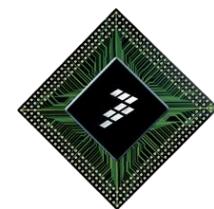


Nov, 2010

Android™ on i.MX Applications Processors



John Birch
Senior Field Applications Engineer

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Session Introduction

- ▶ i.MX Overview
- ▶ Overview of Android and why is it relevant to the consumer industry
- ▶ Intermediate level technical details of Android
- ▶ Understand the positioning of Freescale i.MX SoCs for Consumer
- ▶ High level details of our implementation of Android on i.MX





Agenda

- ▶ i.MX Roadmap
- ▶ Android Introduction
- ▶ Android on i.MX – Technical details
- ▶ Optimizations
- ▶ Review and Q&A





Agenda

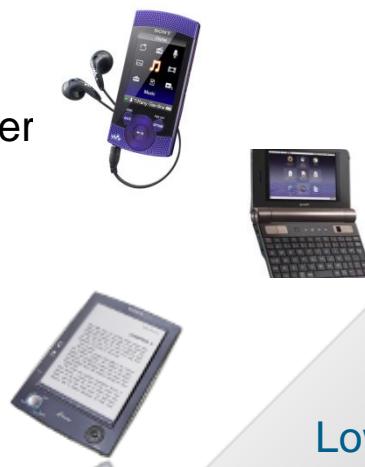
- ▶ i.MX Roadmap
- ▶ Android Introduction
- ▶ Android on i.MX – Technical details
- ▶ Optimizations
- ▶ Review and Q&A



Freescale Multimedia Focus Markets

Portable Consumer

- Portable Media Player
- Smartbook
- E-book
- Smartphone
- Personal Navigation



Automotive Infotainment

- Audio
- Connectivity and Telematics
- Video and Navigation
- Instrument Cluster

Low-Power
High Integration
Advanced Performance
Platform Software

Home Consumer

- Media Phone/Terminal
- iPod accessories
- Remote controls
- Digital Photo Frame
- Appliances



Industrial

- Point of Sale
- Security and Surveillance
- Industrial HMI
- Medical
- Metering

Freescale Based Consumer Devices



Amazon Kindle – i.MX35



Acer - i.MX51



Lumigon - i.MX51



Aigo - i.MX37



Sony – STMP3780



ACN – i.MX27



Isabella - i.MX31



Logitech Squeezebox – i.MX25



i.MX27



Sagem - i.MX31



Huawei MC850 – i.MX51



RealEase – i.MX37



Philips Go Gear Connect – STMP3770



HP - i.MX51



Txtr – i.MX31



Yulong
"Coolpad N900"



Pegatron – i.MX51



China Telecom – Lifepad A800



Ozing - i.MX51



Sony – i.MX31



Creative – STMP3780

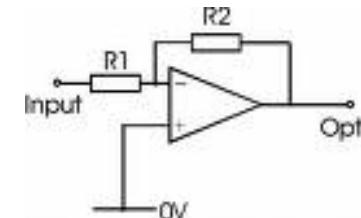
micon
ARTM
r, Inc.



Creative – STMP3780

Freescale Applications Processor Value Proposition

- ▶ Performance
(MHz and Memory Efficiency)
- ▶ Low Power
(Audio < 18 mW system and HD720 Video < 250 mW)
- ▶ State-of-the-art audio, video, graphics and codecs
- ▶ Consistent and scalable architecture
- ▶ Complete OS/SW platform
- ▶ Mixed signal integration



i.MX Roadmap

Cortex A8

Associated PMIC:
MC13783

i.MX31

- OpenGL ES 1.1 3D

i.MX31L

- ARM1136, 400 MHz
- USB (High Speed)
- Video Encode VGA

i.MX27

- D1 Video Encode
- D1 Video Decode

i.MX27L

- ARM926, 400MHz
- Ethernet, mDDR

Associated
PMIC:
MC13892

i.MX357

- Open VG 1.1

i.MX353

- ARM1136, 532 MHz
- Ethernet, DDR2
- USB Phy x 2, CAN x 2

i.MX258

- Security

i.MX257

- Touchscreen
- CAN x 2

i.MX253

- ARM926, 400MHz
- Ethernet, DDR2
- USB Phy x 2

i.MX515

- Open VG 1.1
- OpenGL ES 2.0
- Security

i.MX513

- HD720p Video Decode
- D1 Video Encode

i.MX512

- Cortex A8, 800MHz
- Ethernet, DDR2, USB Phy

i.MX537

- OpenGL ES 2.0
- OpenVG 1.1

i.MX533

- 1080p Video Decode
- 720p Video Encode

- Cortex A8, 800MHz
- DDR2/DDR3 400,
- CAN x2, MLB
- PATA, SATA 1.5Gbps
- Ethernet + 1588

i.MX50x

Associated
PMIC:
MC13892, TBD

i.MX287

- i.MX283+ CAN x 2

i.MX286

i.MX283

- ARM926, 450MHz
- Integrated PMIC
- 1588 Ethernet
- DDR2
- USB Phy x 2
- LCD

2009

2010

2011

In Development

i.MX Cortex-based SoC Feature Summary

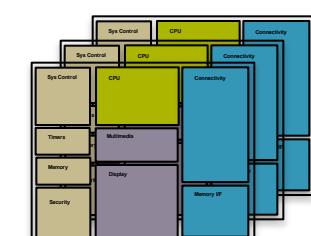
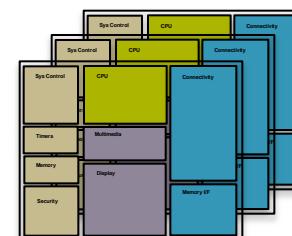
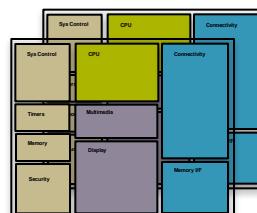
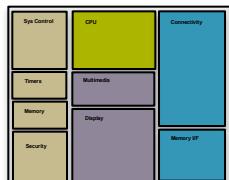
	i.MX51	i.MX503	i.MX508	i.MX53
Sample w/BSP	Now	Now	Now	Now
Qual / Final BSP	Now	1Q11	1Q11	1Q11
Core	Cortex-A8 800MHz(Consumer) 600MHz (Automotive)	Cortex-A8 800MHz(Consumer)	Cortex-A8 800MHz(Consumer)	Cortex-A8 Up to 1.2GHz (Consumer) Up to 1GHz (Automotive)
Memory	512MB, x32 mDDR / DDR2	2GB, x32 DDR2 / mDDR / LP-DDR2	2GB, x32 DDR2 / mDDR / LP-DDR2	2GB, x32 DDR2 / DDR3 / LP-DDR2
Max Mem Speed	400MT/s (200 MHz clock)	533MT/s (266 MHz clock)	533MT/s (266 MHz clock)	800MT/s (400MHz clock)
Video Decode	720p30	N/A	N/A	1080p30
Video Encode	D1	N/A	N/A	720p30
3D GPU	OpenGL/ES 2.0 27M tri/s, 166M pix/s	N/A	N/A	OpenGL/ES 2.0 33M tri/s, 200M pix/s
2D GPU	OpenVG 1.1, 166M pix/s	OpenVG 1.1, 200M pix/s	OpenVG 1.1, 200M pix/s	OpenVG 1.1, 200M pix/s
LCD Resolution	WXGA (1280x800) 60fps	SXGA+ (1400x1050)60fps	SXGA+ (1400x1050)60fps	UXGA (1600x1200) 60fps
Display Interface	LCD, Parallel	LCD, Parallel	EPD Controller	LCD, Parallel, LVDS
EPD Controller	N/A	N/A	(2048x1536) @106 Hz	N/A
Video Out	Component HD720 60fps	N/A	N/A	VGA HD1080p60
Camera I/F	Parallel	N/A	N/A	Parallel
HDD I/F	P-ATA	N/A	N/A	P-ATA, S-ATA 1.5Gbps
Ethernet	10/100Mbps	10/100Mbps + IEEE1588	10/100Mbps + IEEE1588	10/100Mbps + IEEE1588
USB	OTG + PHY Host + ULPI (x3)	OTG + PHY, Host + PHY	OTG + PHY, Host + PHY	OTG + PHY, Host + PHY Host + ULPI (x2)

Blue indicates change from column to the left



i.MX Platform Roadmaps

i.MX Applications Processors



Motion Sensors



MMA8450
Linear Accelerometer



3-axis Gyro

Other Sensors



MPR121 Capacitive
Touch Sensor



MPL115 Barometer



3-axis Magnetometer



Horizon Altimeter

Audio



SGTL 5000



Next Gen Aduio

Power Mgmt



Atlas AP-Lite PMIC
Int. power, charger & IF



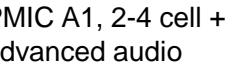
Next Gen PMIC
Int. power, charger & IF



PMIC A1, 1
cell + audio



PMIC A1, 2-4 cell



PMIC A1, 2-4 cell +
advanced audio



PMIC A1, 1 cell

RF4CE/Zigbee Networking



MC13213 Zigbee
802.15.4 Transceiver



MC1323xC Zigbee
802.15.4 Transceiver Family

2009

2010

2011

2012

i.MX Cortex-based SoC Feature Summary

	i.MX51	i.MX503	i.MX508	i.MX53
Sample w/BSP	Now	Now	Now	Now
Qual / Final BSP	Now	1Q11	1Q11	1Q11
Core	Cortex-A8 800MHz(Consumer) 600MHz (Automotive)	Cortex-A8 800MHz(Consumer)	Cortex-A8 800MHz(Consumer)	Cortex-A8 Up to 1.2GHz (Consumer) Up to 1GHz (Automotive)
Memory	512MB, x32 mDDR / DDR2	2GB, x32 DDR2 / mDDR / LP-DDR2	2GB, x32 DDR2 / mDDR / LP-DDR2	2GB, x32 DDR2 / DDR3 / LP-DDR2
Max Mem Speed	400MT/s (200 MHz clock)	533MT/s (266 MHz clock)	533MT/s (266 MHz clock)	800MT/s (400MHz clock)
Video Decode	720p30	N/A	N/A	1080p30
Video Encode	D1	N/A	N/A	720p30
3D GPU	OpenGL/ES 2.0 27M tri/s, 166M pix/s	N/A	N/A	OpenGL/ES 2.0 33M tri/s, 200M pix/s
2D GPU	OpenVG 1.1, 166M pix/s	OpenVG 1.1, 200M pix/s	OpenVG 1.1, 200M pix/s	OpenVG 1.1, 200M pix/s
LCD Resolution	WXGA (1280x800) 60fps	SXGA+ (1400x1050)60fps	SXGA+ (1400x1050)60fps	UXGA (1600x1200) 60fps
Display Interface	LCD, Parallel	LCD, Parallel	EPD Controller	LCD, Parallel, LVDS
EPD Controller	N/A	N/A	(2048x1536) @106 Hz	N/A
Video Out	Component HD720 60fps	N/A	N/A	VGA HD1080p60
Camera I/F	Parallel	N/A	N/A	Parallel
HDD I/F	P-ATA	N/A	N/A	P-ATA, S-ATA 1.5Gbps
Ethernet	10/100Mbps	10/100Mbps + IEEE1588	10/100Mbps + IEEE1588	10/100Mbps + IEEE1588
USB	OTG + PHY Host + ULPI (x3)	OTG + PHY, Host + PHY	OTG + PHY, Host + PHY	OTG + PHY, Host + PHY Host + ULPI (x2)

Blue indicates change from column to the left



i.MX536 Applications Processor

► Specifications:

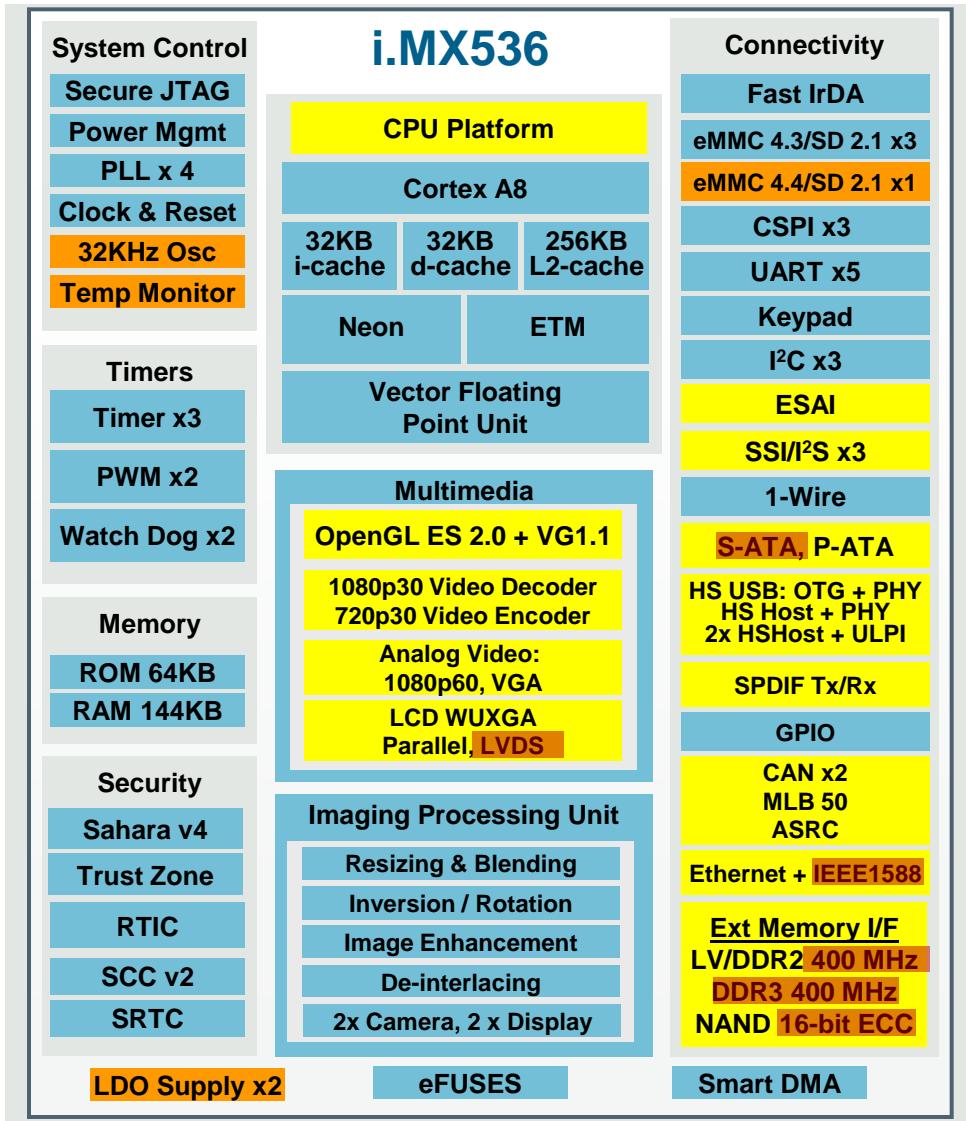
- CPU: Cortex A8, up to 800MHz
- Process: 65nm, LP/GP
- Core Voltage: 1.0V
- Package: TE-BGA 19x19 0.8mm, 529 balls
- Temp Range: -40 to 85C

► Key Features and Advantages

- Multimedia Infotainment Applications
- Up to 2GB DDR2/3 memory at 400MHz
- HDD: PATA, S-ATA interface
- One eSDHC port supports MMC4.4 including DDR mode
- Auto network: 2xCAN, MLB50, Ethernet 10/100 with IEEE1588
- Delivers rich graphics and UI in HW
 - OpenGL ES 2.0 3D accelerator (AMD Z430)
 - OpenVG 1.1 graphics accelerator (AMD Z160)
 - Neon Vector floating point co-processor
 - Display up to WUXGA (1920 x1200) single or dual WXGA
- Drives high resolution video in HW
 - Multi-format HD1080 video decode
 - Multi-format HD720 video encode
 - High quality video processing (resizing, de-interlacing etc.)
 - Displays: Parallel, LVDS or VGA
- Audio
 - High quality sample rate convertor
 - I2S, SPDIF Rx/Tx, ESDI
- Security
 - High Assurance Boot (v4), Cryptographic accelerators, ARM TrustZone
- Analog Integration
 - Temperature Monitor for smart performance control
 - Linear supply regulators
 - 32KHz Oscillator

► Target Availability:

- Production: Q1 2011



Changed from i.MX35/51

Updated from i.MX35/51

i.MX Security Architecture in a Nutshell



► HW Cryptographic Accelerators

- True random number generator
- Symmetric: AES, 3DES, ARC4
- Asymmetric: RSA, ECC
- Message Digest & HMAC: SHA-1, SHA-256, MD-5



► Secure Real-Time Clock

- On-chip, self-powered real-time clock
- Monotonic counter



► HW Firewall

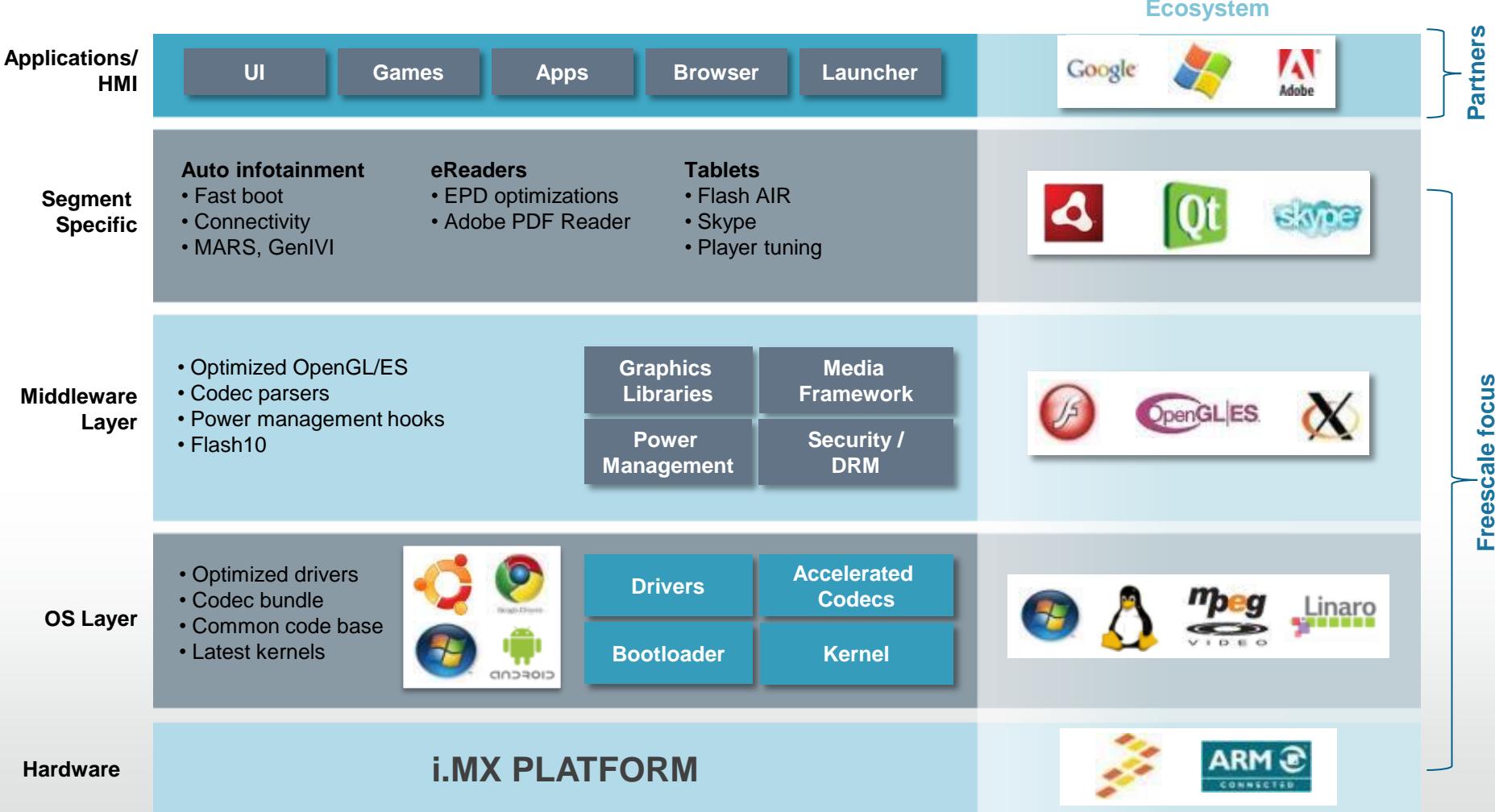
- Controls access to all HW resource from DMA bus masters



► Physical Tamper Detection

- Clock and power supply tamper detection
- Device's cover seal break detection

Software Completeness



► R&D “train schedule”

- Set every release on a train schedule
- α, β, α, SDK904, α, β, α, SDK908, α, β, α, SDK912, α, β, α, SDK1004,...etc
- α ER: Snapshot boot test and only release notes – provided as-is
- β ER: Tested release with all docs (Contains all ‘live’ SoCs)
- SDK release: Fully validated and sanity tested with all docs (contains only SoCs that can be launched)
- Only 4 platforms in any one month

► SDK releases

- 3 times a year (4 platforms in each SDK release fully tested)
- Full validation cycle
- Meant for channel and broad market

► Engineering releases

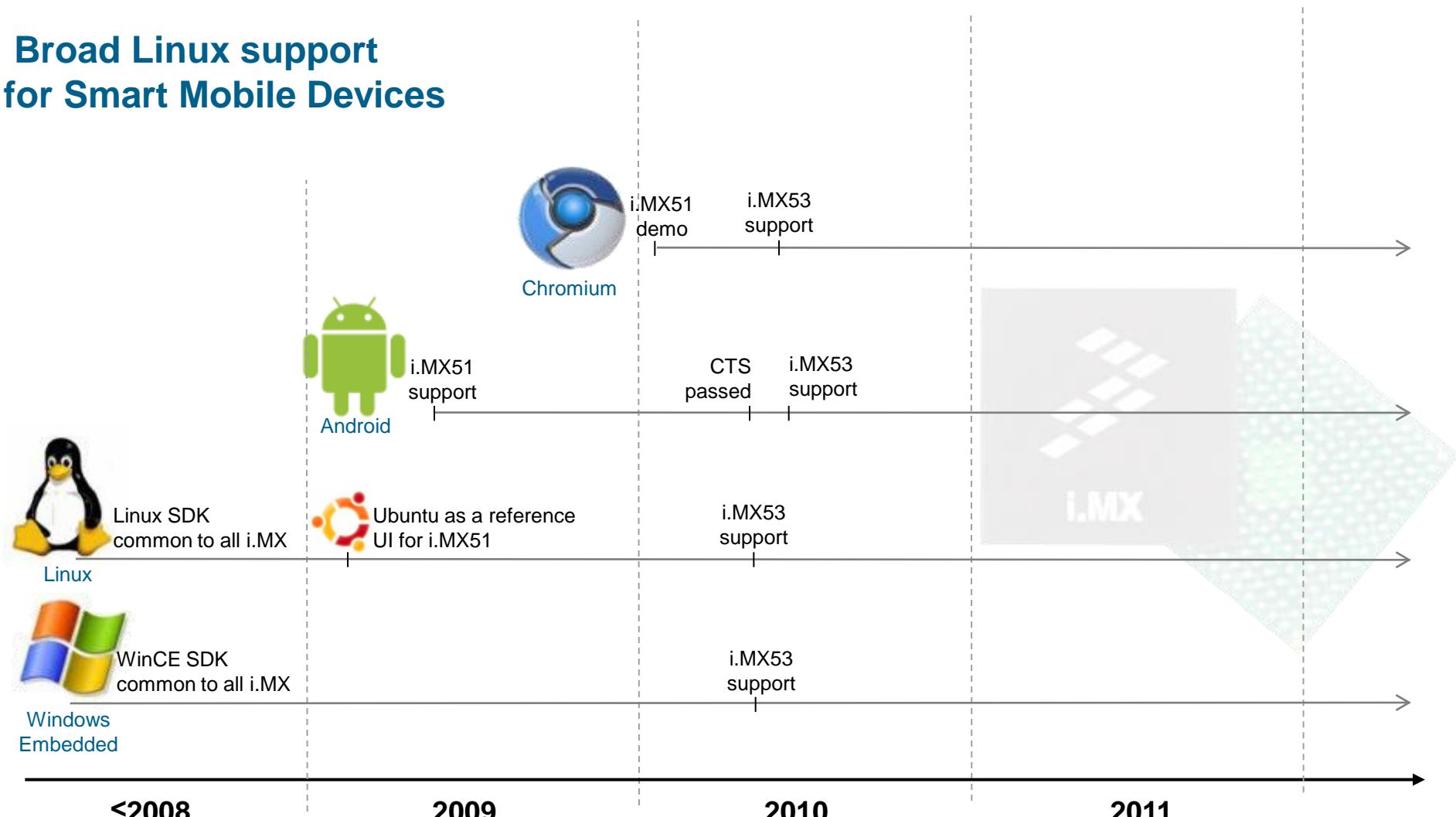
- Once a month regardless of customer requests (4 platforms at any single month)
- Accommodate specific customers based on the monthly cycle
- Meant for Alpha/Beta customers

► Patches for urgent customer requests

- Fixed by R&D as necessary; Patch released through Apps team to customer (outside the release cycle stated above)

OS support for i.MX Cortex series

Broad Linux support for Smart Mobile Devices



Left Edge = Engineering samples

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i.MX51 BSP and Multimedia Software Source Drops

- ▶ Visit www.freescale.com/imx51evk
- ▶ Click on the “Downloads” tab
- ▶ This page always hosts the latest software from Freescale
 - [L2.6.31 10.07.11 ER SOURCE](#)
 - [IMX_ER_1007_LINUX_PATCHES](#)
 - [IMX_ER_1007_LINUX_SOURCE_CODECS](#)

The screenshot shows a web interface for Freescale's i.MX51 BSP and Multimedia Software Source Drops. At the top, there is a navigation bar with tabs: Overview, Documentation, Downloads (which is highlighted with a red box), Buy / Specifications, and Training & Support. Below the navigation bar, there are links for Application Notes, Buy, and Export to Excel. The main content area displays three software packages:

Software Package	Description	Type
L2.6.31_10.07.11_ER_SOURCE	Linux 2.6.31 Source Code Files 2010.07 Engineering Release	Board Support Packages
IMX_ER_1007_LINUX_PATCHES	TV Out and Camera Patch for the ER 2010.07	Board Support Packages
IMX_ER_1007_LINUX_SOURCE_CODECS	Source files for IMX Linux Debian Multimedia Codecs Engineering Release, include source code and...	Codecs and other Algorithms

Other tools to program images

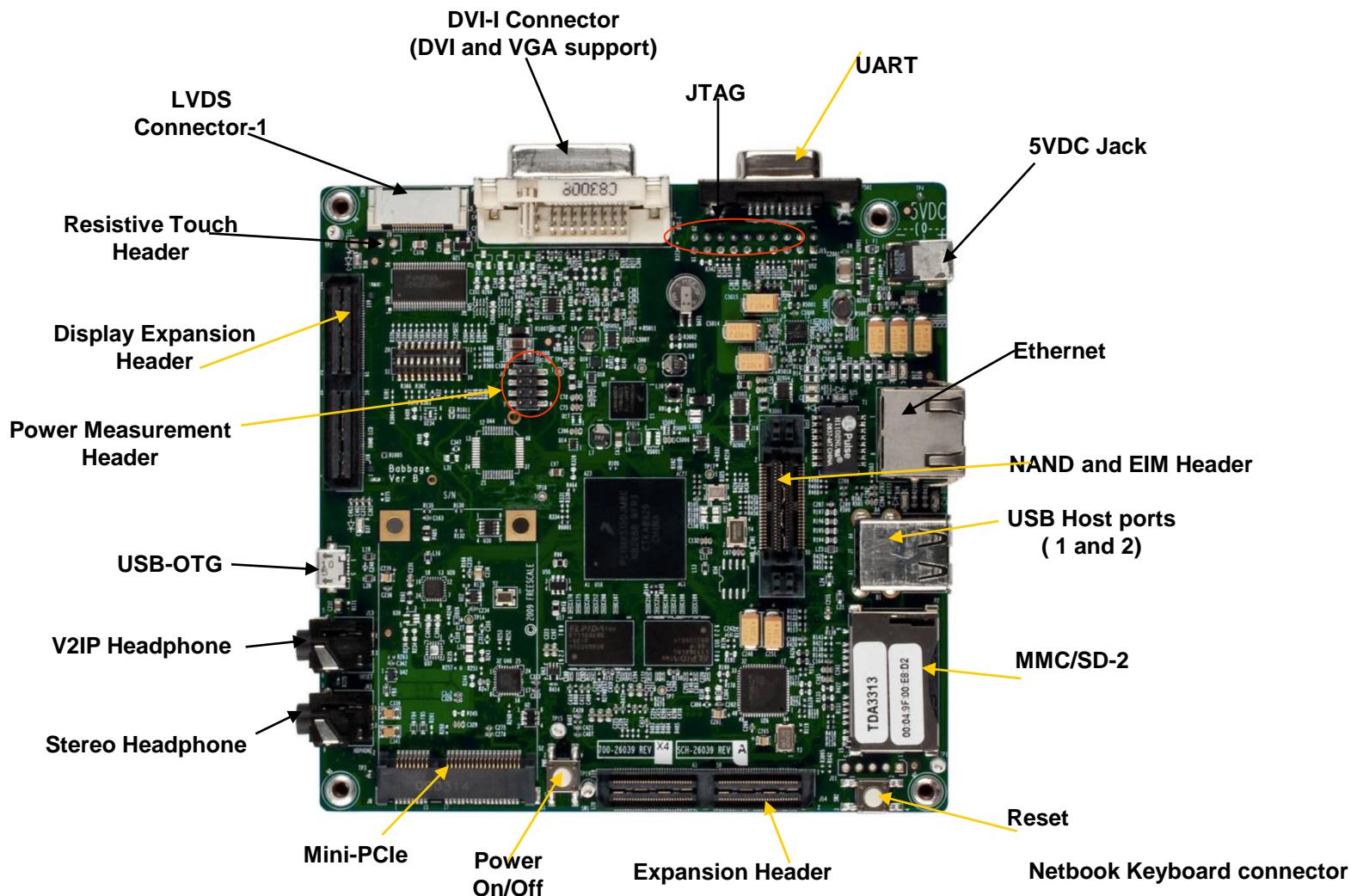
► i.MX Advanced Toolkit (ATK)

- Supports programming over USB and UART
- Excluded version available to program fuses (get with Marketer)
- Visit <http://www.freescale.com/imx51tools>

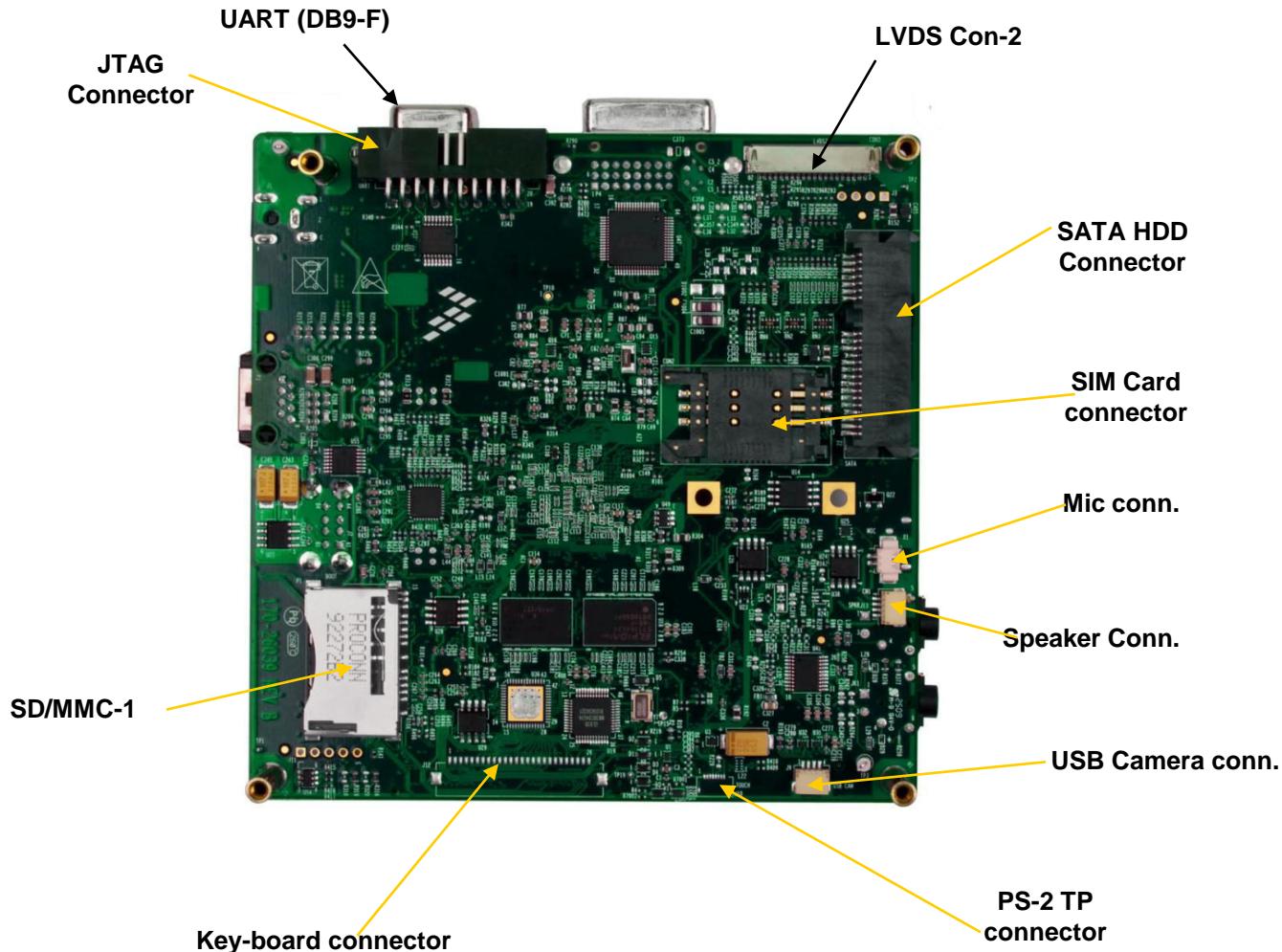
► Manufacturing Tool (aka Universal Updater Tool)

- Available at <http://www.freescale.com/imx51evk>
- XML based with user defined XML tags for different offsets, etc
- Will allow programming multiple devices over a USB hub

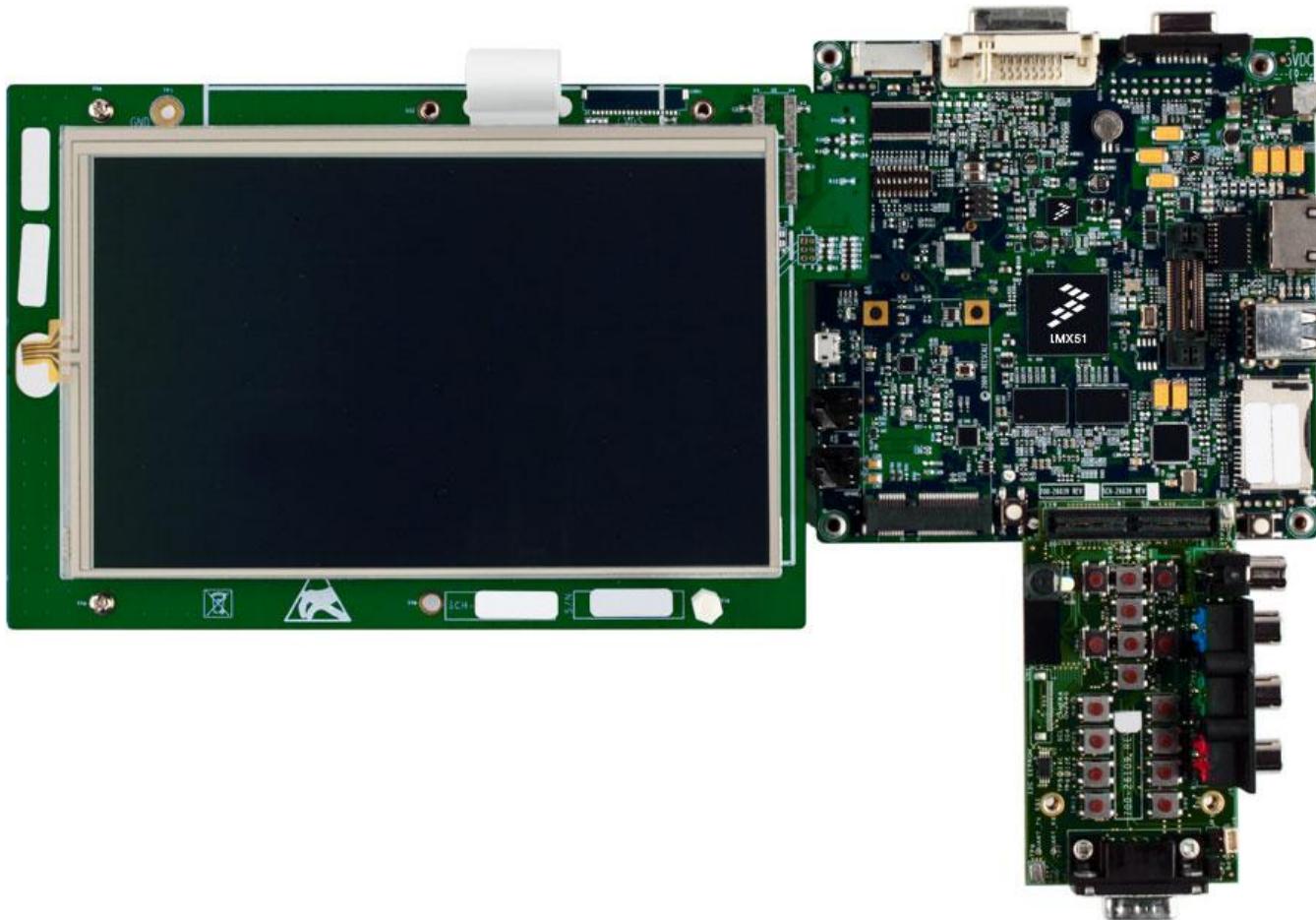
MCIMX51EVK : PCB Top



MCIMX51EVK : PCB Bottom

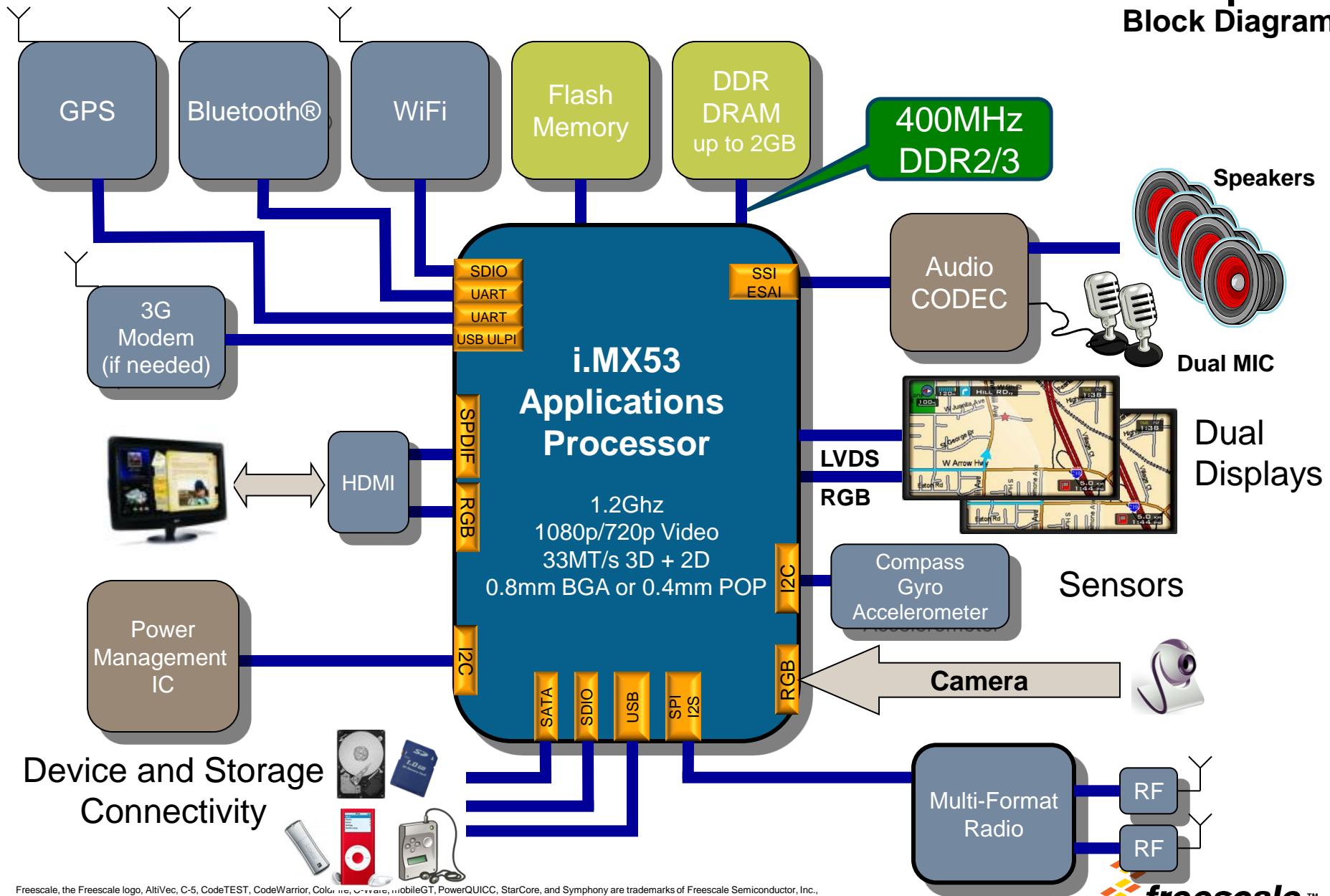


Expansion Support: display, camera and keyboard



i.MX53-Based Tablet Proposal

Block Diagram



Freescale acquired key assets of Swell Software on August 18, 2010, an industry leader in graphical user interface (GUI) software tools.

PEG® Product Family

PEG Pro™

- ▶ Screen transitions
- ▶ Multiple alpha-blended windows
- ▶ True anti-aliasing
- ▶ Gradient manager
- ▶ Open GL support
- ▶ Written in C++

PEG+™

- ▶ Multiple window updates
- ▶ Alpha-blended images
- ▶ Run-time image decoders & language resources
- ▶ Custom widget integration
- ▶ Dynamic themes
- ▶ Written in C++

C/PEG™

- ▶ Designed for:
 - Small LCDs (QVGA)
 - Low color-depth
- ▶ Very small footprint
- ▶ Single window update
- ▶ Multi-language capable
- ▶ Written in ANSI C

One of the smallest footprints and most efficient code bases available

Starting 225 KB Typical 225-250 KB	Starting at 128 KB Typical 160-175 KB	Starting at 64 KB Typical 90-110 KB
---------------------------------------	--	--

Professional Services team provides custom consulting & software development.

Driver Development • UI Development • Graphic Design

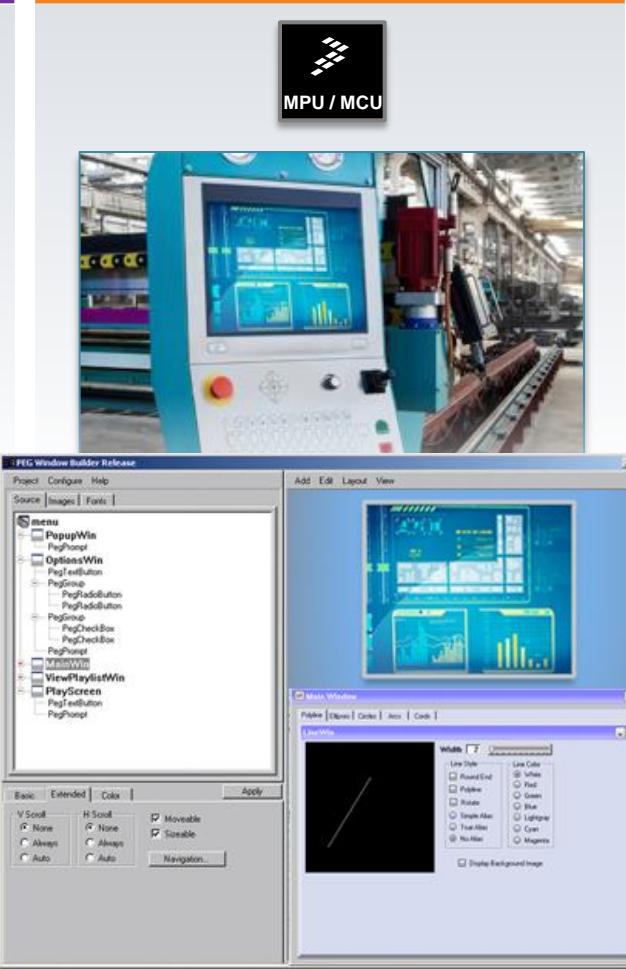
Pricing starts as low as \$4995 for a developer project license with 3 seats.

PEG Products Scalable for Consumer Application Needs

PEG Pro™

PEG+™

C/PEG™

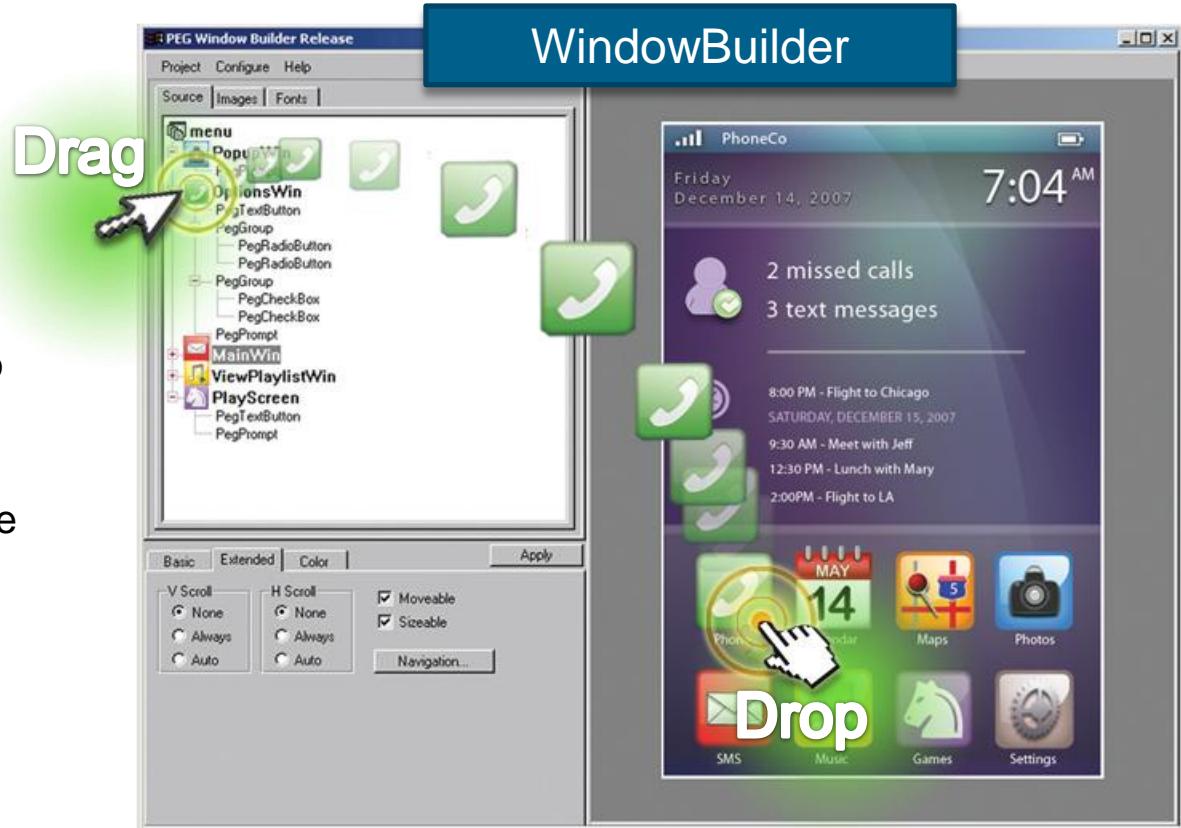


PEG Window Builder for Rapid Development

Window Builder allows a designer to layout each of the screens for a project through a simple-to-use interface. Providing a “What You See Is What You Get” display.

► Full WYSIWYG development

- Simulation environment for PEG+ and PEG Pro
- Runs on PC / Linux / X11 to allow proof of concept development
- Enables hardware / software development to happen in parallel
- Made available for free evaluation



Integrated design and simulation demo software that allows for screen preview / navigation on a Windows or Linux-based desktop environment.



www.iMXcommunity.org

A Freescale supported open web community of developers sharing common interest in transforming i.MX applications processors into practically anything imaginable.

i.MX Community

- Serves all component enablement peripherals including basic to complex software
- i.MX Forums, Groups and Blogs Posts
- News, Photos and Videos
- Training, Events and Promotions

Check it out!

Become a member today and you will be entered to win a i.MX development system of your choice. Drawing will be held on June 30th.

- ▶ i.MX silicon and software solution that enables world-class smartbook/tablet products with real-world consumer benefits
- ▶ Complete hardware and software package provided to enable faster time to market and lower R&D investment
 - BSP's available for Android/Linux/WinCE and other major smartbook/tablet OS's
 - team of over 300 very talented developers which relates to faster support response times
 - Full-featured media framework, including HW-accelerated Flash 10.1
 - Significant investment in HW-acceleration for Linux® and Android™ UI framework
 - Partners in place to provide UI and application customizations if needed
 - Design collateral up to and including complete form-factor reference design
 - Extensive tablet and smartbook consumer market research and thought leadership



Freescale Product Longevity Program

- ▶ The embedded market needs **long-term product support**
- ▶ Freescale has a longstanding track record of **providing long-term production support** for our products
- ▶ Freescale offers a **formal product longevity program** for the market segments we serve
 - For the automotive and medical segments, Freescale will make a broad range of program devices available for a minimum of **15 years**
 - For all other market segments in which Freescale participates, Freescale will make a broad range of devices available for a minimum of **10 years**
 - **Life cycles** begin at the time of launch
- ▶ A list of participating **Freescale products** is available at:
www.freescale.com/productlongevity





Agenda

- ▶ i.MX Roadmap
- ▶ **Android Introduction**
- ▶ Android on i.MX – Technical details
- ▶ Optimizations
- ▶ Review and Q&A



What is Android?

- ▶ A **free, open source** and **fully customizable** software platform and operating system for mobile devices
- ▶ Based on the **Linux kernel**
- ▶ Offers a **full software stack**: an operating system, middleware, and key applications
- ▶ Also contains a **rich set of APIs** that allows third-party developers to develop great applications
- ▶ Developed by **Google** and later the **Open Handset Alliance (OHA)**
- ▶ Allows writing managed code in the **Java language**
- ▶ Unveiling of the Android platform was announced on **5 November 2007** with the founding of OHA
- ▶ Android is under **version 2 of the Apache Software License (ASL)**



What is Open Handset Alliance (OHA)?

- ▶ A group of mobile and technology leaders responsible for the creation and proliferation of Android and an open mobile ecosystem
- ▶ Devoted to advancing open standards for mobile devices
- ▶ Develop technologies that will significantly lower the cost of developing and distributing mobile devices and services
- ▶ Freescale joined OHA in early 2010



- ▶ Android uses Linux for its device drivers, memory management, process management, and networking
- ▶ The next level up contains the Android native libraries. They are all written in C/C++ internally, but you'll be calling them through Java interfaces. In this layer you can find the Surface Manager, 2D and 3D graphics, Media codecs, the SQL database (SQLite), and a native web browser engine (WebKit)
- ▶ Dalvik Virtual Machine. Before execution, Java (jar) files (Android applications) are converted into the compact **Dalvik Executable (.dex)** format, which is designed to be suitable for systems that are constrained in terms of memory and processor speed, ie. embedded systems
 - Multiple Dalvik Virtual Machines (apps) can run at once and they can communicate between each other
 - As of Android 2.2, Dalvik has a just-in-time compile

Android – Software Stack on Mobile Device

Apps (Java) – Everyone can create his/her own application based on “Open” Android API

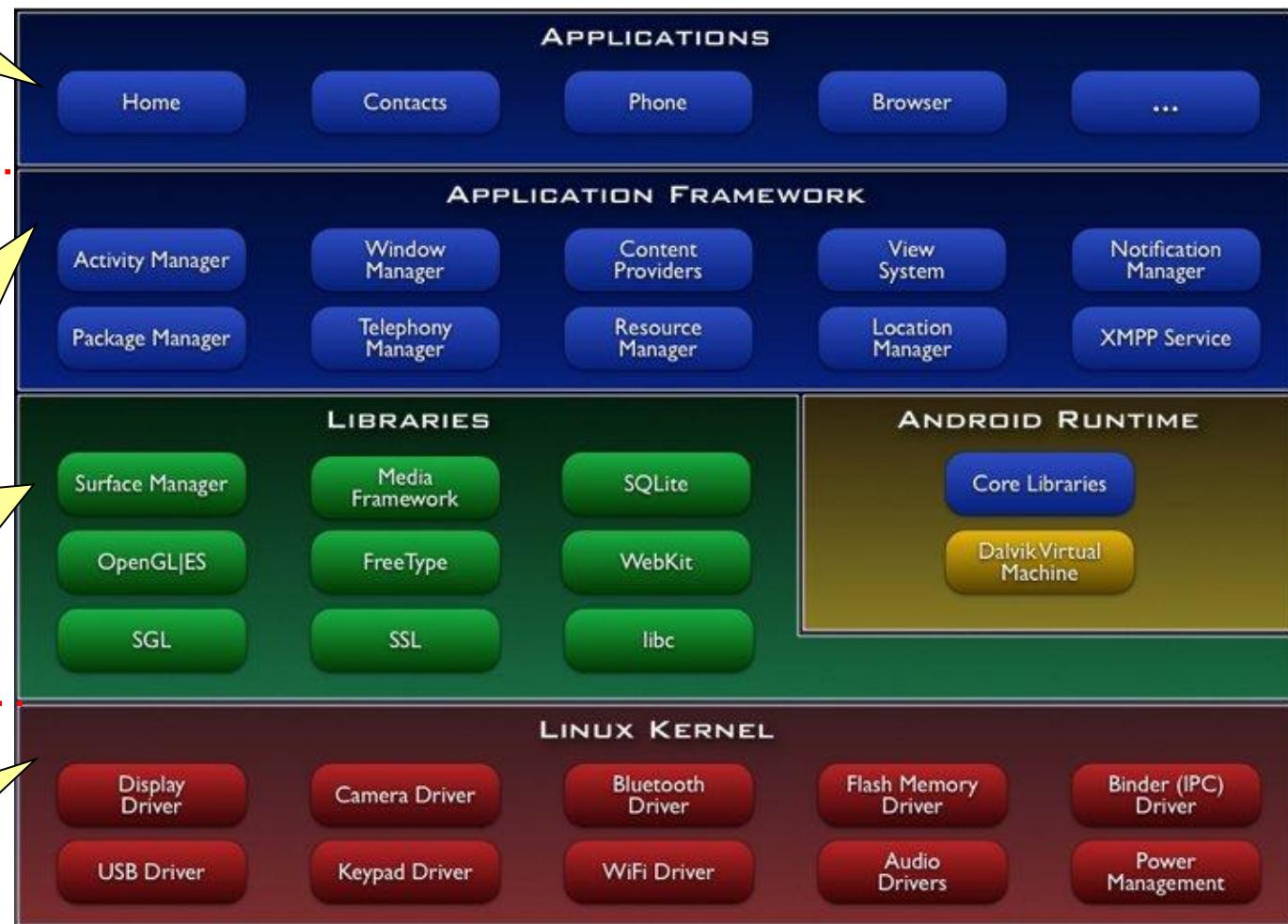
Android “Program” API

Middleware (Java) – App framework including window/focus management, inter-app communication, event notification, etc

Middleware (C/C++) – system libraries for media, graphic, database, font, web engine, etc

Android “Porting” I/F

2.6 based Linux kernel with Android patch.
“Open Source” already



Android Software development Kit and tools

► Android SDK

- Class Library
- Developer Tools
 - dx – Dalvik Cross-Assembler
 - aapt – Android Asset Packaging Tool (application builder)
 - adb – Android Debug Bridge
 - ddms – Dalvik Debug Monitor Service - manage processes on an emulator or device and assists in debugging
- Emulator and System Images
- Documentation and Sample Code

► Eclipse IDE + ADT (Android Development Tools)

- Reduces Development and Testing Time
- Makes User Interface-Creation easier
- Makes Application Description Easier



1.5 (Cupcake)

On 30 April 2009, the official 1.5 (Cupcake) update for Android was released



1.6 (Donut)

On 15 September 2009, the 1.6 (Donut) SDK was released



2.0/2.1 (Eclair)

On 26 October 2009, the 2.0 (Eclair) SDK was released

On 3 December 2009 the 2.0.1 SDK was released

On 12 January 2010 the 2.1 SDK was released



2.2 (FroYo)

On 20 May 2010, the 2.2 (FroYo) SDK was released

Freescale's R9.1 BSP is Froyo

Android – FroYo and Gingerbread – Source Wikipedia

2.2 (Froyo)

Based on Linux Kernel 2.6.32



On 20 May 2010 the 2.2 (Froyo) SDK was released. Changes included:

- * General Android OS speed, memory, and performance optimizations
- * Additional application speed improvements courtesy of [JIT](#) implementation
- * Integration of [Chrome's V8 JavaScript engine](#) into the Browser application
- * Increased Microsoft Exchange support (security policies, auto-discovery, GAL look-up, calendar synchronization, remote wipe)
- * Improved application launcher with shortcuts to Phone and Browser applications
- * USB tethering and WiFi hotspot functionality
- * Support for file upload fields in the Browser application
- * Support for installing applications to the expandable memory
- * [Adobe Flash](#) 10.1 support

Gingerbread

Based on Linux Kernel 2.6.33 or 34



Tentatively scheduled for Q4 launch. Confirmed new features:

Support for [WebM](#) video playback

Improved copy–paste functionalities

Unconfirmed new features:

Android Market music store

Media streaming from PC library

Revamped UI

Support for bigger screens with up to [Wide XGA](#) (1366×768) resolution

Source will be released after SDK release in Q4 - Date TBD - expected in Dec

Some Key Features of Android

► Connectivity

- Supports connectivity technologies including GSM/EDGE, CDMA, EV-DO, UMTS, Bluetooth, and Wi-Fi

► Web browser

- Web browser available in Android is based on the WebKit application framework

► Media

- Supports some audio/video codecs

► Hardware and graphics

- Can use video/still cameras, touchscreens, GPS, accelerometers, magnetometers, accelerated 2D bit blits and accelerated 3D graphics

► Android Market place

- Catalog of applications that can be downloaded and installed to target hardware over-the-air, without the use of a PC

► Dev environment

- Includes a device emulator, tools for debugging, memory and performance profiling



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Bloo - Native Faceb
Dimitris Coughell

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Android SDK – Download at: <http://developer.android.com/sdk>

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Android SDK Starter Package

Download

[Installing the SDK](#)

Downloadable SDK Components

[Adding SDK Components](#)

Android 2.2 Platform new!

Android 2.1 Platform

Android 1.6 Platform

Android 1.5 Platform

▶ Older Platforms

SDK Tools, r6

USB Driver for Windows, r3

ADT Plugin for Eclipse

ADT 0.9.7

Native Development Tools

Android NDK, r4b new!

More Information

SDK System Requirements

SDK Archives

Download the Android SDK

Welcome Developers! If you are new to the Android SDK, please read the [Quick Start](#), below, for an overview of how to install and set up the SDK.

If you are already using the Android SDK and would like to update to the latest tools or platforms, please use the *Android SDK and AVD Manager* to get the components, rather than downloading a new SDK package.

Platform	Package	Size	MD5 Checksum
Windows	android-sdk_r06-windows.zip	23293160 bytes	7c7fce3c6b5c7c3df8ae654b27effb5
Mac OS X (intel)	android-sdk_r06-mac_86.zip	19108077 bytes	c92abf66a82c7a3f2b8493ebe025dd22
Linux (i386)	android-sdk_r06-linux_86.tgz	16971139 bytes	848371e4bf068dbb582b709f4e56d903

Quick Start

The steps below provide an overview of how to get started with the Android SDK. For detailed instructions, start with the [Installing the SDK](#) guide.

1. Prepare your development computer

Read the [System Requirements](#) document and make sure that your development computer meets the hardware and software requirements for the Android SDK. Install any additional software needed before downloading the Android SDK. In particular, you may need to install the [JDK](#) (version 5 or 6 required) and [Eclipse](#) (version 3.4 or 3.5).

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start 5 Windows Explorer 4 Internet Explorer untitled - Paint Android_Training_Chi... Anatomy-Physiology-...

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Examples of Kernel Enhancement

- ▶ **Binder** - driver to facilitate inter-process communication (IPC)
- ▶ **PMEM** - (physical memory) driver is used to provide contiguous physical memory regions to userspace libraries that interact with H/W that cannot cope with scatter-gather – eg DSP
- ▶ **ASHMEM** - is a new shared memory allocator
- ▶ **Logger** - A light weight logging device used to capture system, radio, logdata, etc.
- ▶ **Power** - a light weight power management driver
- ▶ **USB gadget** - Uses the USB function framework
- ▶ **Low Memory Killer** - Based on hits from the userspace, the low memory killer can kill off processes to free up memory as necessary.

For details:

<http://developer.android.com/reference/android/os/Binder.html>

<http://cs736-android.pbworks.com/>

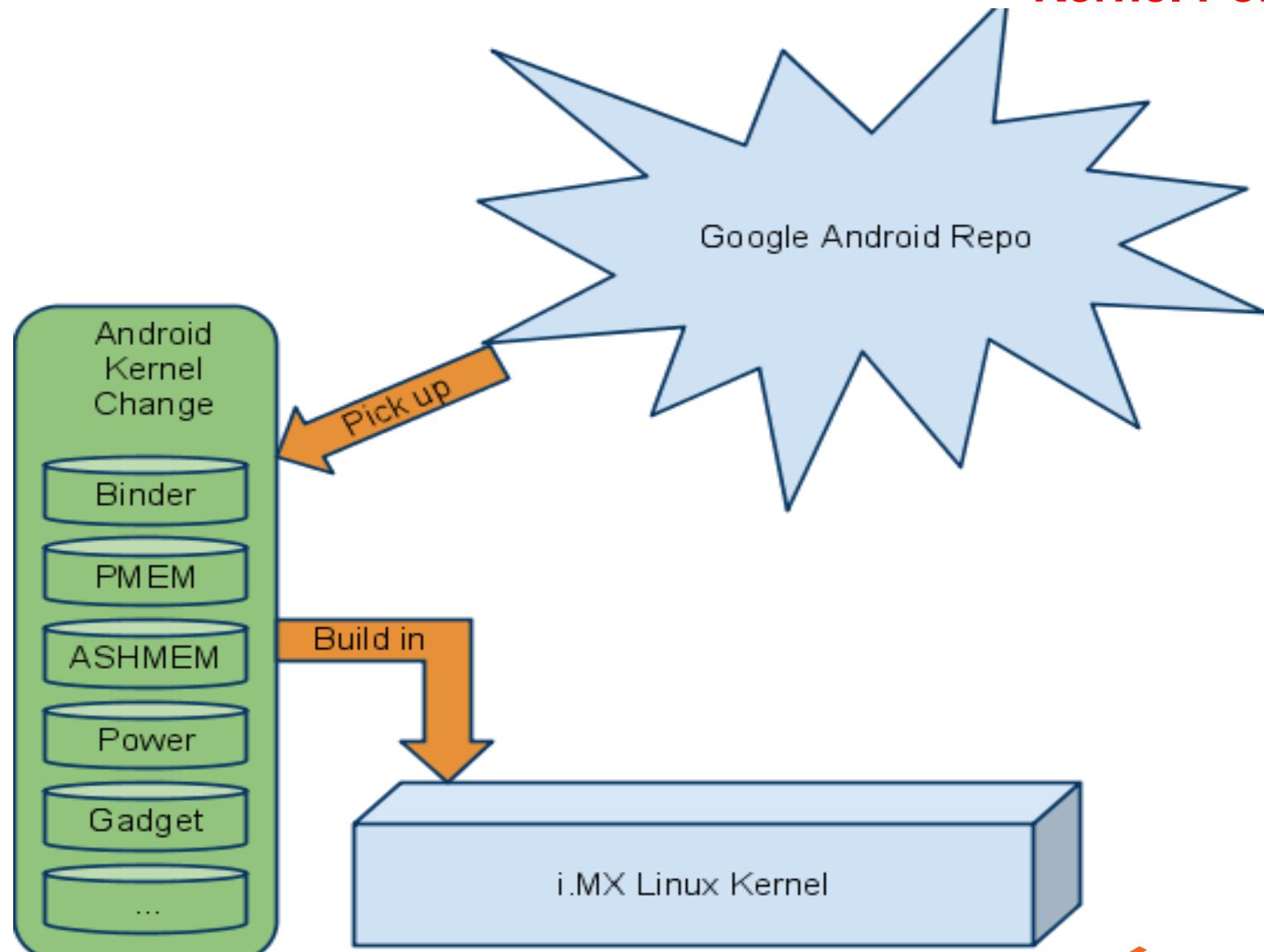


Agenda

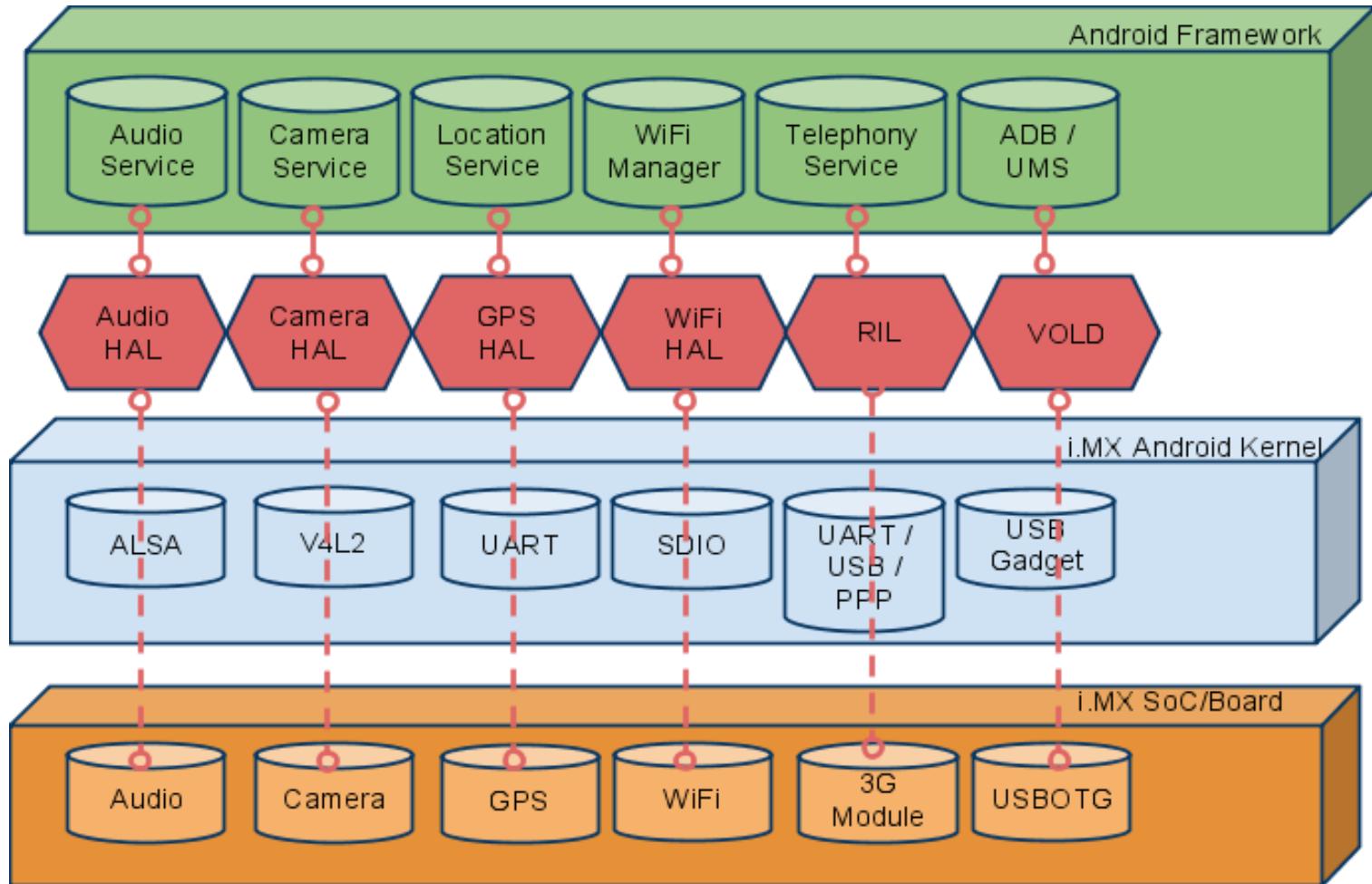
- ▶ Android Introduction
- ▶ i.MX Roadmap
- ▶ **Android on i.MX – Technical details**
- ▶ Optimizations
- ▶ Review and Q&A



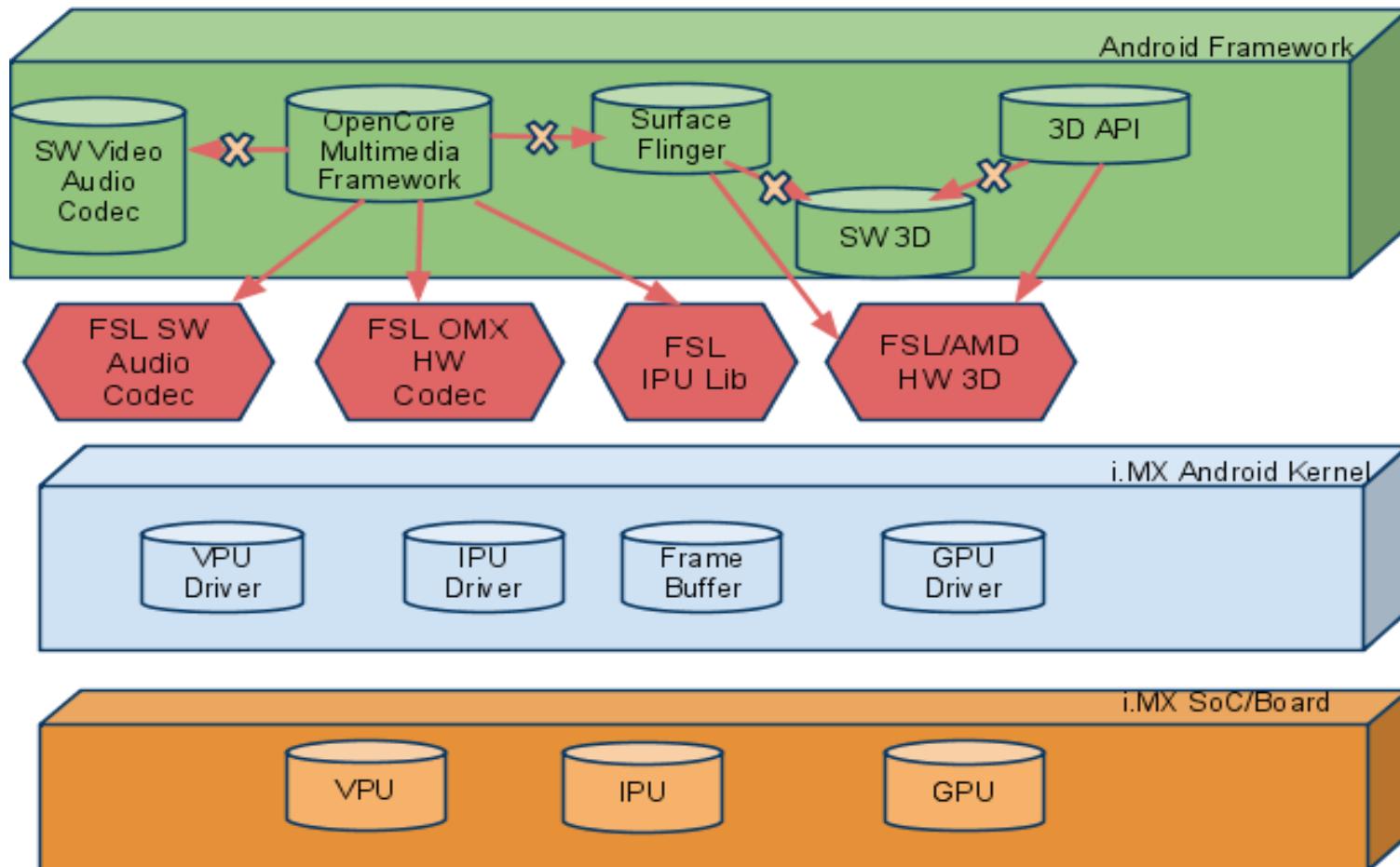
What we did for Android on i.MX - Kernel Porting



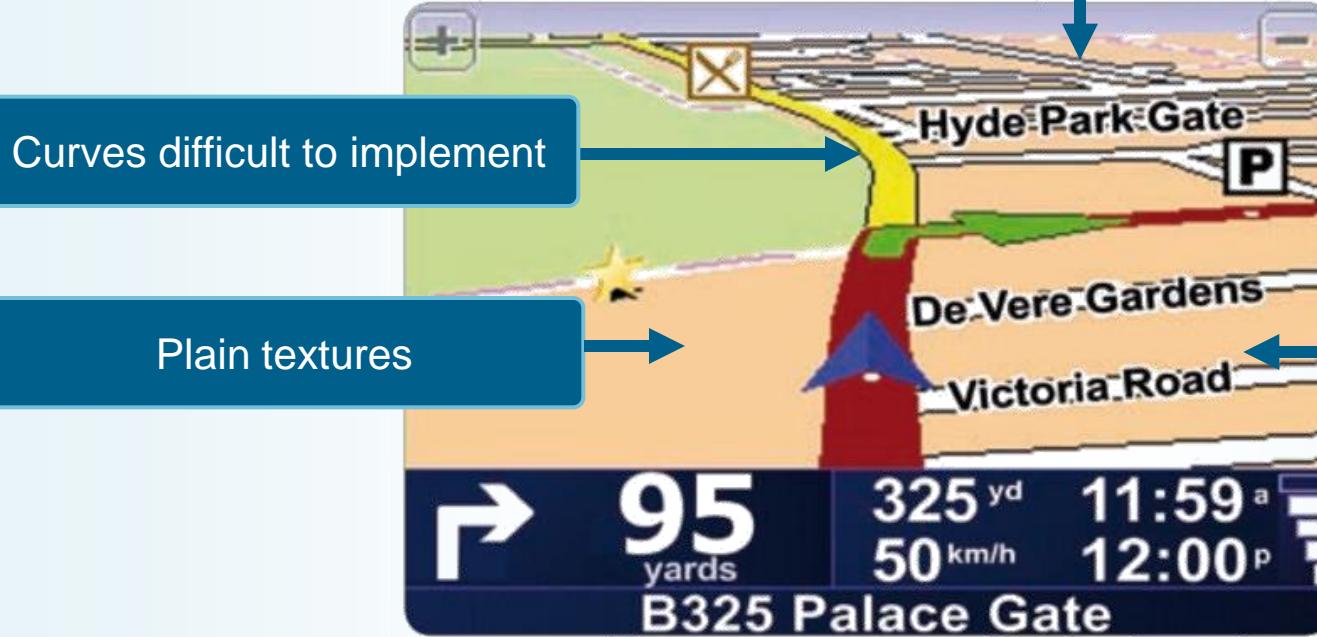
What we did for Android on i.MX - Connecting kernel with Android



What we did for Android on i.MX - Tuning for higher performance



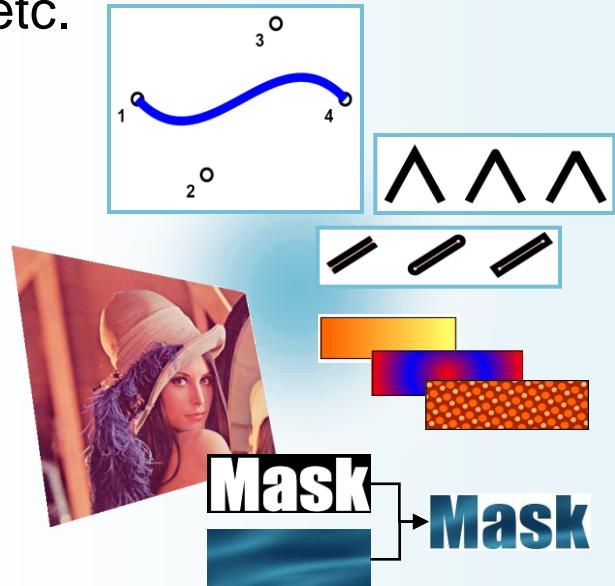
Problems with Existing Graphics



- ▶ **OpenVG** is a standard **API** for hardware-accelerated vector graphics
- ▶ Managed by not-for-profit Khronos Group (also resp. for OpenGL)
- ▶ Royalty-free, open standard
- ▶ Designed to accelerate existing formats
- ▶ e.g. Flash, SVG, PDF, Postscript, Vector fonts, etc.
- ▶ Designed for embedded systems

▶ **OpenVG API natively supports:**

- Lines, curves, paths
- Images
- Filters, masks
- Paint (gradients & textures)
- Blending
- Transformations



What is Vector Graphics?

- ▶ **Vector graphics** are drawn and stored as mathematical vector formulae
- ▶ Each vector and fill is assigned **color value**, instead of assigning color to each separate pixel
- ▶ A black circle can be represented as:

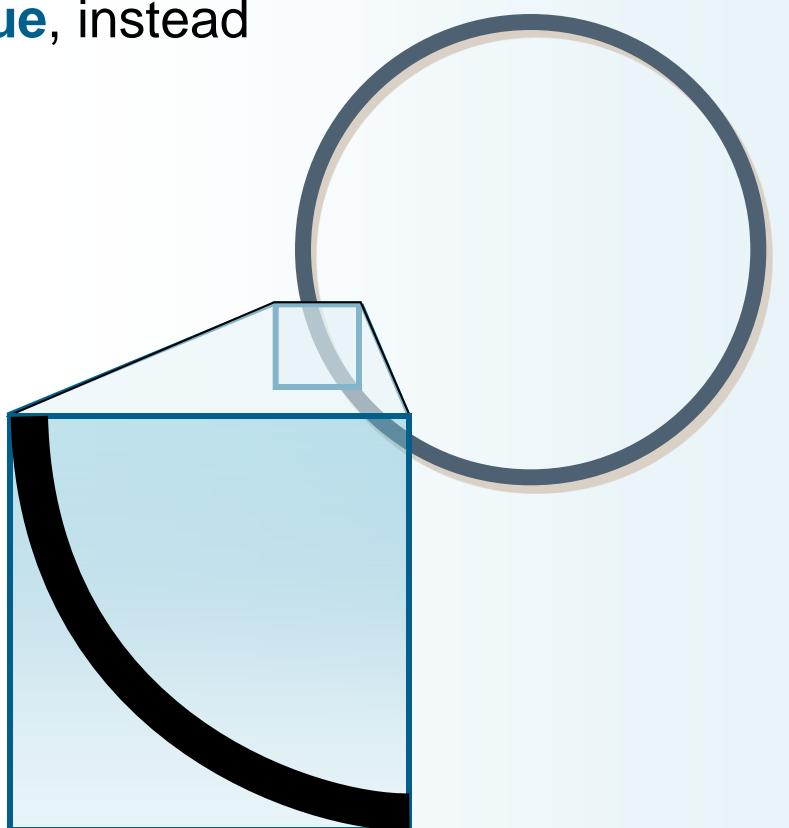
- $x=r \cos \theta$
- $y=r \sin \theta$

or:

- $x^2+y^2=r^2$
- *With color value 0000 for black*

► Benefits

- Infinitely zoomable
- Independent of screen resolution
- Saves data memory



Vector Images vs. Bitmap Images



Vector zoom



Bitmap zoom

Example: Fonts With Bitmaps

Lorem ipsum dolor sit amet, aliquet, nulla eget semper felis dapibus orci. Praesent vel dolor. Qui placerat massa, ut venenatis volutpat vestibulum, qui

Lorem ipsum dolor sit amet, aliquet, nulla eget semper felis dapibus orci. Praesent vel dolor. Qui placerat massa, ut venenatis volutpat vestibulum, qui

Example: Fonts With Vector Graphics

1 Lorem ipsum dolor sit a
aliquet, nulla eget sem
felis dapibus orci. Prae
Praesent vel dolor. Qui
placerat massa, ut ven
volutpat vestibulum, qu

Quisque id est, nonnullam
aliquet, nulla eget ser-
felis dapibus orci. Pra-
Praesent vel dolor. Qu-
placerat massa, ut ve-



Agenda

- ▶ Android Introduction
- ▶ i.MX Roadmap
- ▶ Android on i.MX – Technical details
- ▶ **Optimizations**
- ▶ Review and Q&A



Freescale takes numerous optimization into Android

► Performance optimization for video/audio playback

- Incorporated audio codecs optimized specific for Cortex™-A8/Neon
- Incorporated video accelerator to enable 720p playback (1080p for i.MX53)
- Incorporated video accelerator to enable D1 camcording (720p for i.MX53)
- Video rendering
 - Rendering video through overlay instead of the SurfaceFlinger (UI)
 - Video overlay is accelerated by hardware
 - Frame buffers are shared between the decoder and renderer so avoid memory copy

► Performance optimization for 3D and UI by using the GPU

- Incorporated the GPU for 3D processing
- Hardware BitBlt to combine surfaces into the display buffer

► Functional enhancement for Android OpenCORE

- Added more formats: AVI, MKV, FLV, ASF and RM
- Added more codecs: WMV7/8/9, WMA, Ogg Vorbis and AC3 decoders
- Added MP3 for audio encoding

► Product-quality test

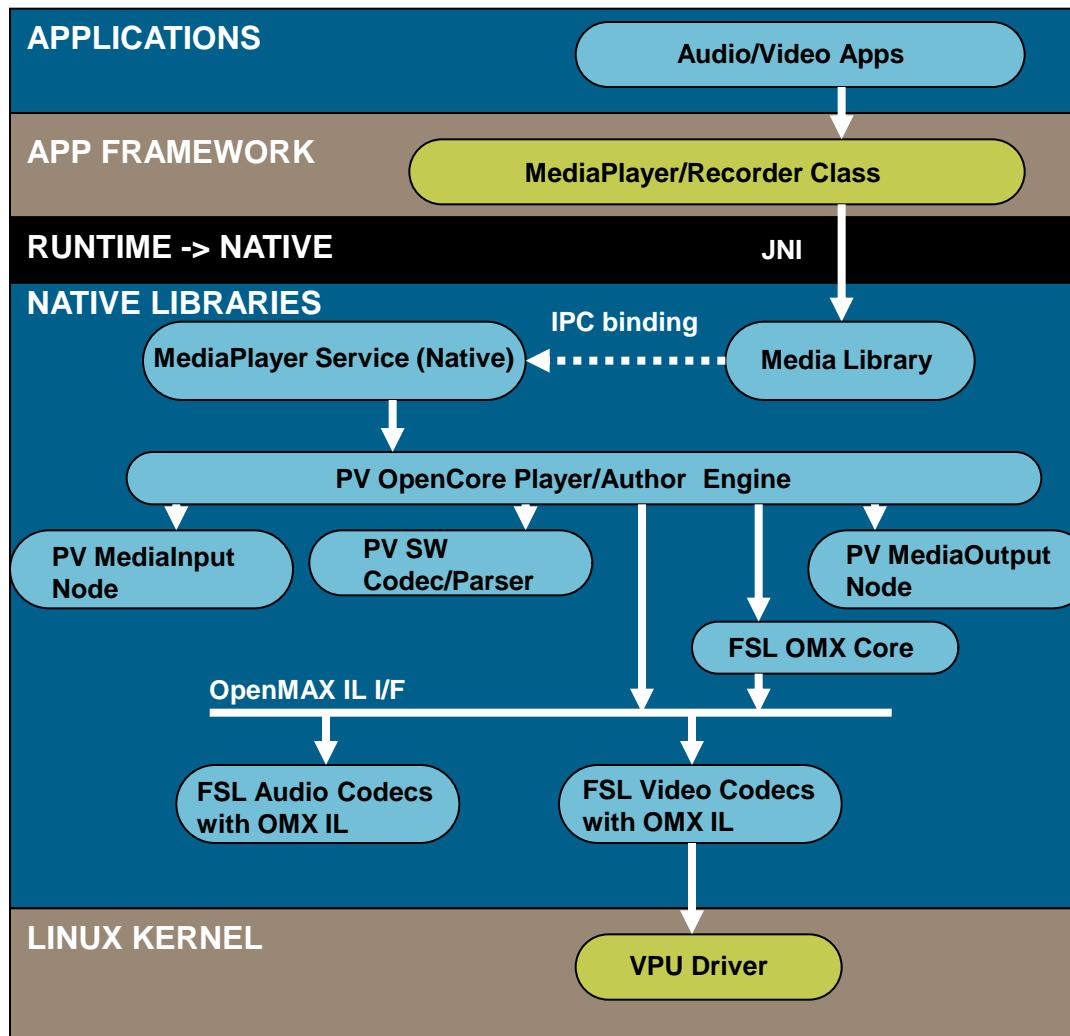
Video playback performance comparison between un-optimized and optimized Android

Container	Video	Audio	Resolution/ Framerate	CPU loading		Frame Dropping Rate		
				Original	Optimized	Original	Optimized	
MP4	MPEG-4	AAC-LC	320x240/30	56.5%	7.3%	0	0	
			640x480/30	96.5%	8.7%	7.4%	0	
			720x576/30	>97%	9.2%	27%	0	
			1280x720/30	N/A	11%	N/A	0	
	H.264		320x240/30	79.6%	7.0%	0	0	
			640x480/30	N/A	7.6%	N/A	0	
			720x576/30	N/A	8.2%	N/A	0	
			1280x720/30	N/A	11.2%	N/A	0	

Notes

- ▶ The test is carried out on Freescale i.MX51 EVK 3.0 board with WVGA output
- ▶ N/A means this specification is not supported
- ▶ The original Android supports MPEG-4 up to VGA and H.264 up to CIF with acceptable quality
- ▶ Freescale version with optimization supports MPEG-4 and H.264 up to 720p without frame dropping

Multimedia – Audio/Video Codec



Matrix of Multimedia Codecs

File Extension	Video Decoders	Audio Decoders
.mp3		<ul style="list-style-type: none"> MPEG-1 Audio Layer I/II/III
.aac/.adts		<ul style="list-style-type: none"> AAC LC/PLUS
.mp4	<ul style="list-style-type: none"> MP4V:MPEG-4 SP/ASP except GMC H264:H.264 BP/MP/HP H263 	<ul style="list-style-type: none"> AAC LC/PLUS MP3
.m4a		<ul style="list-style-type: none"> AAC LC/PLUS
.3gp	<ul style="list-style-type: none"> MP4V:MPEG-4 SP/ASP except GMC H264:H.264 BP/MP/HP H263 	<ul style="list-style-type: none"> AAC LC/PLUS AMR-NB
.avi	<ul style="list-style-type: none"> MP4V:MPEG-4 SP/ASP except GMC Xvid H264:H.264 BP/MP/HP H263 Divx4/5/6 	<ul style="list-style-type: none"> AAC LC/PLUS MP3
.wma		<ul style="list-style-type: none"> WMA STD, PRO, Lossless
.wmv/.asf	<ul style="list-style-type: none"> VC1: VC-1 SP/MP/AP WVC1 WMV7, 8 	<ul style="list-style-type: none"> WMA STD, PRO, Lossless
.mkv/mka	<ul style="list-style-type: none"> H264:H.264 BP/MP/HP Xvid Divx4/5/6 VC1: VC-1 SP/MP/AP MPEG4 	<ul style="list-style-type: none"> AAC MP3 WMA STD, PRO, Lossless Vorbis
.flv	<ul style="list-style-type: none"> Sorenson H263 H264:H.264 BP/MP/HP 	<ul style="list-style-type: none"> MP3 AAC

File Extension	Video Encoders	Audio Encoders
.3gp	<ul style="list-style-type: none"> H263 	<ul style="list-style-type: none"> AMR-NB
.mp4	<ul style="list-style-type: none"> H264 	<ul style="list-style-type: none"> MP3

File Extension	Video Decoders	Audio Decoders
.avi	<ul style="list-style-type: none"> DivX3 	<ul style="list-style-type: none"> AC3
.ra		<ul style="list-style-type: none"> RA6 RA9/10 (AAC-LC)
.rm/rmvb	<ul style="list-style-type: none"> RV8/9/10 	<ul style="list-style-type: none"> RA6 (Up to 2 audio channel) RA9/10 (AAC-LC)
.mkv/.mka	<ul style="list-style-type: none"> RV8/9/10 DivX3 	<ul style="list-style-type: none"> AC3 RA6 (Up to 2 audio channel) RA9/10 (AAC-LC)

Extensive Enhancements for Graphics and Other Modules

- ▶ Incorporated the GPU for 3D processing
 - UI optimizations
 - 3D applications
- ▶ Hardware BitBlt to combine surfaces into the display buffer
- ▶ Multiple overlay
- ▶ Multiple media storage
- ▶ Recovery on EXT3/SD

► SurfaceFlinger

- Provides a system-wide surface “composer” to render all the surfaces in a frame buffer.
- SF Combines 2D and 3D surfaces.
- SF uses OpenGL ES and 2D hardware accelerator for its compositions.

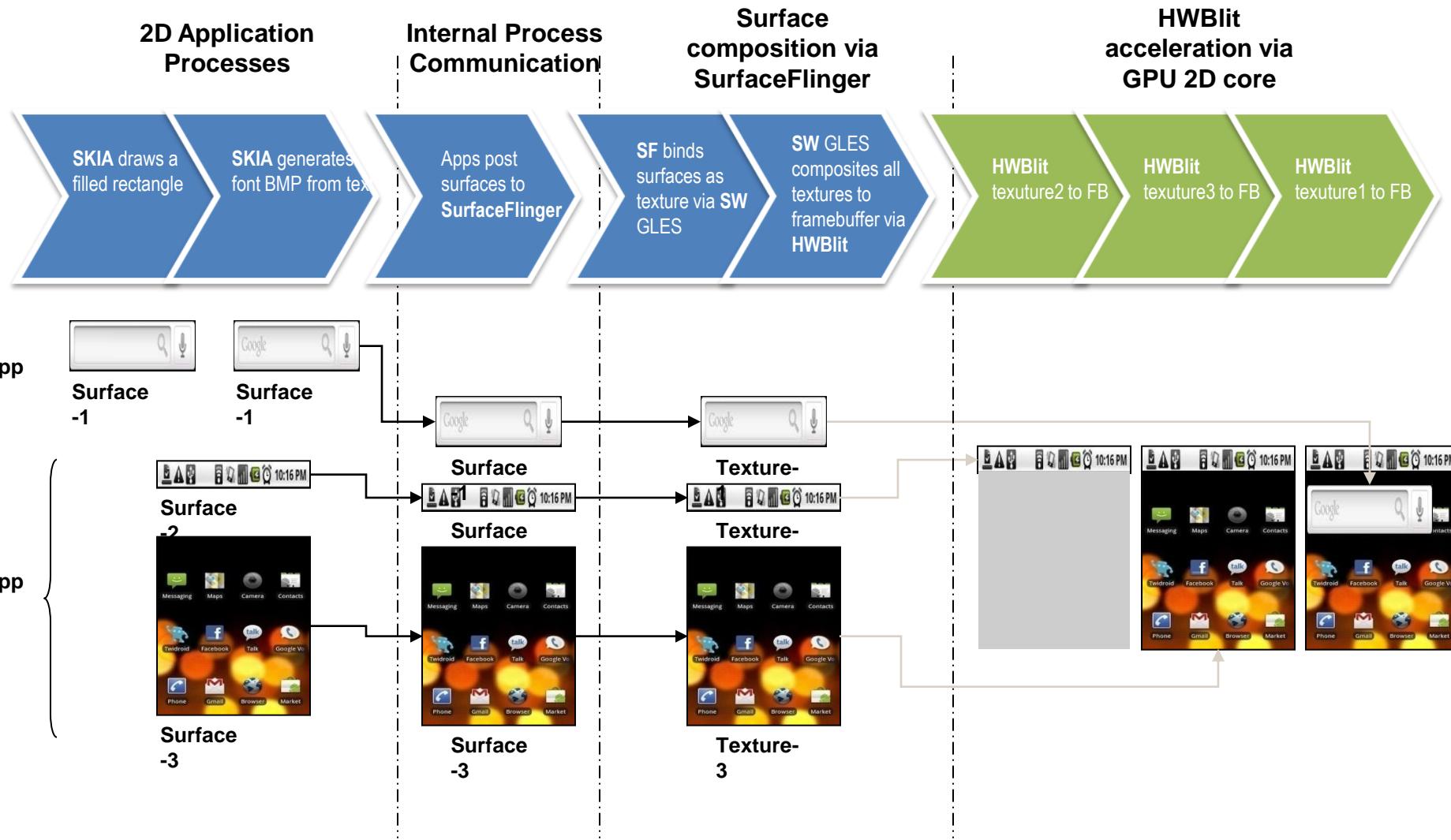
► SKIA

- Skia is a complete 2D graphic library for drawing Text, Geometries, and Images.
- 3x3 matrices w/ perspective.
- antialiasing, transparency, filters.
- shaders, xfermodes, maskfilters, patheffects.

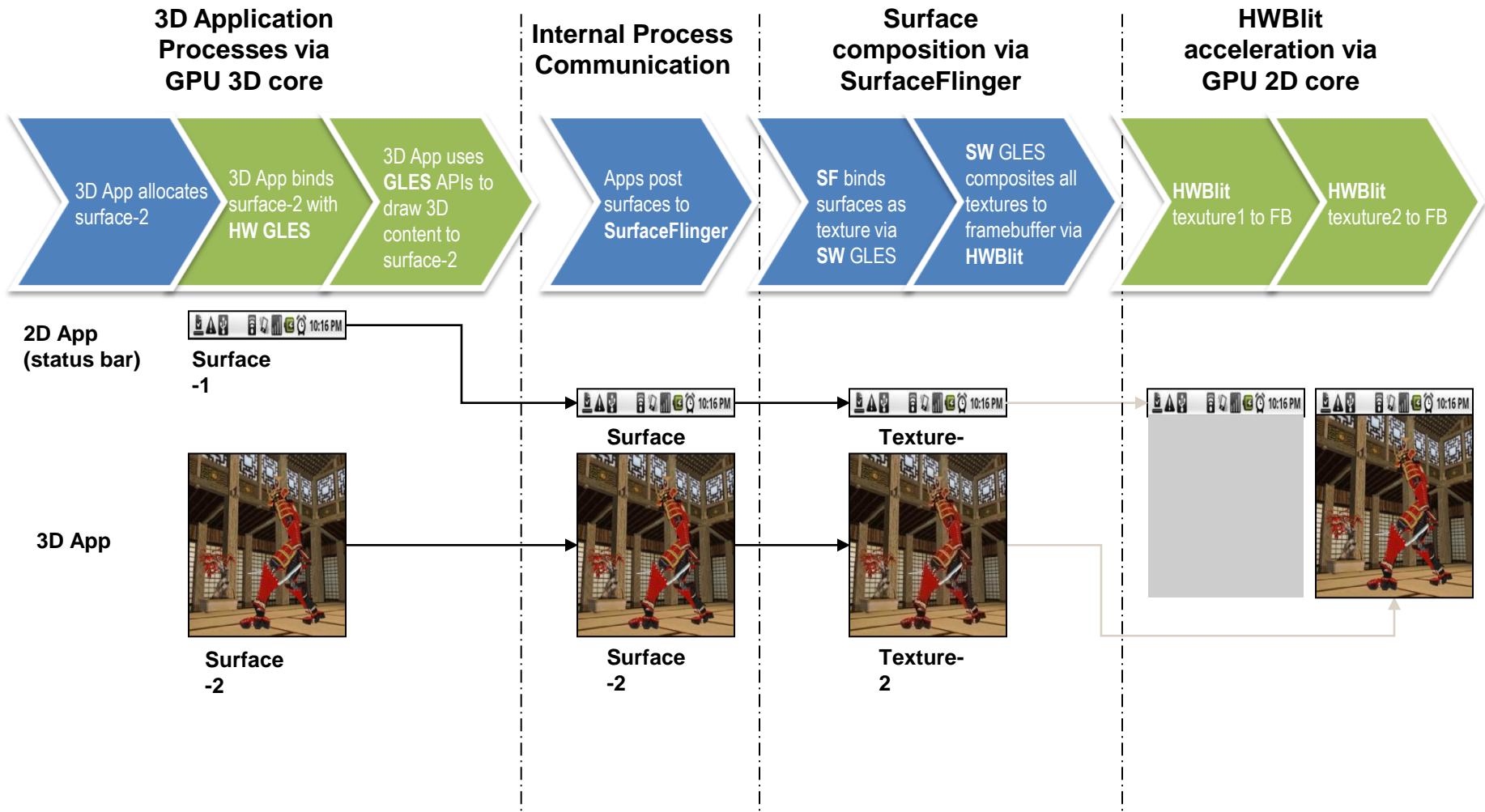
► HW Blit Engine

- HWBlit is a GPU accelerated 2D blit engine for fast bitmap copying, rotation, alpha blending, dithering and other 2D effects.

Android 2D Graphic



Android 3D Graphic



►Samurai

- Z430 clock = 166MHz
- Screen Resolution = 800x480 full screen,16bpp(WVGA RGB565)
- Memory = DDR200
- Average FPS = 34 frame





Agenda

- ▶ Android Introduction
- ▶ i.MX Roadmap
- ▶ Android on i.MX – Technical details
- ▶ Optimizations
- ▶ **Review and Q&A**





Key Messages

- ▶ Android is a free, open source and fully customizable software platform and operating system for mobile devices – Gained tremendous market share
- ▶ Freescale enables customers with integrated hardware/software solutions to realize **faster time to market**. The Android platform provides a **compelling and innovative end user experience** to support this effort
- ▶ The i.MX5x/NextGen processor family with Android is a **full hardware and software solution** that is **ideal for high performance, low power and cost effective mobile devices**, including smartphones and other smart mobile devices such as smartbooks and eReaders ... *and your product!*
- ▶ The Android solution for i.MX is fully optimized and integrated with the video and graphics hardware accelerators
- ▶ Freescale is a member of the **Open Handset Alliance™**



Learn More On

<http://www.freescale.com/imxandroid>





Thank You

Powering Innovation