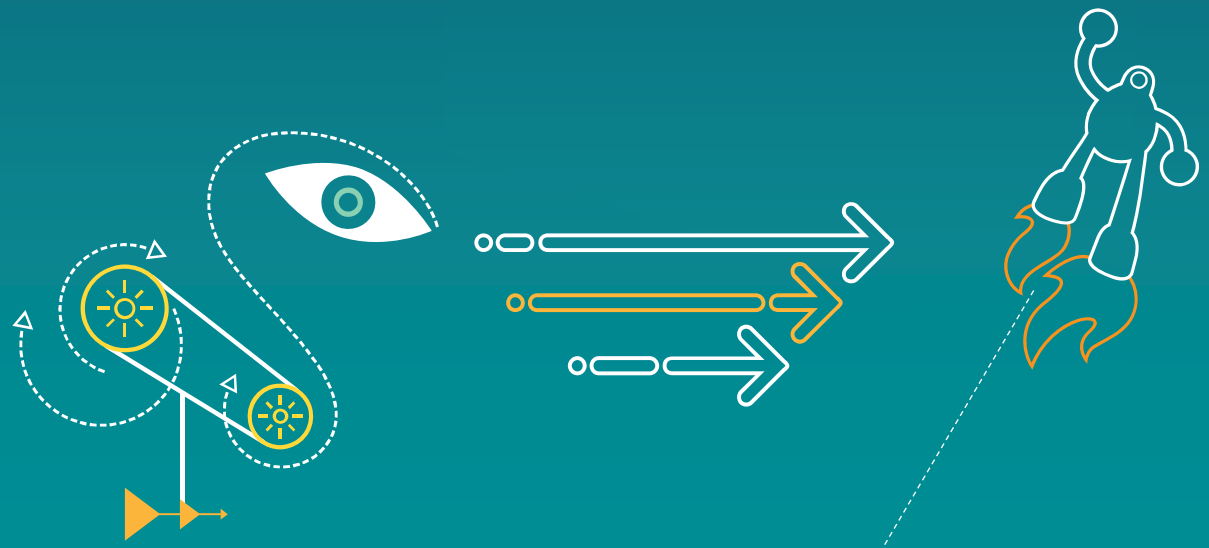
Leon Farasati
Staff Product Manager, Qualcomm
@LeonFarasati

Embedded Development on Android Using the DragonBoard™ Dev Kit

QUALCOMM®



Mobile: A Vibrant, Unprecedented Opportunity

~6.6B+

Mobile Connections

$1.5T

Global Mobile Revenues

#1

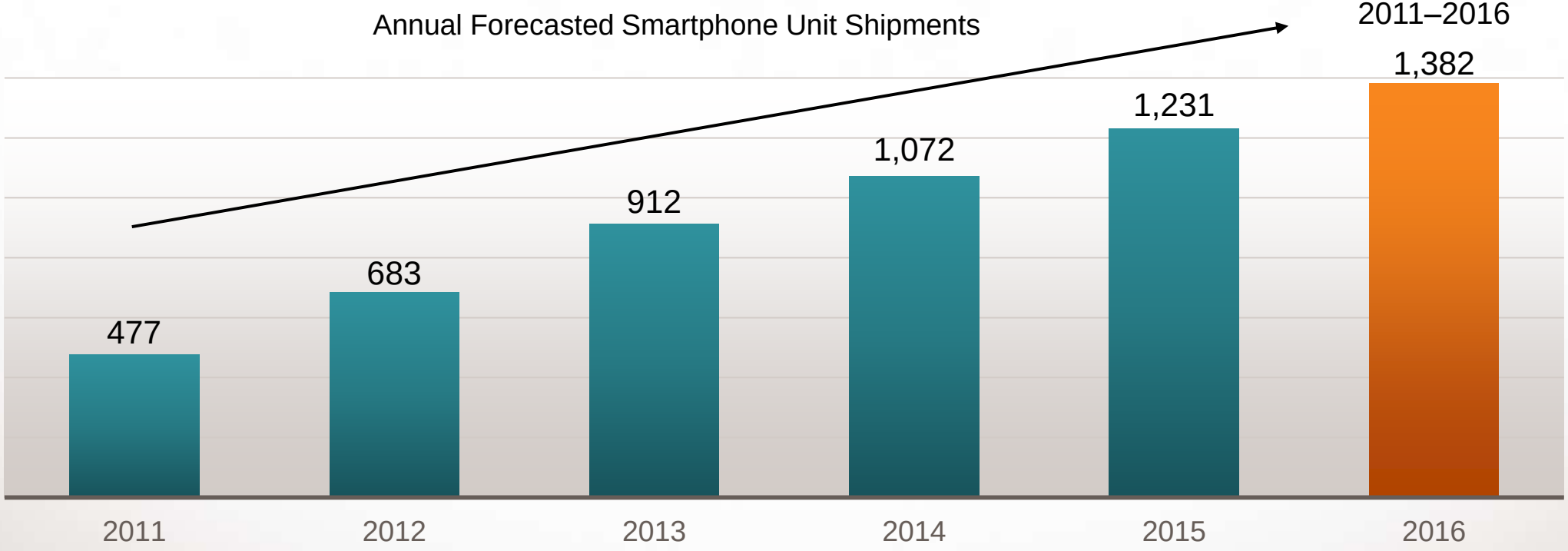
Most Used Device

Source: Wireless Intelligence, Jan. 2013, CIA World Factbook, Dec. ’11, Chetan Sharma Consulting, May, 2012

Continued Smartphone Momentum

Displacing Feature Phones

24% CAGR
2011–2016



Cumulative Smartphone Unit Sales Forecast Between 2012–2016

~5B

Source: Average of Gartner, Oct. ’12; Strategy Analytics, Aug. ’12

Expanding Areas for Smartphone Innovation

CPU
2MB L2 (8064 only) · aSMP · Custom Krait · High Performance Floating Point · Custom System Interconnect · Web Tech Innovations

GPU
FlexRender™ Technology · GPGPU Compute for Imaging/Video (Renderscript, OpenCL, LLVM) · Unified Shader Architecture · Stereoscopic Rendering · Profiling Tools · Low Power Innovations · Accelerated WebGL

DSP/Multimedia
20x Digital zoom · 21 MPix · Zero Shutter Lag · 7.1 Surround Playback · Stereo 3D video · Ultrasound · 5.1 Surround Camcorder · 1080P HD video · Computational Camera · Browser with HTML5 and 1080p Flash · Noise cancellation

Modems
LTE World Mode · LTE Broadcast · Coexistence with connectivity · LTE TDD · VoLTE / SRVCC · RF Multi-band · TD-SCDMA · Advanced Receivers · Power Optimization

Connectivity
GPS/GNSS · Indoor Location · BT · .11ac · Miracast · Coexistence with WWAN · FM · Multiband

Sensors
Proximity · Pressure · Ambient light · Gestures · Accelerometer · Humidity · Temperature · Gyroscope · IR Sensing · Magnetometer

Displays
Content Adaptive Backlight · MEMS · 3D · Color correction · Wireless Display · Frame Buffer Compression

Qualcomm snapdragon · Qualcomm gobi · Qualcomm ATHEROS · mirasol · pixtronix

Smartphone Experience Becoming the Expectation in Other Device Categories

Always Connected

Always On and Up to Date

Power Efficient

Mobile is Redefining Computing

High Performance Computing

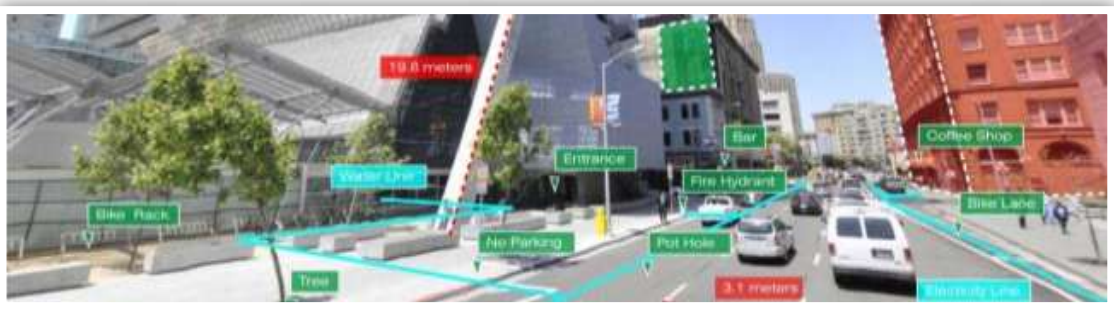
- High resolution screens
- Responsive devices
- Fast, always-on connectivity
- Rich multimedia experience

Without Compromising Mobility

- Sleek, ultra-light
- Longer battery life
- Thermal efficiency

Overcoming I/O Limitations

WiFi Display



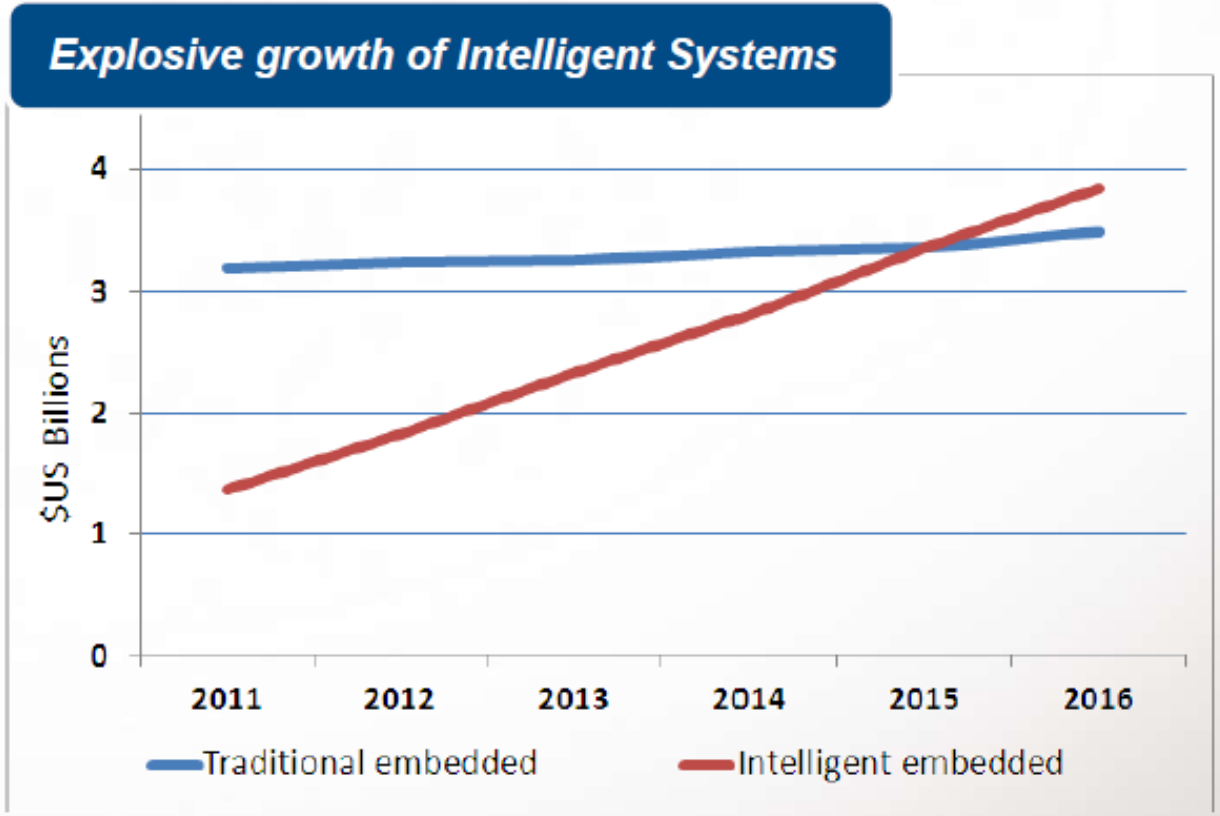
Augmented Reality

Ultrasound Pen Input

Gesture/Movement Recognition

The Next Disruption?

- Internet of Everything
- Digital 6th sense
  - The smartphone has already become the center of our connected lives
  - Mobile blurring the lines between the digital and physical worlds
- Embedded platforms converging with consumer device application platforms
- Touchscreens everywhere!
- Android-based Cameras, Smart TV's running Android apps, Automotive, Digital Signage, …



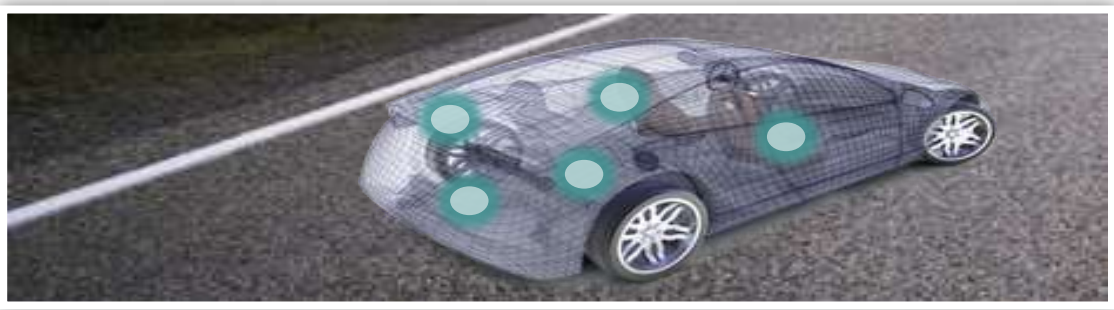
Source: *Worldwide Intelligent Systems 2012-2016 Forecast: The Next Big Opportunity Accelerates.*, Doc #235404. June 2012

Source: IDC Predictions 2013: Application Development and Deployment, 1/24/2013

Internet of Everything

Everything Around Us is Becoming Intelligent and Connected

IoE Verticals



Automotive

Industrial

Health and Fitness

Home

Everything Around Us Is Becoming Intelligent and Connected

Quantity of Content Coming Into the Home Will More Than **Triple** by 2016

Source: Cisco Visual Networking Index, May ’12

Digital 6th Sense

Benefits of Application Processors for Embedded

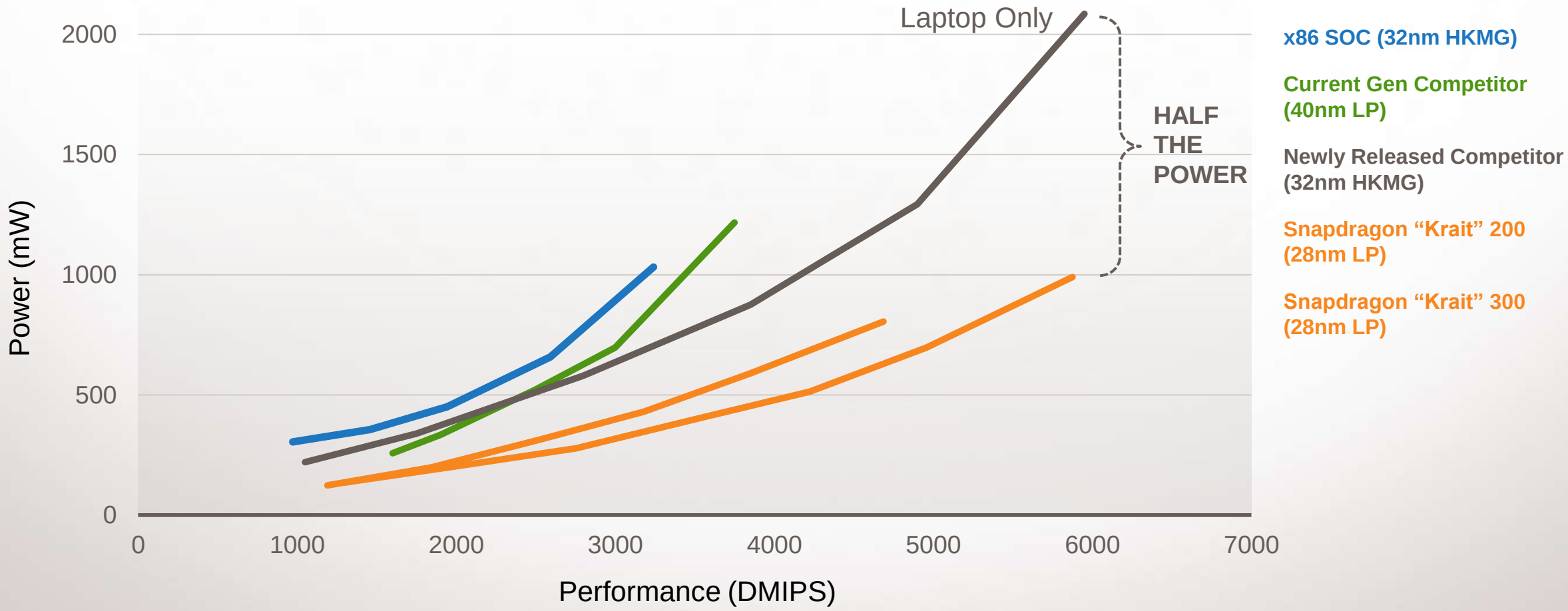
- Power, Power, Power
  - No Fans, no noise
  - Reduced thermal constraints rendering smaller industrial design
  - Portability, mobility, battery operated
  - Lower cost power supplies
- Feature rich, new capabilities
  - Multiple HD Cameras and microphone arrays
  - Video/Audio/2D & 3D Graphics processors
  - Multiple HD Displays
  - Sensors: 3D accelerometers, 3-axis gyro, compass, ambient light, proximity, temperature & pressure, humidity, medical, chemical, ultrasound pen and gestures, finger print reader, etc
  - Location services
  - Computer vision

Why Snapdragon for Embedded Computing?

1. High-performance CPU
2. Energy efficiency
3. Graphics processing unit (GPU)
4. Multimedia capabilities
5. Dedicated digital signal processor (DSP)

CPU Leadership Now and into Next Generation

Highest Performance at the Lowest Power



Source: Qualcomm lab testing

Adreno 320 GPU: Immersive Visual Experiences

Redefining Mobile Graphics

Adreno 225

Adreno 320 GPU: Immersive Visual Experiences

Redefining Mobile Graphics

Adreno 320

More Advanced Lighting Effects

>2x

Performance Improvement

Support for Larger Displays and Higher Resolutions

More Detailed Textures for Improved Visual Realism

More Complex Scenes at High Frame Rate

Custom DSP Architecture

Enabling Rich User Experiences Without Sacrificing Battery Life

Harnessing Developer Innovation

- Open architecture
- DSP access program
- Large installed base

Delivering Rich Experiences

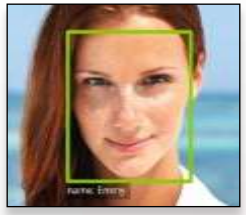
Gestures

Voice Quality

Image Processing

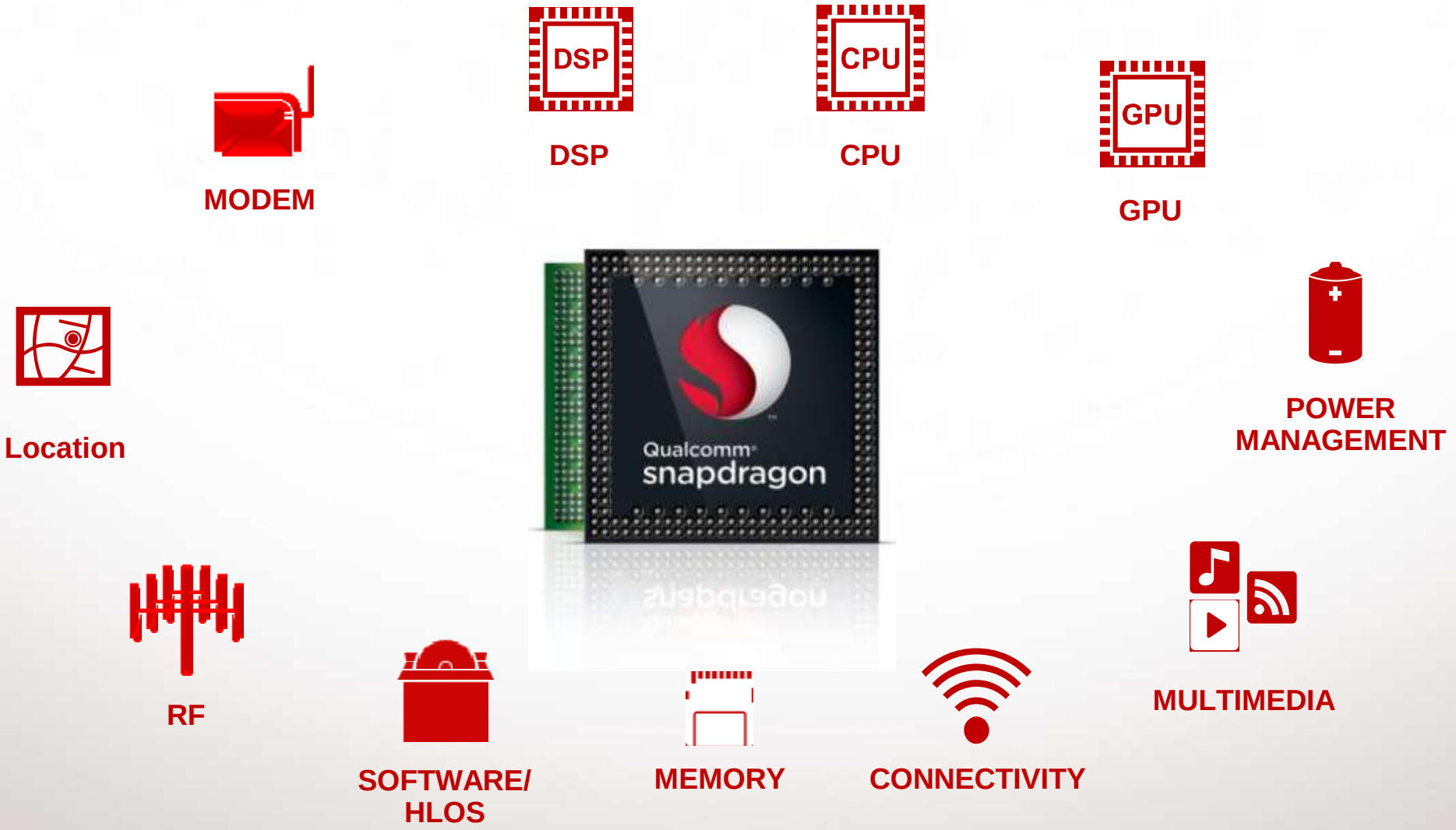
Augmented Reality

Object Recognition

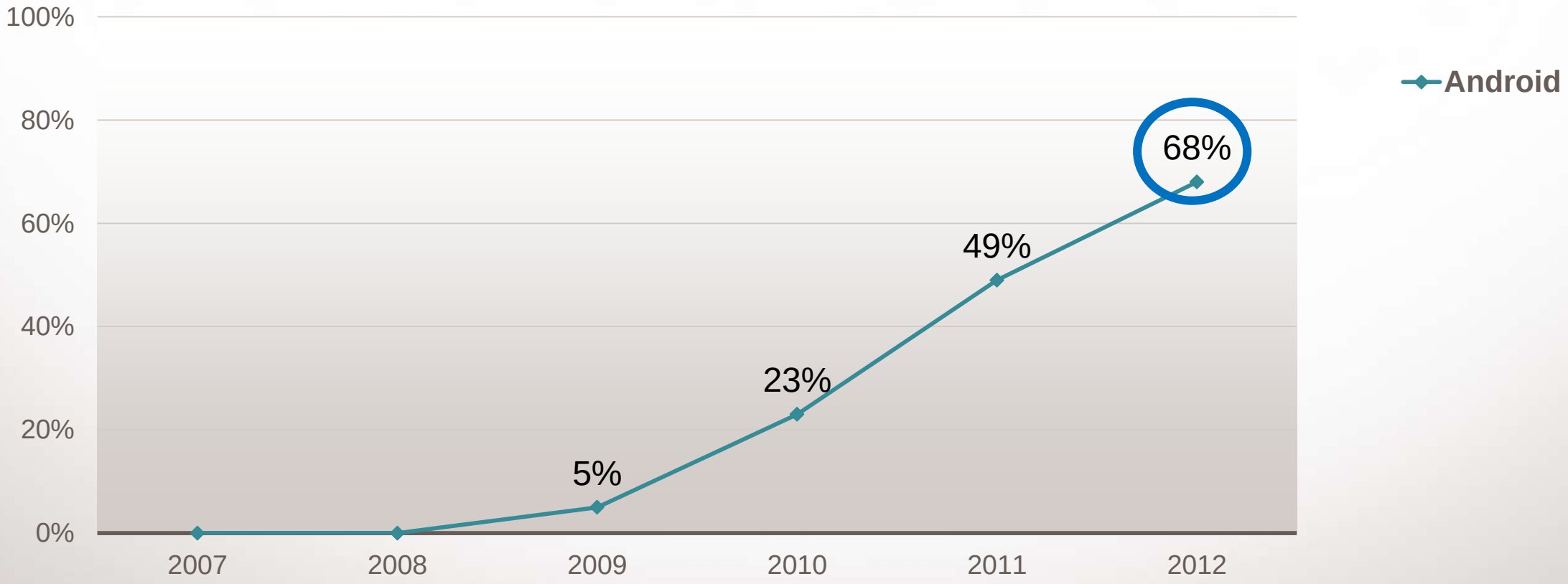


High Definition Audio

Diverse Leading Technologies in One Design



Android Leading Global Smartphone OS Market Share



Global Smartphone OS Market Share: 2007-2012

Source: Strategy Analytics Insight – Wireless Smartphone Strategies – Jan 28, 2013

Why Android for Embedded?

- Standardized development environment
- Skilled developer community
- Royalty free… (Google provides Android at no charge)
- Linux as the foundation
- Source code access, destiny in your hands
- Massive investment as a platform

DragonBoard™

A powerful, feature-rich, versatile and easy-to-use exposed board platform for component vendors, software and embedded developers. It consists of a complete System on Module (SoM) with a Snapdragon processor, a mini-ITX carrier board and a peripheral kit.

DragonBoard Target Users

DragonBoard
A building block for innovation and development around Qualcomm's Snapdragon processors

SW Technology Vendors
Port SW on Qualcomm Platform

- Video
- Audio
- Graphics
- Computer Vision
- Speech

HW Component Vendors
Develop drivers on Qualcomm Platform

- Sensors
- Memory
- Display
- Camera
- Projectors

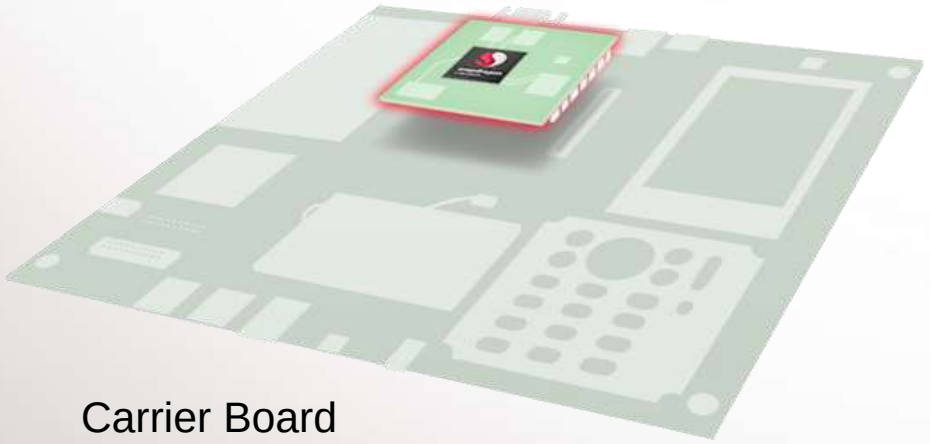
Embedded Market
Build product/project on Qualcomm Platform

- Digital Signage
- Video Surveillance
- Toys
- Government
- Hobbyists

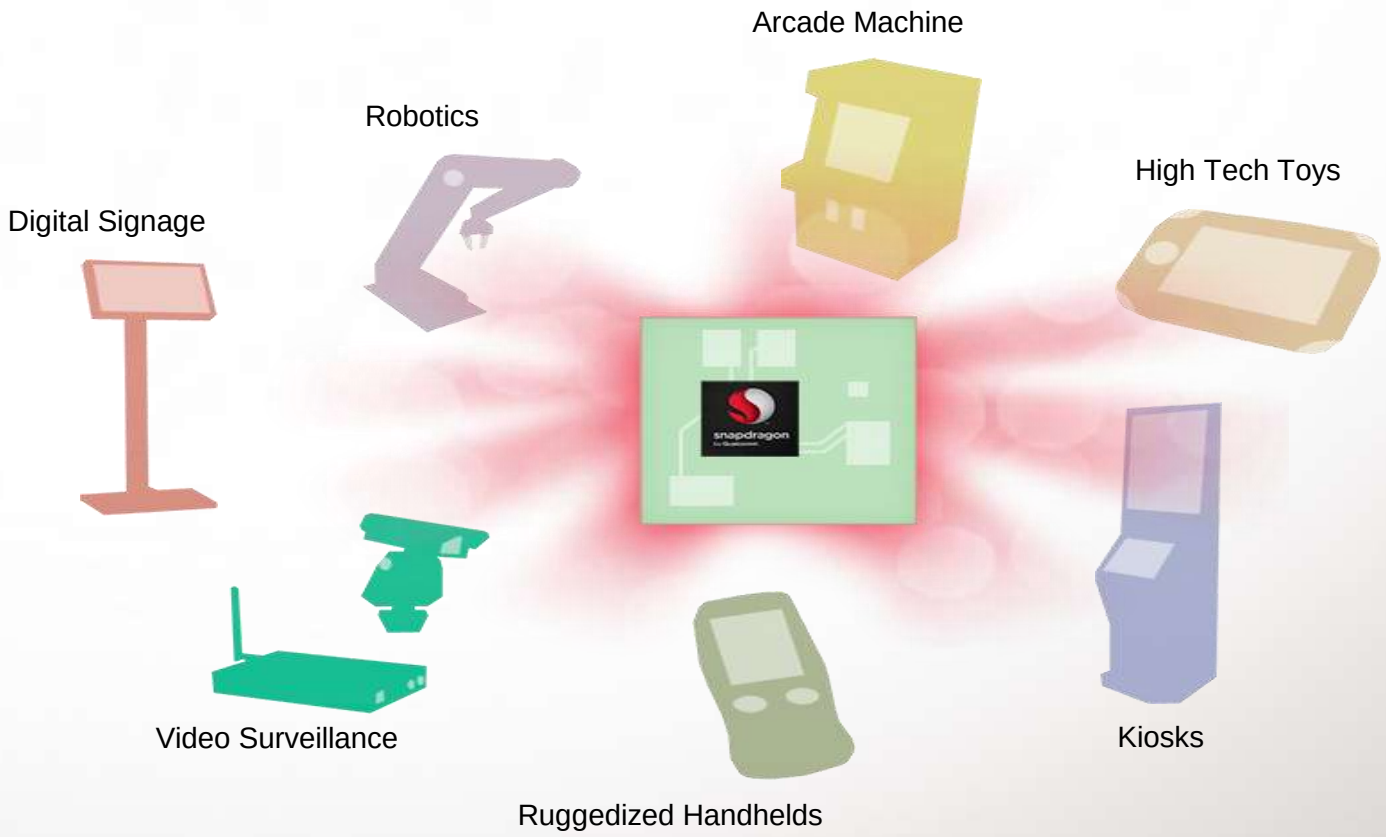
Universities
Research & teach on Qualcomm Platform

DragonBoard with SOM

System on Module (SOM)

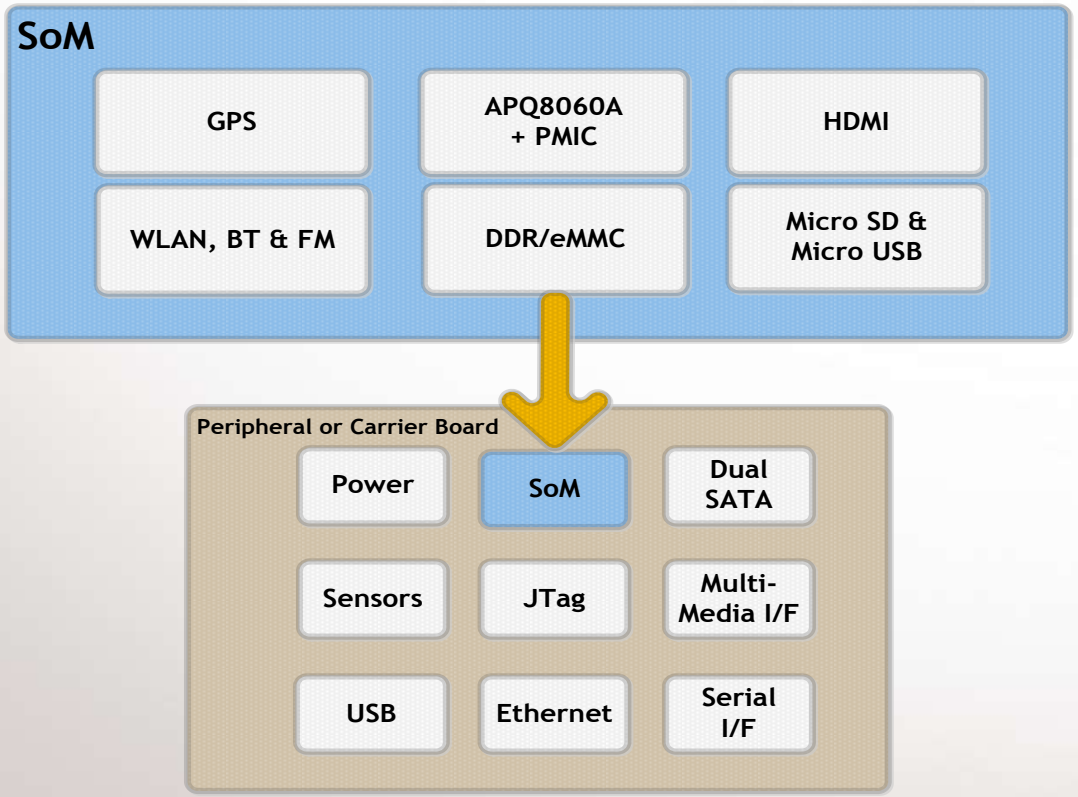


Carrier Board



DragonBoard Design Approach and Benefits

- Stand alone System-on-Module (SoM) with a Carrier Board

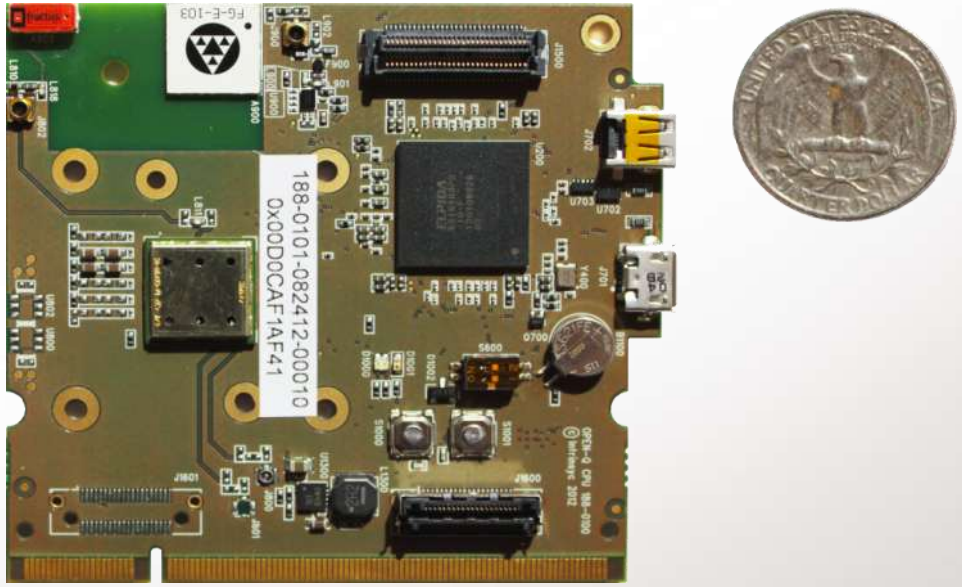


- The SoM is easily integrated into a custom carrier board to create a fully customized solution, but without the full design effort.
  - Best in class ARM™ performance
  - Production ready module
  - Compact form factor
  - Comprehensive software support
- the SoM approach reduces product development costs while decreasing time to market and technical risk.

Intrinsyc OPEN-Q™ SoM Specifications

- Small form factor, high performance platform designed for OEM production
  - Snapdragon S4 Plus APQ8060A
  - 1GB of DDR2 RAM
  - 4GB of eMMC
  - HDMI output
  - Micro SD
  - Micro USB
  - GPS, Wi-Fi, Bluetooth 4.0, and FM radio
  - PMIC with battery support
  - Main and secondary cameras (MIPI) connectors
  - Display (MIPI-DSI) connector

- The SoM is sold separately and is a stand alone production ready module.
- The SoM footprint is 2.5 x 2.6 inches



DragonBoard™ Development Kit

- Intrinsyc Software's DragonBoard™ Development Kit is a full featured Android™ development platform
- The DragonBoard™ Development Kit includes all of the software tools and accessories required to immediately begin development work.
- The DragonBoard™ Development Kit:
  - Main Board (OPEN-Q™ SoM)
  - Carrier Board
  - Peripheral Kit (LCD, Sensor Board, Battery Pack and 8MP Camera.)
  - Power Adapter
  - Android 4.0 OS pre-loaded
  - Quick Start Guide
  - Registered access to web site

- Available now at:
  - http://www.intrinsyc.com/products/qualcomm/dragonboard.aspx

Software, Support and Documentation

- **Open Source Support Sites**
  - Open source community for Qualcomm Snapdragon processors: https://www.codeaurora.org/xwiki/bin/QAEP/
- **Developer Support Sites**
  - Dragonboard product descriptions, FAQs, blogs and forums:

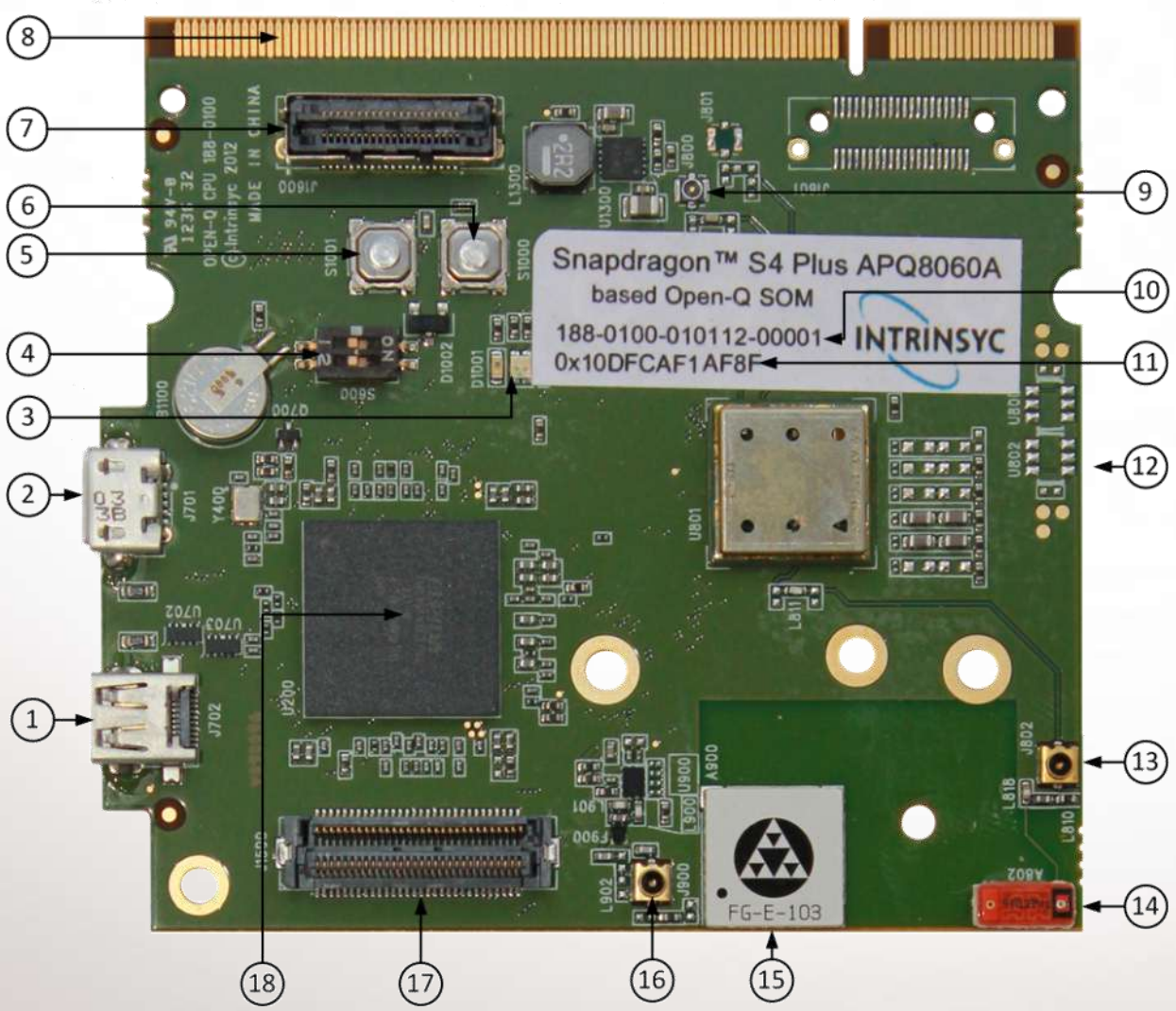
    http://mydragonboard.org/apq8060a/
  - Advanced software solutions and tools for Snapdragon:

    https://developer.qualcomm.com/mobile-development/mobile-technologies
- **Intrinsyc Support Site**
  - Development Kit and SoM store and product descriptions

    http://www.intrinsyc.com/products/qualcomm/dragonboard.aspx
  - Dragonboard customers only area for documentation and software updates

    http://dragonboardsupport.intrinsyc.com/login?back_url=http%3A%2F%2Fdragonboardsupport.intrinsyc.com%2F

APQ8060A-based OPEN-Q SoM Interfaces

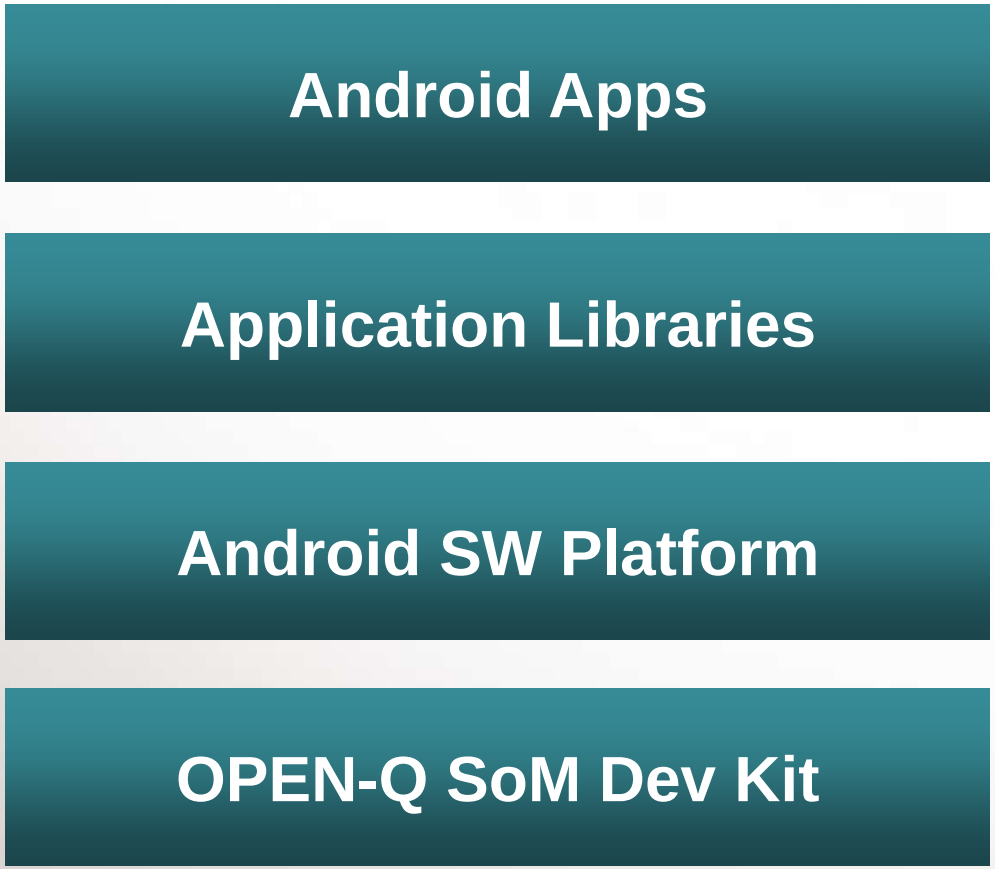


1. Micro HDMI Connector
2. USB Micro AB
3. LEDs for power and charging
4. Boot Configuration DIP Switch
5. Reset Button
6. Power Button
7. Camera Connector
8. Carrier Board Connector
9. FM Antenna Connector
10. CPU board serial number
11. Wi-Fi MAC address
12. Micro SD (on bottom side)
13. External Wi-Fi/Bluetooth Antenna Connector
14. Wi-Fi/Bluetooth Antenna
15. GPS Antenna
16. External GPS Antenna Connector
17. LCD Connector
18. LPDDR2 on top of APQ8060A Processor

DragonBoard Development Kit Interfaces

1. SPDIF (footprint only)
2. Audio Test Connector
3. JTAG Connector
4. FM Antenna footprint
5. SODIMM Connector to CPU Board
6. 3.7V Lithium Ion 18650 Battery
7. Headset Jack 3.5 mm TRRS
8. ANC Headset Connector
9. Infrared Board Connector
10. Focus/Snapshot Dual Action Button
11. Volume/Zoom button -
12. Volume/Zoom button +
13. Qualcomm Sensor Board Connector
14. Education Expansion Connector
15. ST Micro Sensor Board
16. NFC Board Connector
17. SIM Socket for NFC (on bottom side
18. ATX Power Status LED
19. ATX Power Connector
20. Ethernet LED
21. SATA Configuration Button
22. USB LED x 6
23. Dual USB Header Connector
24. 5V/2A DC Adapter Connector
25. SATA port x 2
26. USB x 2 and 10/100 Ethernet
27. 5.1 Audio Line In/Out
28. DB9 Serial (Debug UART)

Android Software & Hardware Layers



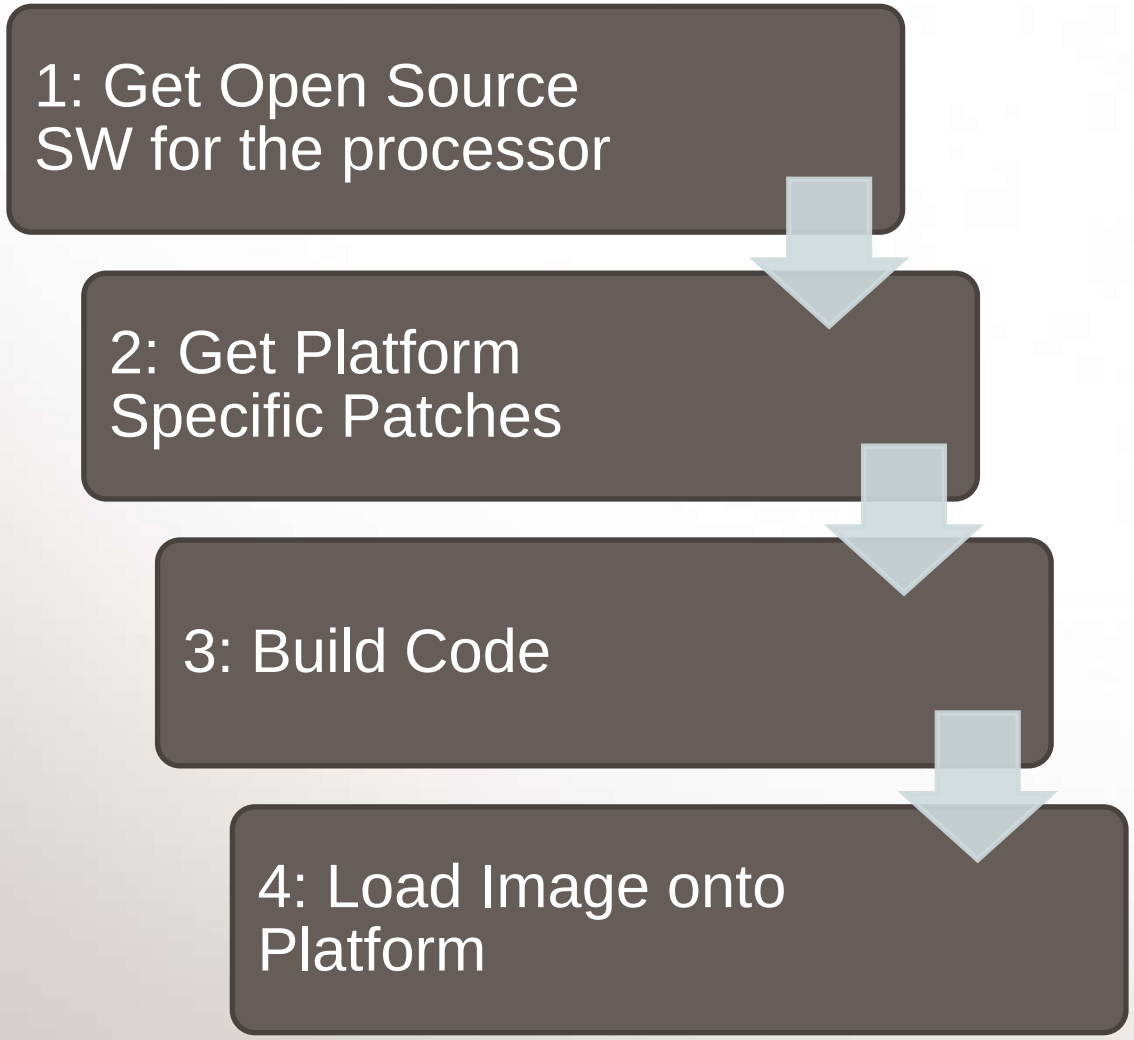
- **User Applications**
  - Vertical specific applications
  - Differentiated user experiences
- **Application Libraries**
  - Qualcomm Snapdragon SDKs & API's
  - Optimized for Snapdragon HW
- **Android SW Platform**
  - Bootloader, Kernel & Drivers
  - Android Framework
  - Android Services
- **Snapdragon S4 Plus Based Development Kit**
  - Hardware Layer
  - CPU, Memory & Peripherals

Android Software Platform

- **Two main sources:**
  - Code Aurora Forum (CAF)
  - Intrinsyc support site
- **The CAF open source site:**
  - Hosts the open source community for Qualcomm Snapdragon processors
- **Intrinsyc customer site:**
  - Hosts Intrinsyc's bootloader and platform specific patches to support the DragonBoard Development Kit
  - Hosts licenced firmware and HW acceleration libraries (DSP/Codecs/GPU/WLAN)
  - Site accessible by registered DragonBoard owners

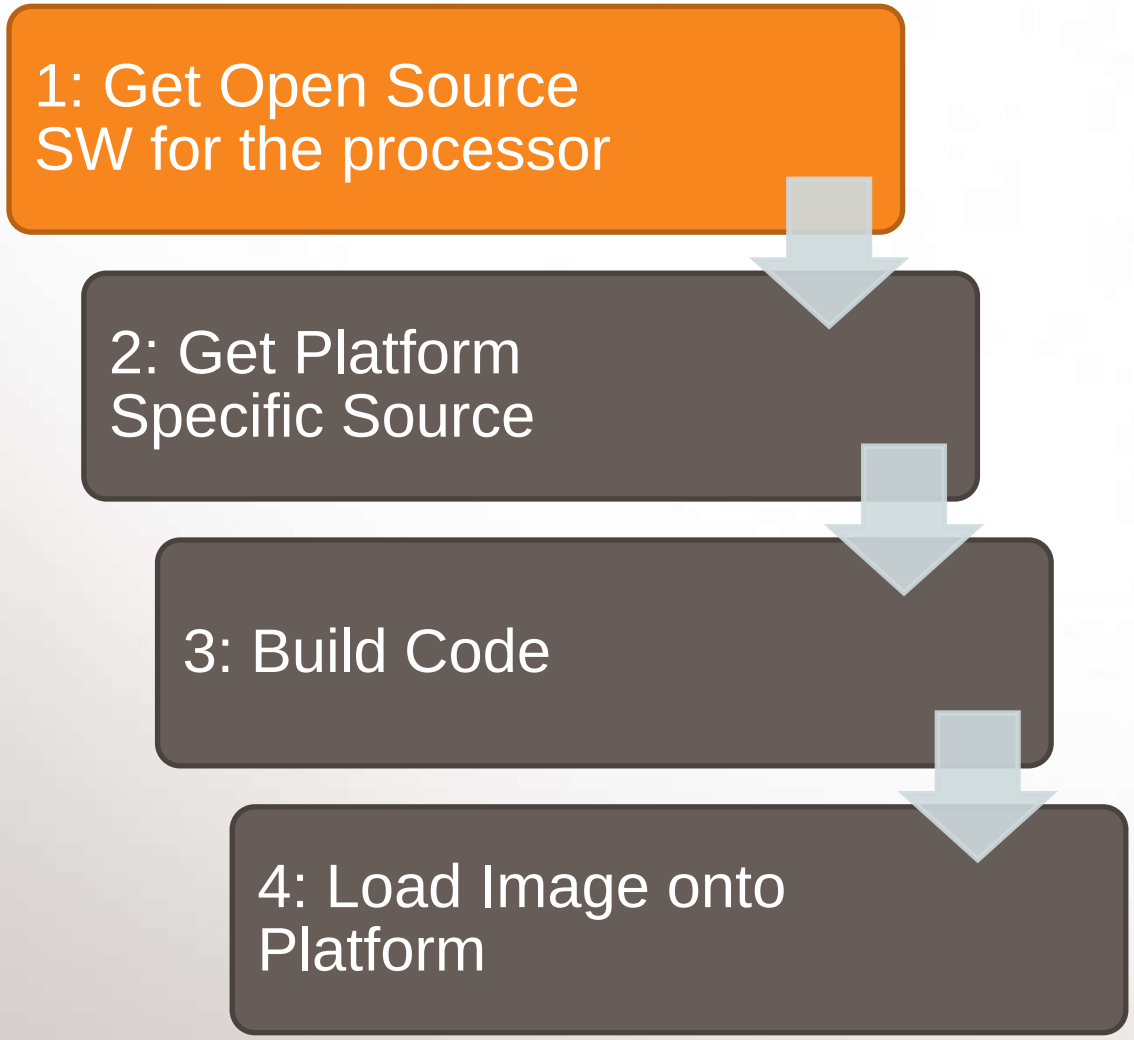
Building the Android Software Platform

Step by Step



- There are four major steps for building the Android software platform for the Development Kit:
  1. Get Open Source for the CPU
  2. Get Platform Specific Patches, plus firmware libraries
  3. Build Code
  4. Load Image onto Platform
- The process is documented in detail in Intrinsyc's release notes and Development Kit Programming Guide

Building the Android Software Platform



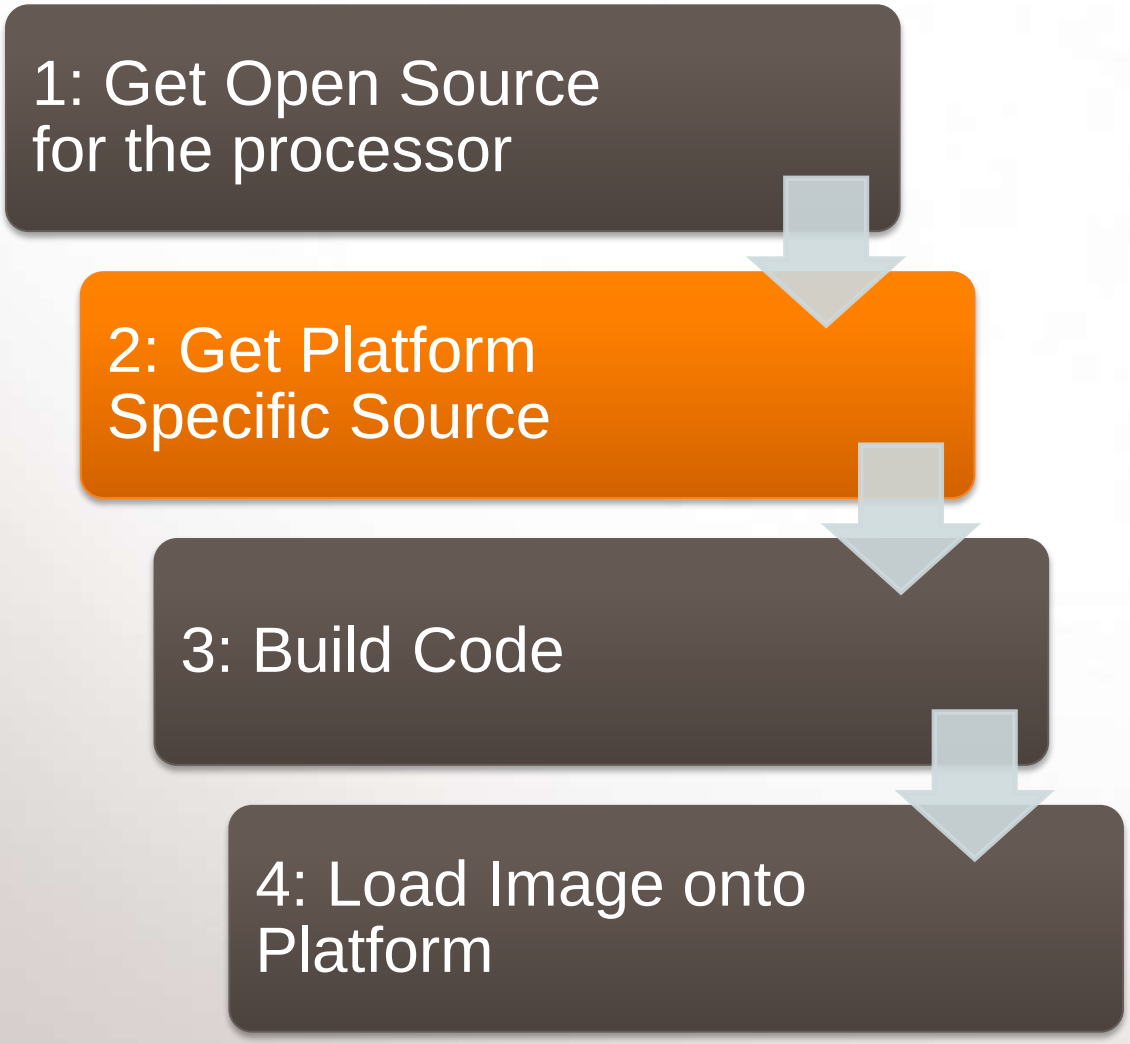
- Make sure that the build environment has been completely and correctly set up as described by the Android Open Source Project instructions:

  http://source.android.com/source/download.html

- Download the kernel and Android framework code for the APQ8060A processor from CAF (codeaurora.org) using Repo:
  1. repo init -u git: //codeaurora.org/platform/manifest.git -b ics_chocolate -m M8960AAAAANLYA1050.xml –repo-url=git://codeaurora.org/tools/repo.git
  2. repo sync
- The Wiki support site for Qualcomm Snapdragon chipsets can be found here:

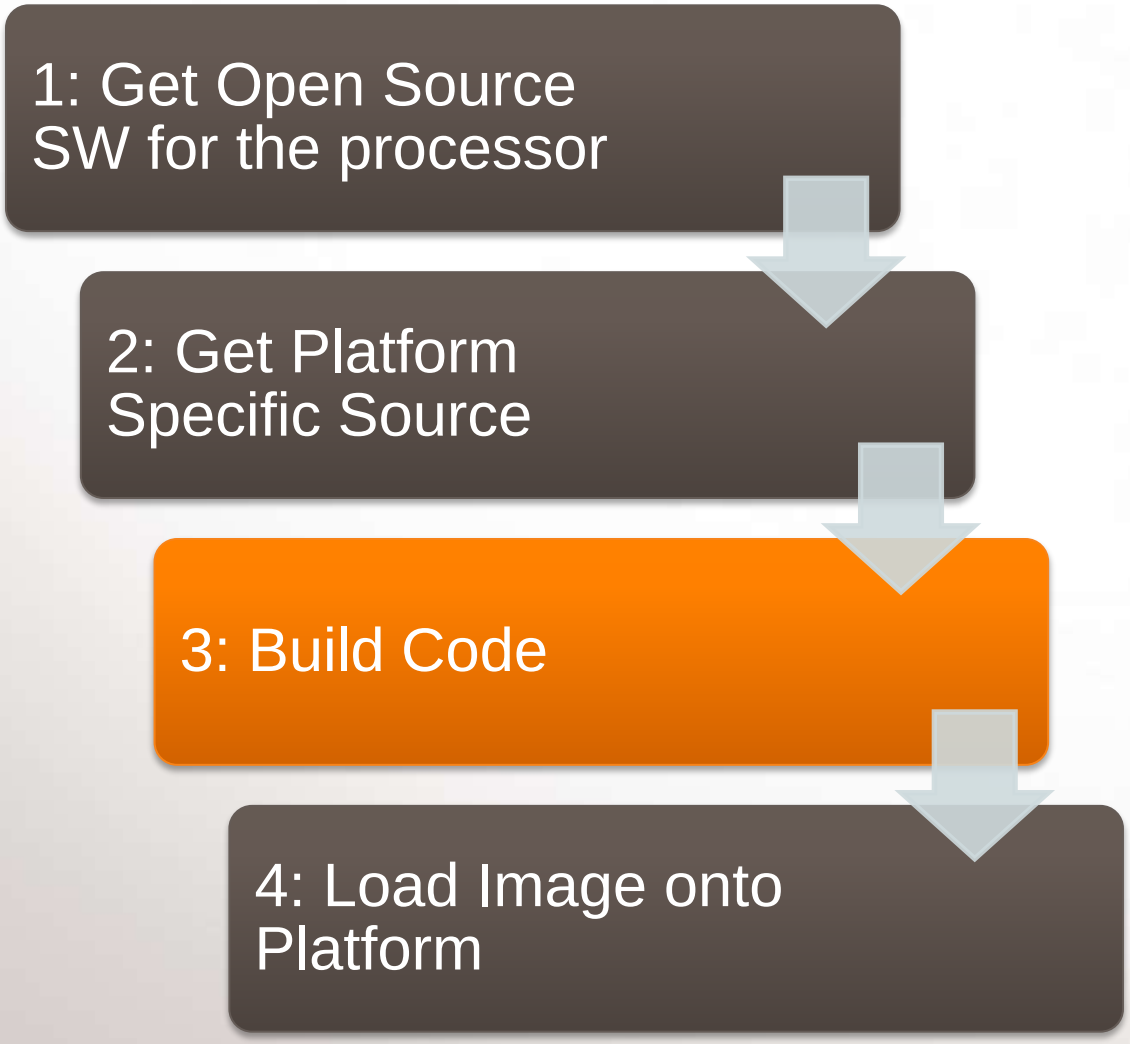
  https://www.codeaurora.org/xwiki/bin/QAEP/

Building the Android Software Platform



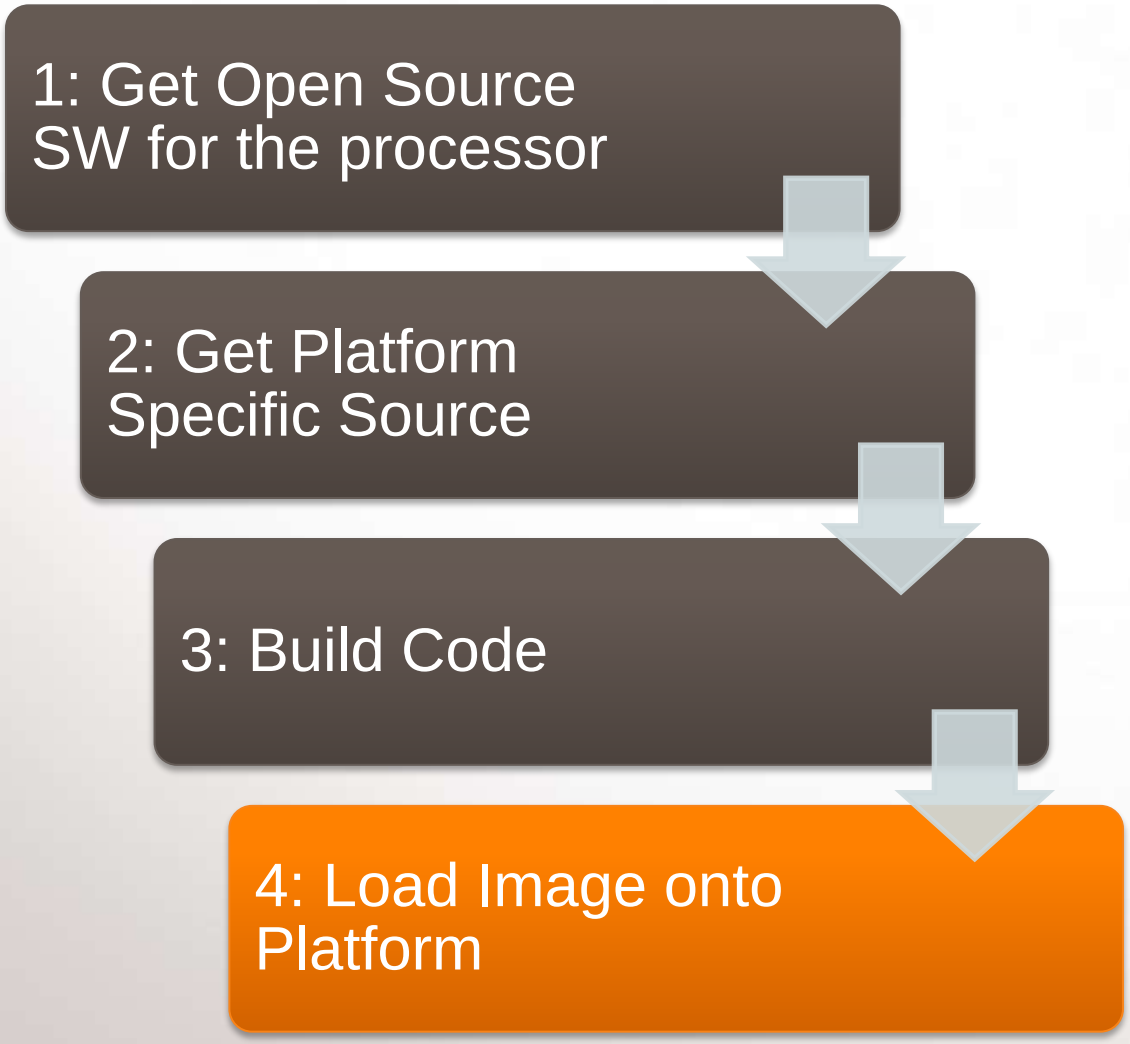
- Download the platform specific release from:
  http://dragonboardsupport.intrinsyc.com/
  3. manually download patches
  4. apply_patch.sh <workdir>
  5. include Qualcomm Lib in the build
- The Intrinsyc customer site contains more detail:
  - The Dragonboard Development Kit Programming Guide

Building the Android Software Platform



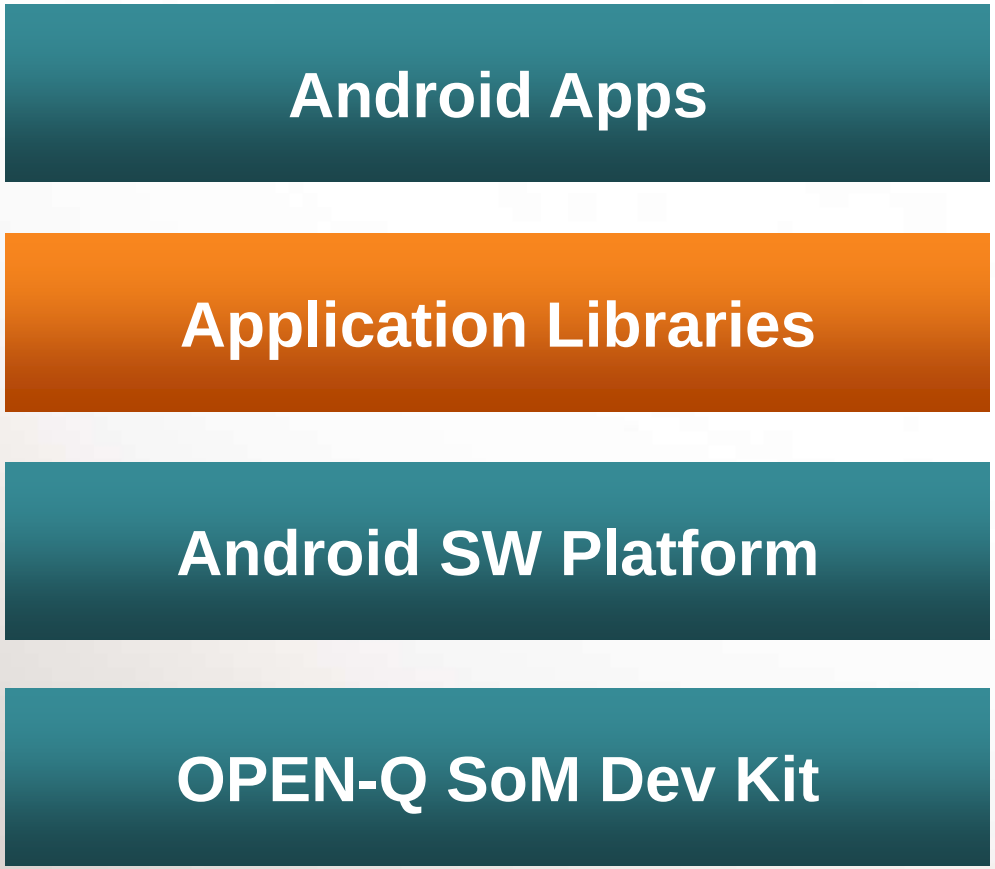
- Build the source tree as follows:
  6. cd <android-source-tree>
  7. $build/environmentsetup.sh
  8. $choosecombo 1 msm8960 eng
  9. $Make –j8
- Running “choosecombo” with no augments will prompt for Android build options and targets

Building the Android Software Platform



- Fastboot is used to install an Android image from a development PC over USB using the Android Debug Bridge (ADB)
- Although JTAG can be used to install binaries on the eMMC, it is safer and advisable to use Fastboot for updates
- The board will be pre-programmed with a bootloader and an Android image
- Each binary can also be flashed selectively through the following Fastboot command options:
  - fastboot flash aboot <path to emmc_appsboot.mbn >
  - fastboot flash boot <path to boot.img>
  - fastboot flash system <path to system.img.ext4>
  - fastboot flash userdata <path to userdata.img.ext4>
  - or use flashall.sh

Application Libraries



- Qualcomm offers a variety of technologies to make it easy for developers to create applications based upon a host of next-generation technologies:
  - **Technologies Built for the Snapdragon™**
    - Snapdragon SDK for Android
    - Mobile Gaming & Graphics Optimization (Adreno™)
  - **Technologies Tuned for Snapdragon™**
    - Augmented Reality (Vuforia™)
    - Computer Vision (FastCV™)
  - **Technologies Enhanced for Snapdragon™**
    - Peer-to-Peer (AllJoyn™)
    - Context Aware (Gimbal™)
    - HTML5 Mobile Device APIs
- For more information about these mobile technologies visit Qualcomm Developer Network at: https://developer.qualcomm.com/mobile-development/mobile-technologies

Snapdragon Software Tools for Developers

Available for download on developer.qualcomm.com

Snapdragon SDK for Android

Adreno™ Profiler

Adreno SDK

AllJoyn™ Peer-to-Peer

Vuforia™ Augmented Reality

FastCV™ Computer Vision

Trepn Profiler

Snapdragon SDK Features Available to Developers

Features driving new experiences

CAMERA

Facial Processing – Blink / Smile / Gaze Detection

Powering smarter camera application technology

SENSORS

New Sensor Event Inputs

Always-on device orientation sensor awareness and input

TOUCH-FREE GESTURES

Touchless Device Input

Interact with your device from variable distances

Snapdragon SDK for Android 1.0 Features

CAMERA – FACIAL PROCESSING
BLINK / SMILE / GAZE DETECTION

SMART SHUTTER
Profile faces in real-time to determine the best moment to take a picture based on everyone smiling, looking at the camera, and not blinking.

TRACKING AUDIENCE ENGAGEMENT
Track facial expressions to estimate level of emotional response and attention span.

TECHNOLOGY
Enhances face detection with blink detection, smile score, gaze / eye tracking

Snapdragon SDK for Android 1.0 Features

SENSORS – ACCESS TO NEW INTEGRATED SENSOR EVENTS

OPTIMIZED SENSOR events allow apps to access device orientation awareness for all-day, always-on functionality.

NEW GAMING INPUT CONTROLS
Enable more intuitive gaming input by using directional tap and shake to interact with the virtual environment.

TECHNOLOGY
Adds sensor events: Directional Tap / Shake, Tilt, Face / Up Down Detection

Snapdragon SDK for Android 1.1 Features

TOUCH-FREE GESTURES – ACCESS TO GESTURE-BASED DEVICE INTERACTION

TOUCH-FREE GESTURES offers new ways of interacting with the device without even touching the screen. Near swipes and far swipes can be performed for basic functionality.

DEVICE ENGAGEMENT also allows fine control using a cursor pointer while tracking hand movements for distance-based interaction.

TECHNOLOGY

Detects near swipe, far swipe, cursor control

Snapdragon SDK Features for Optimizing Performance

Features exposing performance enhancements

AUDIO

Surround Sound Recording, VOIP Enhancements

Enabling Stereo 5.1 audio input and lower latency voice chat

IZat™ LOCATION

Precision Location, Low-Power Geofencing, Indoor Positioning

Improving GPS accuracy and offering geofencing capabilities at low power

Developer Benefits

Increased differentiation

- 3rd party apps integrated w/ the Snapdragon SDK for Android to seamlessly take advantage of optimizations and new features available on SDK-enabled Snapdragon devices
- Accesses deeply integrated software unavailable to other platforms

Ease of Use

- Abstracted APIs are designed for clean and easy integration

Compatibility

- Snapdragon SDK API layer is maintained from release to release. When you target the Snapdragon SDK APIs, the underlying implementation is provided across future releases, minimizing the re-engineering you would regularly be at risk to when working closely with customized Android source.
- Any major API changes will be depreciated over a year to allow migration where necessary.

Have applications eligible to be part of Qualcomm larger Ecosystem marketing

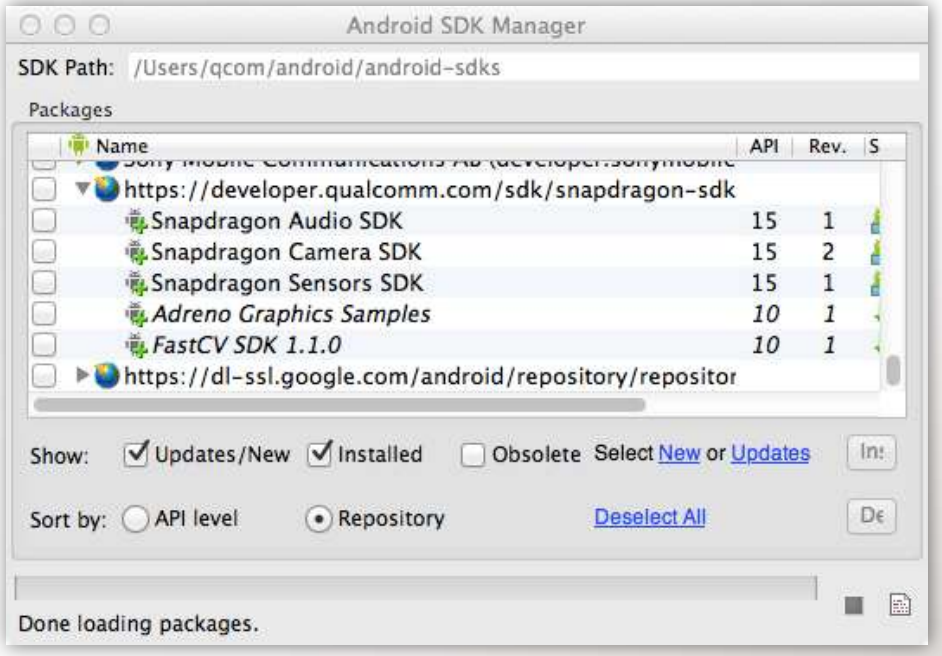
- Qualcomm regularly shows off SDK-enabled applications directly to OEMs, as well as to the public in interviews, keynotes, videos & tradeshows.

Snapdragon SDK Download & Installation

http://developer.qualcomm.com/snapdragonsdk

Download instructions are offered on the Qualcomm Developer website along with tutorials & docs

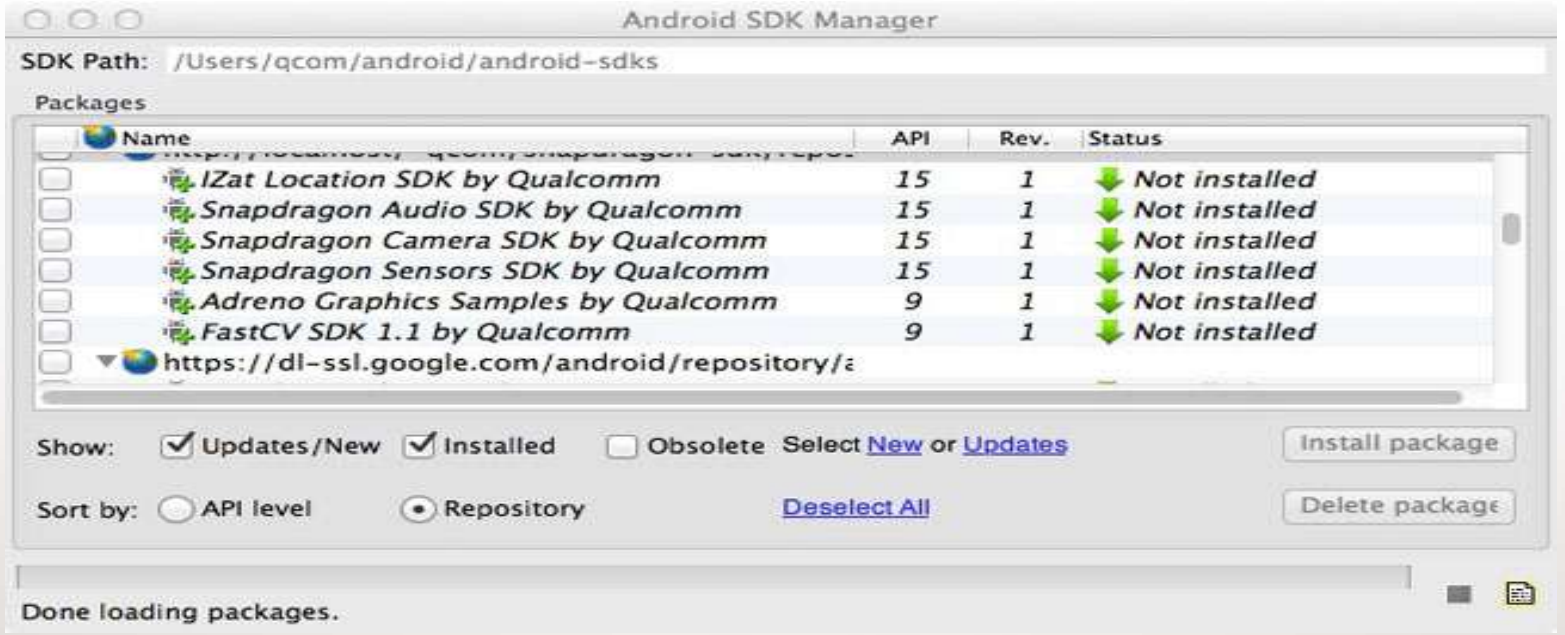
Installation is handled by Android SDK Manager, distributed by Google as part of the Android SDK Tools.



QDevNet™
Qualcomm Developer Network

Snapdragon SDK Deployment for DragonBoard

1. Download & Install Android SDK
2. Find the section "Adding New Sites" and follow the instructions to enter a new repository URL.
3. https://developer.qualcomm.com/sdk/snapdragon-sdk/repository.xml



Snapdragon SDK Deployment for DragonBoard

- Building the SDK sample to get started (Facial Processing Demo here)

1. Select File -> New -> Android Project
2. Select "Create project from existing sample". Click Next.
3. Select Build Target as the SDK Component you are targeting. (e.g. android-sdk-linux/add-ons/addon-snapdragon_camera_sdk-qualcomm-15/samples/SDFacialDataDemo)
4. Edit the Build Path to include any extension jars located in the libs/ folder of the sample

- For running the example

1. Make sure your device contains Snapdragon SDK enabled, otherwise sample will complain about proprietary Qualcomm facial processing library not enable in the device.
2. Make sure your target is connected via ADB (USB cable)
3. From the eclipse menu run the example

Snapdragon Software Tools for Developers

Available for download on developer.qualcomm.com

Snapdragon SDK for Android

Adreno™ Profiler

Adreno SDK

AllJoyn™ Peer-to-Peer

Vuforia™ Augmented Reality

FastCV™ Computer Vision

Trepn Profiler

AllJoyn Open-Source Peer-to-Peer

Seamlessly Discover and Connect

Entertainment Experiences

Multi-Screen Experiences

Social Experiences

AllJoyn is an open source project developed and distributed by Qualcomm Innovation Center, Inc. (QuIC), a subsidiary of Qualcomm Technologies, Incorporated that focuses on open source development.

Vuforia Augmented Reality

Bringing A New Dimension to Mobile Experiences

Qualcomm vuforia

Gaming and Play

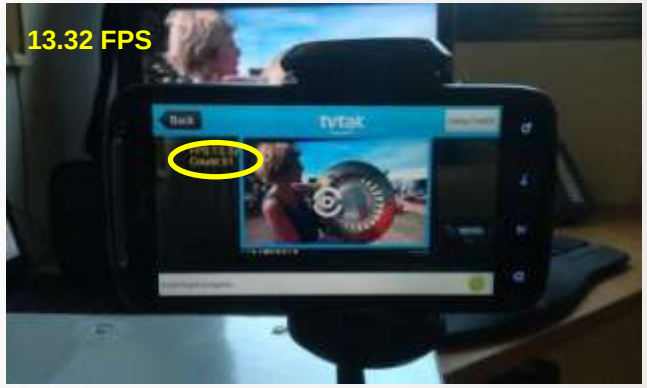
Advertising & Media

Educational & Instructional

FastCV™ Enables Faster and More Responsive Real-Time Computer Vision-Based Experiences

tvtak

With FastCV



Without FastCV

Video Recognition of TV Content

- 10% overall performance increase using Fast CV

iOnRoad™

With FastCV

Without FastCV

Driver Awareness

- 15% overall performance increase using Fast CV
- 30% faster conversion of YUV420 images to RGB
- Simple, quick integration of computer vision to existing code

Source: Developer testing using the HTC Sensation 4G on Snapdragon and a competitive chipset.

TvTak is developed, owned and distributed by by TvTak Ltd.
iOnRoad is developed, owned and distributed by iOnRoad Technologies Ltd.

Snapdragon Software Tools for Developers

Available for download on developer.qualcomm.com

Snapdragon SDK for Android

Adreno™ Profiler

Adreno SDK

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Trepn Profiler

Trepn Profiler

Performance & Power Optimization

- Poor choices by app developers can significantly impact battery life of mobile devices, which leads to a poor user experience with the device, and the app itself.
- Some common examples are:
  - Inefficient or inappropriate use of resources
  - Taking too many GPS location fixes
  - Keeping the display lit for too long
  - Preventing various subsystems from going to sleep or low power mode.

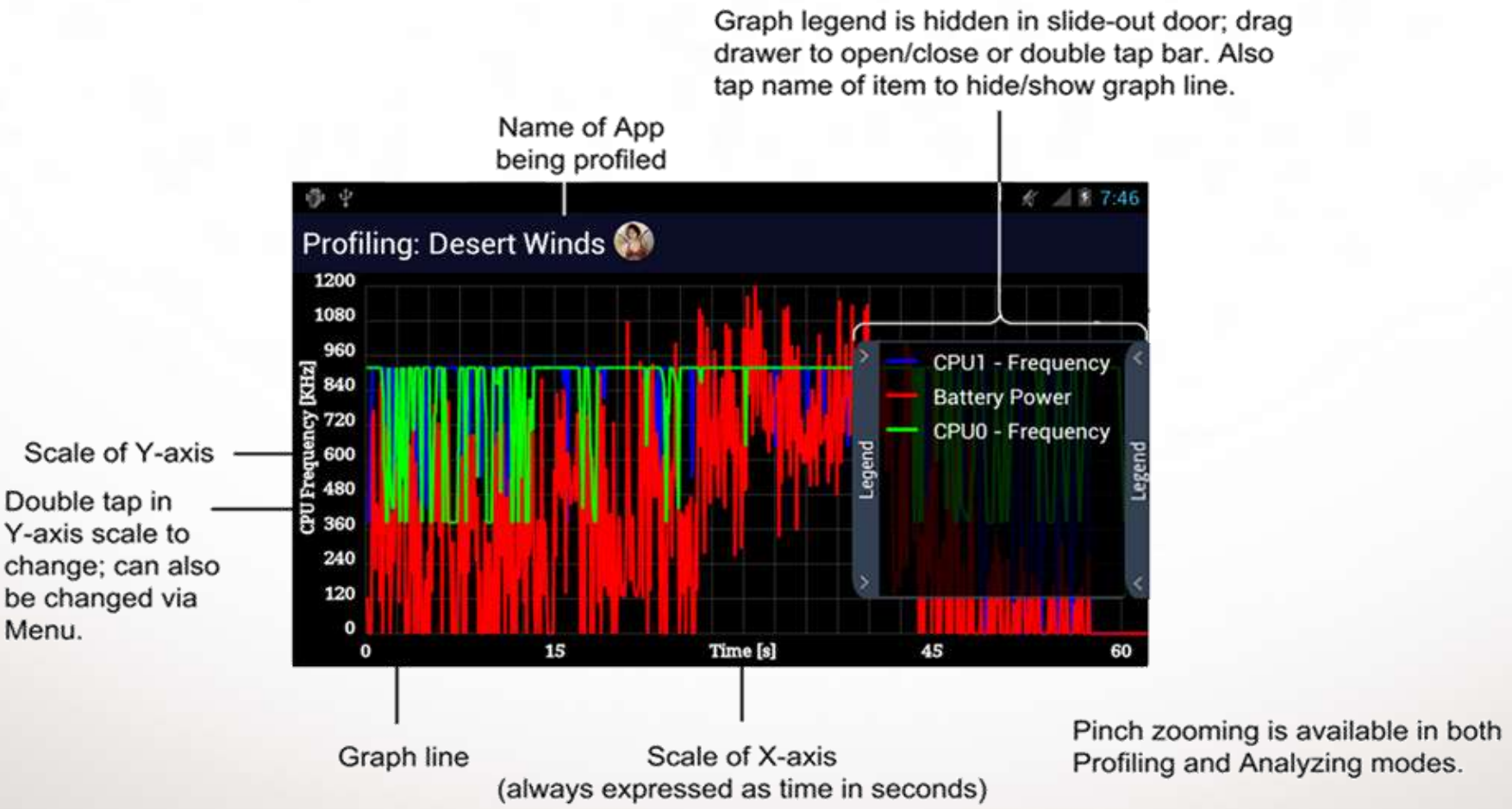
Trepn™ Profiler

- Trepn Profiler is an on-target diagnostic tool that lets you profile the performance and power consumption of Android applications running on devices featuring Qualcomm Snapdragon processors.

- It's designed to help you optimize your code for:
  - CPU usage and frequency
  - memory statistics (virtual and physical)
  - network usage (cellular and Wi-Fi)
  - Power consumption (when coupled w/ Snapdragon Development Platforms)

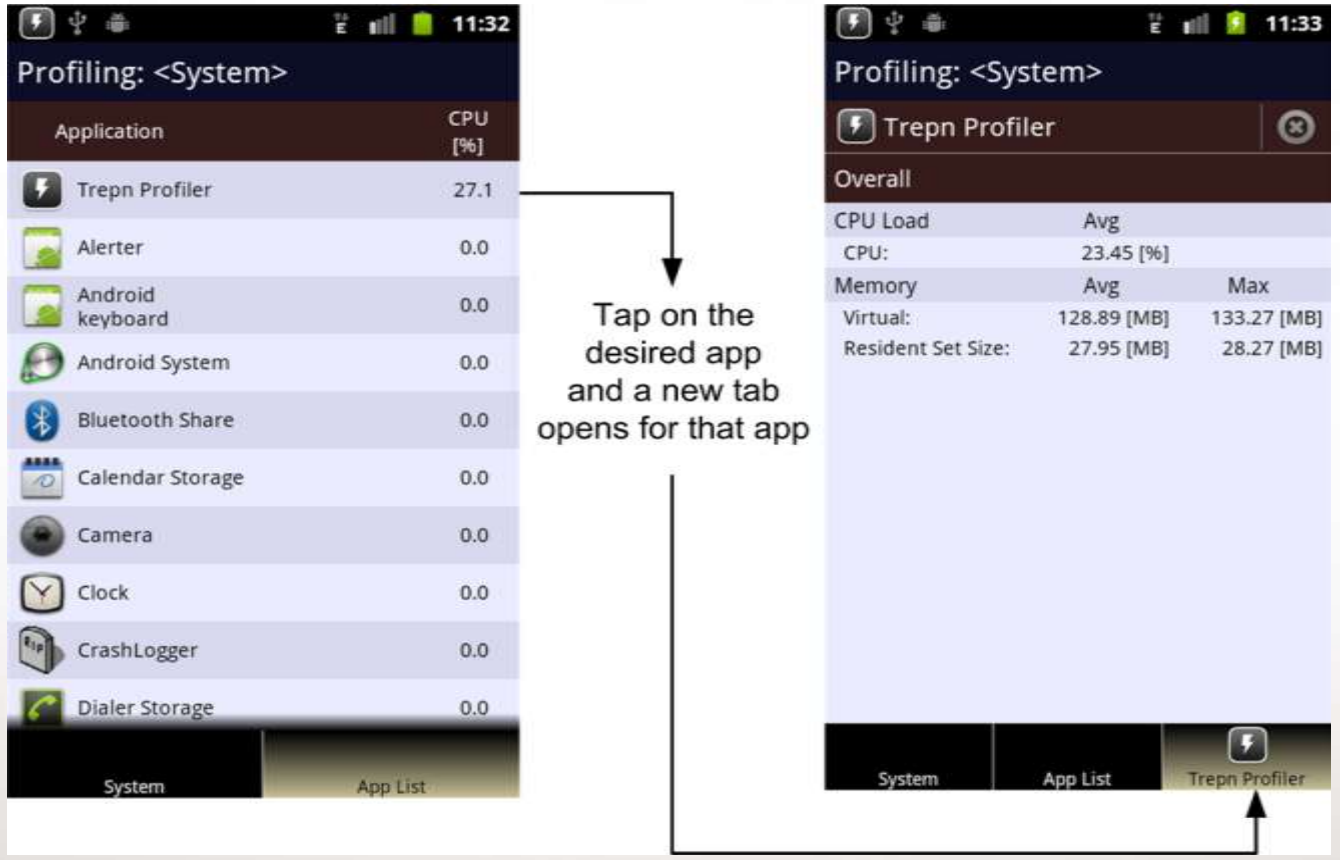
Available for free download at developer.qualcomm.com/Trepn

Trepn Profiler Graph Display



Trepn Profiler Per-App statistics

Per-app tracking of CPU Load and Memory Usage



Trepn Profiler Overlay Graphs

- Overlays allows developers to monitor log points in real-time
- Overlays are setup via “Preferences”

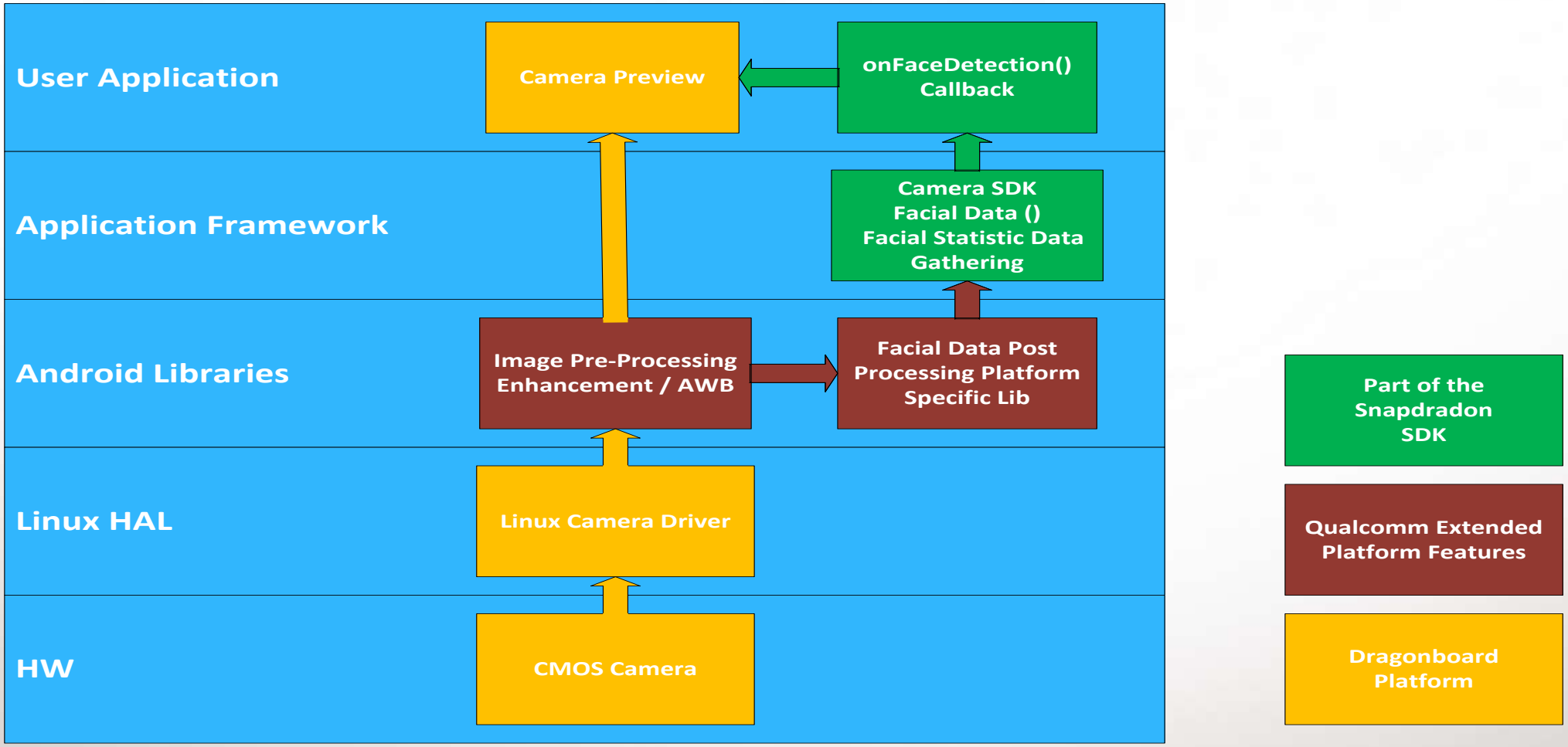
Trepn Profiler Application States

- Use Android ‘Intents’ to change the ‘app state’ log point within Trepn. This will allow you to correlate the Trepn output with your app
- Trepn calculates stats for each state

Snapdragon SDK Application Development Example

- Snapdragon SDK Camera Facial processing can be used to develop applications in:
  - Digital Camera Control
  - Digital Signage
  - Medical Devices
  - Security
- The following example highlights the architecture, capabilities and shows how easy it is to develop an application using the Snapdragon Camera SDK.

Camera Application Example Flow



Camera SDK API Examples

- The Camera SDK augments the standard Android face detection with a rich set of facial analysis meta data
- In addition to the Android facial APIs the Camera SDK APIs include:
  - *info.**getGazePoint(); //Gives Coordinate of your face gaze***
  - *info.**getLeftEyeClosedValue(); // How much your Left Eye closed***
  - *info.**getRightEyeClosedValue(); // How much your Right Eye closed***
  - *info.**getSmileValue(); //Degree of smile :)***

Smile detection and eye tracking for great photos

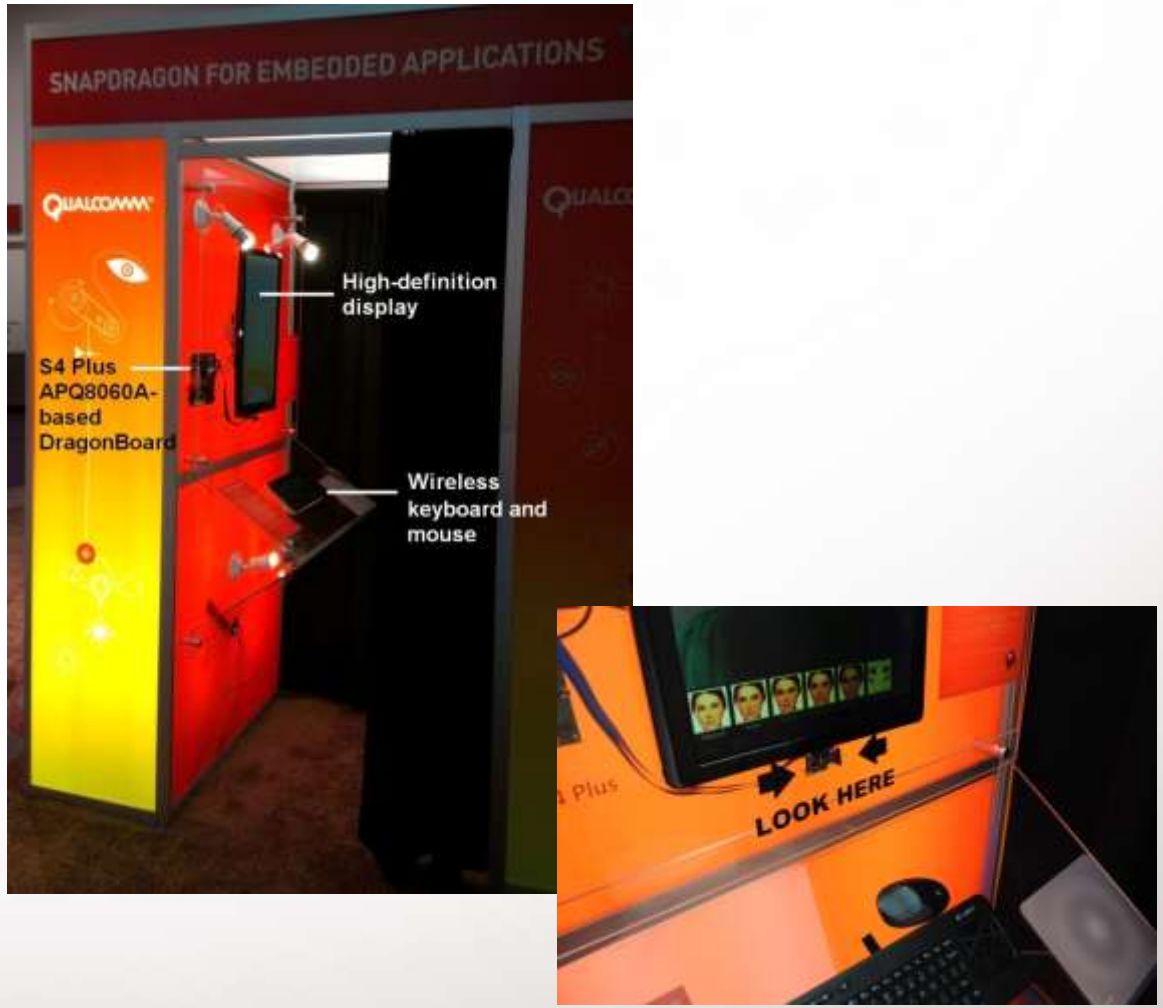
myDragonBoard.org Community Support

Dev Tools, Projects, Forums, Blogs, …

Post your project and or questions here

Example: My Blog Post on our Snapdragon for Embedded Demos @ CES 2013

- Snapdragon Photo Booth
  - Powered by the Snapdragon S4 Plus DragonBoard
  - Used 8MP camera bundled with the DragonBoard for photo capture
  - Wireless keyboard and mouse for user input.
  - Arcsoft Perfect365 app for Photo enhancement
- QtvKitchen Interactive Display
  - Transparent display panel with a removable, washable glass cover.
  - Intrinsyc OPEN-Q SoM embedded in the display stand
  - Concept UI with links to TV, radio, phone, family calendar, cookbooks and the Web.



Thank you

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