May, 2010

Freescale Android Platform Support for i.MX applications processors
Freescale Multimedia Markets

Automotive

- Historic leadership in Telematics
- Ramping in radio and infotainment
- Initial designs in advanced clusters

eReaders

- Dominant market share in emerging eReader market
- Aligned with market leaders

Smart Mobile Devices

- Thought leader for smartbooks
- Focused investment in tablets
- Strong smartphone player

Embedded Multimedia

- Broad traction in the embedded market
- Connected display based devices in consumer and industrial markets
Example of Consumer usage:

High tier smartbook

Smartbook

Smartphone

eReader

i.MX31 family
- ARM1136, 532MHz
- Graphics
- mDDR

i.MX35 family
- ARM1136, 532 MHz
- Graphics
- DDR2

i.MX51 family
- Cortex-A8, 800MHz
- Video (720p dec)
- Graphics
- 512MB DDR2

i.MX508
- Cortex-A8, 800 MHz
- Graphics
- E INK display Controller
- 512MB LP-DDR2

PMP

i.MX27 family
- ARM926, 400MHz
- Video
- STMP37xx
- ARM926, 266-400MHz
- Integrated PMIC

i.MX25 family
- ARM926, 400MHz
- STMP37xx
- ARM926, 266-400MHz
- Integrated PMIC

C90 i.MX Platform
C90/C85 STMP Platform
C65 A8 Platform

Right Edge = Consumer Qualification
Left Edge has no meaning

Applications Processors (i.MX) Roadmap

<2008

2009

2010
i.MX Value Proposition

► 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 all major smartbook/tablet OS’s
  - Full-featured media framework, including HW-accelerated Flash 10 and Skype
  - 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
## Smartbook OS Options

<table>
<thead>
<tr>
<th>OS</th>
<th>Target Markets</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Chrome   | Clamshell                        | • Aimed at cloud computing  
• No touch screen support today                                   |
| Android  | Smartphone                      | • Optimized for smartphones  
• Touch screen support  
• Tremendous pull in multiple markets                               |
|          | Smaller tablets (<7 in)         |                                                                          |
|          | eReaders                        |                                                                          |
| Ubuntu   | Clamshell                        | • Supports netbook applications  
• Smartbook flavors                                                    |
|          | Large tablets (7-10 in)         |                                                                          |
| Millos   | Smartbook                        | • Optimized applications                                                |
|          | Smartphone                       |                                                                          |
| WinCE    | Small clamshell                  | • Highly integrated WinCE6 and WinCE 7 platforms                          |
|          | Tablet                           |                                                                          |
A few words about Android
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 Platform details

Android “Program” API
- Middleware (Java) – App framework including window/focus management, inter-app communication, event notification, etc
- Android native libraries. They are all written in C/C++ internally, but you’ll be calling them through Java interface

Android “Porting” I/F
- Linux kernel with Android patch and BSP integration

Apps (Java) – Everyone can create his/her own application based on “Open” Android API
What Android Is and Is Not

► It’s a software stack for mobile devices including **OS (Linux), middleware and key applications**

► It’s a different Linux OS (or “distribution”) based on Linux kernel. The system libraries, system initialization and program interface in it are distinct from a “standard” Linux OS

► It’s not ONLY an application framework for Linux, although it does include it’s own app framework (window management, inter-app communication, event dispatch, …)

► It’s not ONLY a Java API for phone, although it does include a Java virtual machine (called “Dalvik”) and all system interfaces are exposed only through Java libraries

► It’s not a full phone stack. It’s ONLY SW running on application CPU. It will interact with wireless protocol (GSM/GPRS/WCDMA/….) running on separate baseband chip to implement telephony features
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 open-source WebKit application framework

► Media
  • Supports the following audio/video/still media formats: H.263, H.264 (in 3GP or MP4 container), MPEG-4 SP, AMR, AMR-WB (in 3GP container), AAC, HE-AAC (in MP4 or 3GP container), MP3, MIDI, OGG Vorbis, WAV, JPEG, PNG, GIF, BMP

► Hardware and graphics
  • Can use video/still cameras, touchscreens, GPS, accelerometers, magnetometers, accelerated 2D bit blits (with hardware orientation, scaling, pixel format conversion) 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

► Multi-touch
  • Has native support for multi-touch which is available in newer handsets such as the Nexus One

► Dev environment
  • Includes a device emulator, tools for debugging, memory and performance profiling, a plugin for the Eclipse IDE
Freescale Android strategy
i.MX Android Strategy

► Readiness
An “integrated” solution (kernel + Android framework + dev/debug environment) instead of a “Android compliable” kernel only. Customer should be able to directly develop applications on this “integrated” solution or easily modify/replace their own drivers based on our reference code. i.e. our BSP needs to be “glued” with Android framework seamlessly.

► Performance
Our i.MX+Android integration shows higher performance by careful optimization (e.g. utilizing HW acceleration, SW codec optimization) on current Android base.

► Contribution
Freescale is now an OHA member
Participate and actively contribute in the OHA community.
Contents of a Freescale i.MX Android Release

Consist of three packages:

► Core – Images for board and source patches except FSL's parser/codec enhancement (HW video acceleration is still included in this package)

► Codec standard package - FSL's parser/codec enhancement, but exclude those parser/codec which need additional license agreement

► Codec excluded package - those parser/codec enhancement which need additional license agreement, including DivX/AC3/RMVB
i.MX5x Android Value Add and Roadmap

► Integrated and tested solution
  • Kernel + Android framework + codecs + development/debug environment

► Performance Optimization
  • Hardware acceleration for graphics and multimedia
  • Optimized OpenMax and OpenGL/ES with on chip VPU/GPU

► Extensive Test Case
  • System test: power, audio, video, graphics, camera, connectivity
  • BSP and Codec test

► New release ~ every two months

2009
<table>
<thead>
<tr>
<th>June</th>
<th>July</th>
</tr>
</thead>
<tbody>
<tr>
<td>R3</td>
<td>R4</td>
</tr>
<tr>
<td>(Jun 12th)</td>
<td>(Jul 10th)</td>
</tr>
<tr>
<td>Cupcake; Android Q2 Accel., power mgt, IPU HW video, codec protection</td>
<td>Donut; Android Q2 Power Optimization</td>
</tr>
</tbody>
</table>

2010
<table>
<thead>
<tr>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
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<tbody>
<tr>
<td>R7</td>
<td>R7.1</td>
<td>R8</td>
<td>R9</td>
<td>R10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Jan 26th)</td>
<td>(Mar 15th)</td>
<td>(Apr 15th)</td>
<td>(~May 30)</td>
<td>(~July 30)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Éclair; 3 layer overlay on 1 display, USB Camera, MKV,..</td>
<td>Éclair 2.1; Fancy UI features, Bug fixes</td>
<td>Éclair 2.1; CTS tested</td>
<td>MX53 support</td>
<td>MX53 feature addition</td>
<td></td>
<td></td>
</tr>
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</table>

Started work from late 2008

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Freescale Android optimizations

Platform specific port - some driver work needed

Runs on Dalvik and framework – no porting effort

Runs on Dalvik – no porting effort

Freescale optimizations
Multimedia – Audio/Video Codec

APPLICATONS
- Audio/Video Apps

APP FRAMEWORK
- MediaPlayer/Recorder Class

RUNTIME -> NATIVE
- JNI

NATIVE LIBRARIES
- MediaPlayer Service (Native)
- Media Library
- PV OpenCore Player/Author Engine
- PV MedialInput Node
- PV SW Codec/Parser
- PV MediaOutput Node
- FSL OMX Core

LINUX KERNEL
- OpenMAX IL I/F
- FSL Audio Codecs with OMX IL
- FSL Video Codecs with OMX IL
- VPU Driver
## Multimedia – Graphics

**APPLICATIONS**

- 2D Apps

**APP FRAMEWORK**

- graphic class

**RUNTIME -> NATIVE**

- JNI

**NATIVE LIBRARIES**

- Surface Manager (Native)
- OpenGL/ES wrapper
- agl or hgl – OpenGL/ES implementation
- render to display
- UI lib/egl
- sgl graphic engine
- Other Service (e.g. webkit)

**LINUX KERNEL**

- FrameBuffer
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
  - Incorporated video accelerator to enable D1 camcording
  - 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

<table>
<thead>
<tr>
<th>Container</th>
<th>Video</th>
<th>Audio</th>
<th>Resolution/ Framerate</th>
<th>CPU loading</th>
<th>Frame Dropping Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Original</td>
<td>Optimized</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Original</td>
<td>Optimized</td>
</tr>
<tr>
<td>MP4</td>
<td>MPEG-4</td>
<td>AAC-LC</td>
<td>320x240/30</td>
<td>56.5%</td>
<td>7.3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>640x480/30</td>
<td>96.5%</td>
<td>8.7%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>720x576/30</td>
<td>&gt;97%</td>
<td>9.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1280x720/30</td>
<td>N/A</td>
<td>11%</td>
</tr>
<tr>
<td></td>
<td>H.264</td>
<td></td>
<td>320x240/30</td>
<td>79.6%</td>
<td>7.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>640x480/30</td>
<td>N/A</td>
<td>7.6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>720x576/30</td>
<td>N/A</td>
<td>8.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1280x720/30</td>
<td>N/A</td>
<td>11.2%</td>
</tr>
</tbody>
</table>

**Notes**

- The test is carried out on Freescale Babbage 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
Android Test Methodology

► Freescale provides platform software components under the Android framework, to enable customers develop final Android-based solutions

► Our validation strategy consists of primarily validating the key platform pieces that constitute an Android port – which (as seen in the block diagram) is focused on the HAL, BSP and Codecs

► From a system stand point, we focus on the following pieces for integration and validation: Codecs, WiFi, Bluetooth, GPS, Camera, Graphics, and extensions that would feed into the Android stack.

► We will provide feedback on the Android stack to OHA but will not validate middleware features that are being handled by Google/OHA – we assume they are already extensively validated

► Validation with Android CTS
OHA contribution

► Android enabled kernel for i.MX SoC

► Android runnable configuration (and necessary binaries) which can be used for building Android for our open-available hardware platform

► Utilize HW (Image Processing Unit) for video surface rendering

► Utilize HW (Video Processing Unit) for video codec acceleration

► Utilize HW (Graphics Processing Unit) for OpenGL-ES graphic acceleration

► Utilize/verify Android HAL (GPS/WiFi/BT, Camera, sound with ALSA) on our Android platform
Freescale Semiconductor 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.MX51 Applications processor 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.

The i.MX51 EVK offers a fully integrated and tested Android platform with optimized codecs and graphics and a development and debug environment. This solution is based on the latest stable Android kernel/release.

Freescale is a member of the Open Handset Alliance™ - a group of mobile and technology leaders responsible for the creation and proliferation of Android and an open mobile ecosystem.
Learn more on...

http://www.freescale.com/imxandroid