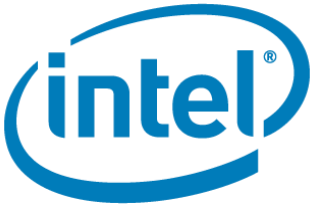

Hotchips 2013: Clovertrail+ Smartphone SoC Platform

Mark Ewert
Prakash Iyer
Vandana Venkatesan

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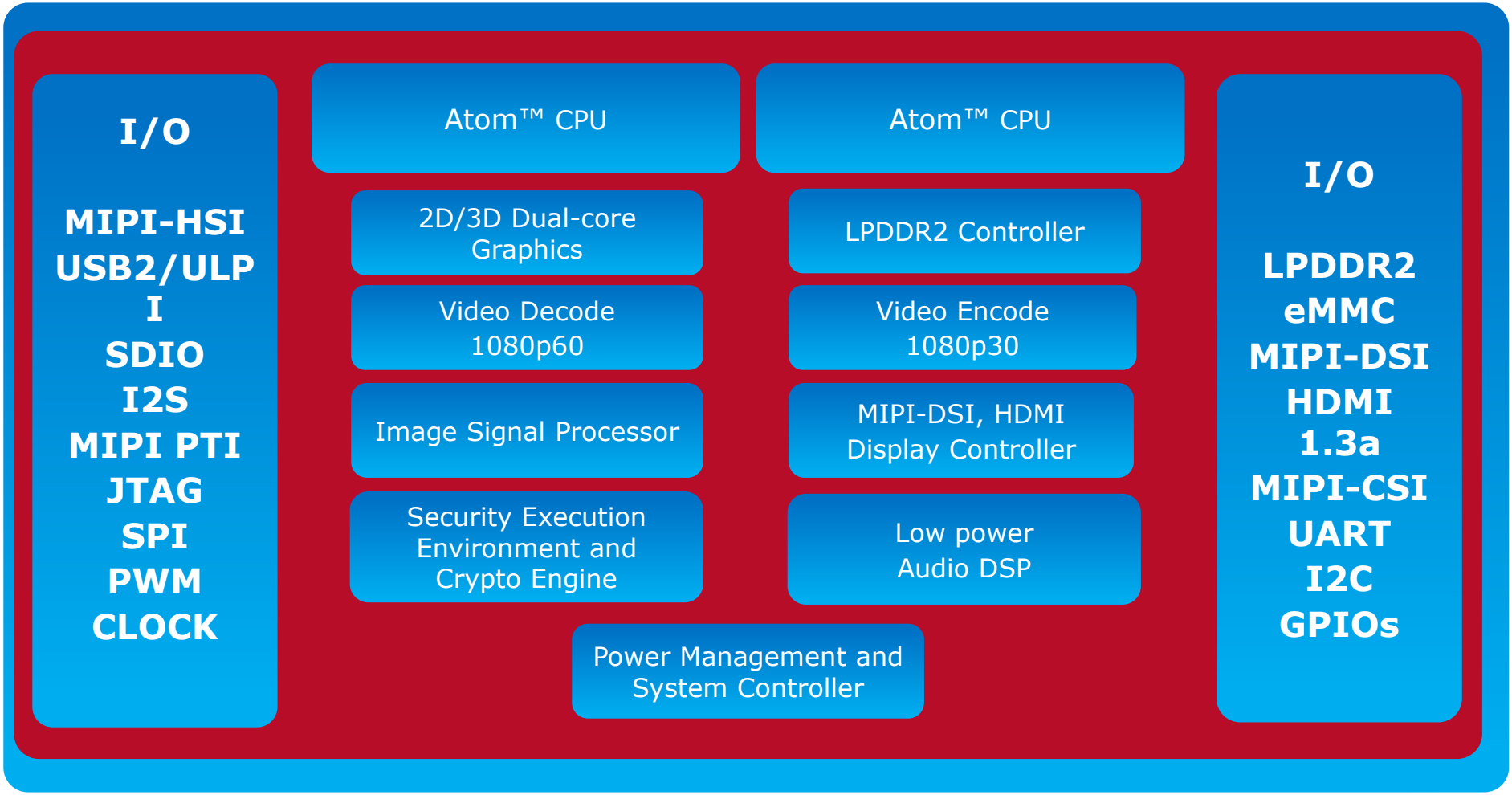
Talk Outline

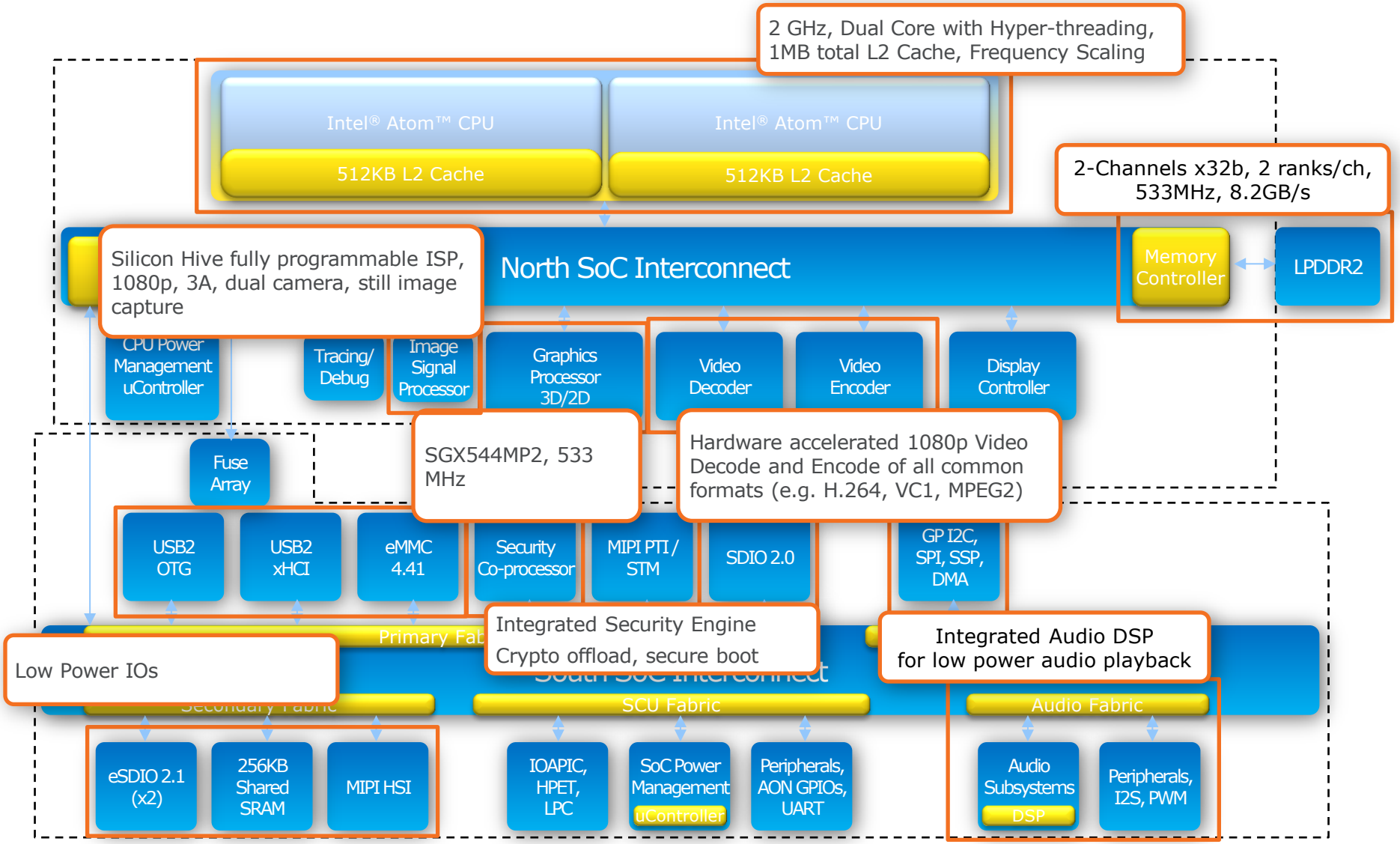
- Clovertrail+ Overview
- Generational improvements
- Key enhancements – media, imaging, power management
- Power and performance

Overview: Intel® Atom™ Clovertrail+ SoC



Intel 32nm High-K + metal gate process
14x14mm coPOP package
CPU ISA compliant with Core 2 processors: SSE2, SSE3, SSSE3

A Look Inside the Clovertrail+ SoC



Platform Generational Improvements

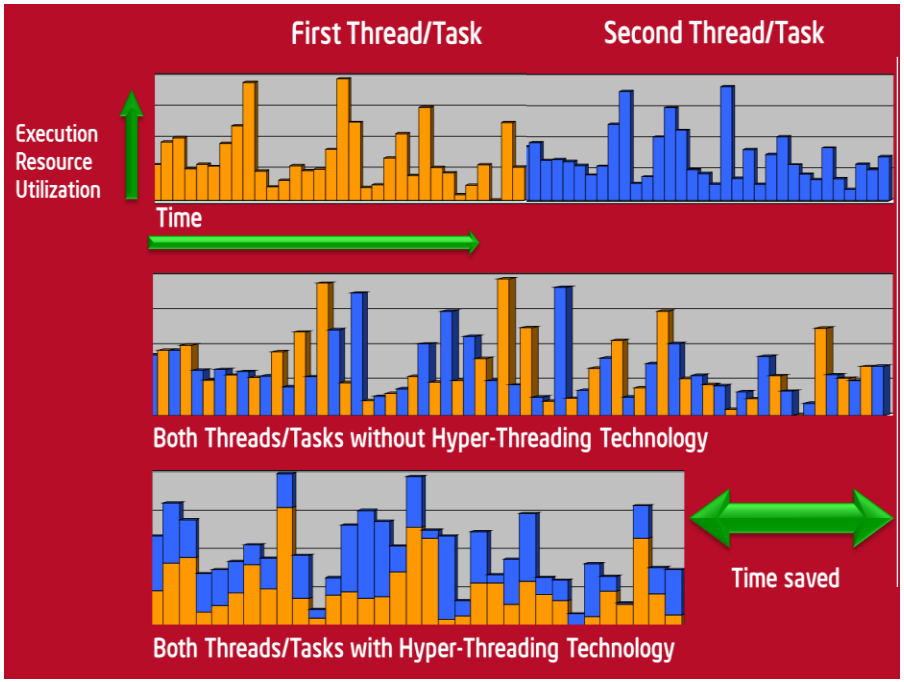
	Medfield Phone	Clovertrail+ Phone
CPU	Intel® Atom™ 1 core 2 threads 2GHz (Intel Atom Z2480)	Intel Atom 2 cores 4 threads 2GHz (Intel Atom Z2580)
Memory, Storage	1GB LPDDR2 @ 800MT/s 64GB eMMC 4.3	2GB LPDDR2 1066MT/s with OOO optimizations 256GB eMMC 4.41
Graphics	SGX 540 @ 400 MHz	SGX 544MP2 @ 400MHz (533MHz burst)
Video Decode	Standard codecs: H.264. MPEG4. VC1, DivX, VP6	Added VP8, Real Video, Sorensen
Camera/Imaging	8 MP with AF/LED Flash, 1080p30 video recording, 1.3 MP front facing	13 MP with AF/LED Flash, 1080p30 video recording, 2 MP front facing
Display	MIPI DSI up to 700Mbps/lane. Up to 13x7 panels	MIPI DSI up to 1Gbps/lane. Up to 19x12 panels concurrent with HDMI
IOs	Standard IOs	Additional ULPI, PWM, I2S
Cellular Modem	Intel® XMM™ 6260 - HSPA+ 21Mbps	Intel XMM 6360 (HSPA+ 42 Mbps), LTE modem in 2013

Clovertrail Generation Derivatives

- Clovertrail 'twins'
  - Clovertrail: Win8 tablets
  - Clovertrail+: Android phones and tablets
- Project success drivers:
  - Started with solid Penwell baseline
  - Re-used >70% of the HW, FW and existing drivers
  - Intel was able to deliver 2 SoCs off the same base architecture
- Clovertrail+ delivers performance enhancements in same package and footprint
  - SGX544-MP2 (versus SGX545) – 4x GFLOPs, >3x Mtri/s, >2x Mpix/s, on-demand burst
  - Improved memory bandwidth and utilization
  - Improved fabric and uarch optimizations

Benefits Of Going To 2 Cores 4 Threads

- Going from Penwell to Clovertrail+, we go from 1 core, 2 threads to 2 cores, 4 threads
- Increases performance by adding logical cpu(s) on top of a physical core
  - Architectural state replicated per thread
  - Each thread presented as a core to the OS
  - 1 thread active – single thread uses all resources optimally
- Based on Simultaneous Multi-Threading (SMT)
  - Switch on Event (SoE) not efficient as pipeline flushed when swapping
    - Triggers on long latency operations given overhead
  - SMT interleaves multiple threads within pipeline
    - Superscalar in-order uarch benefit most
    - Supports thread switch every cycle
- SMT efficiency enables higher freq at same voltage
- 7-15% core area adder (excluding L2)
  - Much lower than multi-core

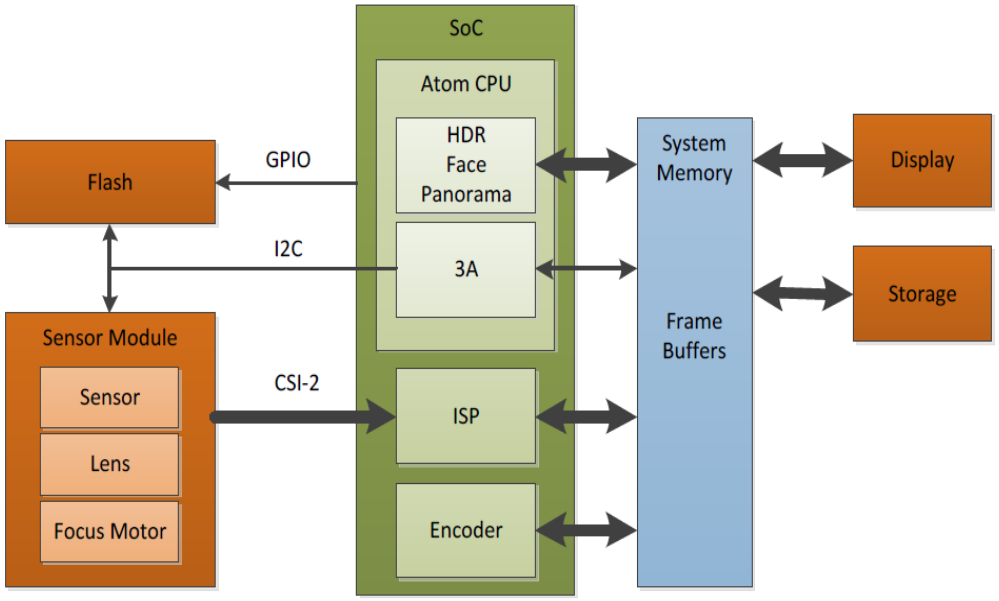


Clovertrail+ Memory/Media Performance Enhancements

- Memory
  - Improved QoS across concurrent memory accesses
  - Out-of-order transactions optimizing page accesses
  - Increased memory frequency from 400 to 533MHz LPDDR2 (2x32-bit)
- Graphics
  - GPU On-demand burst with CPU-GPU power sharing
    - Burst request by Graphics driver based on HW activity counters
    - PM unit manages DVFS; energy management framework ensures optimal burst states for GPU and CPU
- Display
  - Pipeline optimizations to support concurrent 19x12 MIPI DSI panel and 1080p30 over HDMI
  - WiDi stack optimized for latency and power with SoC accelerators
    - Clone mode end-to-end latency 60-80 msec for 1080p
- Ultra low-power music playback – MP3 playback <65mW platform power

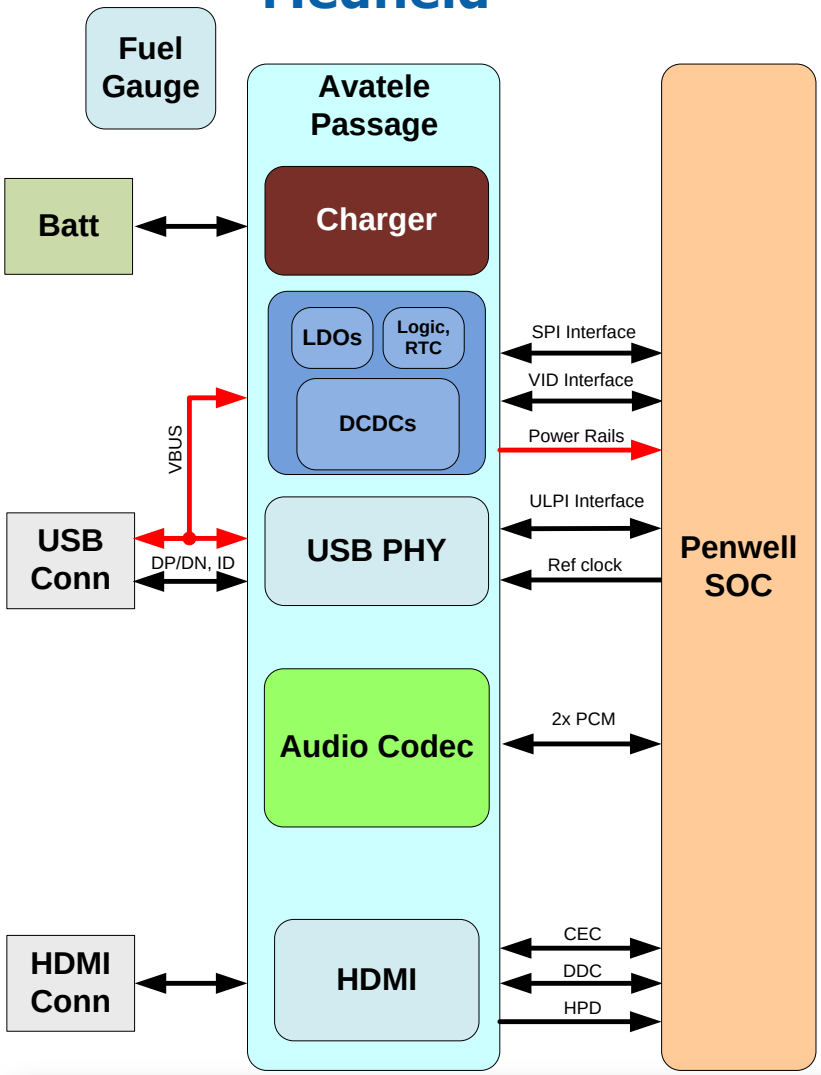
Camera/Imaging Subsystem (CSS) Enhancements

- CSS includes programmable VLIW SIMD vector processor (pixel processing, multiple issue slots), scalar processor (control), DMA, MMU, local memory, CSI2 receiver
- Enhanced CSS firmware infrastructure supports zero shutter lag (ZSL), continuous viewfinder, Time Shift and multi-threading
- Integrated HDR
- Improved single-shot low light performance, faster AF
- 1080p Panorama
- Smart scene, smile and blink detection for smart shutter

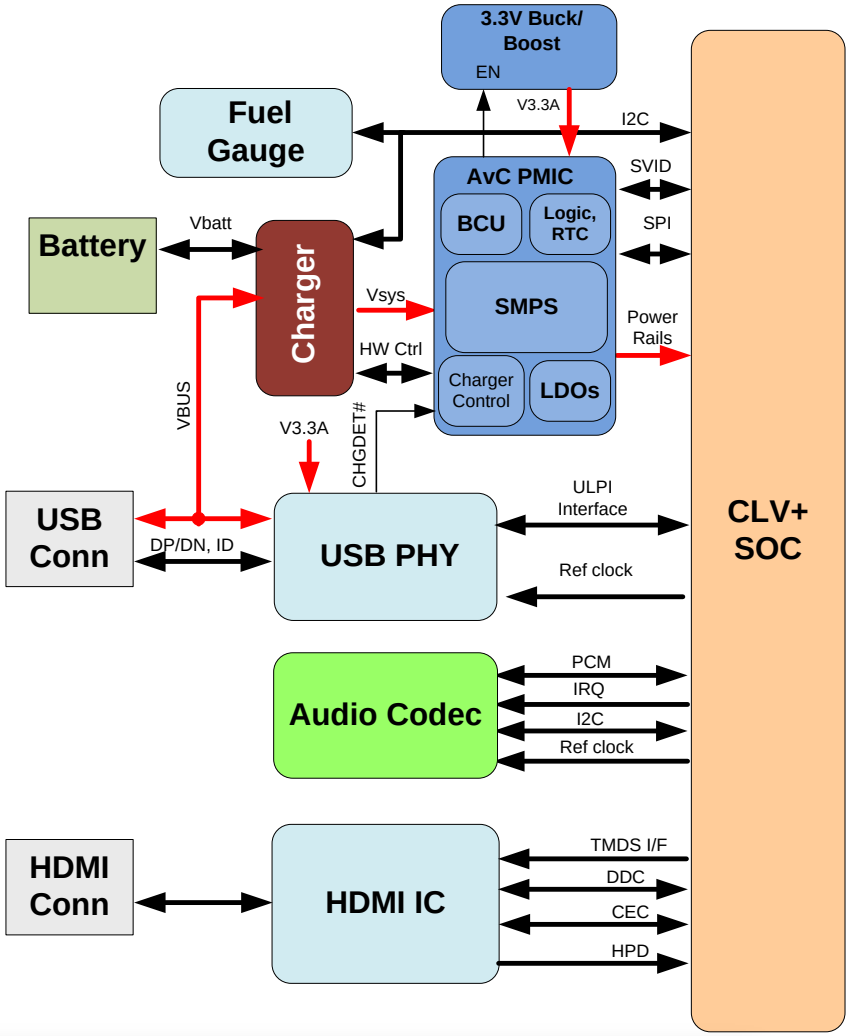


Power Delivery, Codec and PHYs Dis-aggregation

Medfield

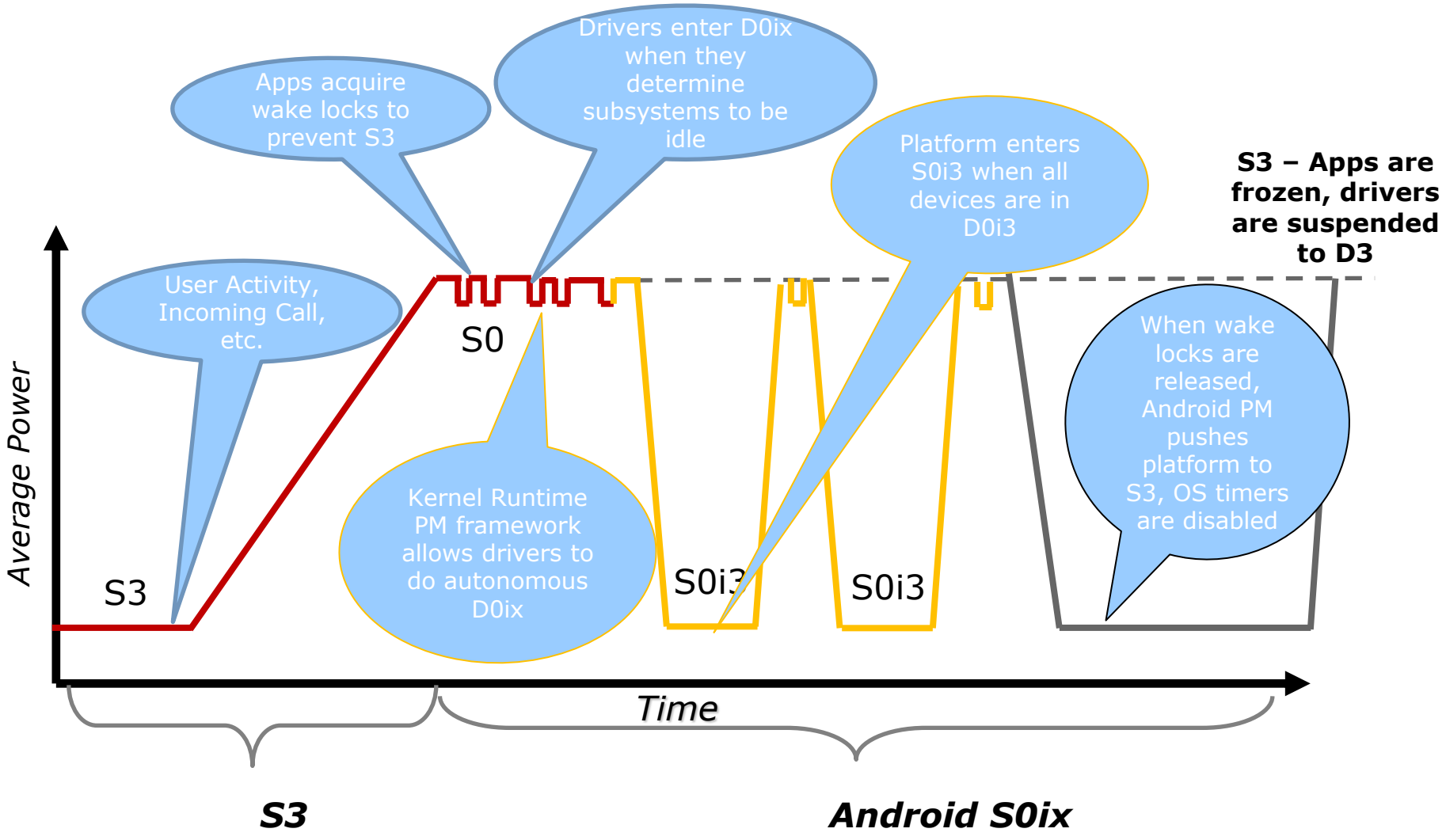


Clovertrail+

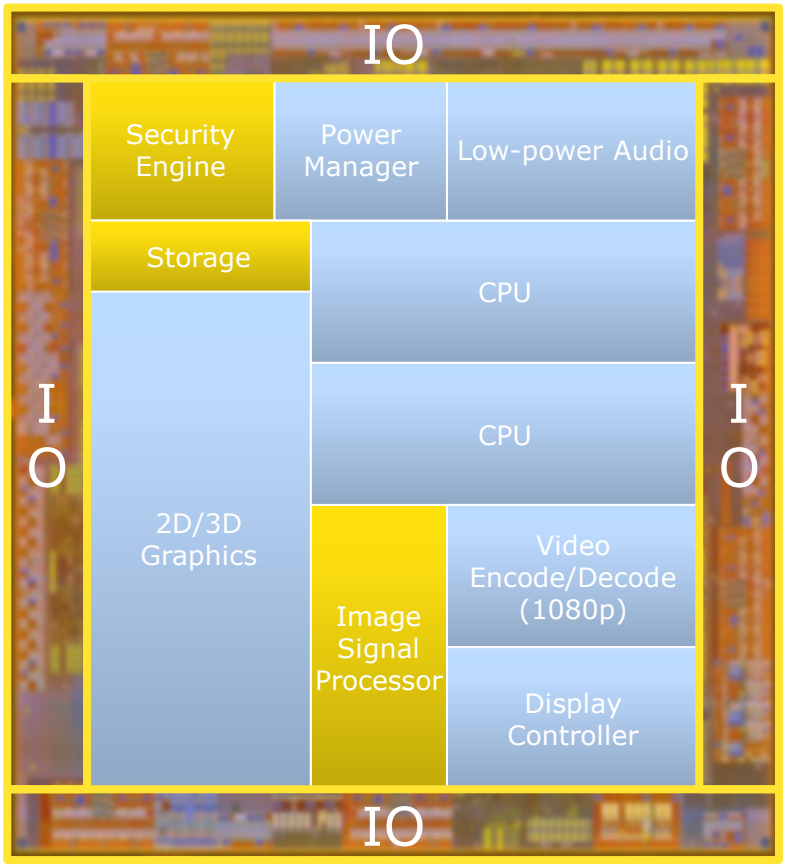


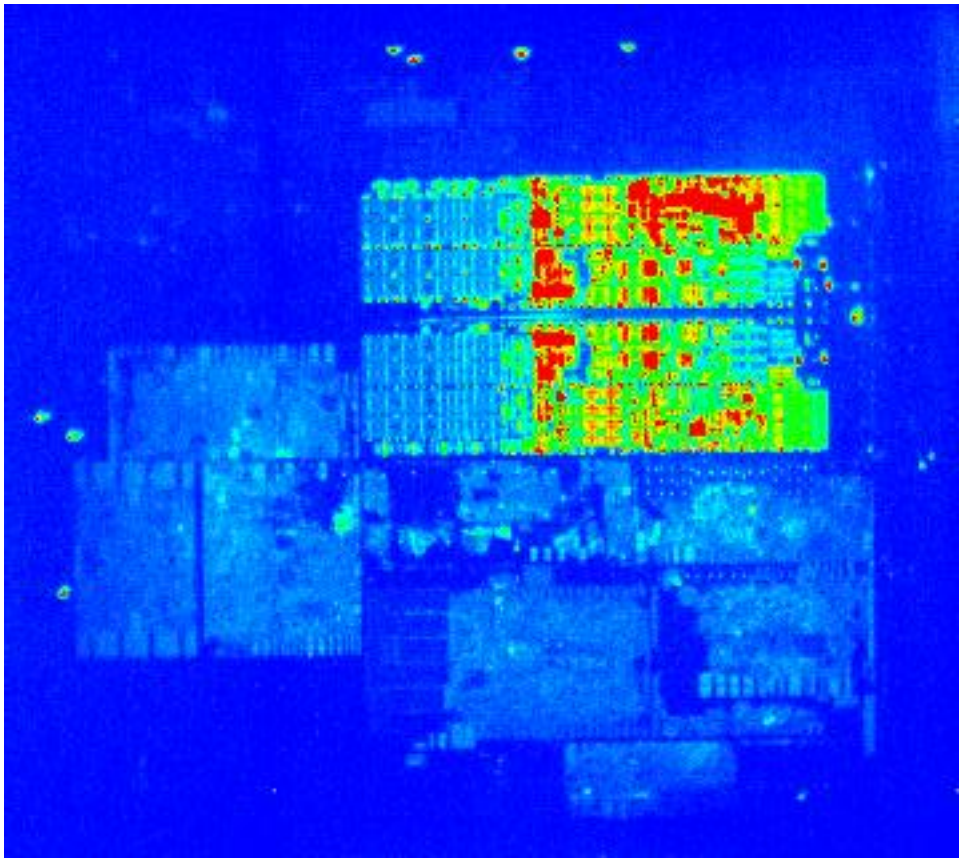
Cheaper PMIC
Platform Arch enables OEM to choose Audio Codec and PHYs

Dynamic Power Management – S0ix/D0ix

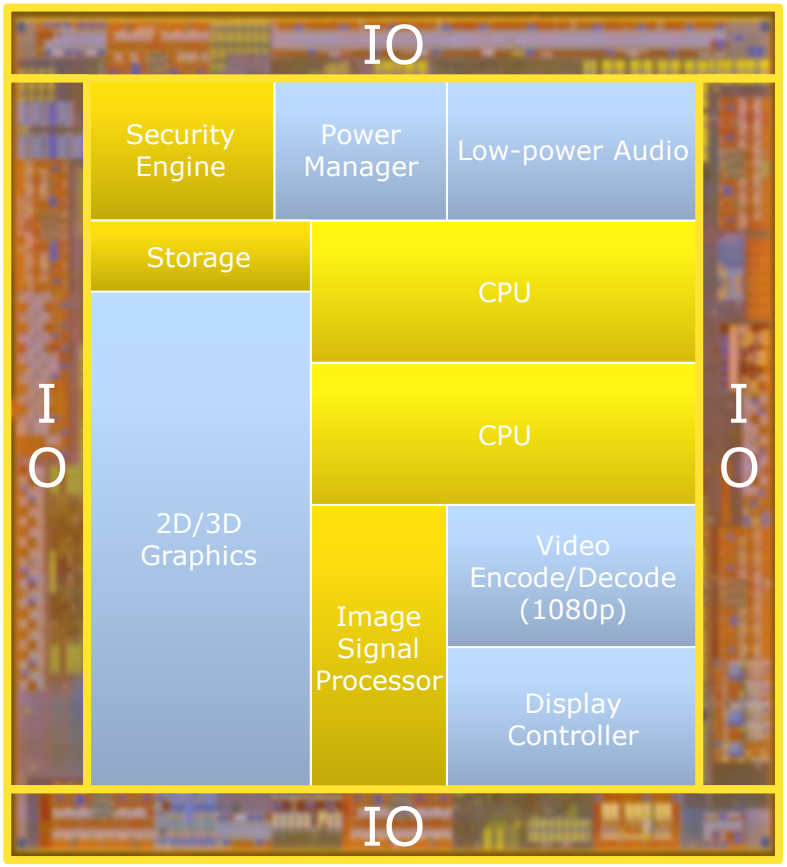


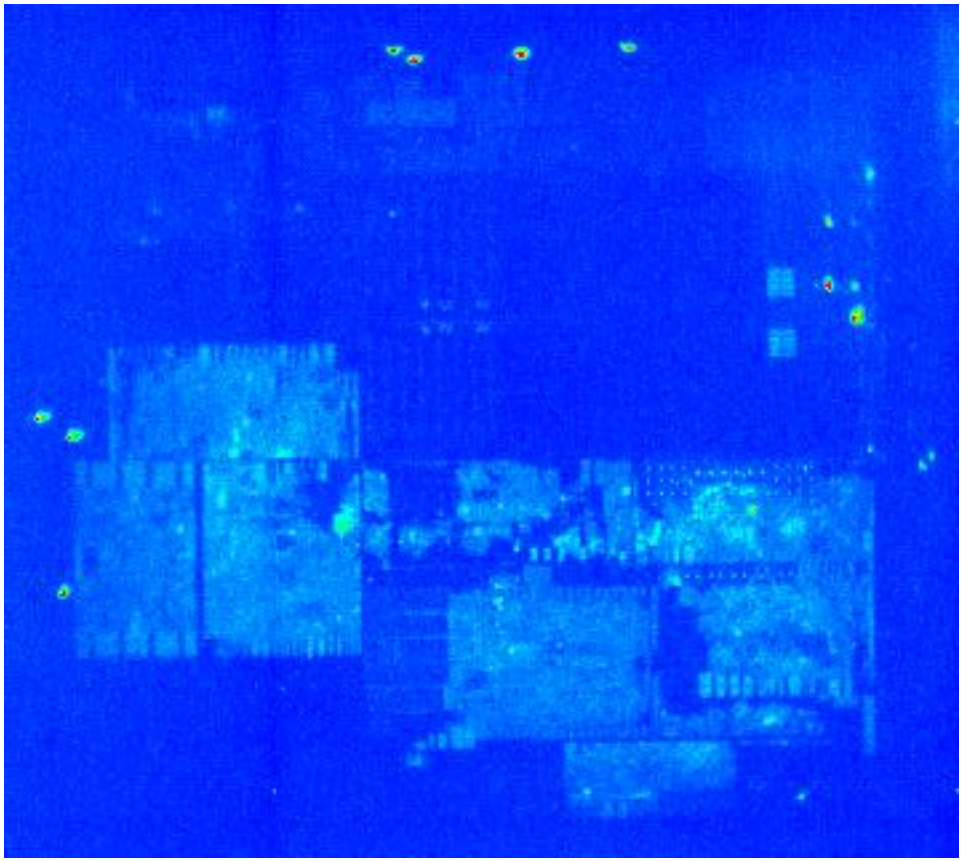
Power Management in Action: CPU Active (S0)



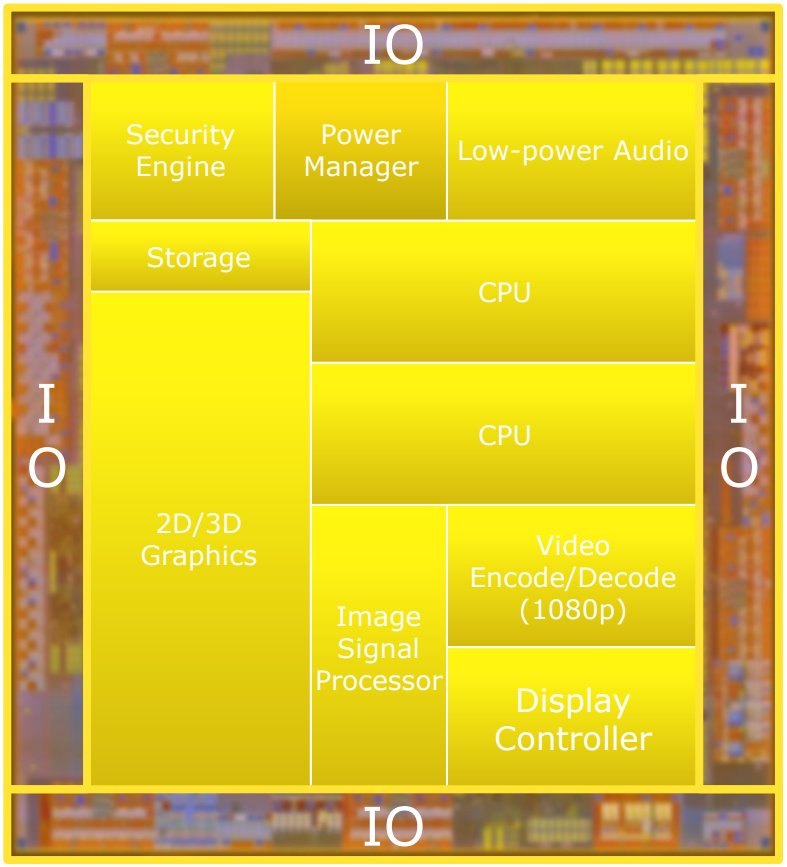


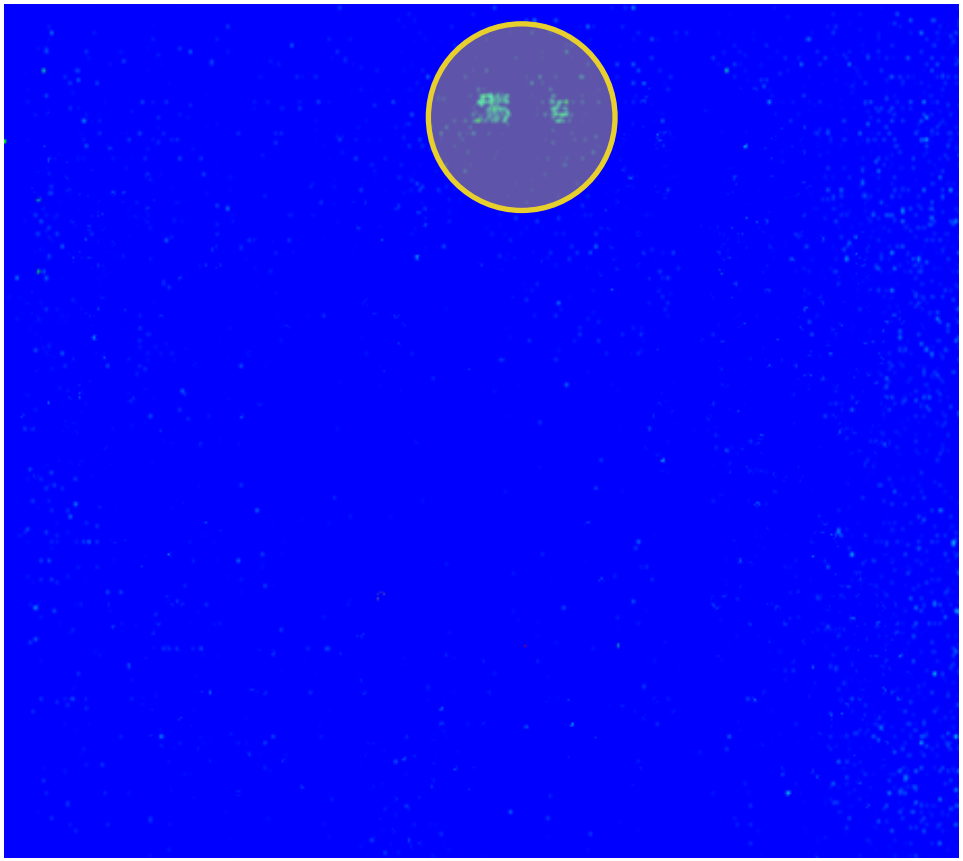
Power Management in Action: CPU Idle (C6)



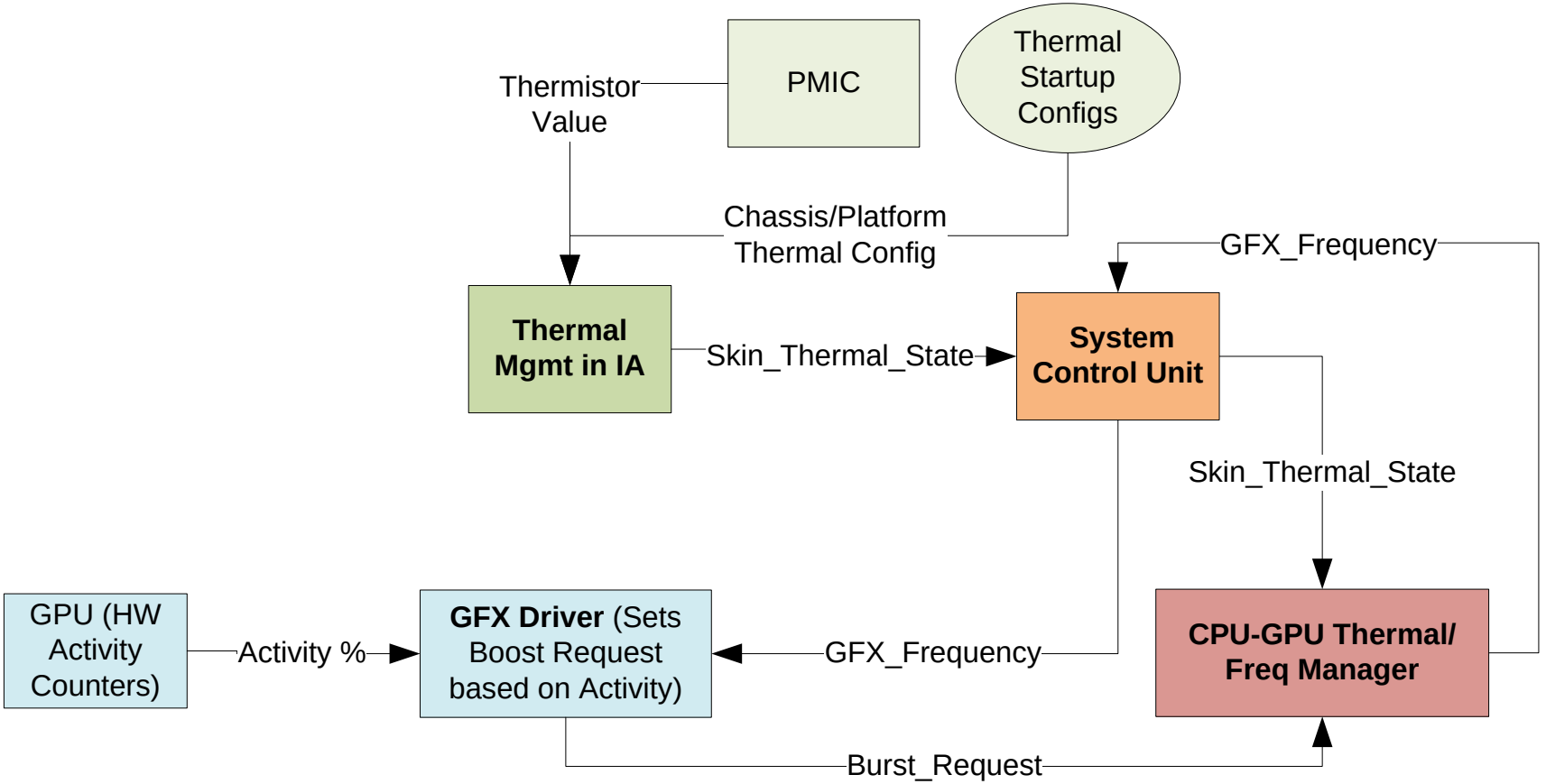


Power Management in Action: SOC Idle (S0i3)



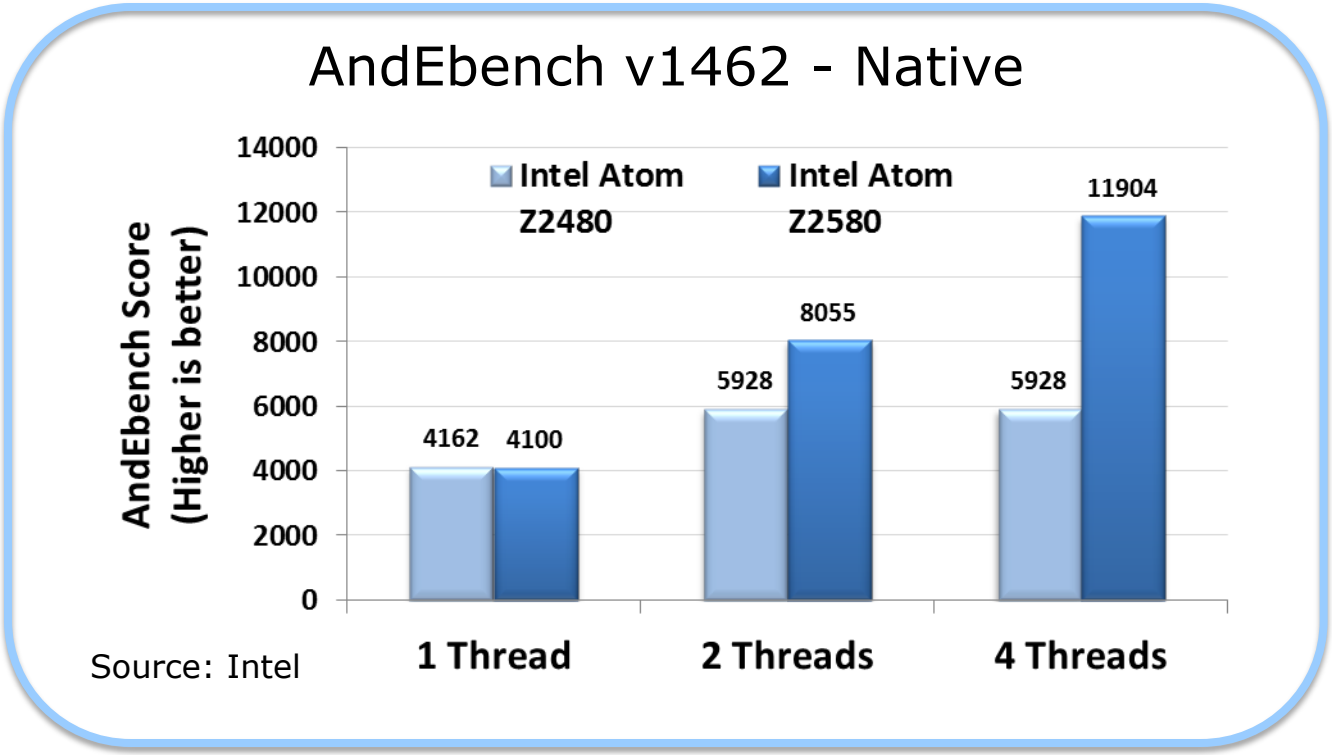


CPU-GPU Dynamic Power Sharing



Generational Comparison: CPU Performance

AndEbench* is an Android benchmark that focusses on CPU performance, concentrating on integer operations.



Dual-core Clovertrail+ SoC supports up to 4 threads to provide higher CPU peak performance compared to Medfield on multi-threaded applications.

Clovertrail+ improves performance over Medfield by up to 2X

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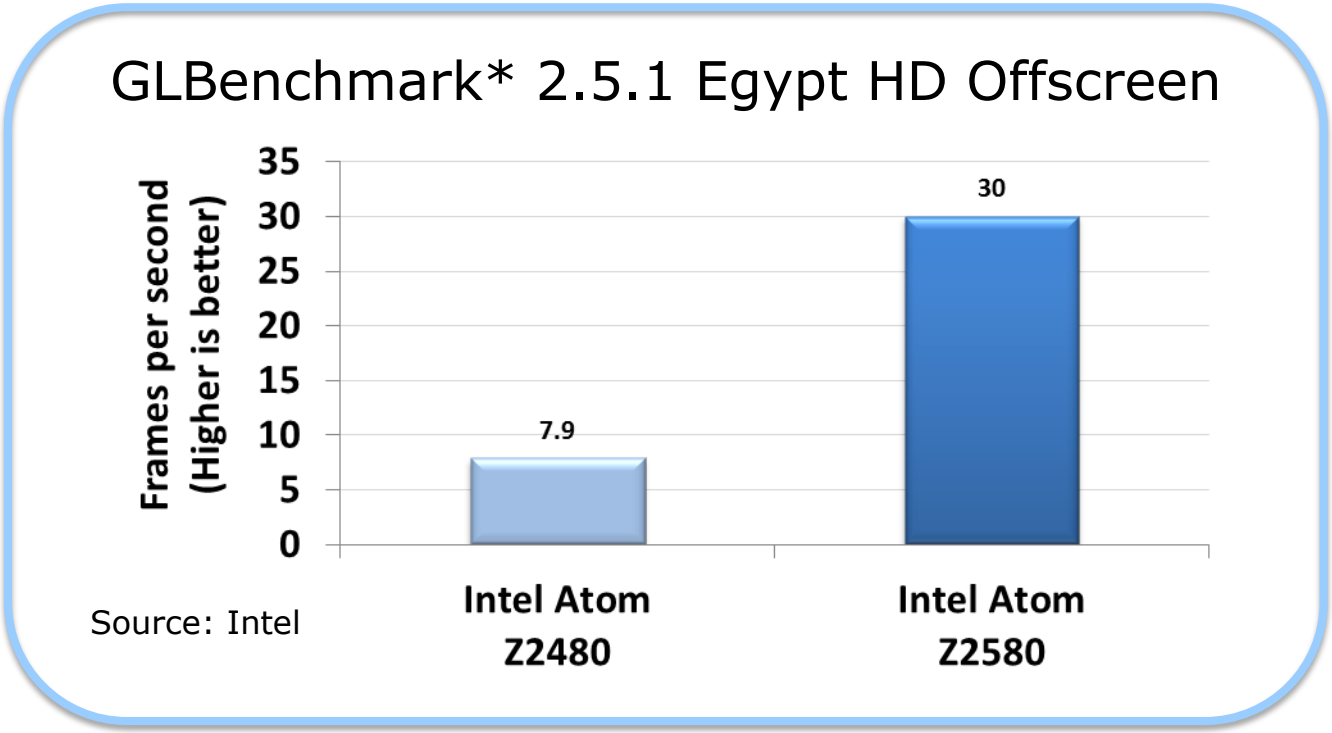
Note: Z2480 scores are measured on the Motorola RAZR i (Android 4.1.2) and Z2580 scores are measured on the Lenovo K900 (Android 4.2.1)

*Other names and brands are property of others.

Generational Comparison: Graphics Performance

Kishonti's GLBenchmark* 2.5.1 measures the performance of the graphics engine using complex 3D animations. The chart below uses the Egypt HD test in offscreen mode using a standard resolution of 1920x1080p.



Clovertrail+ SoC integrates the next generation graphics processor to greatly improve graphics performance over Medfield.

Clovertrail+ improves graphics performance over Medfield by up to 3X

Note: Z2480 scores are measured on the Motorola RAZR i (Android 4.1.2) and Z2580 scores are measured on the Lenovo K900 (Android 4.2.1)

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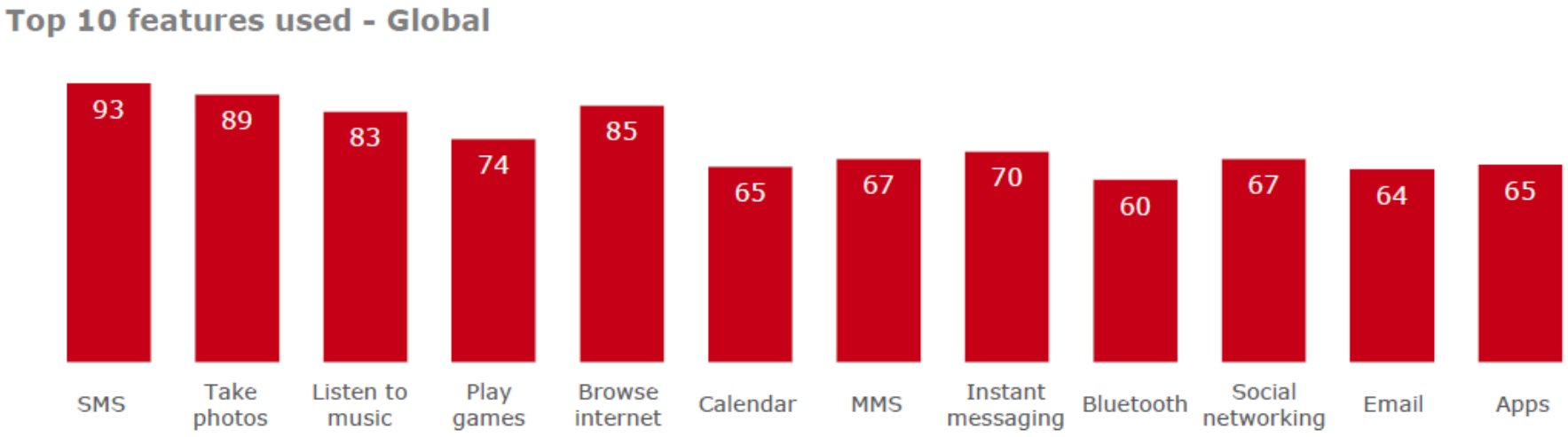
Smartphones are Multi-tasking Devices

Smartphones being more and more of the time for non-voice activities with significant amount of time spent on Gaming, Browsing, Utilities and Social Networking apps.



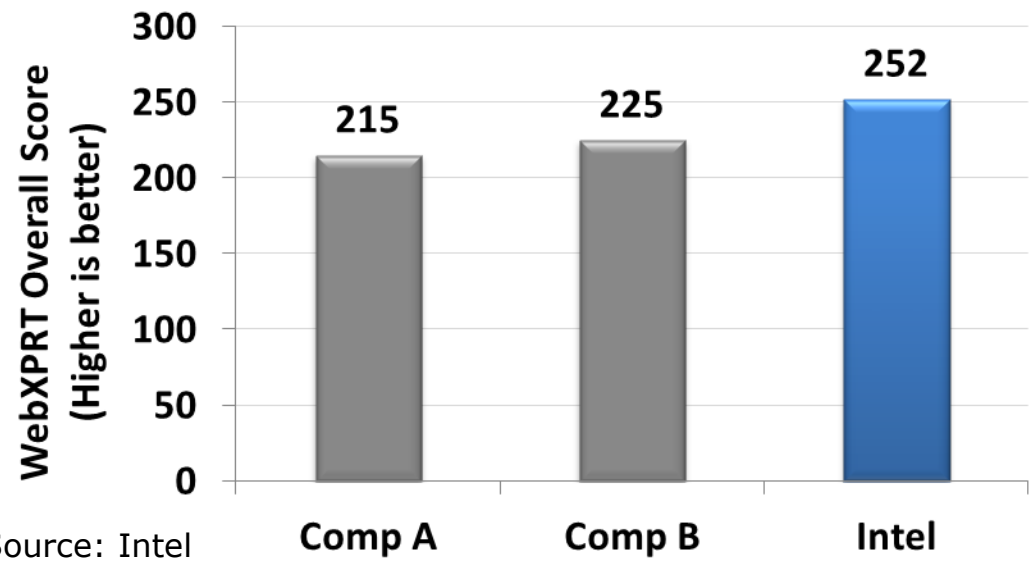
D1: Feature usage
Base: Smartphone owners- Global 17372

Source: TNS Mobile Life Global Report 2013

Smartphones are multi-tasking devices as both web-based applications and Android store applications gain importance

Fast Browser Performance

WebXPRT* from Principled Technologies measures Javascript / HTML5 Performance using web applications based on real-world usages.



Source: Intel

Comp A and Comp B devices are two of the latest ARM-based premium Smartphones on the market today; Intel Smartphone is based on Clover Trail+ SoC.

Real-world usages in WebXPRT:

- *Photo Effects*
- *Face Detection*
- *Stocks Dashboard*
- *Offline Notes*

Clovertrail+ leads the competition on real-world browser usages as indicated by the WebXPRT* scores.

Clovertrail+ provides great user experience for browser-based usages on a smartphone device

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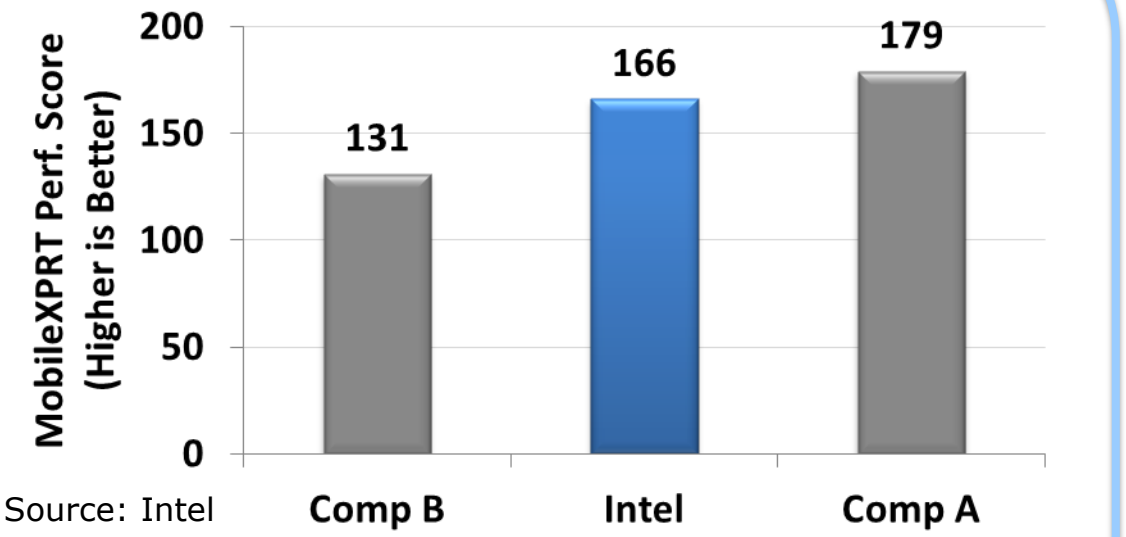
Great Android User Experience

MobileXPRT* from Principled Technologies is a new benchmark that measures the real-world usage performance and end-user experience of Android devices.



Source: Intel

Comp A and Comp B devices are two of the latest ARM-based premium Smartphones on the market today; Intel Smartphone is based on Clover Trail+ SoC.

Real-world usages in MobileXPRT:

- *Detect Faces*
- *Apply Photo Effects*
- *Create Collages*
- *Create Slideshow*
- *Encrypt Content*

Clovertrail+ is very competitive with other premium Smartphones on real-world media applications performed on Android devices.

Clovertrail+ provides great experience for typical end-user applications on Android devices

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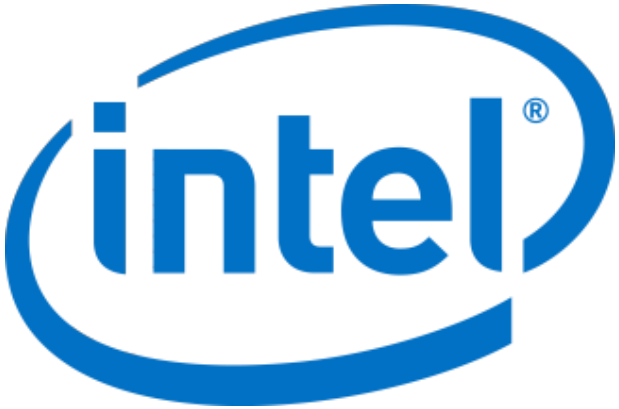
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