



# Android: Taking Convergence to the Next Level

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# Agenda

- ❖ **Who is MIPS?**
- ❖ **Android Origin, Adoption and Proliferation**
- ❖ **Applications on Android (mobile and DTV)**
- ❖ **Fragmentation**
- ❖ **Differentiation**

# MIPS Technologies Corporate Snapshot

**MIPS**  
TECHNOLOGIES

**Number One  
Market Share\***

Digital TV

Cable, Satellite &  
IPTV Set-top Boxes

Blu-ray Players

Broadband CPE

WiFi Access Points  
and Routers

\*MIPS and Industry Analyst Data



**World's second-largest provider of microprocessor IP,  
powering some of the world's most popular products**

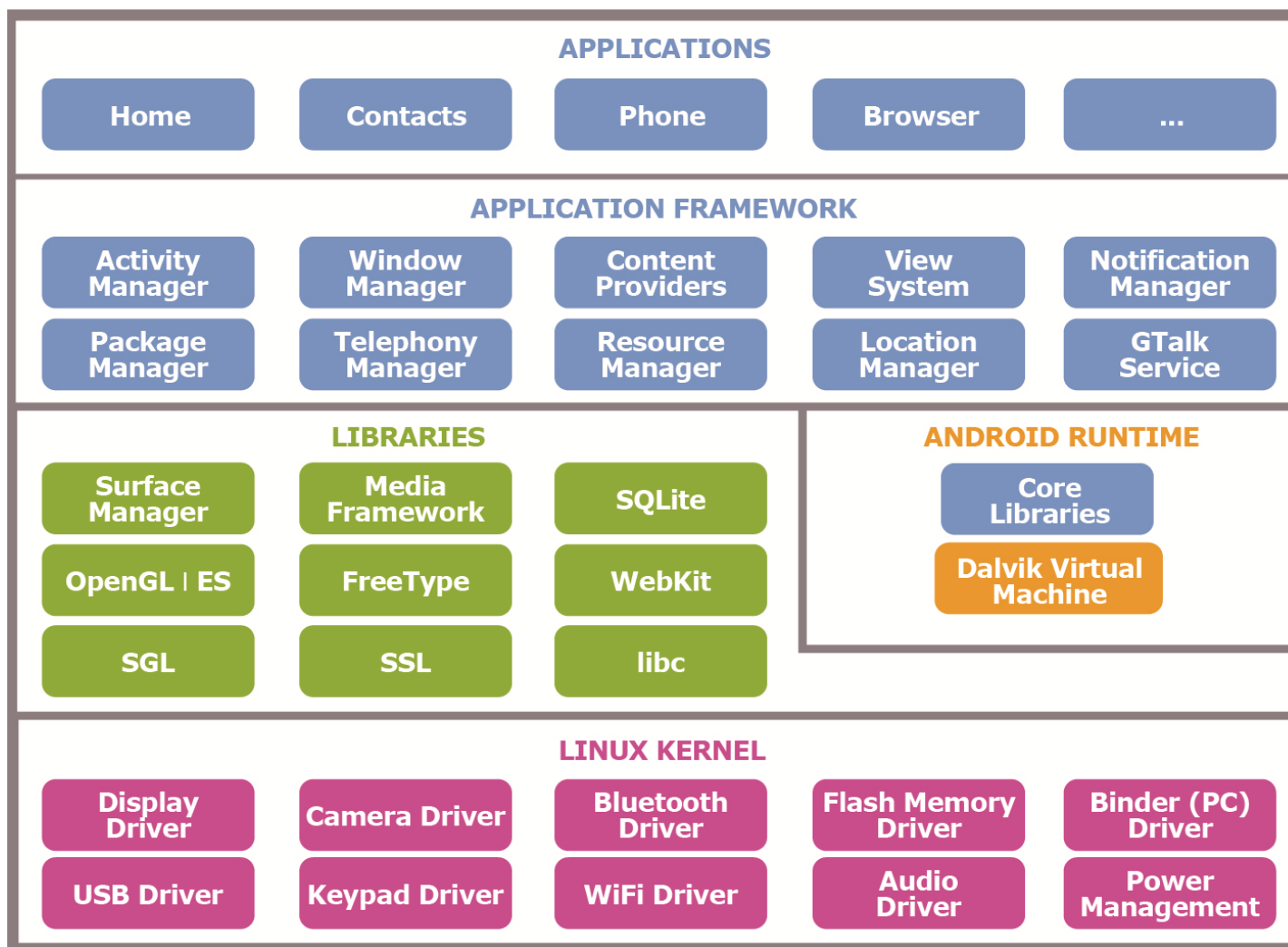
# Industry's Most Scalable Processor Architecture



# Android Origins

- ❖ Open source software platform managed and distributed by Google (Apache license)
- ❖ Includes an operating system (based on Linux kernel), middleware and applications
- ❖ Enables easy development of web-centric applications and games
- ❖ Intent is for applications to be written in Java, run on Dalvik virtual machines (VM) and be hardware independent

# Android Stack



# Contrast to Apple iOS

## ❖ iOS uses LLVM (Low Level Virtual Machine) for compilation

- Language independent
- Can take compiled code and convert and link into machine-dependent code
- Slight performance penalty (but better than Dalvik)

## ❖ Works around Oracle patent infringement issue

- Issue for Android and Dalvik JIT

# Android Presence

**Table 1**  
**Worldwide Sales of Media Tablets to End Users by OS (Thousands of Units)**

OS	2010	2011	2012	2015
Android	2,512	11,020	22,875	116,444
iOS	14,685	46,697	69,025	148,674
MeeGo	179	476	490	197
Microsoft	0	0	4,348	34,435
QNX	0	3,016	6,274	26,123
WebOS	0	2,053	0	0
Other Operating Systems	235	375	467	431
<b>Total Market</b>	<b>17,610</b>	<b>63,637</b>	<b>103,479</b>	<b>326,304</b>

Source: Gartner (September 2011)

Android is the dominant smartphone OS and currently the only real challenger to iOS for tablets.

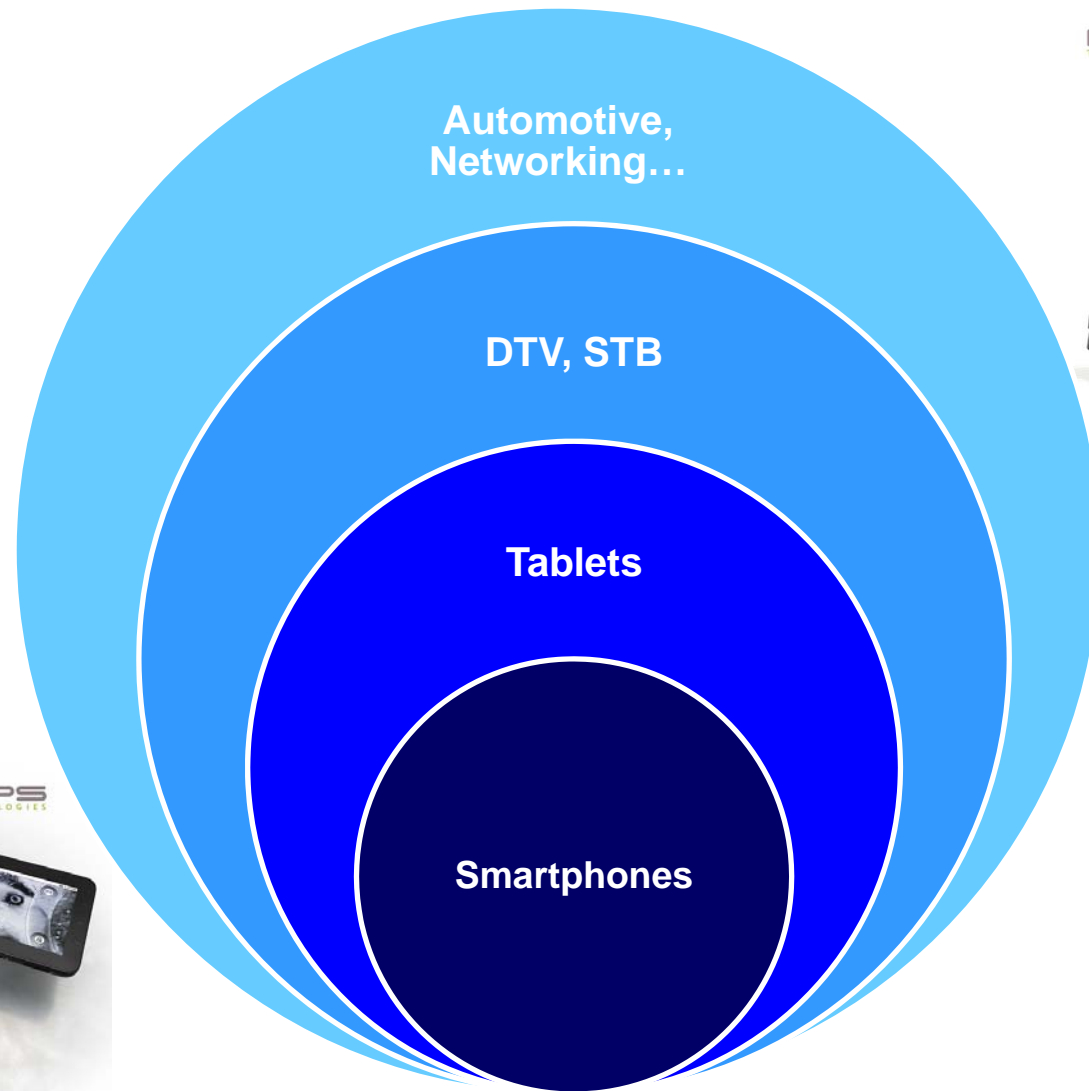
**Table 2**  
**Worldwide Smartphone Sales to End Users by Operating System in 2Q11 (Thousands of Units)**

Operating System	2Q11 Units	2Q11 Market Share (%)	2Q10 Units	2Q10 Market Share (%)
Android	46,775.9	43.4	10,652.7	17.2
Symbian	23,853.2	22.1	25,386.8	40.9
iOS	19,628.8	18.2	8,743.0	14.1
Research In Motion	12,652.3	11.7	11,628.8	18.7
Bada	2,055.8	1.9	577.0	0.9
Microsoft	1,723.8	1.6	3,058.8	4.9
Others	1,050.6	1.0	2,010.9	3.2
<b>Total</b>	<b>107,740.4</b>	<b>100.0</b>	<b>62,058.1</b>	<b>100.0</b>

Source: Gartner (August 2011)



# Android Spheres of Influence



# Understanding Applications for Android (currently)

- ❖ **Applications are written in Java and use the standard Google Android SDK to compile**
  - Provides hardware independence
- ❖ **Applications delivered as .apk file, which get loaded on device**
  - .apk package contains executable code, a manifest, graphical/XML resources and any native libraries necessary
- ❖ **No CPU dependencies in vast majority of applications (>90%)**
- ❖ **Architecture-specific NDKs are provided for:**
  - Legacy C/C++ programs from phone
  - Some performance requirements for some games

# What is an NDK?

- ❖ **Native Development Kit: provides tools that allow Android application developers to embed components that make use of native code in Android applications**
  - Applications still in Java – only allows calls to native libraries
- ❖ **Allows existing software to be used without a rewrite**
- ❖ **Breaks application portability – tied to processor**
- ❖ **Google does not recommend native code applications to ensure app portability**
  - Use of the NDK creates fragmentation

# Application Fragmentation

## ❖ Android app fragmentation issues come from

- Use of NDKs
- Different Android and SDK versions
- Hardware configurations (GPS, WiFi etc.)

## ❖ Google wants to eliminate app fragmentation

- Native library was required when low performance HW and VM were common
- Both Android OS and hardware are getting faster
- Intel and MIPS are shipping Android-based devices today (smartphones, tablets, DTVs, STBs); it's not just ARM anymore
- Google actively discourages the use of architectural specific instructions

## ❖ Application fragmentation is also a serious issue for ARM platforms

- Applications using ARM NDK can only be used with ARMv7
- Fragmentation exists between different ARM architecture versions

# The *Real* App Story Today

- ❖ **90.5% of all Apps on Android work on MIPS *today***
  - >20K apps tested so far
  - Includes titles on the right —————>
- ❖ **7% of apps don't work between ARM-based platforms**
- ❖ **Porting can be done directly by developer**
  - If a recompile to a different NDK (majority of cases), can take as little as 30 seconds
  - If tool chain changes required, slightly more time needed
- ❖ **Countries not supported by Android market (i.e., until recently China)**
  - No access to Android market
  - Serviced by carrier or 3<sup>rd</sup> party app stores
  - MIPS has an apps store that includes mobile and DTV apps

❖ <u>Gmail</u>	❖ <u>YouTube</u>
❖ <u>Google Reader</u>	❖ <u>Pandora Radio</u>
❖ <u>Google Maps</u>	❖ <u>BBC Broadcast SKYPE</u>
❖ <u>Google Goggles</u>	❖ <u>Shazam</u>
❖ <u>Google Voice</u>	❖ Various live wall papers
❖ <u>Google Docs</u>	❖ Advanced Task Killer
❖ Email	❖ Slacker Radio
❖ K9mail	❖ Bible
❖ <u>Kindle</u>	❖ Network Info II
❖ OfficeSuite	❖ RealCalc
❖ Facebook Mobile	❖ Stopwatch & Timer
❖ Browser	❖ Bubble Popper
❖ Calendar	❖ Solitaire
❖ <u>Access (Netfront)</u>	❖ Twidroyd
❖ Angry Frogs	
❖ Air Control Lite	

Apps ported: Angry Birds, Talking Tom Cat, NetFront Suite, Doodle Dash, Transformoid, Finger Dance Revolution, Diamond Miner, Skyfire, iReader, ES Explorer, Squibble, EZ PDF Reader, Airport Mania2

# Anti Fragmentation Defined

## ❖ Anti-fragmentation ensures

- Users have a consistent Android experience
- Developers have a consistent Android interface

## ❖ Key requirements for partners

- Ship Android compatible devices
- Promote only use of the Google Android SDK – no derivatives
- Promote the associated NDK/tool chain regarding direct access to hardware or processor specific coding

## ❖ A product is an Android compatible device if:

- It adheres to the Compatible Device Definition document for the applicable version of Android
- It successfully passes all tests in the Android Certification Test Suite
  - The CTS process is a self-administered process

# Anti Fragmentation Consequences

- ❖ **Google is requiring partners to sign an anti-fragmentation agreement as a prerequisite for a license to versions of Android that have not been open sourced (i.e., Honeycomb)**
- ❖ **The agreement is a prerequisite for**
  - Licensing pre-released software
  - The opportunity to deploy Google's Mobile Applications, where and when available for a platform
- ❖ **Breaching the agreement can cause licenses to be revoked**

# Android TV Applications

- ❖ **Running Android mobile applications is possible, but may not be practical**
- ❖ **Many current mobile applications will not run on TVs regardless of CPUs**
  - UI won't scale to screen resolution
  - HW dependencies: multi- touch touchscreen, GPS, accelerometer, buttons, etc.
- ❖ **Similar to iPhone and iPad ecosystem**
- ❖ **Creation of TV-specific applications**
  - Optimized UI for “lean-back” experience
  - Optimized for high resolution, large screen experience
  - New user interaction for input
    - Interfaces for WiiMote, Playstation Move, Camera
  - Able to handle high definition content



# Developing Android Applications for the TV

- ❖ Apps will need to be optimized for navigation via alternate input technologies, and not touch
- ❖ For obvious reasons, users won't be rotating their screen
- ❖ Evolution and adaptation of input technologies for TV, critical for the new connected entertainment experience



# Differentiating on Android

## ❖ OS

- Issues: fragmentation discouraged by Google

## ❖ Apps

- Issues: hard to scale

## ❖ Mobile device hardware

- Issues: hard to compete against iPhone design

## ❖ Power consumption

## ❖ Cost

# Multi-threading Advantages

- ❖ **Multi-threading (MT) better utilizes CPU resources**
  - Get more work done with a lower clock, lowering power consumption
- ❖ **Multiprocessing (MP) and MT: flexible performance options**
  - Finer grain control on performance vs. gate count
  - Fewer gates means lower static and dynamic power – longer standby and talk-time
- ❖ **MT can significantly reduce latency**
  - Ability to “park” threads for zero overhead context switches
- ❖ **MT results in fewer cache misses and stalls: guaranteed QoS**
  - 20-30% reduction in stalls
  - Far superior user experience – improved responsiveness

**Hardware multi-threading can mean lower power consumption, smaller die size (vs. adding another core), lower cost, lower latency, and faster TTM**

# Multi-threading on Android

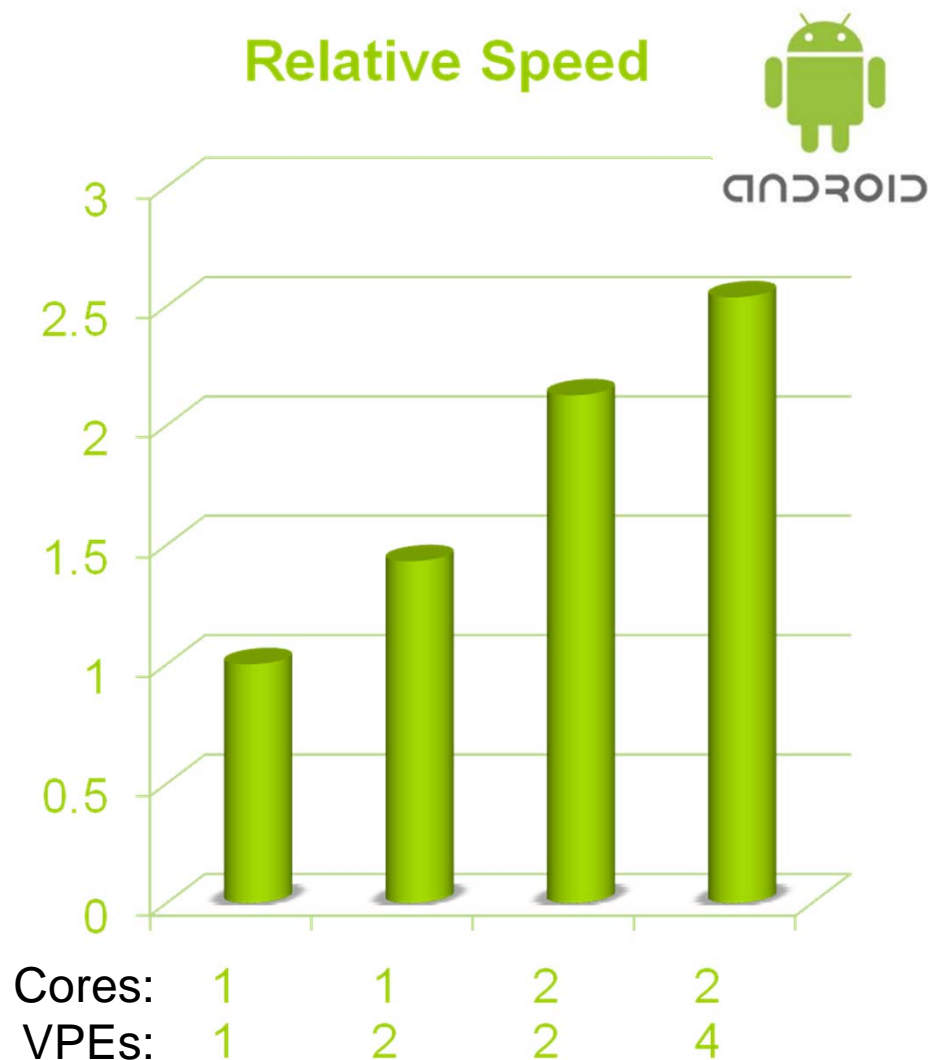
## ❖ Android browser with EEMBC Browsing Bench workload

### ❖ Speed-up

- Second VPE increases performance by 43%
- Second core increases performance by 2X
- A dual-core, 4-VPE system delivers 2.5X the performance of a single core

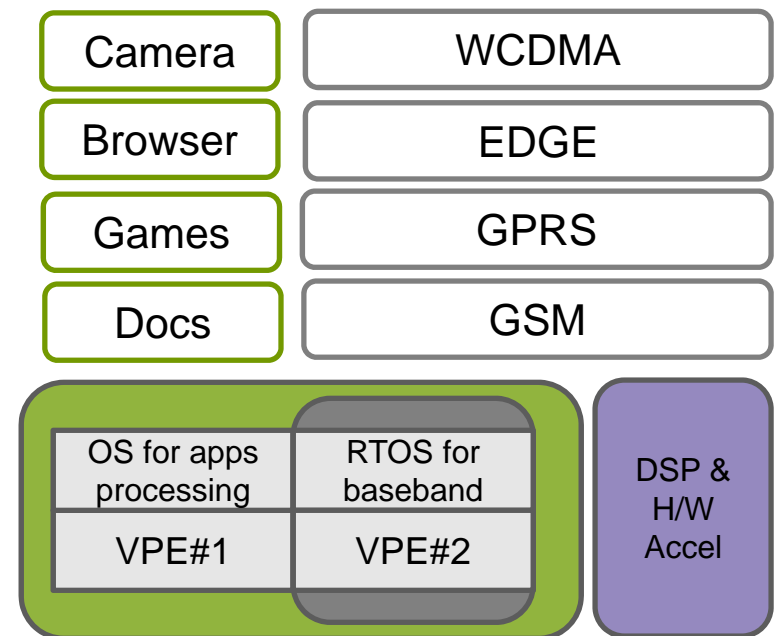
### ❖ Notes:

- Performance was measured on a Malta board with a dual 1004Kf (MR3 with MT-FPU), 32K/32K L1, 512K L2 (1:1), 1:1 FPU, 2:1 CPU to memory.



# Multi-threading Architecture Option: Low End Smartphone

- ❖ **One 34K<sup>®</sup> core can run 2 operating systems at the same time**
  - **OS #1 ~ Linux/Android/Proprietary** (apps processor)
  - **OS #2 ~ RTOS** (baseband processing) for low latency
- ❖ **Offers performance of a dual core solution for much smaller footprint, lower cost & power**
  - Only need to license 1 core, not 2
  - Lower BOM cost



**34K core with 2 VPEs  
for apps and BB control**

# Summary

- ❖ **Android is transforming mobile devices and the applications ecosystem**
- ❖ **Android is proliferating beyond mobile to the digital home and beyond**
  - DTV apps will need to be optimized for screen size and inputs
- ❖ **Fragmentation is a real issue**
  - The situation will improve but will need time for transition
- ❖ **Differentiation is difficult**
  - Multi-threading is one way to differentiate on power consumption and cost



At the core of the user experience<sup>®</sup>

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