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# Android™ on eReader and Smartbooks

CON-F0987

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# Session Introduction

- 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






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# Agenda

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






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# 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






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# Android – Software Stack on Mobile Device

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

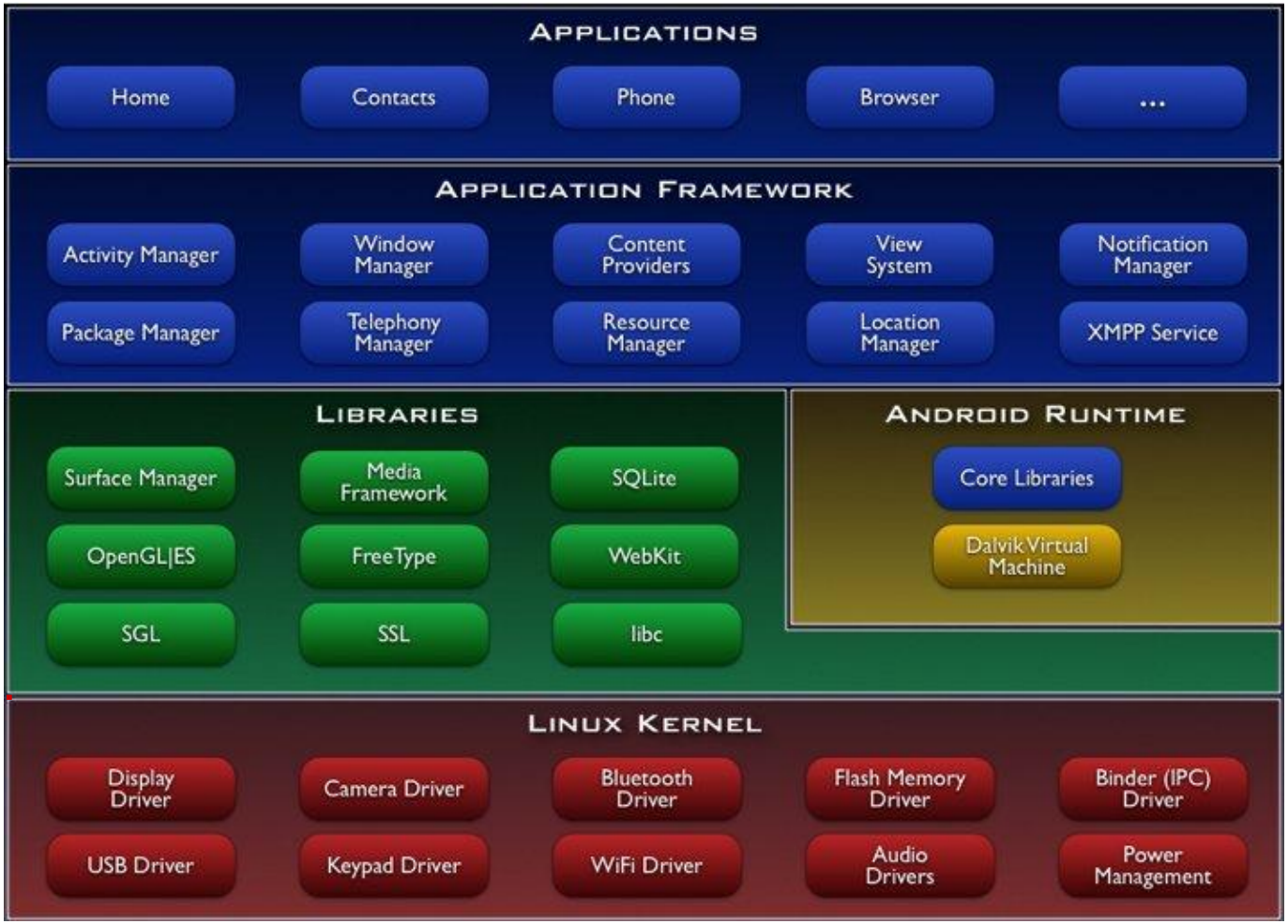
**Android "Program" API**

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



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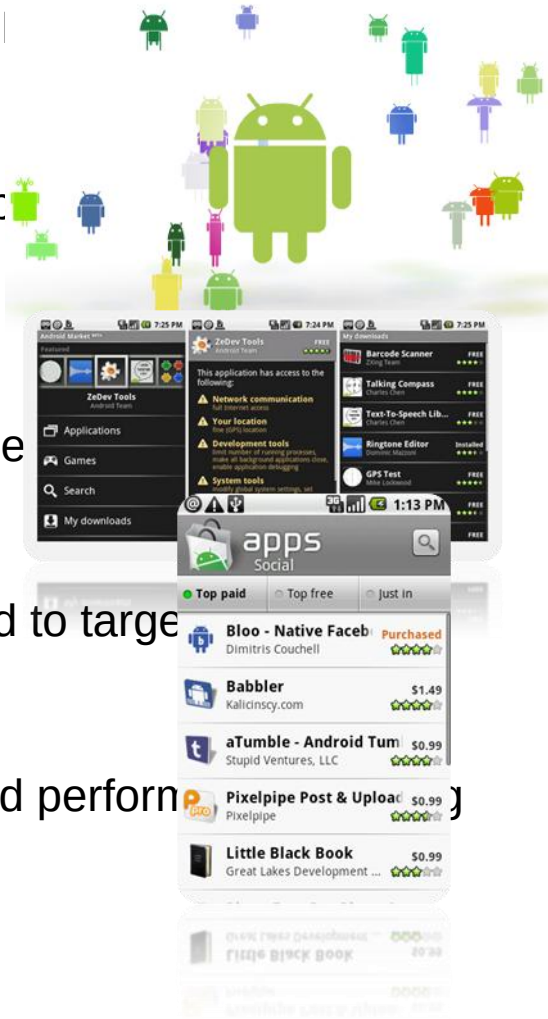
# Some Key Features of Android

- **Connectivity**
  - Supports connectivity technologies including GSM/EDGE, C
    Bluetooth, and Wi-Fi
- **Web browser**
  - Web browser available in Android is based on the WebKit ap
- **Media**
  - Supports some audio/video codecs
- **Hardware and graphics**
  - Can use video/still cameras, touchscreens, GPS, accelerome
    accelerated 2D bit blits and accelerated 3D graphics
- **Android Market place**
  - Catalog of applications that can be downloaded and installed to targe
    over-the-air, without the use of a PC
- **Dev environment**
  - Includes a device emulator, tools for debugging, memory and perform





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# Examples of Kernel Enhancement

- Binder (Android IPC support)
- PMEM
- ASHMEM
- Logger
- Power
- USB gadget
- Low Memory Killer

For details:

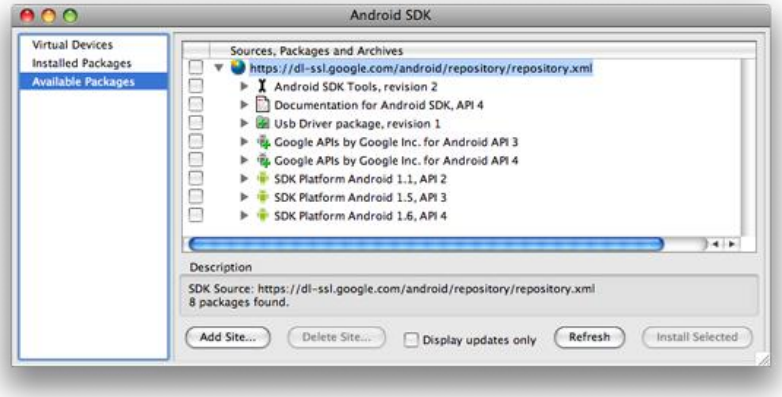
http://developer.android.com/reference/android/os/Binder.html

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

# Android Software Development Kit and Tools

## ▶Android SDK

- Class Library
- Developer Tools
  - dx – Dalvik Cross-Assembler
  - aapt – Android Asset Packaging Tool
  - adb – Android Debug Bridge
  - ddms – Dalvik Debug Monitor Service
- 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



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# Past Android Releases

## 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



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# Android – FroYo and Gingerbread – Source Wikipedia

| | |
|---|---|
| **2.2 (Froyo)**<br><br>**Based on Linux Kernel 2.6.32**<br><br>  | On 20 May 2010 the 2.2 (Froyo) SDK was released. Changes included:<br>* General Android OS speed, memory, and performance optimizations<br>* Additional application speed improvements courtesy of JIT implementation<br>* Integration of Chrome's V8 JavaScript engine into the Browser application<br>* Increased Microsoft Exchange support (security policies, auto-discovery, GAL look-up, calendar synchronization, remote wipe)<br>* Improved application launcher with shortcuts to Phone and Browser applications<br>* USB tethering and WiFi hotspot functionality<br>* Support for file upload fields in the Browser application<br>* Support for installing applications to the expandable memory<br>* Adobe Flash 10.1 support |
| **Gingerbread**<br>**Based on Linux Kernel 2.6.33 or 34**<br><br>  | Tentatively scheduled for Q4 launch. Confirmed new features:<br><br>Support for WebM video playback<br>Improved copy–paste functionalities<br>Unconfirmed new features:<br>Android Market music store<br>Media streaming from PC library<br>Revamped UI<br>Support for bigger screens with up to Wide XGA (1366×768) resolution<br>***Source will be released after SDK release in Q4 - Date TBD - expected in Dec*** |

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# Enabling the Multimedia Experience


Trends driving need for a intuitive, rich user experience with seamless connectivity. See it and touch it

- Proliferation of tablet centric devices
- Content centric
- Instant on and always connected
- Great user experience

**Requirements:**

- Optimized performance-power-cost
- Open OS support with complete solution including reference designs
- Strong ecosystem and partners
- Ease of use for fast time to market

**Smart processing solutions for the connected world**





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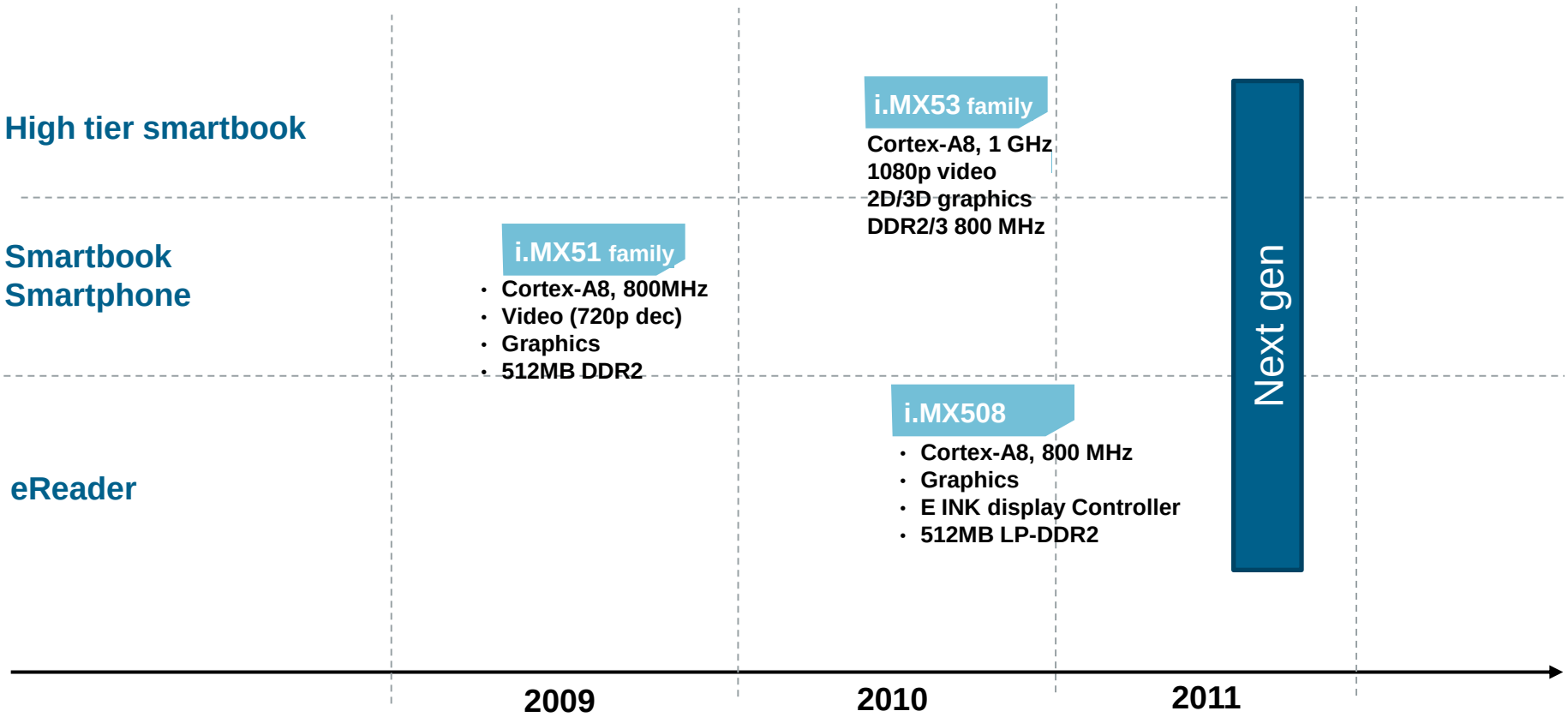
# Applications Processors (i.MX) Roadmap




C90 i.MX Platform

C90/C85 STMP Platform

C65 A8 Platform





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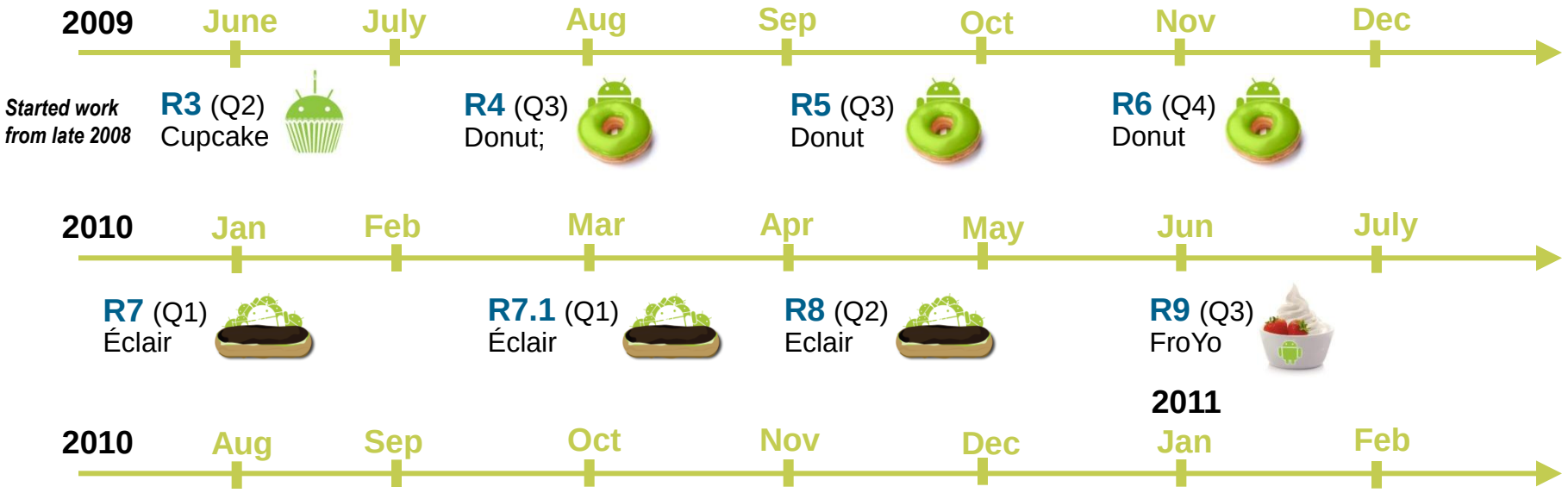
# Freescale Android Value Add and Roadmap

- 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
- New release ~ every two months




*Regular cadence of updates*



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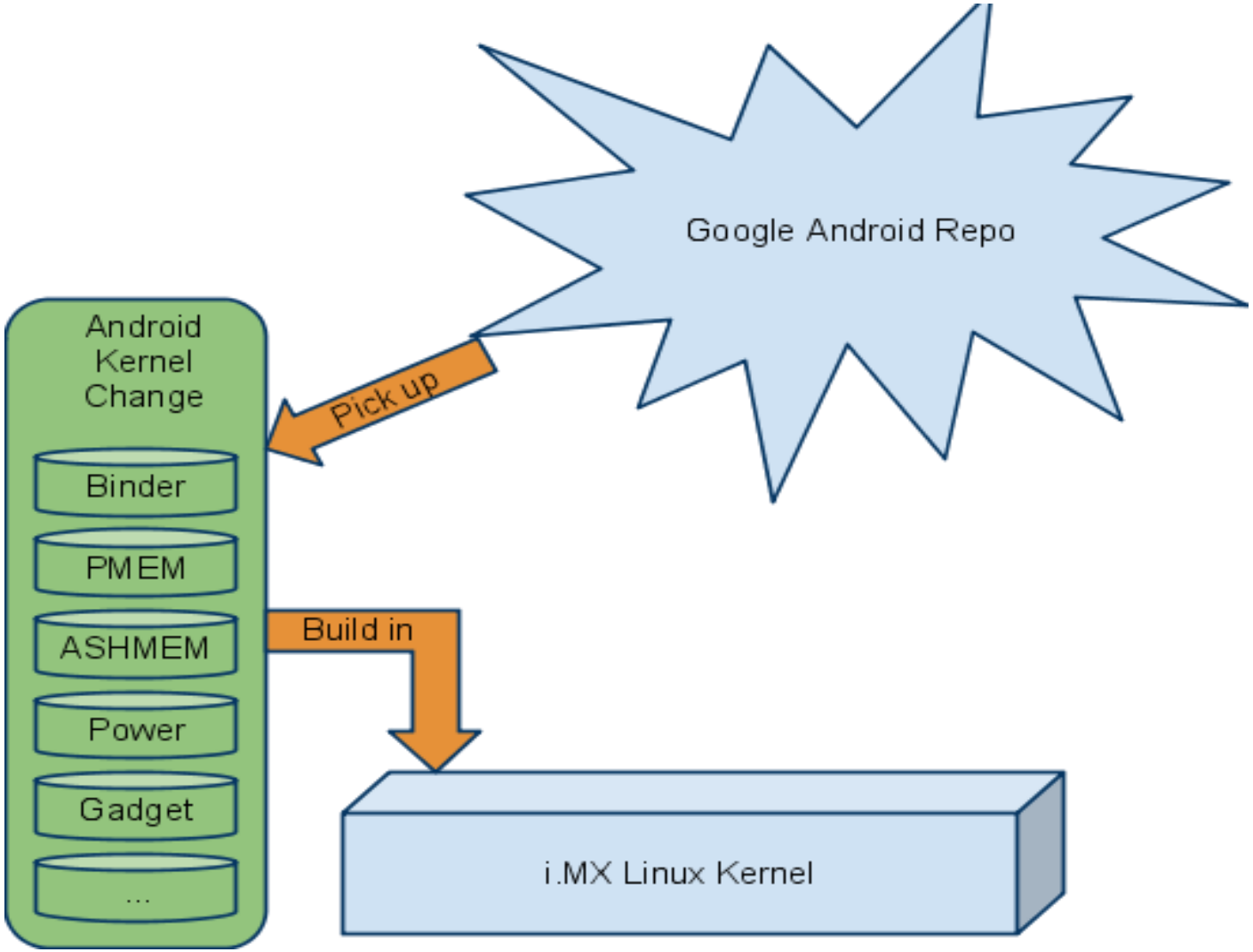
# What We Did for Android on i.MX - Kernel Porting



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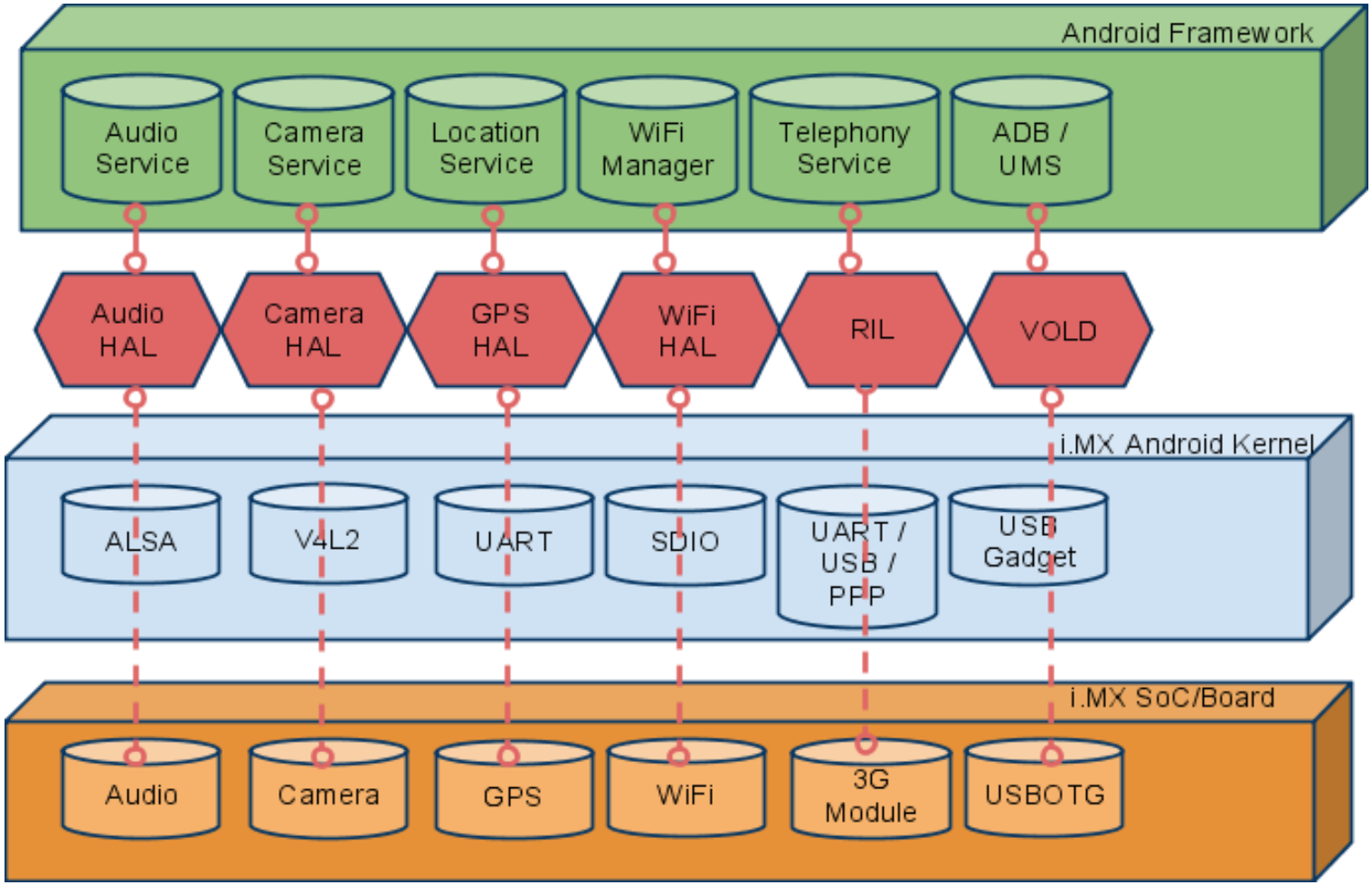
# What We Did for Android on i.MX - Connecting kernel with Android





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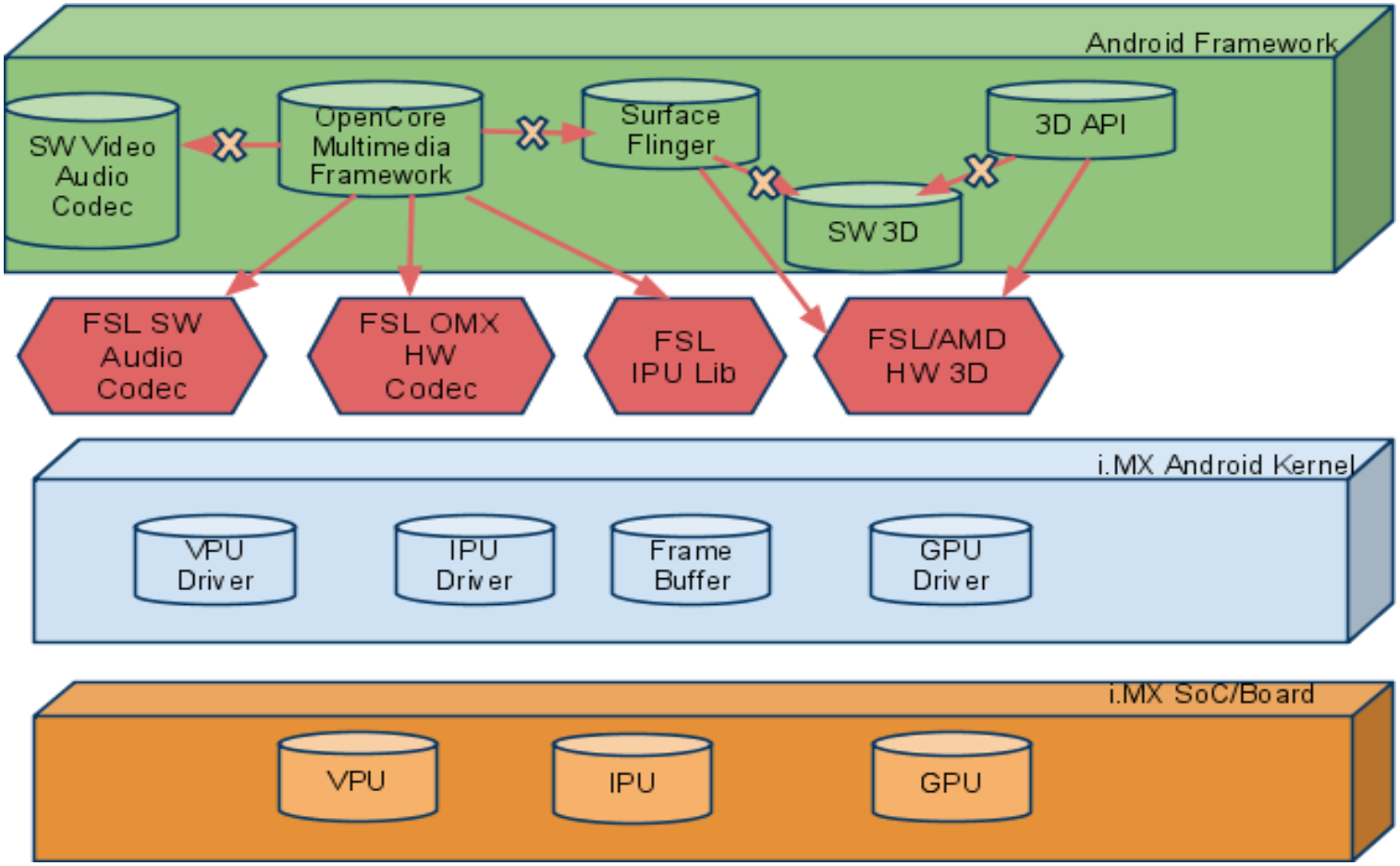
# What We Did for Android on i.MX - Tuning for Higher Performance





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# Android for eReader

- Android was designed for smartphones with LCD interfaces which does not allow for application decisions to overcome the EINK challenges
  - Screen size is limited to phone resolutions (<6"); eReaders are much larger (6"-11")
  - EPD displays have very slow refresh rates (~1s); Android requires 3D rendering and other graphics required for a rich internet experience
  - Android Applications can not run on eReaders due to slow screen refresh rates
  - All eReader Apps must be tuned to function on the slow screen

- Developers of eReaders in Android must modify the framework and application to work smoothly on an eINK display. By the time the modifications are complete, it no longer looks like 'Android'
  - Android Modifications – Modifications to display framework, surface flinger and views to allow application control over display updates

- Developers prefer Android for the following reasons:
  - Development platform for tools and community involvement
  - Easy integration of network stacks and other services
  - Leverage applications



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- **Simple Programming Model** – Standard Framebuffer call with extensions for control over update
  - Allows application control over screen region, update mode (full or partial) and waveform mode
  - Framebuffer driver manages active update lists and collision events
  - Wait for completion available for synchronization of updates
  - PXP hardware acceleration
    - RGB to greyscale color space conversion
    - Rotation, scaling and blending
    - Histogram to support automatic waveform mode detection

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# Extensive Optimizations in Multimedia

- Incorporated audio codecs optimized specific for **Cortex™-A8/Neon**
- Incorporated video accelerator to enable **1080p/720p playback**
- Incorporated video accelerator to enable **720p/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

# Extensive Enhancements in Multimedia

- **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

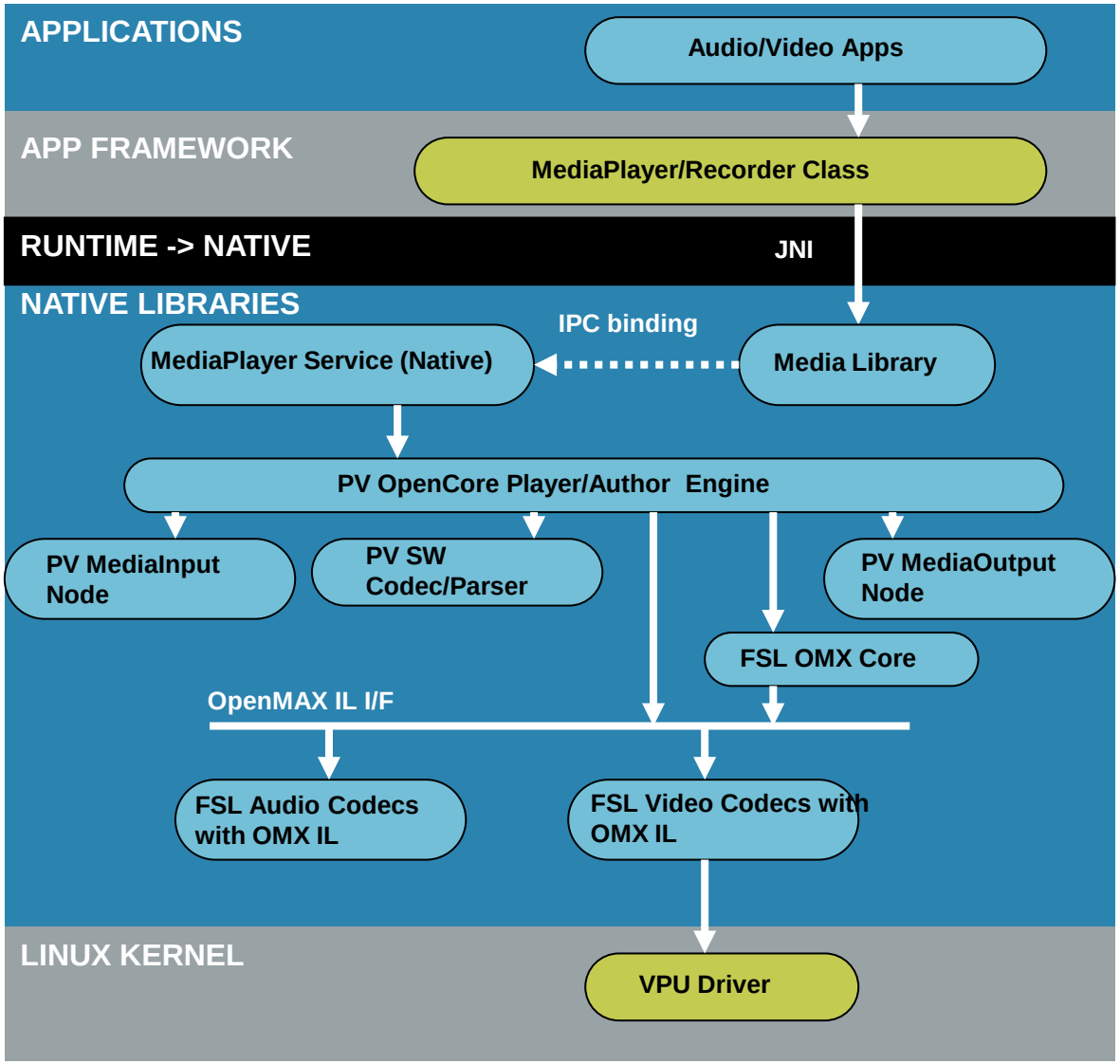
# Video Playback Performance Comparison Between Un-optimized and Optimized Android

| 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 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

# Multimedia – Audio/Video Codec





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# i.MX standard Audio/Video Decoders

| File Extension | Video Decoders | Audio Decoders |
|---|---|---|
| .mp3 | | MPEG-1 Audio Layer I/II/III |
| .aac/.adts | | AAC LC/PLUS |
| .mp4 | MP4V:MPEG-4 SP/ASP except GMC<br>H264:H.264 BP/MP/HP<br>H263 | AAC LC/PLUS<br>MP3 |
| .m4a | | AAC LC/PLUS |
| .3gp | MP4V:MPEG-4 SP/ASP except GMC<br>H264:H.264 BP/MP/HP<br>H263 | AAC LC/PLUS<br>AMR-NB |
| .avi | MP4V:MPEG-4 SP/ASP except GMC<br>Xvid<br>H264:H.264 BP/MP/HP<br>H263<br>Divx4/5/6 | AAC LC/PLUS<br>MP3 |
| .wma | | WMA STD, PRO, Lossless |
| .wmv/.asf | VC1: VC-1 SP/MP/AP<br>WVC1<br>WMV7, 8 | WMA STD, PRO, Lossless |
| .mkv/mka | H264:H.264 BP/MP/HP<br>Xvid<br>Divx4/5/6<br>VC1: VC-1 SP/MP/AP<br>MPEG4 | AAC<br>MP3<br>WMA STD, PRO, Lossless<br>Vorbis |
| .flv | Sorenson H263<br>H264:H.264 BP/MP/HP | MP3<br>AAC |





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# i.MX standard Encoders and Restricted Codecs

| File Extension | Video Encoders | Audio Encoders |
|---|---|---|
| .3gp | H263 | AMR-NB |
| .mp4 | H264 | MP3 |

## Restricted Codecs

| File Extension | Video Decoders | Audio Decoders |
|---|---|---|
| .avi | DivX3 | AC3 |
| .ra | | RA6<br>RA9/10 (AAC-LC) |
| .rm/rmvb | RV8/9/10 | RA6 (Up to 2 audio channel)<br>RA9/10 (AAC-LC) |
| .mkv/.mka | RV8/9/10<br>DivX3 | AC3<br>RA6 (Up to 2 audio channel)<br>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 (to support V2IP)
- Multiple media storage
- Recovery on EXT3/SD

# Android Graphic Modules

## ▶ 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.

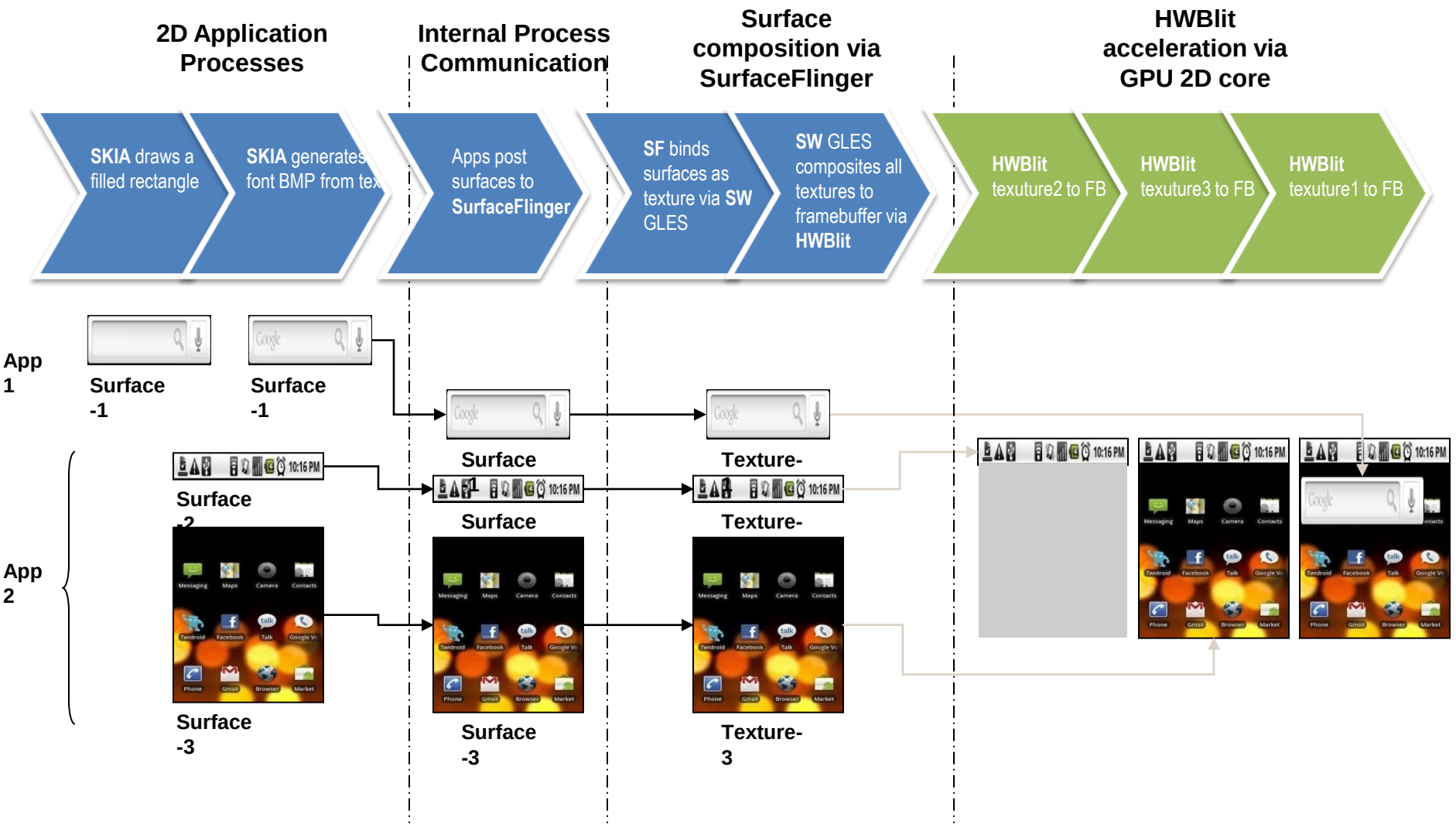
## ▶ SKIA

- 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



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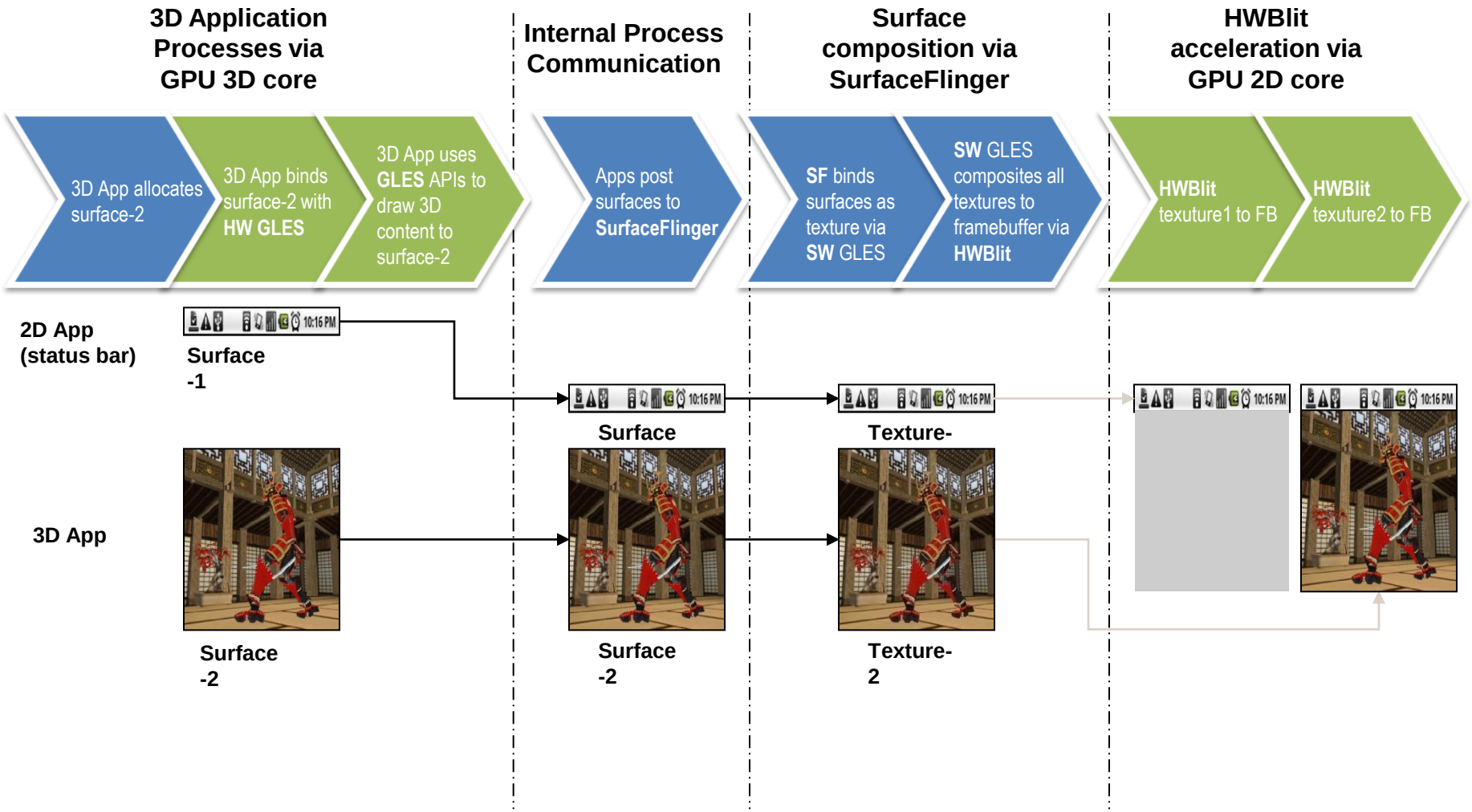
# Android 3D Graphic



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# 3DMM gaming

## ▶Samurai

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



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# 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 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
- 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™***





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# Learn More On

## http://www.freescale.com/imxandroid






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## 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.





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