

RISC Architecture

Ch 12

Some History
 Instruction Usage
 Characteristics
 Large Register Files
 Register Allocation
 Optimization
 RISC vs. CISC

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1

Major Inventions in Computer Architecture

- General purpose computer
 - Howard Aiken, Mark I, 1944
 - relays, 17m long, 2.4m tall
 - 500 miles of wire, 5 tons
 - 3 million connections
 - 6 sec mult, 12 sec div
 - IBM ASCC
 (automatic sequence controlled calculator)
 - turned off last time
 1959



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Major Inventions in Computer Architecture



– J. P. Eckert and John Mauchly, Eniac, 1946

- 1500 relays
- 18000 vacuum tubes
- 70,000 resistors
- 20 accumulators
- 10 digits
- modify program by rewiring



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Major Inventions in Computer Architecture

- Stored Program Computer
 - store both program and data in memory
 - John von Neumann, 1945
 - Electronic Discrete Variable Automatic Computer (EDVAC) prototype
 - Maurice Wilkes, 1949
 - Electronic Delay Storage Automatic Calculator (EDSAC)
 - first fully operational stored program computer
 - software was born



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Major Inventions in Computer Architecture



Floating Point hardware

- Gene Amdahl, 1953
- IBM 704
 - OS allowed for batch processing
 - combine existing commands into new commands
 - 5 kFLOPS
 - 19 units produced

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Major Inventions in Computer Architecture

- Family of computers with different implementations of the same architecture
 - Computer system can grow within the family and all SW will still run
 - Need faster/bigger
 - ⇒ buy a faster/bigger system in the family
 - Gene Amdahl
 - IBM S/360
 - DEC PDP-8



1964

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Major Inventions in Computer Architecture

- Microprogrammed control unit
 - can modify implementation easily
 - makes it easier to implement families of systems
 - can have different instruction set architecture (ISA) on top of the same HW
 - Maurice Wilkes, 1951
 - IBM System/360, 1964



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Major Inventions in Computer Architecture

- Cache memory
 - Maurice Wilkes, 1965
 - major speed up
 - IBM System/360 Model 85

1968



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Major Inventions in Computer Architecture



Atlas
accumulator
cabinet

- Virtual memory
 - Tom Kilburn, 1962
 - Atlas, 1962
 - 20 bits for virtual address space
 - 512 word (each 48 bits) page
 - 16 KB main mem
 - 2 units sold

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Major Inventions in Computer Architecture

- Pipelining
 - Tom Kilburn (?)
 - Atlas, 1962
 - 2 ALU's
 - overlap execution of 3 instructions



Atlas Main and B-Arithmetic Units

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Major Inventions in Computer Architecture

- Multiple processors
 - J. P. Eckert and John Mauchly
 - Sperry Rand Univac 1108II (1108A), 1964
 - 3 CPU's
 - 2 I/O controllers
 - DMA
 - 36 bit words
 - test-and-set instruction was added for synchronization between processors



Mauchly & Univac console

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Major Inventions in Computer Architecture

- Static RAM
 - Fairchild 4100, 1970
 - 256 bits
- Dynamic Random Access Memory
 - Robert Dennard, IBM, 1966
 - Intel 1103, 1970
 - John Reed
 - 1024 bits
 - replaces magnetic core memory by 1972



Dennard



Reed

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12

Major Inventions in Computer Architecture

- Single chip microprocessor
 - Federico Faggin, Marcian E. (Ted) Hoff, and Stan Mazor
 - Intel 4004, 1971
 - 2250 transistors
 - 4 bit words
 - 60K OPS
 - Japanese investors abandoned failed project (!)



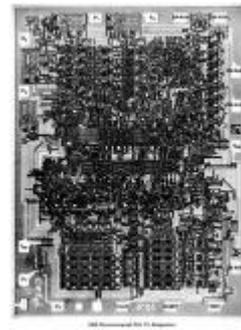
Faggin



Hoff



Mazor



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Major Inventions in Computer Architecture

- Vector processors
 - operate on entire vectors with one instruction
 - Texas Instrument Advanced Scientific Computer (ASC), 1971
 - W. Joe Watson
 - 4 pipelines
 - vectors stored in memory
 - 7 machines built
 - vectorizing Fortran compiler
 - theoretical max speed 50 MFLOPS
 - slow scalar unit



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Major Inventions in Computer Architecture

- ... ??? ...

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Major Inventions in Computer Architecture

- Reduced Instruction Set Computer (RISC)
 - John Cocke, 1974
 - IBM 801 (prototype), 1979
 - project cancelled because instruction set not compatible with OS/360



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Major Inventions in Computer Architecture -- ??

- Make cache visible to application and (partly) under application control
 - Edmund J. Kelly, Malcolm John Wing & Robert Cmelik (?), Transmeta Corp., 1996
 - Certain applications can optimize and dynamically rebuild (translate & optimize) their (instruction) cache
 - lots of work, possibly big speedups
 - E.g., emulators for other architectures
 - Crusoe processor, 2000 (??)

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18