OMAP4430 Architecture and Development

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David Witt

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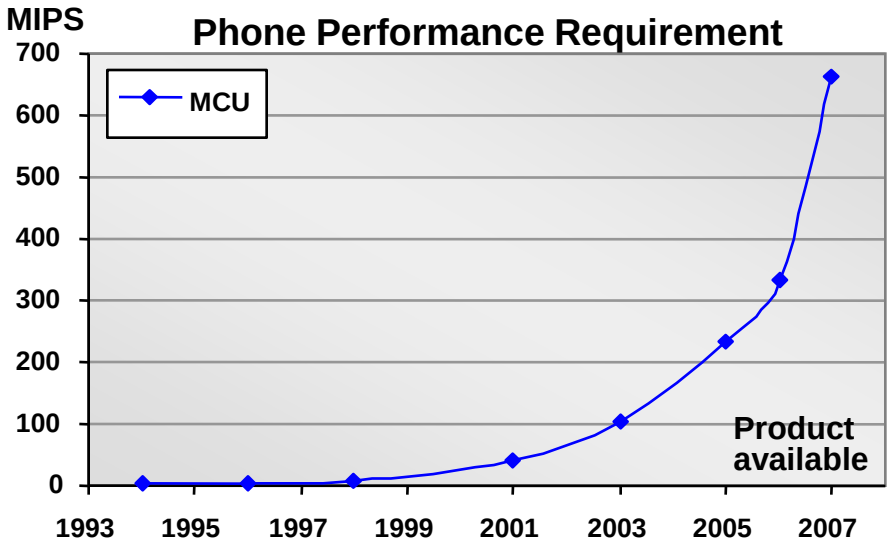
OMAP 4430

- Requirements and challenges of building a “class of 2009” application processor
- What did we want to build?
- How did we build it?
- How does it fit in a system?
- Summary/Questions..

Application processor – class of 2009

- Process Technology
  - 45nm – LP 7LM with a very thick top layer –
  - See next couple of foils of challenges with application processors..
- Package technology
  - 12mm x 12mm 0.4mm pitch BGA flip-chip with POP flash/DRAM –
- Memory technology
  - LPDDR2 400MHz
- Power/performance/Area/Schedule
  - 600mW to 100uW max to min..
  - 1Ghz 2p A9 processors with 1MBL2 + lots of other multi-media accelerators and high speed peripherals..
  - As small as possible and/or it had better fit in the package
  - It is 2009 – so it is “imminent”

BOILER PLATE – Advanced Process and Leakage

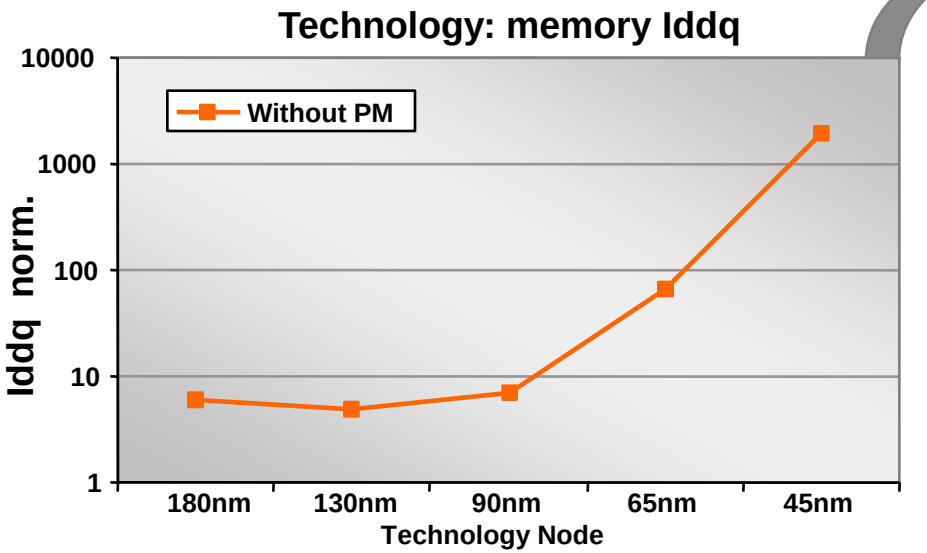


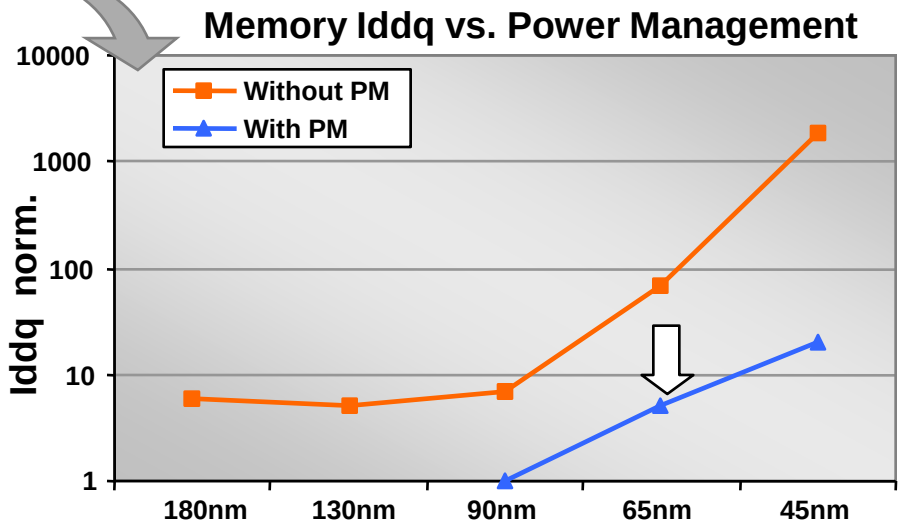
Processing: Pwr_Active = CV^2F + Leakage

- C: Decrease/node,offset by complexity
- F: Increases/node
- Leakage: Increases/node, temp.

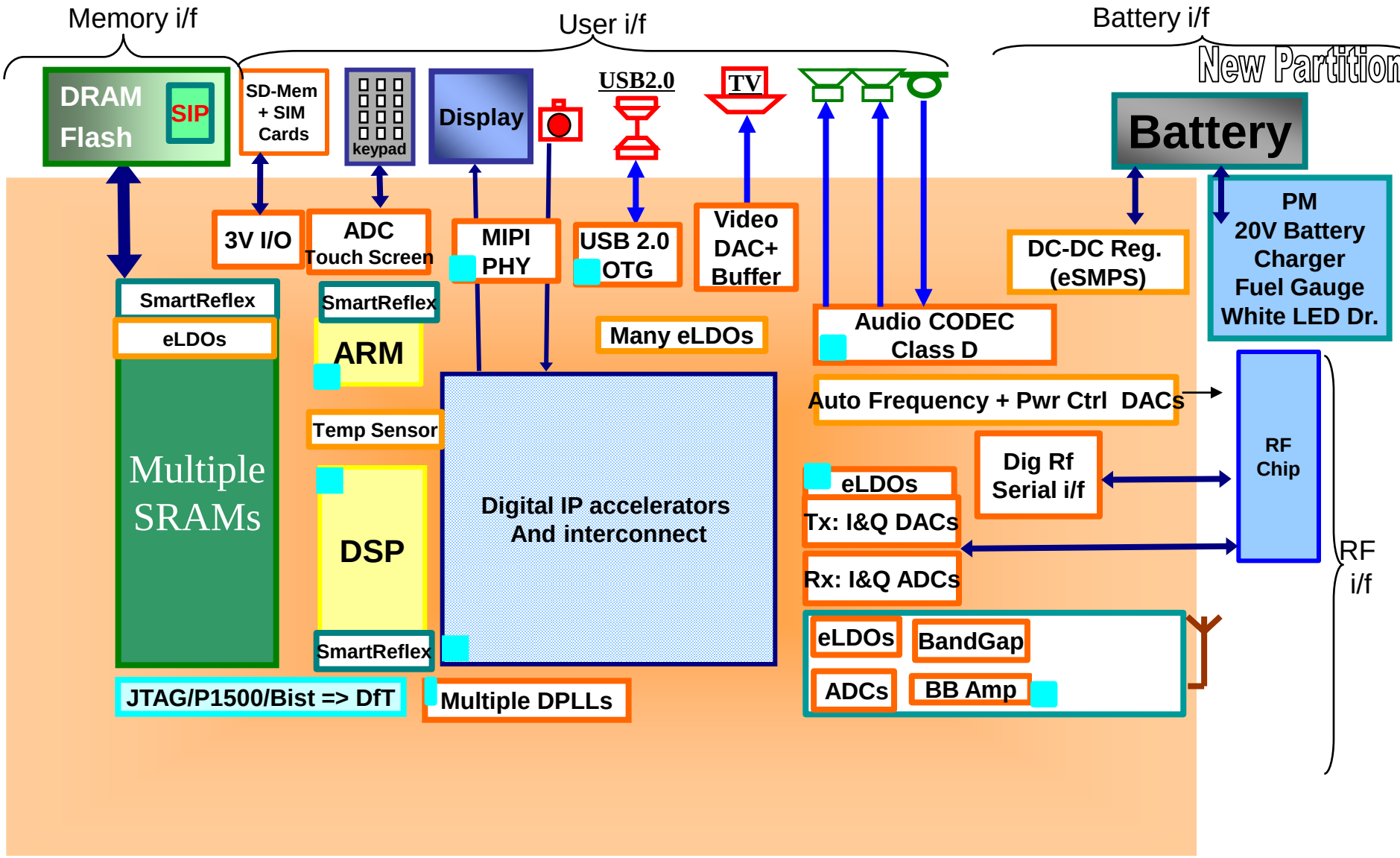
Idle : Pwr_Idle = Leakage

- Leakage: Increases/node, temp





BOILER PLATE – We are not just digital guys anymore



What did we want to build and why ?

- Processors and memory
  - Highest possible performance with SMP ARM Processors
  - Distributed processing and control – Gstreamer/OPENMAX
  - High speed memory optimized for bandwidth and Latency
- Multi-media
  - Best in class Image/video/display
  - 2D/3D graphics with vertex shading
  - Flexible/low power audio – 100 hour playback++
- Interconnect and Peripherals and Protection
  - High performance/flexible interconnect
  - Multiple standard parallel/serial interfaces
  - Flexible method to allow sharing memory and peripherals with different external modems and accelerators
  - Trust zone, Secure RAM/ROM, firewalls, crypto accelerators with secure DMA
- S/W and H/W mechanisms that enable only blocks that need to be powered to be powered for key use cases..
  - Ie be best in class in everything we run between 600MW and 100uW..
  - At the system level not just the OMAP level..
- All of this to enable a wide variety of applications to be always on always connected and that will fit in your pocket…

Processors

- Highest performance processor + L2 + memory system
  - 2p Cortex A9 core 32KBi/32KBD
  - 1MB L2 cache
  - 1GHz+ max clock
- Real time task offload processors
  - 2p cortex M3 @ 200MHz with unified cache/backing SRAM
    - Fast L2 reload – 3 cycles on miss
    - Offloading image/display/video codecs
    - Fast real time response - not subject to main processor HLOS overhead and task switch latency
- General purpose DSP processor
  - 64x-lite DSP @ 466Mhz with 32KB L1 / 128KB L2
  - Fast L2 reload – 5 cycles on miss
  - General purpose pre and post processing task
  - Low power audio codec
  - Large enough L2 to prevent flash/DRAM access in low power mode

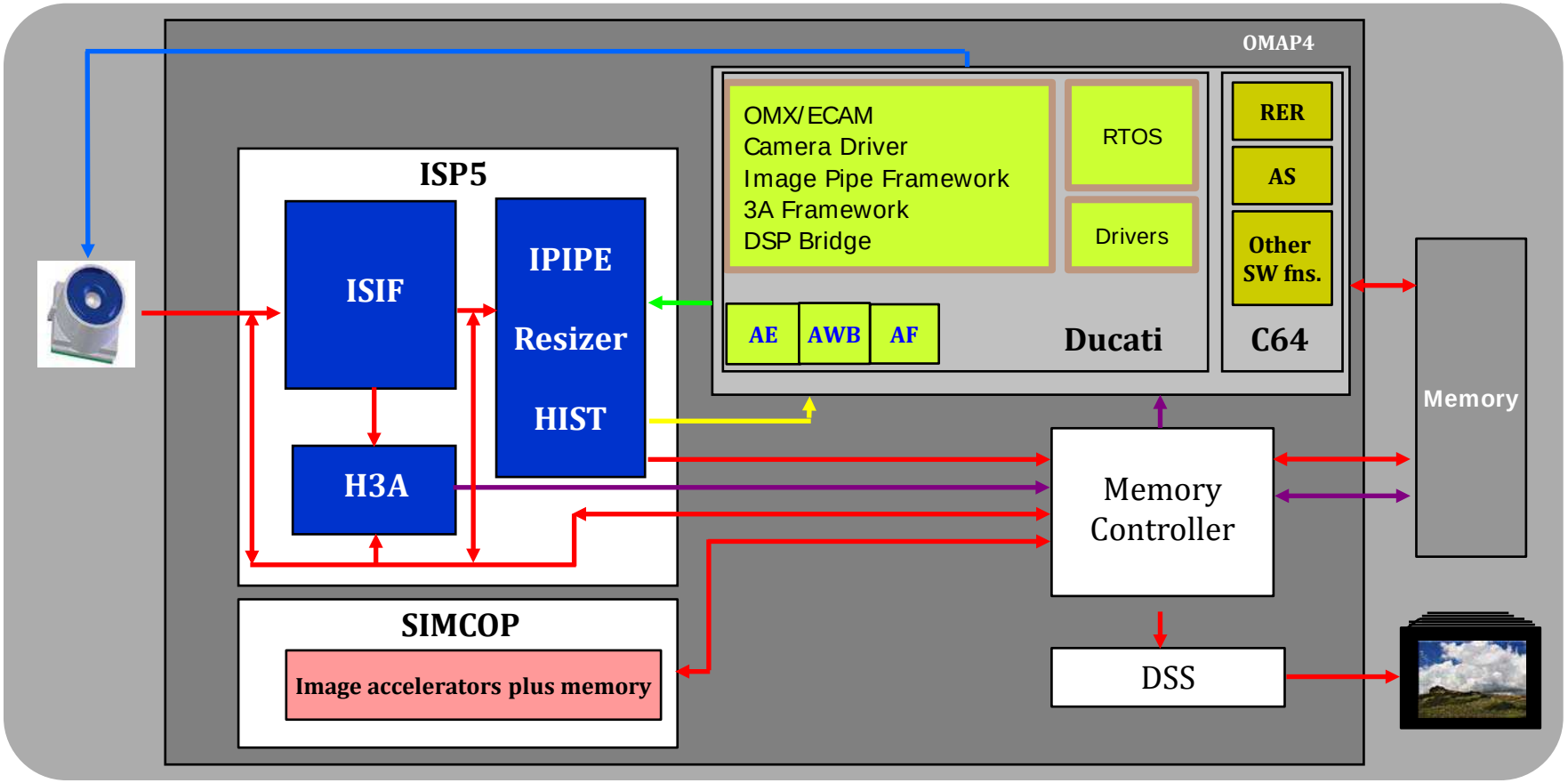
Memory system and backplane

- 2x LPDDR2 for OMAP4430
- 400MHz operating frequency
  - i.e. OMAP4430 SDRAM BW budget ~5x OMAP3430
  - 2 x32 channels map to 200Mhz 128 bits OCP 2.2 interconnect..
  - Image, video and display IPs are 2D aware
- 2x-LPDDR2 mapped as 2 interleaved channels for OMAP4
  - Transparent for both SW and HW modules
  - Direct path from processor cluster to memory controllers
- Powerful DRAM Memory Manager (DMM) for BW optimization
  - 2D-Tiling – Rotation - Interleaving – Virtual memory management for all HW operators

Multimedia – image and display

- Image engine
  - Internal proprietary HW/SW/Accelerators mix
  - Enables 200Mpixels/second raw data rate
  - 1000 plus operations/pixel at that data rate..
  - Multiple different camera inputs
  - Usual suspects
    - Defect Pixel correction/Lens distortion correction
    - Gamma correction/color filter adapter/color space conversion
    - Noise filters / Resizers
    - Optimized path 2D path to/from LPDDR2 frame buffer
- Display engine
  - Multiple parallel video and 3D graphics paths
  - Horizontal/vertical filters
  - Programmable overlaps/alpha blending/color space conversion with hardware rotation
  - Optional “snapshot” path to capture and feedback blended images
  - Primary/secondary DSI outputs + HDMI
  - Very low power modes with intelligent display fetch...

OMAP4 image/display HW/SW paths..

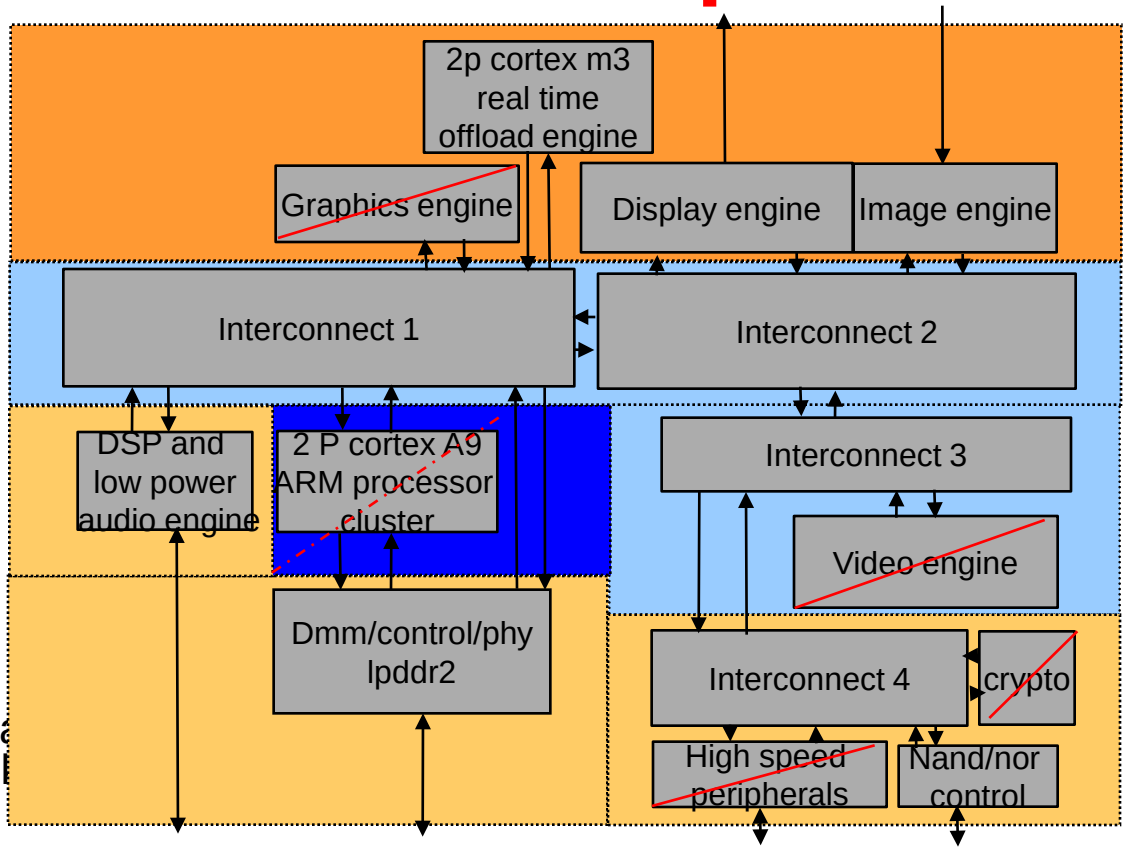


Low power audio

- Leverage flexibility of existing ARM/DSP codecs
- Minimize everything that needs to be on for MP3 playback
  - Chip wide Only 1 DPLL active [out of 10..]
  - Chip wide only 1 power domain always on [out of many..]
  - Minimize ARM/DSP on time so they are 95% off
  - Build one programmable mixer/buffer for final stage to I/O
  - Optimize all I/O to/from this one small block
  - Optimize external drive/power amplifier to speakers.
- Results on MP3..
  - Battery level for 1000mamp-hr = 100 hours of playback

HW/SW power/use case example

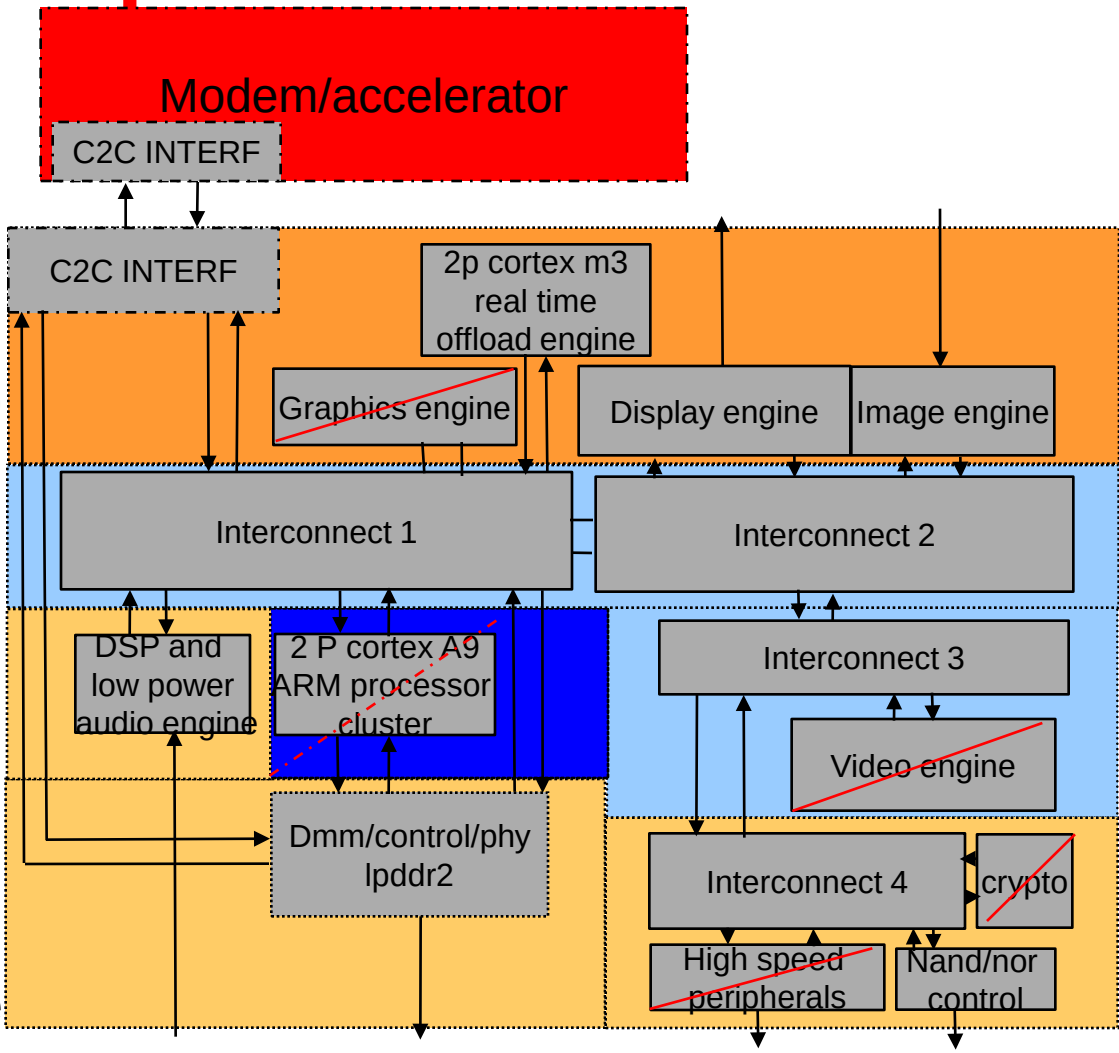
- Different voltage domains
  - Blue/orange/yellow
- Different clocks/power
  - Blocks called out
- Unique connections
  - Wires optimized
  - Master/slave protocol
- Use case
  - Given at “application level
  - Can be SW or HW or mixed control..
  - Blocks can “watch for activity” a in absence remove power/clock and wait..
  - Optimization –
    - Shut anything off not needed
    - Balance wakeup time to off time
    - Application must tell O/S
    - O/S tells middleware and HW/SW



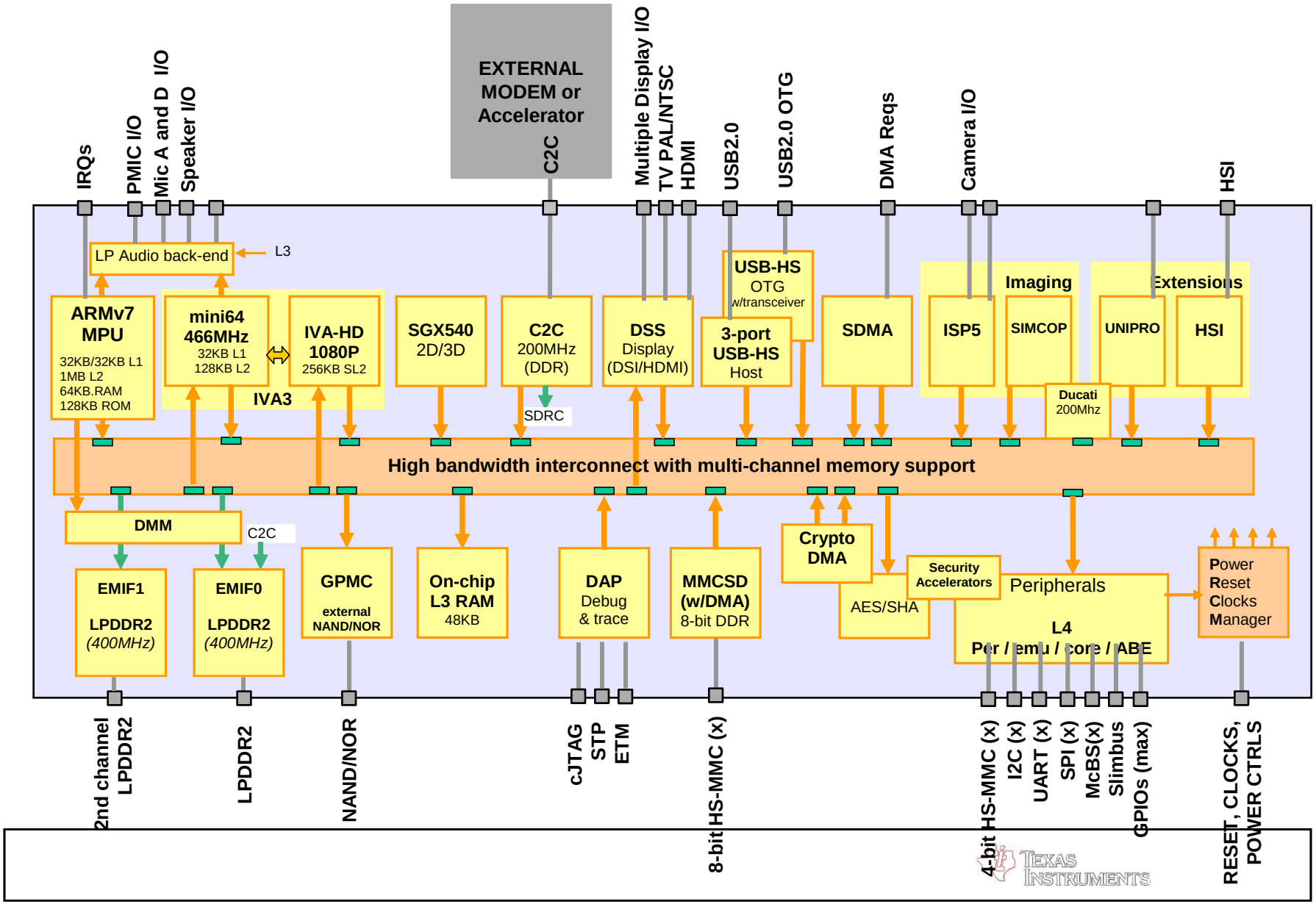
Example say
1 capture image/compress display
2 Listen to MP3 while doing above
3 minimize power – unless wakeup..

Efficient Chip2Chip communication

- External modems
  - Need low latency path to memory
  - Expensive to replicate entire memory
  - Expensive modem+apps chip
    - Modems and apps move at different rates
- Solution
  - Use LPDDR2 signaling
  - Dedicated links to/from
  - Direct path to LPDDR2
  - Access with protection to all other blocks
  - Side by side placement
  - As efficient as larger package



OMAP4430 Block Diagram



Summary

- OMAP 4430
  - State of the art application processor
  - Best in class power/performance
  - All the fundamental IP blocks are major upgrades from the OMAP 3430 [state of the art in 2007..]
  - All the supporting devices - ready and waiting -
    - Power management/Audio chips
    - Clock distribution chips
    - WLAN/GPS/BT/Fm radio + S/W integration
    - Modem integration
- If interested contact your local TI representative..

Thank you
And thanks to WW OMAP 4430 team -