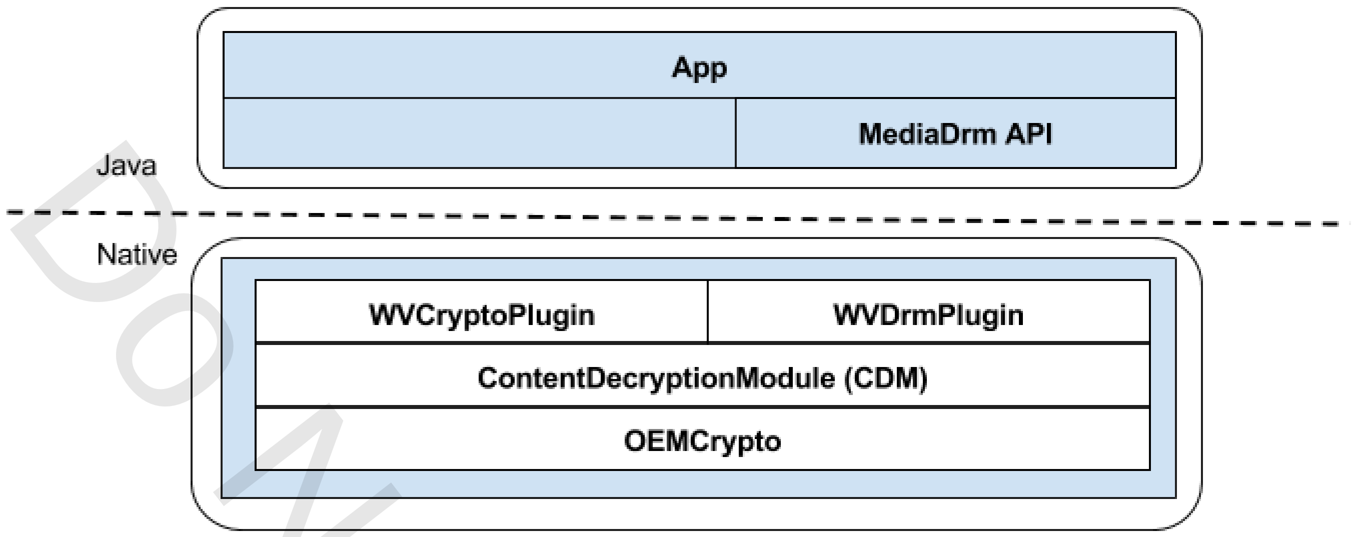
Once you are familiar with the how to run the unit tests, you should implement and build your own oemcrypto library. In your own directory, build the shared library liboemcrypto.so. It should use the include file OEMCryptoCENC.h, which is found here:

```
    LOCAL_C_INCLUDES  := \

       vendor/widevine/libwvdrmengine/oemcrypto/include
```

Targeted Components

The tests provided verify the following emboldened components:



Testing OEMCrypto Library

The reference implementation of OEMCrypto library is in the directory
$ANDROID_BUILD_TOP/vendor/widevine/libwvdrmengine/oemcrypto/mock

Out of the box, you should be able to compile existing unit tests. Build the unit tests for oemcrypto.so:

```
cd $ANDROID_BUILD_TOP/vendor/widevine/libwvdrmengine/oemcrypto/test
mm
```

If the command "mm" fails because of missing dependencies, try the command "mma". The command "mma" takes longer, but it scans all the makefiles in the tree and attempts to make all dependencies.
Run the existing unit tests:

```
cd $ANDROID_BUILD_TOP
adb root
adb remount
adb disable-verity
adb push $OUT/system/bin/oemcrypto_test /system/bin
adb shell /system/bin/oemcrypto_test
```

You should see output that starts with:

```
        uses_keybox = true.
        loads_certificate = true.
        uses_certificate = true.
        generic_crypto = true.
        api_version = 11.
        usage_table = true.
        cast_receiver = false.
        LOAD_TEST_KEYBOX: Call LoadTestKeybox before deriving keys.
        GTest Filter: *-*ForceKeybox*:*CastReceiver*
        Note: Google Test filter = *-*ForceKeybox*:*CastReceiver*
        [==========] Running 162 tests from 17 test cases.
        [----------] Global test environment set-up.
```

```
[----------] 16 tests from OEMCryptoClientTest
[ RUN      ] OEMCryptoClientTest.VersionNumber
             OEMCrypto Security Level is L1
             OEMCrypto API version is 12
             OEMCrypto supports usage tables.
[       OK ] OEMCryptoClientTest.VersionNumber
```

… and ends with:

```
[----------] Global test environment tear-down
[==========] 159 tests from 14 test cases ran. (229937 ms total)
[  PASSED  ] 159 tests.
```

Near the top you should see the test NormalGetDeviceId, which should print out your device's device ID. Make sure your security level is correct. There is also a test that prints out the system ID:

```
[----------] 3 tests from OEMCryptoKeyboxTest
[ RUN      ] OEMCryptoKeyboxTest.NormalGetKeyData
             NormalGetKeyData: system_id = 4445 = 0x115D, version=2
```

If you see the system ID 4445 = 0x115D, then your liboemcrypto.so library did not load correctly, and you are running with level 3 fallback.

Starting with version 10 of the API, the unit test program will filter out tests that are not expected to run. For example, if you have not implemented usage tables yet, it will not run most of those tests. Instead, you will see

```
[   FAILED ] OEMCryptoAndroidLMPTest.SupportsUsageTable
```

Once you have usage tables supported, you will see the rest of those tests running. Near the top of the output is the test filter. Most devices should have a filter of

```
GTest Filter: *-*ForceKeybox*:*CastReceiver*
```

Cast Receiver or Android TV

Android TV devices should implement functionality to sign with an alternate RSA certificate using the alternate RSA padding schemes. To test this functionality, you should pass the argument "--cast" to the oemcrypto_test program:

```
adb shell /system/bin/oemcrypto_test --cast
```

This tells the unit tests not to filter out the CastReceiver tests.

Forcing the Test Keybox

Before version 10 of the API, the unit tests had to install a test keybox before running. If your device does not implement LoadTestKeybox, then you can force the installation of the test keybox using the command line argument --force_load_test_keybox:

```
adb shell /system/bin/oemcrypto_test --force_load_test_keybox
```

This should **NOT BE DONE ON PRODUCTION DEVICES**. It will install the test keybox on the device and removes the filter preventing the tests from loading keyboxes.

Testing ContentDecryptionModule

The full suite of tests can be built and run using the provided script.

```
cd $ANDROID_BUILD_TOP/vendor/widevine/libwvdrmengine
```

```
./build_and_run_all_unit_tests.sh
```
Two of the tests are used to verify the CDM functions, they are request_license_test and cdm_engine_test. If the script fails because of missing dependencies, try the command “mma” in the offending directory. The command “mma” takes longer than “mm”, but it scans all the makefiles in the tree and attempts to make all dependencies.

The request_license_test uses wvcd::WvContentDecryptionModule interface. The tests include generating and sending a license request to the license server and verifying the response coming back from the server. It also performs query key status and query status tests.

The cdm_engine_test is a unit test that calls the cdm_engine directly to generate a license request and sends it to the license server, then verifies the response coming back from the server.

There are other tests that verify various other cdm code. Please review the script to see a full list of tests.

Testing Java Drm API and Plugins

The plugin tests include tests for the Java Drm API for DASH, WVCryptoPlugin, WVDrmPlugin and WVDrmPluginFactory.

These are isolated unit tests for the top level components of the DRM engine, they do not exercise the OEMCrypto API.

Build libwvdrmdrmplugin_test from vendor/widevine/libwvdrmengine/mediadrm/test.
```
cd $ANDROID_BUILD_TOP/vendor/widevine/libwvdrmengine/mediadrm/test
mm
adb push $OUT/system/bin/libwvdrmdrmplugin_test/system/bin
adb shell /system/bin/libwvdrmdrmplugin_test
```

Build libwvdrmmediacrypto_test from vendor/widevine/libwvdrmengine/mediacrypto/test.
```
cd $ANDROID_BUILD_TOP/vendor/widevine/libwvdrmengine/mediacrypto/test
mm
adb push $OUT/system/bin/libwvdrmmediacrypto_test/system/bin
adb shell /system/bin/libwvdrmmediacrypto_test
```

Build libwvdrmengine_test from vendor/widevine/libwvdrmengine/test/unit.
```
cd $ANDROID_BUILD_TOP/vendor/widevine/libwvdrmengine/test/unit
mm
adb push $OUT/system/bin/libwvdrmengine_test/system/bin
adb shell LD_LIBRARY_PATH=/system/vendor/lib/mediadrm//system/bin/libwvdrmengine_test
```

Build the Java Drm API for DASH test from vendor/widevine/libwvdrmengine/test/java. This is an end-to-end test that uses the MediaDrm APIs to obtain a key request, send it to the Google Play license server and load the response into the CDM, which will cause keys to be loaded into the TEE via the

OEMCrypto APIs.

```
cd $ANDROID_BUILD_TOP/vendor/widevine/libwvdrmengine/test/java
mm

adb install $OUT/system/app/MediaDrmAPITest/MediaDrmAPITest.apk
```

To run this test, find the MediaDrmAPITest icon in the applications on the device and launch it.

Note that there is no UI yet, you will just see a blank screen, and then some text giving the test result. You should see details in the logcat output and note that keys are loaded.