



CPU and Memory - Advanced

Reading: Chapter 8



References

- X86
<http://en.wikipedia.org/wiki/X86>
<http://en.wikipedia.org/wiki/X86-64>
- ARM Cortex A8 (Droid)
http://en.wikipedia.org/wiki/ARM_architecture
- Apple custom A4 chip (iPhone 4)



Current CPU Architectures

- Current CPU Architectures
 - Intel x86 family (including AMD)
 - ARM (mobile devices)
 - IBM Mainframe series

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x86

- Family of ISAs based on Intel 8086 CPU (1978)
- Extensions to the x86 ISA have almost complete backwards compatibility
- Pentium brand name trademarked (not 86)
- Market
 - Dominant in desktop/server systems
 - Rare in mobile applications (e.g., smart phones)
- Design
 - Early models – 16-bit
 - Recent – 64-bit
 - Intermediate – 32-bit (beginning 1985)

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X86 ISA Architecture

- Variable instruction length (CISC)
- Integer arithmetic and memory addressing correspond to 16, 32, 64 architectures
- Floating point co-processor now included in most CPUs (with 80-bit registers)
- Hardware support for paging (with 80386)

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Implementations

- Instructions decoded into micro-coded pipeline instructions
- Multiple execution units (superscalar)
- Out of order and speculative execution

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Intel x86 Instruction Sets

- SSE- Streaming SIMD Extensions
- SSE – graphics enhancements (e.g., for game display), including SIMD (1999)
- SSE2 – adds double precision floating point (2000)
- SSE3 – permuting bytes in a word,
- SSE4 – dot product, additional integer instructions, etc.
- SSE5
- AVX (Advanced Vector Instructions) – advanced floating point instructions

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X86-64

- x86-32 allowed for direct addressing of only 4GB of memory (database engines need more)
- Extension of the x86 instruction set
- X86-64 is a vendor neutral term (for Intel, AMD, etc.)
- Based on previous Intel 64 bit architectures (see Itanium)
- Runs 32 bit instruction set

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X86-64 – 64 Bit Capability

- 64 bit general purpose registers
- 64 bit integer arithmetic
- 64 bit virtual addresses (48 bits actually used)
- 48 bit physical addressing (256TB RAM)

Large address space means that files can be mapped into address space, eliminating the need for slow I/O

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X86-64 - Extensions

- Extensions
 - Additional registers (16, instead of 8)
- Compatible operating systems
 - Linux
 - Mac OS X
 - OpenBSD
 - Solaris
 - Windows

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ARM

- Advanced RISC Machine
- Most widely used 32-bit ISA (90% of embedded RISC processors – 2009)
- Suitable for low-power applications
- Processors developed by ARM-licensees
- ICs can be build with old fabrication facilities and still deliver good performance
- Revenue - \$.11/unit shipped (licenses & royalties)
- Cortex-A – 2 GHz
- Large range of compatible OSs

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Products with ARM

- Nintendo
- Blackberry Pearl
- iPad 2
- Motorola Droid X
- Garmin
- Canon Powershot
- Nokia

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ARM Architecture Features

- Load/Store Architecture
- 32-bit fixed width instructions
- 16 x 32-bit register file
- Mostly single cycle execution
- Conditional execution
- 3-stage pipeline (fetch, decode, execute)
- Thumb instruction set (16-bit instructions)
- Vector floating point co-processor

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iPhone A4

- Specs not widely published
- Apple purchased PA Semiconductor (creator of mobile PowerPC) after the Apple switch to Intel processors in other devices
- includes two 64-bit PowerPC G5 cores
- 2.0 GHz
- A4 uses the ARM architecture

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