Qualcomm® Snapdragon™ embedded platforms HW and SW Overview

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Constantine Elster, Senior Staff Engineer
Qualcomm Israel, Ltd.
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Qualcomm Snapdragon is a product of Qualcomm Technologies, Inc.
Agenda

1. Chipset overview
2. Hardware sub-systems and typical applications
3. Development platforms (DragonBoard)
4. Software distributions and features overview
5. Eco system
## Bringing Snapdragon platforms to embedded devices

### Identifying the challenges

<table>
<thead>
<tr>
<th></th>
<th>Mobile OEMs</th>
<th>Embedded Customers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Relationship</strong></td>
<td>High touch, 1-1</td>
<td>Low-touch, web-based</td>
</tr>
<tr>
<td><strong>Primary fulfillment</strong></td>
<td>Direct</td>
<td>Distribution</td>
</tr>
<tr>
<td><strong>Minimum order</strong></td>
<td>10,000s</td>
<td>100</td>
</tr>
<tr>
<td><strong>Customers</strong></td>
<td>High dependency, few</td>
<td>Low dependency, many</td>
</tr>
<tr>
<td><strong>Roadmap influence</strong></td>
<td>Strong</td>
<td>Weak</td>
</tr>
<tr>
<td><strong>Engineering capability</strong></td>
<td>Strong, large teams</td>
<td>Varied, small teams</td>
</tr>
<tr>
<td><strong>Primary support</strong></td>
<td>Direct</td>
<td>Web-based/Contract work</td>
</tr>
<tr>
<td><strong>End-product volume</strong></td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Design type</strong></td>
<td>Iterative</td>
<td>Clean-slate</td>
</tr>
</tbody>
</table>
Snapdragon 410E and 600E embedded platforms
Drawing from the mobile portfolio for a targeted, tiered offering

Snapdragon 600E
1.5 GHz quad-core Qualcomm® Krait™ 300 CPU

Snapdragon 410E
1.2 GHz quad-core ARM v8 Cortex-A53, 32/64-bit capable

Supported for longevity
- Available through distribution for a minimum of 10 years from Snapdragon 600 and 410 commercial sample in 2015

Available through Arrow Electronics
- 1st time Snapdragon platforms are sold through 3rd party distribution
Snapdragon embedded platforms

**Snapdragon 410E**

**Application Processor** - APQ8016E
- 12 mm x 14 mm non-PoP package size
- LPDDR2/3 533 MHz single channel
- Quad ARM Cortex A53 at 1.2GHz per core

**Power module** - PM8916
- Power management and codec IC
- 6.2 mm x 6.2 mm

**Connectivity** - WCN36x0
- WCN3620/3660B - 802.11 b/g/n
- Bluetooth 4.x/LE
- 3.3 mm x 3.5 mm

**Location** - WGR7640
- Integrated Location (GNSS, GPS) support
- 2.1 mm x 1.5 mm

**Snapdragon 600E**

**Application Processor** - APQ8064E
- 23 mm x 23 mm non-PoP package size
- Dual DDR3/DDR3L up to 533MHz
- Quad core Krait 28LP-LVT up to 1.5GHz

**Power module** - PMM8920AU
- Power Management
- 13.9 mm x 12.3 mm

**Connectivity** - QCA9377 module
- QCA9377 - 802.11a/b/g/n/ac 1x1 DB 2.4GHz/5GHz
- Bluetooth 4.1
- 18.0 mm x 17.0 mm module, FCC pre-certified

**Location** - RGR7640AU
- Integrated Location (GNSS, GPS) support

**Audio** - WCD9311
- Next Gen Audio Codec
- 6.0 mm x 6.0 mm

**Ethernet (optional)** - AR8151
- Ethernet connectivity

APQ8016E, PM8916, WCN3620/3660B, WGR7640, APQ8064E, PMM8920AU, RGR7640, QCA9377, AR8151 and WCD9311 are products of Qualcomm Technologies, Inc.
Snapdragon sub-systems

Chipset Interface
- PMIC / WCN / Codec busses
- Analog interfaces (ADCs / DACs)

Air Interface
- Integrated GPS modem
- Integrated WLAN / BT modem

Wired Connectivity
- USB
- PCIe
- GPIOs
- Programmable serial interfaces (I2C / SPI / UART)
- Secure Digital (SD)
- I2S

Memory
- DDR
- eMMC
- Internal memory

Multimedia
- GPU
- VFE
- Display controller
- Camera controller
- ISP
- Audio

Internal Functions
- Security
- Debugging (e.g., JTAG)
- Housekeeping
- Clocks & power
Processors and memory

Snapdragon 410E

Application Processor
- Quad core
- 64-bit Cortex A53 (ARM v8) up to 1.2GHz
- 512kB L2 cache

DSP
- Qualcomm® Hexagon™ QDSP6 V5 core up to 691MHz

Supporting processors
- RPM, Cortex M3

Memory
- LPDDR2/3, 32-bit, up to 533MHz
- eMMC v4.5
- iMEM 128kB

Snapdragon 600E

Application Processor
- Quad core
- 32-bit Krait uP (ARM v7 compliant) up to 1.5GHz
- 2MB L2 cache

DSP
- Qualcomm ® Hexagon™ QDSP6 V4 core up to 500MHz

Supporting processors
- RPM, ARM7
- SPSS, ARM7

Memory
- DDR3, 32-bit, dual channel (4 chip-selects), up to 4GB density, up to 533MHz
- eMMC v4.5
- iMEM 256kB LMEM + 192kB MIMEM

Qualcomm Hexagon and Qualcomm Adreno are products of Qualcomm Technologies, Inc.
## Multimedia

### Snapdragon 410E

**Display support**
- 1080p external displays supported
- HDMI via converter

**Image processing**
- Up to 2x CSIs
- 4-lane CSI up to 13MP
- 2-lane CSI 8MP web cam

**Qualcomm® Adreno™ 306 GPU (400 MHz)**
- 3D graphics accelerator
- On-chip graphics memory (128 kB unified SRAM)

**Video Decode**

**Audio**
- 5.1 surround sound with Dolby and DTS
- Low Power Audio Core
- DSP Post-Proc programmability

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### Snapdragon 600E

**Display support**
- 2560x1600 via 2xDSI
- 2048x1560 via 1xDSI

**Image processing**
- Up to 3x CSIs
- 4-lane CSI:
- Up to 20MP in-line JPEG encode at 15 fps

**Qualcomm® Adreno™ 320 GPU (400+ MHz)**
- 200 M peak triangles/sec; 6.4 B vector shader instructions/sec; 3.2 BP/sec; 3.2 B texel/sec
- On-chip graphics memory 512 KB for fast Z, color, and stencil rendering

**Video Decode**
- 30fps D1 @ FWVGA (H.263)

**Audio**
- Dolby 7.1 surround sound with Digital Plus audio
- Low Power Audio Core
- DSP Programmability

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**Connectivity**

<table>
<thead>
<tr>
<th>Function</th>
<th>Snapdragon 410E</th>
<th>Snapdragon 600E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bluetooth</td>
<td>2x2048x1536 via 1xDSI</td>
<td>2048x1536 via LVDS or 2048x1560 via 1xDSI</td>
</tr>
<tr>
<td>WiFi</td>
<td>1080p via 1x800 / 2x800</td>
<td>1080p HDMI</td>
</tr>
<tr>
<td>GPS</td>
<td>4-lane CSI 20MP in-line JPEG encode at 15 fps</td>
<td>60 fps WXGA viewfinder frame rate</td>
</tr>
<tr>
<td>On-chip graphics memory</td>
<td>4-lane CSI 8MP web cam</td>
<td>1-lane CSI 3D cam support</td>
</tr>
</tbody>
</table>

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**Video Encode**


30fps D1 @ FWVGA (H.263)

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**Chipset I/F**

<table>
<thead>
<tr>
<th>Serial buses</th>
<th>Discrete start &amp; ctrl</th>
</tr>
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<tbody>
<tr>
<td>GNSS ADC</td>
<td></td>
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<tr>
<td>WLAN DACs</td>
<td></td>
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<tr>
<td>WLAN ADcs</td>
<td></td>
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</table>

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**Processes**

**App processor**
- 3D graphics accelerator
- On-chip graphics memory (128 kB unified SRAM)

**Memory Support**

<table>
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<tr>
<th>Memory Support</th>
<th>Snapdragon 410E</th>
<th>Snapdragon 600E</th>
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<tbody>
<tr>
<td>EBI0</td>
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<tr>
<td>EBI1</td>
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<tr>
<td>Internal memory</td>
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<tr>
<td>Secure Digital (SDC1)</td>
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**Connectivity**

<table>
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<tr>
<th>SDC1 (with WCN ifc)</th>
<th>2x12S Mics</th>
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<tr>
<td>2x12S Spi</td>
<td></td>
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<tr>
<td>M2S</td>
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<tr>
<td>2x TSBFs</td>
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</table>

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**Air Interface**

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<th>EtherCAT</th>
<th>SPI</th>
</tr>
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<tbody>
<tr>
<td>PCIe</td>
<td>UART</td>
</tr>
<tr>
<td>GSIP (x7)</td>
<td>I2C</td>
</tr>
</tbody>
</table>

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**Display Support**

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<th>Display Support</th>
<th>Snapdragon 410E</th>
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<table>
<thead>
<tr>
<th>Video Encode</th>
<th>30fps 1080p (MPEG-4 / MPEG-2 / H.264 / H.263 / DivX / VC-1 / WMV-9)</th>
<th>30fps D1 @ FWVGA (H.263)</th>
</tr>
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**Video Decode**


30fps D1 @ FWVGA (H.263)

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**Audio**

- Dolby 7.1 surround sound with Digital Plus audio
- Low Power Audio Core
- DSP Programmability

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**Internal functions**

<table>
<thead>
<tr>
<th>Resource &amp; PWR mgmt.</th>
<th>Security</th>
<th>Mode / config / reset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal sensors</td>
<td>GP clock &amp; PDM outputs</td>
<td>JTAG</td>
</tr>
<tr>
<td>GP clock &amp; PDM</td>
<td>JTAG</td>
<td>Clock generation</td>
</tr>
</tbody>
</table>

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Qualcomm Adreno is a product of Qualcomm Technologies, Inc.
Snapdragon 410E

- **USB**: 1x USB 2.0 HS ports (w/ build-in PHY)

Secure Digital
- 2x ports
- Supports SD3.0 and MMC, eMMC4.5 NAND flash, SD/eMMC boot
- Different operating voltages

BLSP
- 6x 4-bit wide ports
- Multiplexed serial interfaces
- UART, I2C, SPI (master), GPIO

GPIOs
- 122x GPIOs
- Top-level mode multiplexer
- Input config: pullup, pulldown, keeper, no-pull
- Output config: drive strength

Audio
- DMIC
- 2x Mi2S (2-bit)
- CDC PDM port

Snapdragon 600E

- **USB**: 3x USB 2.0 HS ports (w/ build-in PHY)
- 1x USB 2.0 FS port
- 1x HSIC

Secure Digital
- 4x ports
- Supports SD3.0 and MMC, eMMC4.5 NAND flash, SD/eMMC boot

PCIe
- 1-lane PCIe 2.0

GSBI
- 7x 4-bit wide ports
- Multiplexed serial interfaces
- UART, UIM, I2C, SPI (master), GPIO

GPIOs
- 90x GPIOs
- Top-level mode multiplexer
- Input config: pullup, pulldown, keeper, no-pull
- Output config: drive strength

Audio
- 4x I2S / 1x Mi2S (4-bit)
- PCM
- SLIMbus

Wired Connectivity
Snapdragon 410E typical application

Chipset I/F
- Serial busses
- Discrete stat & ctrl
- GNSS ADC
- WLAN DACs, WLAN ADCs

Connectivity
- WLAN command

APQ8016E
- Processors
  - App quad-A53 uP
  - DSP QDSP6
  - WCN Modem
  - RPM Cortex M3
  - GNSS Modem

Memory Support
- EB10
- Internal memory
- Secure Digital (SDC1)

Multimedia
- MDP
  - 4-lane DSI
  - CAMIF timing
  - 4-lane CSI
  - 2-lane CSI
- Video front-end (VFE)
  - Video encoders / decoders
  - Adreno 3D graphics
  - Audio
  - LPA, Codecs

Air Interface
- GPS
  - GPS, Galileo, Beidou, Glonass

GPIOs / PWR
- Internal functions
  - Resource & PWR mgmt.
  - Security
  - Mode / config / reset
  - Thermal sensors
  - GP clock & PDM outs
  - JTAG
  - Clock generation

Display 1
- eMMC
- NAND Flash
- LPDDR3 SDRAM
- Display

General housekeeping
- Input PWR mgmt.
- Output PWR mgmt.
- IC level interface
- Audio Codec
- PM8916

User Interface
- Ext. charge
- Buttons
- LEDs
- Audio devices
- Supply voltages
- SPMI
- Sensors
- Clocks
Snapdragon 600E typical application

Chipset I/F
- Serial busses
- Discrete stat & ctrl
- GNSS ADC
- WLAN DACs, WLAN ADCs

Connectivity
- SDC 4 (w/ WCN ic)
  - 2x 12S Mics
  - 2x 12S Sptkr
  - MII
  - 2x TSIIFs
- UART
- I2C
- SPI
- Extra SPI chip selects
- Secure Digital (SDC2)
- Secure Digital (SDC3)
- PCM (audio)
- MIPI/SlimBus
- 1x USB (UICC)
- 3x USB (w/ PHY)
- PCIe

APQ8064E
- Processors
  - App quad-Krait uP
  - DSP QDSP6
  - WCN ARM9 uP
  - RPM ARM7 uP
  - GNSS Cortex A5 uP

Memory Support
- EBI0
- EBI1
- Internal memory
- Secure Digital (SDC1)

Multimedia
- LVDS
- HDMI
- 4-lane DSI
- 4-lane DSI
- Video front-end (VFE)
- Video encoders / decoders
- Adreno 3D graphics
- Audio
- LPA, Codecs

Air Interface
- GPS
- GPS, Galileo, Beidou, Glonass

GPIOs / PWR
- Internal functions
  - Resource & PWR mgmt.
  - Security
  - Mode / config / reset

- Thermal sensors
- GP clock & PDM outs
- JTAG
- Clock generation

Input PWR mgmt.
- Output PWR mgmt.
- User Interface
- IC level interface
- General housekeeping

Ext. charge
- Supply voltages
- Output PWR mgmt.
- Buttons
- Ext. source
- Users
- LEDs
- IC level interface
DragonBoard™ 410c development board overview

Powerful processing and multimedia capabilities
- Snapdragon 410E Processor
- Quad-core ARM Cortex A53
- Adreno 400MHz PC-class graphics
- Power management and audio codec

Memory and storage
- 1GB LPDDR3
- 8GB eMMC 4.5
- Micro SD card slot

A wide array of expansion capability
- One 40-pin low-speed (LS) expansion connector
- One 60-pin high-speed (HS) expansion connector
- Footprint for one optional 16-pin analog expansion connector
  - e.g. Stereo headset/line-out, speaker and analog line-in

Integrated connectivity
- Wi-Fi, Bluetooth, GPS
- On-board Wi-Fi & GPS antennas

I/O Interfaces
- HDMI full-size
- USB
DragonBoard™ 410c - an evaluation and enablement tool

https://www.96boards.org/product/dragonboard410c/

https://www.96boards.org/products/mezzanine/
Software Overview
## HLOS supported for community and commercial use

### Commercial Distributions

<table>
<thead>
<tr>
<th>Distribution</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linux Open Embedded/Yocto from Qualcomm Technologies</td>
<td>- Recommended for commercial customers</td>
</tr>
<tr>
<td></td>
<td>- Tested and packaged by Qualcomm Technologies</td>
</tr>
<tr>
<td></td>
<td>- Highly flexible and customizable</td>
</tr>
<tr>
<td></td>
<td>- Upstream LTS kernels</td>
</tr>
<tr>
<td></td>
<td>- Variety of 3rd parties providing support services</td>
</tr>
<tr>
<td>Ubuntu Core</td>
<td>- Recommended for commercial customers</td>
</tr>
<tr>
<td></td>
<td>- Supported on Snapdragon 410E embedded platform</td>
</tr>
<tr>
<td></td>
<td>- Support via 3rd parties</td>
</tr>
<tr>
<td>Windows 10 IOT Core</td>
<td>- Recommended for commercial customers</td>
</tr>
<tr>
<td></td>
<td>- Supported on Snapdragon 410E embedded platform</td>
</tr>
<tr>
<td></td>
<td>- Support via 3rd parties</td>
</tr>
</tbody>
</table>

### Community Distributions

<table>
<thead>
<tr>
<th>Distribution</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linux Debian from Linaro</td>
<td>- Developed for community by Linaro</td>
</tr>
<tr>
<td></td>
<td>- Out of the box Desktop experience for evaluation and fast prototyping</td>
</tr>
<tr>
<td></td>
<td>- Upstream LTS kernels</td>
</tr>
<tr>
<td></td>
<td>- Community support through 96boards.org forums</td>
</tr>
<tr>
<td>Linux Open Embedded/Yocto from Linaro</td>
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<td></td>
<td>- Highly flexible and customizable</td>
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<td>- Upstream LTS kernels</td>
</tr>
<tr>
<td></td>
<td>- Community support through 96boards.org forums</td>
</tr>
<tr>
<td>Android</td>
<td>- For hobbyist projects</td>
</tr>
<tr>
<td></td>
<td>- Supported on DragonBoard 410c</td>
</tr>
</tbody>
</table>
## Software Features (Snapdragon 410E)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OS</strong></td>
<td>Linux Open Embedded/Yocto Morty, Kernel 4.9 -&gt; 4.14</td>
</tr>
<tr>
<td><strong>Wireless Connectivity</strong></td>
<td>WiFi STA and HostAP (supplicant and network manager layers)</td>
</tr>
<tr>
<td></td>
<td>Bluetooth via BlueZ Stack</td>
</tr>
<tr>
<td></td>
<td>GPS via GPSD</td>
</tr>
<tr>
<td><strong>Wired Connectivity</strong></td>
<td>Flash Memory, SD Card (storage and boot)</td>
</tr>
<tr>
<td></td>
<td>USB - storage, HID, Camera, Ethernet, Audio, 3G/4G modem</td>
</tr>
<tr>
<td></td>
<td>GPIOs, I2C, SPI, UART (96board compliant)</td>
</tr>
<tr>
<td><strong>Display/Video/Graphics</strong></td>
<td>HDMI/DSI, Xorg and Wayland, OpenGL, Accelerated Video decoding and encoding (H.264 via V4L2)</td>
</tr>
<tr>
<td><strong>Audio</strong></td>
<td>Analog, HDMI, USB, BT via ALSA or pulseaudio</td>
</tr>
<tr>
<td><strong>Camera</strong></td>
<td>MIPI CSI YUV, USB</td>
</tr>
<tr>
<td><strong>Security</strong></td>
<td>Secure Boot</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>Chromium Browser (not accelerated)</td>
</tr>
<tr>
<td></td>
<td>Fastboot</td>
</tr>
<tr>
<td></td>
<td>Qualcomm Technologies tools (QPST, QRCT, QXDM)</td>
</tr>
</tbody>
</table>
Software Features (Snapdragon 600E)

**OS**
Linux Debian Sid, Kernel 4.14

**Wireless Connectivity**
WiFi STA and HostAP (supplicant and network manager layers)
Bluetooth via BlueZ Stack

**Wired Connectivity**
Flash Memory, SD Card
USB - storage, HID, Camera, Ethernet, Audio, 3G/4G modem
GPIOs, I2C, SPI, UART (96board compliant)

**Display/Video/Graphics**
HDMI, Xorg, OpenGL

**Audio**
HDMI, USB, BT via ALSA or pulseaudio

**Other**
Chromium Browser (not accelerated)
Fastboot
Upstream and Software Updates

“Upstream First” Paradigm

• Features are developed and upstreamed as early as possible

Open Source  Easy to work with  Enables generic Linux developers to work with our products

Major Annual Updates (~March)

• Long Term Support (LTS) Kernels
• Open Embedded / Yocto Upgrades

Minor Quarterly Feature and Fixes Updates

• Cadence may be reduced in later stages of the product life
Linaro and 96boards

Linaro's mission is to lead collaboration in the ARM ecosystem by bringing together industry and the open source community to work on key projects, deliver great tools, reduce industry wide fragmentation, avoid redundant effort, and provide common software foundations for all. The mission is not exclusive to ARM - Linaro can work on other architectures and technologies where the work benefits Linaro members and the ARM ecosystem.

https://www.linaro.org

About 96Boards

96Boards is a range of hardware specifications created by Linaro to make the latest ARM-based processors available to developers at a reasonable cost. The specifications are open and define a standard board layout for SoC-agnostic (processor independent) development platforms that can be used by software application, hardware device, kernel and other system software developers. Boards produced to the 96Boards specifications are suitable for rapid prototyping, hobbyist projects or incorporation into new systems for a wide range of applications including desktop and laptop computing, the digital home, digital signage, point of sale (POS), high-end audio, robotics and drones, artificial intelligence, virtual reality, IoT and industrial control.

Standardized expansion buses for peripheral I/O have led to a wide range of compatible add-on mezzanine boards that will work across a variety of 96Boards products. Users have access to a wide range of boards with different features at various price points. In addition, some SoC vendors have announced long term availability of the SoC to encourage their use in products with long life cycles.

https://www.96boards.org
Ecosystem

96boards.org Forums

- https://discuss.96boards.org/c/products/dragonboard410c

3rd party Software Providers

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<thead>
<tr>
<th>eInfochips</th>
<th>Intrinsyc</th>
<th>Inforce Computing</th>
<th>MM Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>HW and SW consulting and support</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Camera tuning, features and support</td>
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Forums @96boards.org

https://discuss.96boards.org/c/products/dragonboard410c
# Online Resources

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<thead>
<tr>
<th>Webpage Name</th>
<th>URLs</th>
<th>Content / Used for</th>
</tr>
</thead>
</table>
| Qualcomm Developer Network       | • [https://developer.qualcomm.com/hardware/snapdragon-410e](https://developer.qualcomm.com/hardware/snapdragon-410e)  
|                                  | • [https://developer.qualcomm.com/hardware/snapdragon-600e](https://developer.qualcomm.com/hardware/snapdragon-600e)  
• [https://developer.qualcomm.com/hardware/snapdragon-600/tools](https://developer.qualcomm.com/hardware/snapdragon-600/tools) | Snapdragon 600E documentation                                                      |
|                                  | • [https://developer.qualcomm.com/hardware/dragonboard-410c](https://developer.qualcomm.com/hardware/dragonboard-410c)  
• [https://developer.qualcomm.com/hardware/dragonboard-410c/software](https://developer.qualcomm.com/hardware/dragonboard-410c/software) | DragonBoard 410c documentation, access to public proprietary blobs (FW) for SW build reproduction |
|                                  | • [https://discuss.96boards.org/c/products/dragonboard410c/](https://discuss.96boards.org/c/products/dragonboard410c/) | Community Forums                                                                   |
| Code Aurora                      | • [https://www.codeaurora.org/openembedded-mass-market-and-ioe-qualcomm-snapdragon](https://www.codeaurora.org/openembedded-mass-market-and-ioe-qualcomm-snapdragon) | OpenEmbedded for Snapdragon Embedded project code repository                        |
Thank you

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