Intel® Architecture Based Smartphone Platforms

Tim Towell Director, Mobile & Communications Group
Nov 6, 2012
Mobile Platform Architecture Overview
Intel® Technology is Used in a Broad Range of leading Smartphones and Tablets ...

...and more to come

- Galaxy S III
- Galaxy Nexus
- Ideatab K2110
- K800
- Droid RAZR
- Droid RAZRi
- BOLD 9780
- Curve
- XOLO X900
- Ascend P1s
- San Diego
- E369
- Xoom
- Torch 9800
- One X

*other brands and names may be claimed as the property of others
2012 Android Smartphones with Intel® Atom™ Chips Inside
Intel® Atom™ Processor Roadmap

### Tablets

**Medfield**
- Intel Atom Z24610
- Up to 1.6 GHz (burst)

**Clover Trail**
- Intel® Atom™ Z2760
- Up to 1.8 GHz (Burst)
- Dual core w/ 2X CPU performance

**Bay Trail**
- New microarchitecture
- 22nm

### Smartphones

**Medfield**
- Intel Atom Z2480
- Up to 2.0 GHz (burst)
- HSPA+

**Clover Trail+**
- Intel® Atom™ Z2580
- Dual core w/ 2X CPU performance
- SGX544-MP2 dual core graphics

**Next Generation...**
- New microarchitecture
- 22nm
Memory Peak Bandwidth
- 6.4GB/s @ 800MT/s
- Dual 32 bit channels
  - Supports 1 or 2 ranks per channel

Memory Size and Density
- Supports total memory size of 128MB, 256MB, 512MB and 1GB per channel
- Supports 1Gb, 2Gb and 4Gb chip densities

Other Features
- Aggressive power management to reduce power consumption
- Proactive page closing policies to close unused pages
- Supports different physical mappings of bank addresses to optimize for performance

Package-on-Package (POP)
- 12 x 12 mm PoP FCMB4 – 32nm
- Non PoP SoC < 0.8 mm
- PoP z height < 1.4mm
- OEM/ODM can solder up to 2 GB of LPDDR2 memory on top of SOC
Medfield SOC Block Diagram

- LPDDR2
- eMMC
- SD/MMC
- Power Delivery IC: VRs Audio CODEC USB2 OTG
- Rails I2S ULPI
- IMC 6260 HSPA+ Modem
- TI WiFi & BT CSR GPS
- HDMI Display
- Internal Display
- Penwell SOC (Intel Hi-K 32nm Process Technology)

Key Components:
- Security Engine
- Power Manager
- Low Power Audio
- Storage
- CPU w/512KB L2$
- 2D/3D Graphics
- Image Signal Processor
- Video Enc/Dec (1080p30)
- Display Controller (3 pipes)
- Primary Camera: 8MP, 15fps, 1080p
- Secondary Camera: 1.3MP, 1080p
- MIPI-CSI
- MIPI-HSI
- UART SPI
- HDMI 1.3a
- MIPI-DSI
- Medfield SOC Block Diagram
Key Technologies Assembled

- Imaging / Camera
- Security
- Intel® Atom™ Processor Technology
- Software & Services
- Graphics
- Wireless WAN
- Connectivity
- Power Management

*Other brands and names are the property of their respective owners.
Intel’s Performance Leadership

**CPU AND PROCESS**
- Intel Hi-k 32nmLP SoC Process
- Intel® Hyper-Threading Technology
- Enhanced Intel SpeedStep® Technology
- 512KB L2$/core
- ISA: Streaming Extensions Intel® SSE2, SSE3, SSSE3

**HARDWARE ACCELERATORS**
- Optimized Memory Controller
- Multi Core 2D/3D Graphics with Dynamic Voltage & Frequency Scaling
- High Performance Image Sensor Processing with 240 Mega Pixels / Second
- Low Power Audio DSP
- 1080p30 Encode & Decode
- Isolated Security Engine

**OPTIMIZED PLATFORM**
- Optimized platform power management
- Footprint and cost-optimized Power Management IC
- Wireless Connectivity Integrated
- Multi-options for memory, audio codec
- Rich suite of IOs for OEM customization
## Low Power Platform Progression

**Mooresstown (45nm)**  
**Medfield (32nm)**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Mooresstown</th>
<th>Medfield</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Board size</td>
<td>5,000mm²</td>
<td>4,150mm²</td>
<td>↓ 17%</td>
</tr>
<tr>
<td>Standby power</td>
<td>21mW</td>
<td>14mW</td>
<td>↓ 33%</td>
</tr>
<tr>
<td>Browsing power</td>
<td>1.2W</td>
<td>0.85W</td>
<td>↓ 29%</td>
</tr>
<tr>
<td>Video</td>
<td>+ 720p encode</td>
<td>+ 1080p encode</td>
<td></td>
</tr>
<tr>
<td>Camera</td>
<td>5 mega-pixel</td>
<td>up to 16 mega-pixel</td>
<td></td>
</tr>
<tr>
<td>Graphics</td>
<td>800 MPPS</td>
<td>2,000 MPPS</td>
<td>↑ 250%</td>
</tr>
</tbody>
</table>
Webkit* SunSpider scores for Intel® Atom based smartphones is competitive against popular Android* phones

"... look at that SunSpider score... it slides in just underneath the Galaxy S III. It demonstrates that Intel was serious when it promised to focus on web browsing."

- June 14, 2012

Great performance for key Internet technologies
Smartphone Platform Integration

Integration across the hardware and software stack
Software Enhancements in Android* for Intel® Smartphones
Optimizing Android* for Intel® Atom™ Processor Based Devices

We optimize web technologies such as HTML 5, WebKit and javascript†

GPU & Video support for canvas operations

Most Android applications just run on Intel® Atom™ based platforms†

Apps
- Home
- Contacts
- Phone
- Browser
- ...

Application Framework
- Windows Manager
- Activity Manager
- Telephony Manager
- Resource Manager
- Content Providers
- View System
- Notification Manager
- Package Manager...

Libraries
- Surface Manager
- Media Framework
- SQLite
- FreeType
- WebKit
- SSL
- libc
- SGL
- OpenGL* ES
- Core Libraries
- Dalvik Virtual Machine

Middleware
- Display Driver
- Camera Driver
- Flash Memory Driver
- Binder (IPC) Driver
- Keypad Driver
- WiFi Driver
- Audio Drivers
- Power Management

Operating System
- Linux* Kernel
- Optmizing Android* for Intel® Atom™ Processor Based Devices
Optimizing Android* for Intel® Atom™ Processor Based Devices

- Extensive middleware development in imaging, media and DRM deliver compelling media experiences
- SKIA and OpenGL optimizations
- Memory Optimizations, AVI, DivX*, and ASF container types, WMV/VC-1 decoder. Live Streaming optimizations, HDMI and WiDi Extended Video Modes, Video Playback DRM
- Enhanced Debugging and logging
- App Compatibility Enhancements
- Apply our extensive experience optimizing Java* to the Dalvik* VM

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- Apply our extensive experience optimizing Java* to the Dalvik* VM
Optimizing Android* for Intel® Atom™ Processor Based Devices

Drivers validated & optimized for power & memory footprint

- Shared Memory Architecture
- Low Power Audio Offload

Linux Kernel
- Display Driver
- Camera Driver
- Flash Memory Driver
- Binder (IPC) Driver
- Keypad Driver
- WiFi Driver
- Audio Drivers
- Power Management

Applications
- Home
- Contacts
- Phone
- Browser

Application Framework
- Activity Manager
- Windows* Manager
- Content Providers
- View System
- Package Manager
- Telephony Manager
- Resource Manager
- Location Manager
- Notification Manager

Libraries
- Surface Manager
- Media Framework
- SQLite
- OpenSSL
- SGL
- Surface Manager
- OpenGL* ES
- FreeType
- WebKit
- SSL
- libc

Core Libraries
- Dalvik Virtual Machine

Android* Runtime
- Core Libraries
- Dalvik Virtual Machine

Optimizing Android* for Intel® Atom™ Processor Based Devices
Drivers validated & optimized for power & memory footprint
Browser Experience

Fishtank* HTML5 workload developed by Microsoft*

We have customized for internal demonstration

- Removed randomness
  - Fish position, direction, size
- Added ability to customize parameters via URL
  - Specify Canvas size vs full screen
  - Number of fish to draw
  - How long to run
- We tell Fishtank how many frames to draw
- The FPS score it reports is the average during the test

Routinely develop and integrate optimizations from V8 and Webkit into Android* Platform

SKIA rendering
22.8 FPS

GL accelerated rendering
60 FPS
**Medfield: Camera Burst Capture**

User select burst size up to 10 pictures

Burst capture speed: 10 pictures in under a second

Full resolution images: 8MP

Shoot & select → PERFECT IMAGE

**Note:** Pictures captured in burst mode with a Lava Xolo X900 Smartphone using the Intel® Atom™ Processor Z2460.
Intel® Developer Tools for Android*
Intel® VTune™ Amplifier Performance Profiler

Hardware Collection – low overhead
- Event-based sampling for tuning platform performance
- Uses Intel® Atom™ microarchitecture events (i.e., cache misses, floating point assists)
- Performance collector collects CPU and performance management unit counters

• GUI-based evaluation results - quickly identify cause of performance issues
  - CPU timeline provides workload context
  - Powerful filtering

• Compare results quickly, sort by difference
  - Compare 2 optimizations, what improved
  - Compare 2 systems – what didn’t speed up as much

Remove the guesswork with fast, accurate performance profiles
Intel® VTune™ Amplifier Power Analysis

Analyzes behaviors that may cause unnecessary platform-wide power consumption

- Detailed processor WakeUps
- Analysis Types
  - Sleep State Analysis (C-state, S-State, D-State)
  - Frequency Analysis (P-State)
  - Android* Wakelocks
- GUI-based results - quickly identify cause of power issues
  - Frequency and sleep state transition timeline
  - CPU timeline provides workload context
- Powerful filtering
Intel® Graphic Performance Analyzers

**System Analyzer and HUD**
Real-time, in-game analysis with graphical metrics displays and state overrides

**Platform Analyzer**
Full system analysis of CPU metrics and workloads across multiple threads and cores, plus simultaneous GPU metrics

**Frame Analyzer**
Deep frame performance analysis down to the draw call level, including shaders, textures, D3D states, pixel history and textures

Future Support
Intel® JTAG Debugger

- Source level debug of Android* OS kernel software and drivers including
  - Dynamically loaded kernel modules
  - SMP support
- Flashing support for Intel® Atom™ processor-based platforms
- Peripheral register support for Intel Atom processor-based SoCs
- Access to CPU page translation and descriptor tables
- On-Chip instruction trace support
- Host OS: Linux* and Windows*
## Intel SOC Design-in, Manufacturing and Debug Tools for OEM and ODM

<table>
<thead>
<tr>
<th>Tool Description</th>
<th>Functional Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mfg. Phone Flashing Tool</td>
<td>Host based reference software to flash all or part of the phone SW/FW image. Tool can flash 1 to 8 phones to support development and manufacturing.</td>
</tr>
<tr>
<td>Firmware Stitching and Flashing Tools</td>
<td>Host based combination tool used to stitch FW and to flash Medfield firmware components and initial boot loader. Can be used standalone or integrated in customer tool stack via API’s.</td>
</tr>
<tr>
<td>Multi-Media Audio MSIC device audio configuration tool</td>
<td>Host based tool to adjust MSIC device gain &amp; levels, modem output gain &amp; levels, and configure Audio offload processing parameters for multimedia playback.</td>
</tr>
<tr>
<td>Platform Trace Capture and Analysis Tool</td>
<td>Host based tool to capture and decode log messages from the platform. Online and offline tracing &amp; logging. Uses either Lauterbach or “Fido” probe via MIPI interface. Crash dump available via standard Android* DDMS.</td>
</tr>
<tr>
<td>Modem Flashing Tool</td>
<td>Host based tool to flash Modem firmware. Includes IMC Modem Flash client to enable Modem FW update from the AP side. Requires direct USB connection to modem.</td>
</tr>
<tr>
<td>Modem RF Calibration Tool</td>
<td>Host based Reference Tool for RF calibration. Generates RF calibration content to be integrated in the modem FW.</td>
</tr>
<tr>
<td>Modem Tuning, incl. Audio Features</td>
<td>Host based tool to tune the parameters of components in modem, including Modem audio. Signing module reference code available for mfg (e.g. IMEI).</td>
</tr>
<tr>
<td>Modem Trace Capture and Analysis Tool</td>
<td>Host based tool to capture and analyze mobile station software operational traces. Focus is on modem operation. Includes pluggable decoder libraries, analysis DLL’s and scripts.</td>
</tr>
<tr>
<td>WiFi Calibration Tool</td>
<td>Code embedded in Test OS and within the TI driver to generate WiFi design calibration. In mfg, TXBIP Calibrates WiFi on 1st Power-up.</td>
</tr>
<tr>
<td>Modem Voice Path Audio tuning tool for the Audience chip</td>
<td>Host based tool for configuration and tuning of voice processing within the Audience Audio chip. Generates Audience voice tuning content to be integrated in the FW image.</td>
</tr>
</tbody>
</table>
Near Real Time Emulation for Developers
Inte® Hardware Accelerated Execution Manager (Inte® HAXM)

Accelerates Android* emulation by 5-10x by natively executing x86 CPU commands

Leverages Intel® Virtualization Technology
- Available on most IA-based PCs since 2005
- Support for Mac* & Windows*
- KVM for Linux*

Applicable for both Dalvik and NDK apps
- Must compile NDK apps for x86
- Only works with x86 System Image

Available as an “Extra” in the SDK Manager

“Thanks to contributions to AOSP from Intel, the emulator now supports running x86 system images in virtualization mode on Windows and Mac OS X. This allows the emulator running at near native speed.”

Xavier Ducrohet, Android SDK Tech Lead, Mar 2012

“The x86 emulator runs twice as fast as Android phone, and almost 4 times faster than the ARM emulator.”

Android Developer ADevCon™ May 2012
Intel® Hardware Accelerated Execution Manager (Intel® HAXM) Video
Intel® Graphics Performance Analyzer
Intel® Graphics Performance Analyzers
System Analyzer (video demo)

- Real-time system-level performance analysis with CPU and GPU metrics
- Detailed Analysis for OpenGL-ES* applications
- OpenGL-ES experiments help narrow down problems
Summary

2nd Generation of Intel® Platforms for Smartphones
Full support for standard Android* Development
Intel Software Developer tools, OEM & ODM support
Innovations to boost developer productivity
Next Steps

http://developer.android.com

• Download the Android* SDK
• Download the SDK add-on for the Intel® Emulator with HAXM acceleration
• Download the x86 NDK

http://www.intel.com/software/android

• Download Intel® Developer Tools For Android

Start porting and optimizing your apps today
Where to Get More Info

Intel® Software Network (ISN)
- Real developers sharing knowledge and offering help
- Dedicated communities and forums focused on your interests
- Worldwide reach
- News and insights on cutting edge technology

Intel Android Developer Website
- Great content you won’t find anywhere else
- Technical articles, tools, and “How-To” guides
- Native app porting tips & case studies
- Info on x86 emulator and Intel® Hardware Accelerated Execution Manager
- Active forums and blogs written by Intel and community experts

www.intel.com/software/android
Q&A
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