Windows 10 IoT Core Board Support Package (BSP) for DragonBoard™ 410c

Customization Guide

LM80-P0436-67 Rev. D

September 24, 2018
## Revision history

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<td>A</td>
<td>April 2017</td>
<td>Initial release</td>
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<td>B</td>
<td>January 2018</td>
<td>Chapter 5 Building ACPI: Updated the procedure for compiling ACPI</td>
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<td>C</td>
<td>April 2018</td>
<td>Chapter 5 Building ACPI: Edited steps 6 and 7 in the procedure for compiling ACPI</td>
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1 Windows Board Support Package (BSP)

Windows BSP downloaded from https://developer.qualcomm.com/hardware/dragonboard-410c/tools is zipped up in a file of the form <BUILD_ID>_DB410c_BSP.zip

For example, A8016AAATNWZA21100000.1_DB410c_BSP.zip

NOTE: Use BUILD_ID as a reference when posting concerns

- Upon unzipping the file the following folder structure is visible:

- The folder “prebuilt” has the binaries delivered by Qualcomm® that are required for booting the device.

- The folder “src” has the ACPI source code that can help reprogram hardware resources or creating ACPI enumerated wdf drivers.

- The file “QC_Version.txt” has information about the Qualcomm Build ID

<qcversion>A8016AAATNWZA21100000.1</qcversion>
2 Building FFU image

FFU stands for Full Flash Update. FFU image bundles boot loaders, Windows OS, drivers, peripheral images, and other required files into a single package that can be flashed onto the device.

By flashing FFU to the image all of the required software is flashed on to the target at once.

Required Software:

- Matching Microsoft WDK (refer to the qclabel.xml file for the required version) under 
  
  ```xml
  <target_root>\DB410c_BSP\prebuilt\8016\firmware\wpk
  ```

  Example: `<build>14955.14955</build>`

- Microsoft ADK (matching the installed WDK).

- Copy MobileOS folder from Microsoft WDK drop to

  `<target_root>\DB410c_BSP\prebuilt\MobileOS`

- [OPTIONAL] Prior to building the FFU image [follow only if a new driver is required in the FFU]:

- Copy all the required spkgs of new drivers into the

  `<target_root>\DB410c_BSP\prebuilt\8016\cabfiles` folder.


- Make an entry for all the new spkgs in the following feature manifest file:

  ```xml
  
  <target_root>\DB410c_BSP\prebuilt\8016\FMFiles\QCFMOEMCustomized.xml
  ```

  e.g. To add spkg “Custom.QC8016.ExampleDriver.spkg” at the location “<target_root>

  - DB410c_BSP\prebuilt\8016\cabfiles” insert the following entry under

  ```xml
  <BasePackages>

  <PackageFile Path="%QCPackageDir%\cabfiles"
  Name="Custom.QC8016.ExampleDriver.spkg"/>

  </BasePackages>
  ```

  **NOTE:** `%QCPackageDir%` is pointing to `<target_root>\DB410c_BSP\prebuilt\8016\cabfiles`

- Open an Administrator-Mode command prompt window

- Setup the following environment variables

- set wdkcontentroot=c:\Program Files (x86)\Windows Kits\10\
- Point it to the location of the tools folder in the installed wdk (note the ‘\’ at the end)
  - MSPackageDir=<target_root>\DB410c_BSP\prebuilt\MobileOS\MSPackages
  - OSContentRoot=<target_root>\DB410c_BSP\prebuilt\MobileOS\n  - Set device=8016
  - Set qecplatform=8916
  - Set QCNHDebug=
  - Set bsproot=<target_root>\DB410c_BSP\prebuilt\8016
  - Call postbld.bat
  - set bsproot=<target_root>\DB410c_BSP\prebuilt\8016
  - Call postbld.bat
3 Mass storage mode

To set the device in to mass storage and directly access:
1. Open an Administrator-Mode command prompt
2. Ensure device enumerates in FFU mode [see FFU Mode section]
3. Run the following command:
   “<wdkcontentroot>\Program Files\Windows Kits\10\Tools\bin\i386\ffutool.exe”
   -massStorage

Device resets and enumerates as mass storage drive in the host PC.
4 FFU mode

FFU mode is very helpful for developers to directly access the file system on the dragon board. A developer can first put the device into mass storage mode and then view/modify the files with windows explorer. The device in FFU mode will show the following graphic on the display device:

- By default the FFU mode is disabled. A device flashed with FFU will boot directly to screen with tiles.
- To enable FFU mode, user can follow one of the following approaches:
  - Enabling FFU Mode by default during FFU generation:
  - To have the “FFU mode” enabled in the FFU by default, before generating the FFU, edit the file
    `<target_root>\DB410c_BSP\prebuilt\8016\oeminputtemplates\oeminput_productionos.x ml.`
    Under the following tag:
    `<Microsoft>`
    ...
    `<Feature>LABIMAGE</Feature>`
    ...
    `</Microsoft>`
  - In the default FFU, user can also go to FFU mode by pressing and holding the “Volume up” key on the device as soon as the device powers up.
  - Enable FFU mode from mass storage mode:
    - User can also set a BCD entry in the default image to have the device always halt in the FFU mode.
    - Put the device in to mass storage [refer to Mass storage mode section]
    - Device now enumerates in host PC. Remember the drive letter.
Run the following command:

```
bcdedit.exe /store <mass-storage drive letter>:\efiesp\efi\Microsoft\boot\bcd /set {globalsettings} custom:26000203 yes
```
5 Building ACPI

Windows BSP shipped via QDN packs in the ACPI source files for reconfiguring the DragonBoard hardware. BSP also packs few helper batch files, which when executed generates both the acpi binary- `dsdt.aml` and the acpi spkg - `ualcomm.M8016SOC_SBC.acpi.spkg`.

To compile ACPI perform the following steps:

- Open an Administrator-Mode command prompt
- Set `wdkcontentroot=c:\Program Files (x86)\Windows Kits\10\`
- Point it to the location of the tools folder in the installed wdk (note the ‘\’ at the end)
- Execute "C:\Program Files (x86)\Microsoft Visual Studio 12.0\VC\vcvarsall.bat" x86_arm

**NOTE:** If the development machine is used for the first time to build any of the windows software (drivers or applications) against WDK, install OEM Certificates. See section Installing OEM Certificates below.

- `cd` to the location of `build_acpi.bat` [i.e. `<target_root>\DB410c_BSP\src\acpi\rel9.2>`]
- Run `build_acpi.bat`

ACPI binaries are found at `<target_root>\DB410c_BSP\src\acpi\rel9.2\TABLES`

ACPI spkg is found at `<target_root>\DB410c_BSP\src\acpi\rel9.2\arm\Debug`
6 Replacing ACPI

- Put the device in mass storage mode [see Mass storage mode section.]
- Use the following command to replace with new dsdt.aml file:
  
copy /Y <source dsdt.aml> \?\Hard Disk\partition2\acpi
7 Installing OEM certificates

To install OEM Certificates perform the following steps:

- Open an Administrator-Mode command prompt window
- Set wdkcontentroot=c:\Program Files (x86)\Windows Kits\10\mksdk\content\root
- Set wdkcontentroot=c:\Program Files (x86)\Windows Kits\10\mksdk\content\root
- set PATH=%PATH%;%WDKContentRoot%\Tools\bin\i386;%WDKContentRoot%\bin\x86
- set SIGN_OEM=1
- installoemcerts.cmd
8 How to write ACPI code for my driver

A developer must define their custom ACPI entries in order to develop their own device drivers. The following section describes a sample SSDT.ASL file and provides a way for the developer to define their own bus & gpio entries based on the hardware schematics.

See Sample ACPI Code in Appendix for the entire ACPI sample.

**NOTE:** See ACPI specification at [http://www.acpi.info/DOWNLOADS/ACPIspec50.pdf](http://www.acpi.info/DOWNLOADS/ACPIspec50.pdf) for complete details of the Resource descriptors and the ASL information.

- All developer written code must be present in the SSDT.ASL file. SSDT stands for Secondary System Description Table. Also, it is the responsibility of the developer to make sure that entries in SSDT.ASL do not conflict with Qualcomm entries in DSDT.ASL.
- The SSDT.ASL file can be compiled to SSDT.AML using the compiler asl.exe.
- The SSDT.AML file can coexist along with Qualcomm’s DSDT.AML file in the PLAT partition of the device.
- The SSDT.AML file can be copied to the target’s PLAT partition from mass storage mode of the device.

**8.1 DefinitionBlock**

The following rectangle depicts the standard way of defining the SSDT.ASL DefinitionBlock. Please make sure the first line stays the same even in your custom implementations.

All Device () definitions must be scoped to system bus – “_SB_” as shown below

```
DefinitionBlock ("SSDT.AML", "SSDT", 0x02, "USERS ", "MSM8016 ", 1) --->
Use this line as is
{
  // should be scoped under System Bus
Scope (_SB_) ---> This entry should be used as is
{
  // All device entries must fall in this block
  Device (DEV1) {}
  Device (DEV2) {}
  ...
}
}
```


8.2 Device entry

A device declaration entry must not be conflicting with existing Qualcomm entries. If there is a conflict the DragonBoard’s behavior can be unpredictable. Please make the proper choice of names when writing a device entry.

In the device entry a developer can declare the resources that are consumed by the driver software once the device boots up. The following rectangle shows an example Device entry.

```
// User Sample Device
Device (USRS) ---> Make sure the name does not conflict with any other entries
{
Name (_HID, "USRS0000") ---> Make sure this hardware ID does not conflict with other entries.
Name (_UID, 1)
Method (_CRS) {} ---> This method will hold the resources consumed by the driver.
Method (xxxx) {} ---> Developer can define their custom methods to parse in driver code
...
Method (zzzz) {}
}
```

Each Device () entry is associated with a driver module with "_HID" value described as above. These _HID values must be non-conflicting with other _HID values. The _HID value referred to must also match up with the Hardware ID defined in the drivers .inf file for the driver loading to be successful.

Please refer to the Appendix for samples on defining entries for I2C, SPI, UART and GPIO. The comments in the section will help understand the ACPI definition process.

8.3 Compiling the SSDT.ASL

Follow these steps to compile your ACPI:

1. Launch an admin mode command prompt
2. CD to the location of ssdt.asl and execute:
   "C:\Program Files (x86)\Windows Kits\10\Tools\x64\ACPIVerify\asl.exe" ssdt.asl
3. Output will be stored in the current working directory
9 DPP – Device provisioning partition

Qualcomm BSP stores certain device related information in the DPP Partition of the DragonBoard. This partition essentially holds provisioning files that contain MAC addresses for Bluetooth and Wi-Fi connectivity.

After flashing the FFU for the first time and the device is left to boot to tiles the System creates the files WLAN.PROVISION and BT.PROVISION (These can be viewed from mass storage mode as shown below). These files have the auto generated MAC addresses for Bluetooth and Wi-Fi functionality.

A developer can manually modify these files (using Hex Editor) to configure known static MAC addresses for Wi-Fi and Bluetooth. With known static MAC addresses a predictable Wi-Fi and Bluetooth behavior can be achieved. Notice that a MAC address is a unique 6 byte value and must not be conflicting with devices on the same network.

The format of the provision files are as shown below:

### 9.1 WLAN.PROVISION

This file holds 4 MAC address values as highlighted in the diagram below.

- **Green Box** – This is used for `Soft Access Point` connectivity
- **Red Box** – This is used for `Wi-Fi station` connectivity
- **Maroon Box** – This is used for `P2P client` connectivity
- **Blue Box** – This is used for `P2P Go` connectivity

The developer can hand edit these 4 6 byte values to configure a known mac address.

The developer **must not** edit the 3 byte file header which are used to distinguish between the provisioning files.
9.2 BT.PROVISION

This file holds 1 MAC address value that is used by Bluetooth hardware. The following picture shows the location of the BT MAC address in the BTPROVISION file.

![BT.PROVISION](image)

The developer can hand edit this 6 byte value to configure a known Bluetooth mac address. The developer **must not** edit the 2 bytes of the file header which are used to distinguish between the provisioning files.
10 Must know

10.1 ACPI

A developer can add their own SSDT (Secondary System Description Table) tables without making any changes to the Qualcomm delivered ACPI code. But, the developer must ensure that the entries are not conflicting with Qualcomm delivered source code.

10.2 USB mode detection

DB410c has one micro-B connector for peripheral mode and two standard-A connectors for host mode. The device can only be used in either host mode or peripheral mode at any one time. Windows USB mode dynamic detection relies on the presence of the micro-B connector port. The following table lists possible connector configurations and the mode detected:

<table>
<thead>
<tr>
<th>Standard-A</th>
<th>Standard-B</th>
<th>USB Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>Yes</td>
<td>Peripheral</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
<td>Host</td>
</tr>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Peripheral</td>
</tr>
</tbody>
</table>

10.3 Asix Ethernet-USB dongle

DB410c has inbox support for Asix Ax88772 Ethernet-USB dongle in order to use wired Ethernet. Use of this dongle will provide you with faster internet speeds.

10.4 Wi-Fi caveat

It is very important to note that every flash of FFU generates a new random mac address. Since the MAC address changes for every flash it will also force repopulate your Wi-Fi access points with new mac addresses and might break your current test setup. Please make arrangements to take care of these situations when setting up test scenarios.
11 Secure Boot Enablement

11.1 Creating Signed FFU

Follow the below steps to sign the NHLOS images:

**NOTE:** The Machine should have Internet connectivity.

1. Install necessary tools 1) Openssl 1.0.1g or later 2) Python 2.7 or later (Python 3 is not supported)
2. Create working directory Create directory WP_SEC_BOOT, and it subdirectories OemPKCertificate, SSDKeys, fuse, firmware, signedmbn and cabfiles.
3. Generate OEM PK cert Go to WP_SEC_BOOT\OemPKCertificate, open command window as Administrator.

```
openssl.exe "genrsa" -out "qpsa_rootca.key" -3 "2048"
```

qpsa_rootca.key is generated.

```
Set OPENSSL_CONF=C:\OpenSSL\bin\openssl.cnf
openssl.exe "req" -new -key "qpsa_rootca.key" -x509 -out "rootca_pem.crt" -subj /C="CN"/ST="BJ"/L="Beijing"/OU="SecBoot"/O="QTI"/CN="QCT"/days "7300" -set_serial "1" -sha256 -config "C:\OpenSSL\bin\openssl.cnf"
```

rootca_pem.crt is generated.

OEM should change below strings to identify their own information.

/C="CN" – Country
/ST="BJ" – State
/L="Beijing" – Location
/OU="SecBoot" – Purpose
/OU="QTI" – Organization Unit
/O="QCT" – Organization
/CN="RootCA" – RootCA Common Name
-config "C:\OpenSSL-Win64\bin\openssl.cfg" – openssl configuration file in openssl bin directory
openssl.exe "x509" -inform "PEM" -in "rootca_pem.crt" -outform "DER" -out "qpsa_rootca.cer"
qpsa_rootca.cer is generated.

Create a plain txt file name “v3_attestCA.ext” with below content
authorityKeyIdentifier=keyid,issuer
subjectKeyIdentifier=hash
basicConstraints=CA:TRUE
keyUsage = cRLSign, keyCertSign
openssl.exe "genrsa" -out "qpsa_attestca.key" -3 "2048"
qpsa_attestca.key is generated.

openssl.exe "req" -new -key "qpsa_attestca.key" -out "attestca.csr" -subj /C="CN"/ST="BJ"/L="Beijing"/OU="QTI"/O="QCT"/CN="AttCA" -days "7300" -config "C:\OpenSSL\bin\openssl.cnf"
attestca.CSR™ is generated.

openssl.exe "x509" -req -in "attestca.csr" -CA "rootca_pem.crt" -CAkey "qpsa_rootca.key" -out "attestca_pem.crt" -set_serial "5" -days "7300" -extfile "v3_attestCA.ext" -sha256
attestca_pem.crt is generated.
openssl.exe "x509" -inform "PEM" -in "attestca.pem.crt" -outform "DER" -out "qpsa_attestca.cer"

qpsa_attestca.cer is generated.

openssl.exe dgst -sha256 qpsa_rootca.cer > sha256rootcert.txt

sha256rootcert.txt is generated.

Now, OemPKCertificate generation is done, it contains below files

11.2 Generate SSD Keys

SSD key is only used for HDCP key provisioning, you can skip this step if not use HDCP.

1. Copy everything except “keys” subdirectory from WP\prebuilt\8016\app\Qwpct\projects\keys\SSDKeys to WP_SEC_BOOT\SSDKeys

2. Modify key_config.xml to replace the path string before /keys in <path> and <id_Path> to current WP_SEC_BOOT\SSDKeys. For example, the first one in my machine is

   <path>C:\WP_WOS\APQ8016.WP.2.0.1\WP_SEC_BOOT\SSDKeys\keys\dvc_rsa\rsa_pkcs8_pr_key.der</path>

3. Go to WP_SEC_BOOT\SSDKeys, open command window as Administrator

   python.exe "gen_keys.py" --key_dir=keys
**11.3 Generate fuse data (sec.dat)**

1. Open command window, enter WP_SEC_BOOT directory
   Set environment variable SECTOOLSPATH, for example:
   ```
   set SECTOOLSPATH=C:\WP_SEC_BOOT\SECTOOLS\common\tools\sectools
   ```

2. Edit `%SECTOOLSPATH%\config\8916\8916_fuseblower_USER.xml`, update root cert path and several flags, changed parts are highlighted in below table. oem_product_id can be any value between 0x0001 and 0xffff.

```
<entry ignore="true">
  <description>contains the OEM public key hash as set by OEM</description>
  <name=root_cert_hash></name>
  <value>0000000000000000000000000000000000000000000000000000000000000000</value>
</entry>

<entry ignore="false">
  <description>SHA256 signed root cert to generate root hash</description>
  <name=root_cert_file></name>
  <value>C:\WP_WOS\APQ8016.WP.2.0.1\WP_SEC_BOOT\OemPKCertificate\qpsa_rootca.cer</value>
</entry>

<entry ignore="false">
  <description>PK Hash is in Fuse for SEC_BOOT1 : Apps</description>
  <name=SEC_BOOT1_PK_Hash_in_Fuse></name>
  <value>true</value>
</entry>

<entry ignore="false">
  <description>PK Hash is in Fuse for SEC_BOOT2 : MBA</description>
  <name=SEC_BOOT2_PK_Hash_in_Fuse></name>
  <value>true</value>
</entry>

<entry ignore="false">
  <description>PK Hash is in Fuse for SEC_BOOT3 : MPSS</description>
  <name=SEC_BOOT3_PK_Hash_in_Fuse></name>
  <value>true</value>
</entry>
```
3. Run below command in WP_SEC_BOOT directory, OEM can also use absolute path accordingly.

```
python.exe "%SECTOOLSPATH%\sectools.py" "fuseblower" -u "%SECTOOLSPATH%\config\8916\8916_fuseblower_USER.xml" -e "%SECTOOLSPATH%\config\8916\8916_fuseblower_OEM.xml" -q "%SECTOOLSPATH%\config\8916\8916_fuseblower_QC.xml" -g -o ".\fuse" -d -a
```

The output file is WP_SEC_BOOT\fuse\fuseblower_output\v1\sec.dat, it will be load to SEC partition in factory floor.
11.4 Sign Boot Loader chain and subsystem images

1. Update flash programmer so that VIP can be disabled. Make below code change and rebuild boot_image to get new prog_emmc_firehose_8916.mbn

File path: boot_images\core\storage\tools\deviceprogrammer\src\firehose\deviceprogrammer_initialize.c

```c
#define SKIP_SECBOOT_CHECK_NOT_RECOMMENDED
#ifndef SKIP_SECBOOT_CHECK_NOT_RECOMMENDED_BY_QUALCOMM
// This check below is to ensure that only VIP programmer is run on secure boot devices
// In otherwords, signing the non VIP programmer is highly not recommended
if (FALSE == isValidationMode() && TRUE == isAuthenticationEnabled()) {
    strlcat(err_log, "Secure boot detected. VIP not enabled:fail ", sizeof(err_log));
}
#endif
```

2. Download apq8016-wp-2-0-1_amss_device_precompile from Chipcode, get below mbn files, copy to WP_SEC_BOOT\firmware, need to rename some files.

WP\prebuilt\8016\firmware\uefi.mbn -> uefi_sign_ready.mbn
WP\prebuilt\8016\firmware\production\uefi.mbn -> production\uefi_sign_ready.mbn
(OEM usually need to rebuild their own UEFI)

boot_images\build\ms\bin\8916\prog_emmc_firehose_8916.mbn (the one disabled VIP, built from above step)

boot_images\build\ms\bin\8916\sbl1.mbn
rpm_proc\build\ms\bin\8916\rpm.mbn
trustzone_images\build\ms\bin\MAUAANAA\tz.mbn
trustzone_images\build\ms\bin\MAUAANAA\hyp.mbn
winsecapp_image\build\ms\bin\BATAANAA\uefi_sec.mbn
winsecapp_image\build\ms\bin\BATAANAA\winsecapp.mbn
modem_proc\build\ms\bin\EAAAANGZ\mba.mbn
modem_proc\build\ms\bin\EAAAANGZ\qdsp6sw.mbn
wcnss_proc\build\ms\bin\8916\wcnss.mbn
WP\prebuilt\8016\firmware\qcvss8916.mbn -> venus.mbn

3. Except prog_emmc_firehose_8916.mbn, other images can also be extracted from package files in WP\prebuilt\8016\cabfiles.

Qualcomm.QC8916.UEFI.spkg -> 2_UEFI.bin -> uefi_sign_ready.mbn
Qualcomm.QC8916.UEFI_PRODUCTION.spkg -> 2_UEFI.bin -> production\uefi_sign_ready.mbn
prog_emmc_firehose_8916.mbn will not be packaged to cab/pkg, so need to copy from boot_images
Qualcomm.QC8916.SBL1.spkg -> 2_SBL1.bin -> sbl1.mbn
Qualcomm.QC8916.RPM.spkg -> 2_RPM.bin -> rpm.mbn
Qualcomm.QC8916.QSEE.spkg -> 2_QSEE.bin -> tz.mbn
Qualcomm.QC8916.QHEE.spkg -> 2_QHEE.bin -> hyp.mbn
Secure Boot Enablement

4. Continue use environment variable SECTOOLSPATH, edit %SECTOOLSPATH%\config\8916\8916_secimage.xml, change MSM_part and model_id as below, the model_id needs to be same as oem_product_id in 8916_fuseblower_USER.xml.

   <msm_part>0x007060E1</msm_part>
   <oem_id>0x0000</oem_id>
   <model_id>0x0005</model_id>
   <debug>0x0000000000000002</debug>

   ...

   <image sign_id="modem" name="qdsp6sw.mbn" image_type="elf_has_ht">
     <general_properties_overrides>
     <sw_id>0x0000000000000002</sw_id>
     </general_properties_overrides>
     <pil_split>true</pil_split>
   </image>

   (it removes output_file_name="modem.mbn" in <image...>)

5. Create directory “oem_signing” under %SECTOOLSPATH%\resources\data_prov_assets\Signing\Local

   Like below one in my machine:
   C:\WP_WOS\APQ8016.WP.2.0.1\apq8016-wp-2-0-1_amss_oem_oem-src\common\tools\sectools\resources\data_prov_assets\Signing\Local\oem_signing

   Copy all files in WP_SEC_BOOT\OemPKCertificate to oem_signing directory
   Copy WP\prebuilt\8016\app\Qwpct\tools\security\config.xml to oem_signing directory


   python.exe "%SECTOOLSPATH%\sectools.py" "secimage" -i ".\firmware\uefi_sign_ready.mbn" -g "uefi" -o ".\signedmbn" -p "8916" -s --cfg_selected_cert_config=oem_signing

   python.exe "%SECTOOLSPATH%\sectools.py" "secimage" -i ".\firmware\production\uefi_sign_ready.mbn" -g "uefi" -o ".\signedmbn\production" -p "8916" -s --
   cfg_selected_cert_config=oem_signing
python.exe "%SECTOOLSPATH%\sectools.py" "secimage" -i ".\firmware\prog_emmc_firehose_8916.mbn" -g "firehose" -o ".\signedmbn" -p "8916" -s --cfg_selected_cert_config=oem_signing

python.exe "%SECTOOLSPATH%\sectools.py" "secimage" -i ".\firmware\sbl1.mbn" -g "sbl1" -o ".\signedmbn" -p "8916" -s --cfg_selected_cert_config=oem_signing

python.exe "%SECTOOLSPATH%\sectools.py" "secimage" -i ".\firmware\rpm.mbn" -g "rpm" -o ".\signedmbn" -p "8916" -s --cfg_selected_cert_config=oem_signing

python.exe "%SECTOOLSPATH%\sectools.py" "secimage" -i ".\firmware\tz.mbn" -g "qsee" -o ".\signedmbn" -p "8916" -s --cfg_selected_cert_config=oem_signing

python.exe "%SECTOOLSPATH%\sectools.py" "secimage" -i ".\firmware\hyp.mbn" -g "qhee" -o ".\signedmbn" -p "8916" -s --cfg_selected_cert_config=oem_signing

python.exe "%SECTOOLSPATH%\sectools.py" "secimage" -i ".\firmware\uefi_sec.mbn" -g "uefiapp" -o ".\signedmbn" -p "8916" -s --cfg_selected_cert_config=oem_signing

python.exe "%SECTOOLSPATH%\sectools.py" "secimage" -i ".\firmware\wcnss.mbn" -g "wcnss" -o ".\signedmbn" -p "8916" -s --cfg_selected_cert_config=oem_signing

python.exe "%SECTOOLSPATH%\sectools.py" "secimage" -i ".\firmware\venus.mbn" -g "venus" -o ".\signedmbn" -p "8916" -s --cfg_selected_cert_config=oem_signing

7. Copy signed image to WP_SEC_BOOT\signedmbn and rename.

WP_SEC_BOOT\signedmbn\8916\uefi\uefi_sign_ready.mbn -> WP_SEC_BOOT\signedmbn\uefi.mbn

WP_SEC_BOOT\signedmbn\production\8916\uefi\uefi_sign_ready.mbn -> WP_SEC_BOOT\signedmbn\production\uefi.mbn
WP_SEC_BOOT\signedmbn\8916\firehose\prog_emmc_firehose_8916.mbn –> WP_SEC_BOOT\signedmbn\prog_emmc_firehose_8916.mbn

WP_SEC_BOOT\signedmbn\8916\sbl1\sbl1.mbn –> WP_SEC_BOOT\signedmbn\sbl1.mbn
WP_SEC_BOOT\signedmbn\8916\rpm\rpm.mbn –> WP_SEC_BOOT\signedmbn\rpm.mbn
WP_SEC_BOOT\signedmbn\8916\qsee\tz.mbn –> WP_SEC_BOOT\signedmbn\qsee.mbn
WP_SEC_BOOT\signedmbn\8916\qhee\hyp.mbn –> WP_SEC_BOOT\signedmbn\qhee.mbn
WP_SEC_BOOT\signedmbn\8916\uefisecapp\uefi_sec.mbn –> WP_SEC_BOOT\signedmbn\uefi_sec.mbn

WP_SEC_BOOT\signedmbn\8916\winsecapp\winsecapp.mbn –> WP_SEC_BOOT\signedmbn\winsecapp.mbn
WP_SEC_BOOT\signedmbn\8916\mba_wp\mba.mbn –> WP_SEC_BOOT\signedmbn\qcdsp1v28916.mbn
WP_SEC_BOOT\signedmbn\8916\modem\qdsp6sw.mbn –> WP_SEC_BOOT\signedmbn\qcdsp28916.mbn
WP_SEC_BOOT\signedmbn\8916\wcnss\wcnss.mbn –> WP_SEC_BOOT\signedmbn\qwcwcnss8916.mbn
WP_SEC_BOOT\signedmbn\8916\venus\venus.mbn –> WP_SEC_BOOT\signedmbn\qcvss8916.mbn

Copy below files to WP_SEC_BOOT\signedmbn\TZAPPS

Copy TZAPPS directory under WP_SEC_BOOT\signedmbn,

Copy below files to WP_SEC_BOOT\signedmbn\TZAPPS

WP\prebuilt\8016\app\Qwpct\tools\security\fat_16MB.bin;
WP\prebuilt\8016\app\Qwpct\tools\security\fatadd.py
WP_SEC_BOOT\signedmbn\uefi_sec.mbn

Rename fat_16MB.bin to TZAPPS.bin, run below command in command window

```
fatadd.py --name=tzapps.bin --from=uefi_sec.mbn --dir=TZAPPS
```

Copy TZAPPS.bin to WP_SEC_BOOT\signedmbn

If you mount TZAPPS.bin in PC with “ImDisk Virtual Disk Driver”, you will see directory tzapps and it contains uefi_sec.mbn
11.5 Packaging signed

Signed prog_emmc_firehose_8916.mbn will be used in factory process and no need to package to cab/pkg, other signed image files need to build into cab/pkg files.

1. Copy below pkg.xml file from WP\prebuilt\8016\app\wpctestools to WP_SEC_BOOT\pkgxml directory.

   ![Directory of C:\WP_WOS\APQ8016.WP.2.0.1\WP_SEC_BOOT\pkgxml](image)

   Edit uefi.pkg.xml, add file path \uefi.mbn

   ```xml
   <Components>
   <BinaryPartition ImageSource="\$(CONTENT_PATH)\uefi.mbn" />
   </Components>
   ```

   Edit uefi_production.pkg.xml, add file path \production\uefi.mbn

   ```xml
   <Components>
   <BinaryPartition ImageSource="\$(CONTENT_PATH)\production\uefi.mbn" />
   </Components>
   ```

   Edit amss.pkg.xml as below

   ```xml
   <?xml version="1.0" encoding="utf-8"?>
   <Package xmlns="urn:Microsoft.WindowsPhone/PackageSchema.v8.00"
   Platform="QC$(QCPlatform)" Owner="Qualcomm" Component="QC$(QCChipset)"
   SubComponent="AMSSPeriImage" OwnerType="SiliconVendor"
   ReleaseType="Production" Partition="MainOS">
   ```

2. Open command window, go to WP_SEC_BOOT, set below environment and others for WP driver build, like WDKContentRoot.

   Call "C:\WDK\15165.15165\LaunchBuildEnv.cmd"
   Set WPDKContentRoot=%WDKContentRoot%
   Set SIGN_OEM=1
   Set QCPlatform=8916
   Set QCChipset=8016
   Set PackageXMLDir=C:\WP_WOS\APQ8016.WP.2.0.1\WP_SEC_BOOT\pkgxml
   Set SignedMBNDir= C:\WP_WOS\APQ8016.WP.2.0.1\WP_SEC_BOOT\signedmbn
   Set PackageRoot=C:\WP_WOS\APQ8016.WP.2.0.1\WP_SEC_BOOT\cabfiles
   Set PkgVersion="2119.0.0.0"

   **NOTE:** Version 2119.0.0.0 means Version Major="2119" Minor="0" QFE="0" Build="0"
Call “%WPDKContentRoot%\Tools\bin\i386\installomcerts.cmd”

3. Run below commands:

pkggen.exe "%PackageXMLDir%\SBL1.pkg.xml" /build:fre /cpu:arm
/config:"%WPDKContentRoot%\Tools\bin\i386\pkggen.cfg.xml"
/variables:"QCPlatform=%QCPlatform%;CONTENT_PATH=%SignedMBNDir%"
/output:"%PackageRoot%" /version:%PkgVersion%

pkggen.exe "%PackageXMLDir%\rpm.pkg.xml" /build:fre /cpu:arm
/config:"%WPDKContentRoot%\Tools\bin\i386\pkggen.cfg.xml"
/variables:"QCPlatform=%QCPlatform%;CONTENT_PATH=%SignedMBNDir%"
/output:"%PackageRoot%" /version:%PkgVersion%

pkggen.exe "%PackageXMLDir%\qsee.pkg.xml" /build:fre /cpu:arm
/config:"%WPDKContentRoot%\Tools\bin\i386\pkggen.cfg.xml"
/variables:"QCPlatform=%QCPlatform%;CONTENT_PATH=%SignedMBNDir%"
/output:"%PackageRoot%" /version:%PkgVersion%

pkggen.exe "%PackageXMLDir%\qhee.pkg.xml" /build:fre /cpu:arm
/config:"%WPDKContentRoot%\Tools\bin\i386\pkggen.cfg.xml"
/variables:"QCPlatform=%QCPlatform%;CONTENT_PATH=%SignedMBNDir%"
/output:"%PackageRoot%" /version:%PkgVersion%

pkggen.exe "%PackageXMLDir%\winsecapp.pkg.xml" /build:fre /cpu:arm
/config:"%WPDKContentRoot%\Tools\bin\i386\pkggen.cfg.xml"
/variables:"QCPlatform=%QCPlatform%;QCChipset=%QCChipset%;CONTENT_PATH=%SignedMBNDir%"
/output:"%PackageRoot%" /version:%PkgVersion%

pkggen.exe "%PackageXMLDir%\uefi.pkg.xml" /build:fre /cpu:arm
/config:"%WPDKContentRoot%\Tools\bin\i386\pkggen.cfg.xml"
/variables:"QCPlatform=%QCPlatform%;QCChipset=%QCChipset%;CONTENT_PATH=%SignedMBNDir%"
/output:"%PackageRoot%" /version:%PkgVersion%

pkggen.exe "%PackageXMLDir%\uefi_production.pkg.xml" /build:fre /cpu:arm
/config:"%WPDKContentRoot%\Tools\bin\i386\pkggen.cfg.xml"
/variables:"QCPlatform=%QCPlatform%;QCChipset=%QCChipset%;CONTENT_PATH=%SignedMBNDir%"
/output:"%PackageRoot%" /version:%PkgVersion%

pkggen.exe "%PackageXMLDir%\amss.pkg.xml" /build:fre /cpu:arm
/config:"%WPDKContentRoot%\Tools\bin\i386\pkggen.cfg.xml"
/variables:"QCPlatform=%QCPlatform%;QCChipset=%QCChipset%;CONTENT_PATH=%SignedMBNDir%"
/output:"%PackageRoot%" /version:%PkgVersion%
pkggen.exe "%PackageXMLDir%\wcns.xml" /build:fre /cpu:arm
/config:"%WPDKContentRoot%\Tools\bin\i386\pkggen.cfg.xml"
/variables:"QCPlatform=%QCPlatform%;QCChipset=%QCChipset%;CONTENT_PATH=%SignedMBNDir%" /output:"%PackageRoot%" /version:%PkgVersion%

pkggen.exe "%PackageXMLDir%\qcvss.xml" /build:fre /cpu:arm
/config:"%WPDKContentRoot%\Tools\bin\i386\pkggen.cfg.xml"
/variables:"QCPlatform=%QCPlatform%;QCChipset=%QCChipset%;CONTENT_PATH=%SignedMBNDir%" /output:"%PackageRoot%" /version:%PkgVersion%

11.6 Creating FFU

1. Copy below files to "...\Packages\QCOM\prebuilt\8016cabfiles" folder
   Qualcomm.QC8016.AMSSPeriImage.cab
   Qualcomm.QC8016.AMSSPeriImage.spkg
   Qualcomm.QC8916.qcvss.cab
   Qualcomm.QC8916.qcvss.spkg
   Qualcomm.QC8916.QHEE.cab
   Qualcomm.QC8916.QHEE.spkg
   Qualcomm.QC8916.QSEE.cab
   Qualcomm.QC8916.QSEE.spkg
   Qualcomm.QC8916.RPM.cab
   Qualcomm.QC8916.RPM.spkg
   Qualcomm.QC8916.SBL1.cab
   Qualcomm.QC8916.SBL1.spkg
   Qualcomm.QC8916.TZAPPS.cab
   Qualcomm.QC8916.TZAPPS.spkg
   Qualcomm.QC8916.UEFI.cab
   Qualcomm.QC8916.UEFI.spkg
   Qualcomm.QC8916.WCNSSPeriImage.cab
   Qualcomm.QC8916.WCNSSPeriImage.spkg
   Qualcomm.QC8916.WINSECAPP.cab
   Qualcomm.QC8916.WINSECAPP.spkg
2. Copy below file to "...\Packages\QCOM\prebuilt\8016\cabfiles\production" folder
   Qualcomm.QC8916.UEFI_PRODUCTION.cab
   Qualcomm.QC8916.UEFI_PRODUCTION.spkg

3. Open command prompt and run the 'SetupBuildEnv.cmd' file from "...\WDK\15165.15165\BuildEnv".

4. Set below environment variables in same command prompt:
   set QCChipset=8016
   set QCPlatform=8916
   set FFU_TARGETS=SBC_Health < Flavour of FFU image >

5. After setting above variables, run the 'postbld.bat' from "...\Packages\QCOM\prebuilt\8016" folder.

   NOTE: [Note : Delete or Rename the old ffu folder in "...\Packages\QCOM\prebuilt\8016"].

11.7 Enabling the Secure Boot on the Device

1. To enable the secure boot on Dragon Board, We have to blown the fuse on device using "sec.dat" file.
   To blown the fuse, the device should not be RPMB provisioned.
   You can find the "sec.dat" in "WP_SEC_BOOT\fuse\fuseblower_output\v1\sec.dat", where
   WP_SEC_BOOT is the folder where NHLOS images are signed.
   a. Flash sec.dat using mass storage mode
      `emmcdl.exe -b SEC sec.dat`
   b. Flash sec.dat file using EDL (9008) mode
      `emmcdl.exe -p COMx -f prog_emmc_firehose_8916.mbn -b SEC sec.dat`

2. Verify secure boot enabled :
   Put device in EDL(9008) mode, use below command to read OEM_PK_HASH, the value
   should be same to the value in WP_SEC_BOOT\OemPKCertificate\sha256rootcert.txt
   `emmcdl.exe -p COMx -info`
   `emmcdl.exe -p COMx -info`

3. Try to flash your secure image on the device.
A Appendix

A.1 Installing ADK

The release of the installed ADK should match the Windows 10 IOT Core packages being used. When installing the ADK, install to default path and make sure that the features below are selected at minimum:

![Select the features you want to install](image)

A.2 Installing Windows 10 IoT Core Packages

When installing IoT Core Packages, you only need to install the ARM, as shown below.

![Windows 10 IoT Core ARM Packages](image)
A.3 Cloning IoT ADK Addon Kit from Github

It is recommended that you use a git client (such as this one) to clone the repo at https://github.com/ms-iot/iot-adk-addonkit.

A.4 Windows 10 IoT Core Board Support Package (BSP)

After downloading and extract the BSP zip file, the folder structure should look similar to this:

```plaintext
Local Disk (C):
  a805aaatnwza21120000.2_db410c_bsp
  DB410c_BSP
  prebuilt
  src
```

We will be extracting the CAB files from the BSP package into the IoT ADK Addon Kit build tree in the next steps.
A.5 Using IoT ADK Addon Kit to build a Test FFU

1. Edit C:\iot-adk-addonkit\Tools\setOEM.cmd and change it to the name of your company.

2. Run C:\iot-adk-addonkit\IoTCoreShell-arm.cmd

3. You should see the command window showing the ADK version and the IoT Core Package version and the OEM name you’ve set.
4. Install Test Sign Certificates on the system – **this only need to be run once per system.**
   Run installomcerts.cmd

5. Assuming C:\a8016aaattnwza21120000.2_db410c_bsp is where the BSP was extracted to as in the screen capture above
   Run (on one line)
   C:\iot-adk-addonkit\Tools\bsptools\QCDB410C\export.cmd
   C:\a8016aaattnwza21120000.2_db410c_bsp\DB410c_BSP

6. You should see the CAB file successfully exported from the BSP.
7. Run `newproduct.cmd DemoDevice QCDB410C` and choose to enter SMBIOS data to uniquely identify your device in SMBIOS. You should change `DemoDevice` to your product name. Example:

   ![Image of command prompt output]

8. Edit `C:\iot-adk-addonkit\Source-arm\Products\DemoDevice\oemcustomization.cmd` to configure boot time scripts, e.g., change default password etc. `oemcustomization.cmd` is run at every boot, and contains a section that is only run on first boot. **Interesting command line utilities**

   [https://docs.microsoft.com/en-us/windows/iot-core/manage-your-device/commandlineutils](https://docs.microsoft.com/en-us/windows/iot-core/manage-your-device/commandlineutils)

9. Edit `C:\iot-adk-addonkit\Source-arm\Products\DemoDevice\prov\customizations.xml` to configure policies and computer name.

10. Run `buildpkg.cmd all`
11. Edit
   C:\iot-adk-addonkit\Source-arm\Products\DemoDevice\TestOEMInput.xml
   To change the features to be included in the Test Image
   see https://docs.microsoft.com/en-us/windows-hardware/manufacture/iot/iot-core-feature-list

12. To start creating a Test FFU, **unplug all USB storage device** and run
   createimage.cmd **DemoDevice** Test
   It may take between 10 to 30 min to build an FFU depend on your build system speed.

13. Navigate to
   C:\iot-adk-addonkit\Build\arm\DemoDevice\Test
   to find the Flash.ffu

See IoT Core Manufacturing Guide for additional customizations, security lock downs and
building retail images.
B Sample ACPI code

//
// SSDT (Secondary System Description Table) sample file
// This file shows an example of writing ACPI Device entries for
// user developed driver for user device
//

DefinitionBlock("SSDT.AML", "SSDT", 0x02, "USERS ", "MSM8016 ", 1)
{
    // Should be scoped System Bus
    Scope(_SB_)
    {
        // An User Sample Device
        Device (USRS)
        {
            Name (_HID, "USRS0000") Name (_UID, 1)

            // define your Current Resource Settings
            Method (_CRS, 0x0, NotSerialized)
            {
                Name (RBUF, ResourceTemplate())
                {
                    // An end user device can consume bus resources as depicted below
                    // A sample entry to access I2C bus
                    I2CSerialBus(   // I2C0_SCL - GPIO 7 - Pin 15
                        // I2C0_SDA - GPIO 6 - Pin 17
                        0xFFFF, // SlaveAddress: placeholder
                        , // SlaveMode: default to ControllerInitiated
                        0, // ConnectionSpeed: placeholder
                        , // Addressing Mode: default to 7 bit
                        "\\_SB.I2C2", // ResourceSource: I2C bus controller name
                        ,
                        , // Descriptor Name: creates name for offset of resource descriptor
                        ) // VendorData
// A sample entry to access SPI bus
SPISerialBus(  // SPI0_SCLK - GPIO 19 - Pin 8
  // SPI0_MOSI - GPIO 16 - Pin 14
  // SPI0_MISO - GPIO 17 - Pin 10
  // SPI0_CS   - GPIO 18 - Pin 12
0, // Device selection (CS) PolarityLow,   // Device selection polarity
FourWireMode,   // wiremode
8, // databit len
ControllerInitiated, // slave mode
4000000, // connection speed ClockPolarityLow,   // clock
          // polarity ClockPhaseFirst,   // clock phase
"\_SB.SPI5", // ResourceSource: SPI bus controller name
, // ResourceSourceIndex
,
,
RawDataBuffer()  // VendorData
{
  0x00, // Reserved
  0x00, // DeassertWait
  0x00, // ClockAlwaysOn
  0x00, // MXCSMode
  0x00, // HSMode
  0x00,  // LoopBackMode
}

// A sample entry to access UART bus
UARTSerialBus(
  115200, // ConnectionSpeed
,   // BitsPerByte (defaults to DataBitsEight)
,   // StopBits   (defaults to StopBitsOne)
0xC0,  // LinesInUse
,   // IsBigEndian (defaults to LittleEndian)
,   // Parity  (defaults to ParityTypeNone) FlowControlHardware,  // FlowControl  (defaults to FlowControlNone)
0,    // ReceiveBufferSize
0,    // TransmitBufferSize
"\_SB.UAR1", // ResourceSource
,   // ResourceSourceIndex (defaults to 0)
,   // ResourceUsage   (defaults to ResourceConsumer)
,   // DescriptorName
)

// A sample entry to access Gpio PIN for general purpose data, control operation
GpioIO(Shared, PullNone, 0, 0, IoRestrictionNone, "\_SB.GIO0", 0, ResourceConsumer, , }  { 36 }
// A sample entry to access Gpio PIN for configuring as an interrupt
GpioInt(Edge, ActiveBoth, Shared, PullNone, 0, "\\_SB.GIO0"){ 36 }
EXHIBIT 1

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