



Computer Microprocessor Architecture & Programming HCA1109

Computer Evolution and Performance





ENIAC - Background

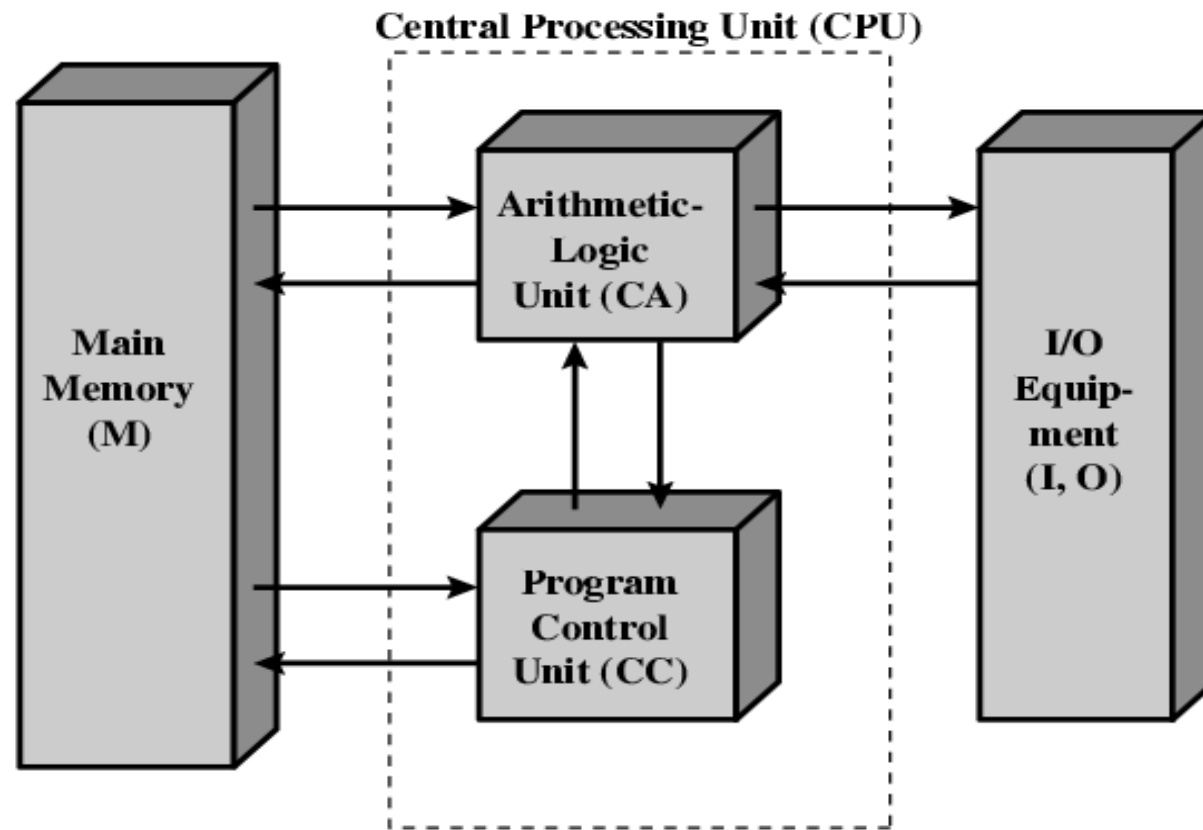
- ✦ Electronic Numerical Integrator And Computer
- ✦ Eckert and Mauchly - University of Pennsylvania
- ✦ Trajectory tables for weapons
- ✦ Started 1943 - Finished 1946: Too late for war effort
- ✦ Used until 1955
- ✦ Decimal (not binary)
- ✦ 20 accumulators of 10 digits
- ✦ Programmed manually by switches
- ✦ 18,000 vacuum tubes - 30 tons - 15,000 square feet
- ✦ 140 kW power consumption - 5,000 additions per second



Von Neumann

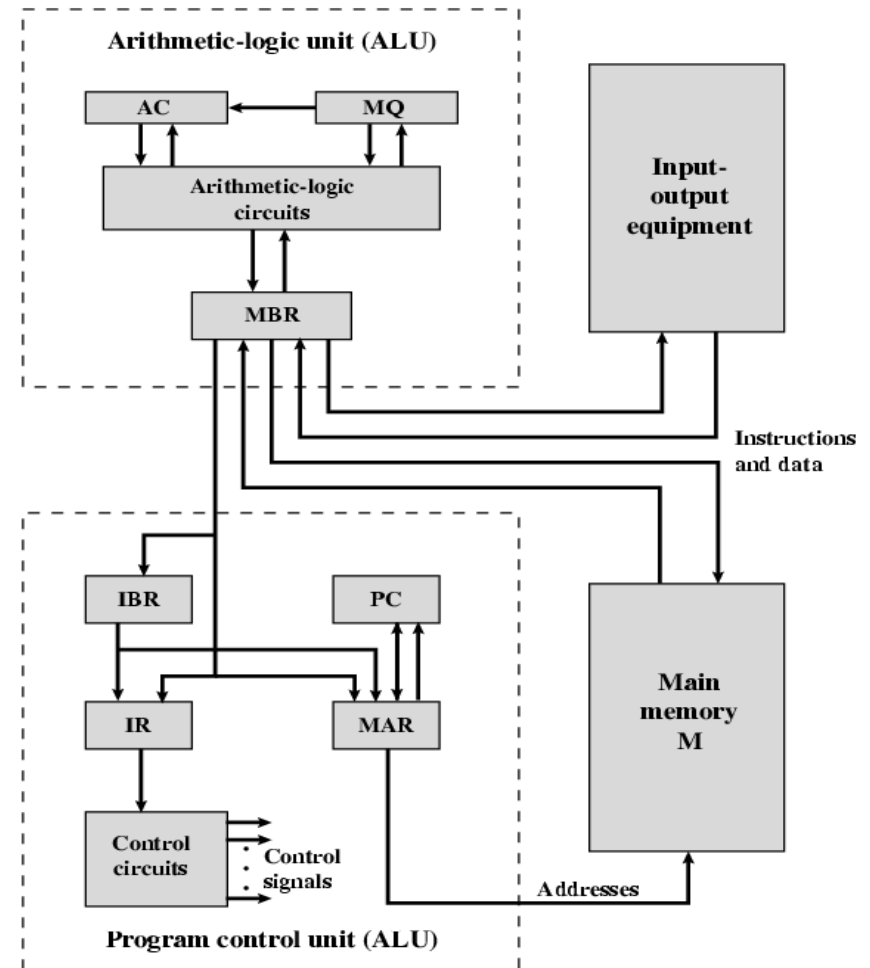
- ✦ Stored Program concept
- ✦ Main memory storing programs and data
- ✦ ALU operating on binary data
- ✦ Control unit interpreting instructions from memory and executing
- ✦ Input and output equipment operated by control unit
- ✦ Princeton Institute for Advanced Studies - IAS
- ✦ Completed 1952

Structure of Von Neumann machine



Structure of IAS

- ✦ 1000 x 40 bit words
 -
 -
- ✦ Set of registers (storage in CPU)
 -
 -
 -
 -
 -
 -
 -





Commercial Computers

- ✦ 1947 - Eckert-Mauchly Computer Corporation
- ✦ UNIVAC I (Universal Automatic Computer)
- ✦ US Bureau of Census 1950 calculations
- ✦ Became part of Sperry-Rand Corporation
- ✦ Late 1950s - UNIVAC II -Faster with more memory

IBM

- ✦ Punched-card processing equipment
- ✦ 1953 - the 701: IBM's first stored program computer for Scientific calculations
- ✦ 1955 - the 702: Business applications
- ✦ Lead to 700/7000 series



Transistors

- ✦ Replaced vacuum tubes: Smaller, Cheaper, Less heat dissipation and Solid State device
- ✦ Made from Silicon (sand)
- ✦ Invented 1947 at Bell Labs by William Shockley et al.

Transistor Based Computers

- ✦ Second generation machines
- ✦ NCR & RCA produced small transistor machines
- ✦ IBM 7000
- ✦ DEC – 1957: Produced PDP-1



Generations of Computer

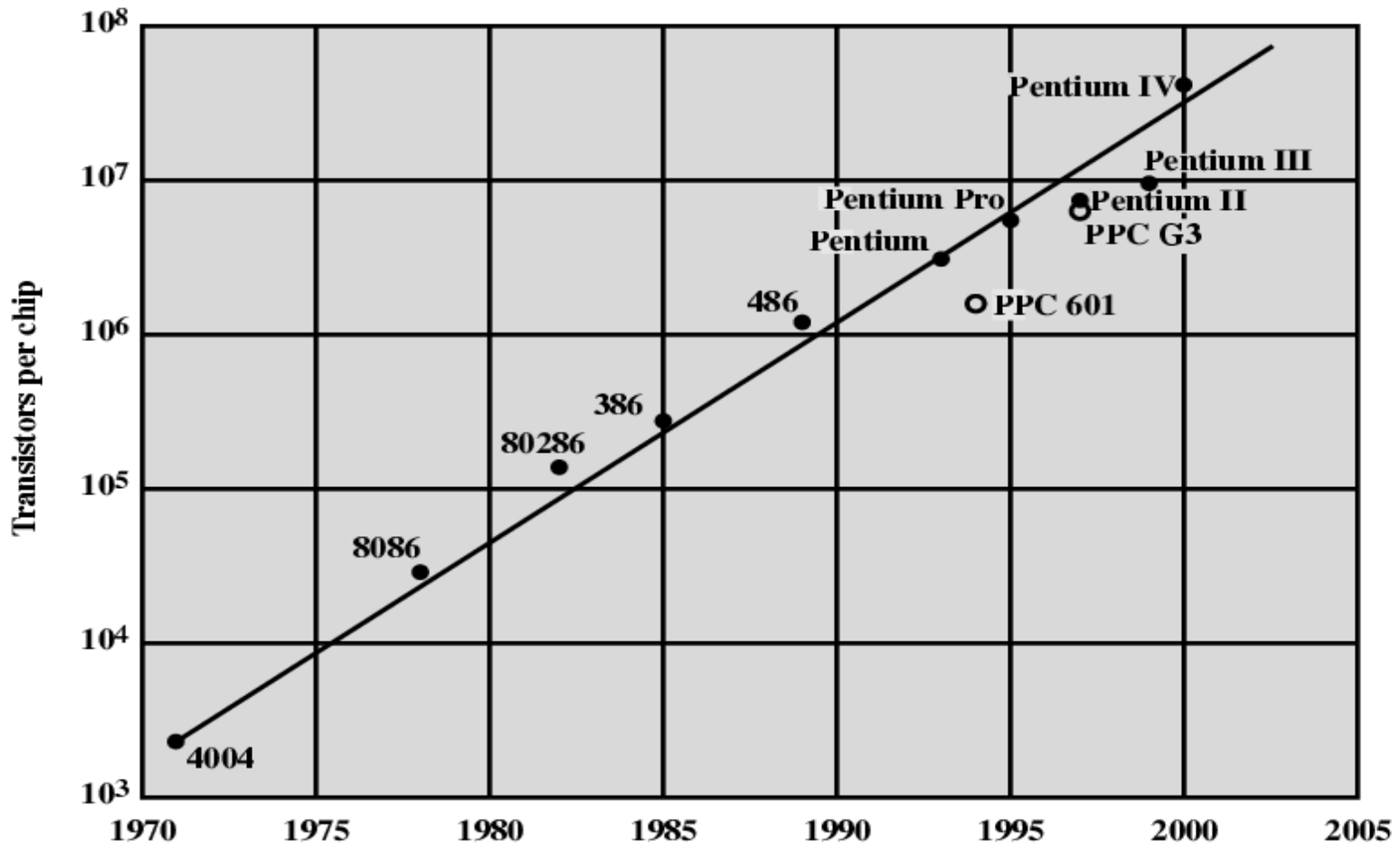
- ✦ Vacuum tube - 1946-1957
- ✦ Transistor - 1958-1964
- ✦ Small scale integration - 1965 on
 - Up to 100 devices on a chip
- ✦ Medium scale integration - to 1971
 - 100-3,000 devices on a chip
- ✦ Large scale integration - 1971-1977
 - 3,000 - 100,000 devices on a chip
- ✦ Very large scale integration - 1978 to date
 - 100,000 - 100,000,000 devices on a chip
- ✦ Ultra large scale integration
 - Over 100,000,000 devices on a chip



Moore's Law

- ✦ Increased density of components on chip
- ✦ Gordon Moore - co-founder of Intel
- ✦ Number of transistors on a chip will double every year
- ✦ Since 1970's development has slowed a little
 - Number of transistors doubles every 18 months
- ✦ Cost of a chip has remained almost unchanged
- ✦ Higher packing density means shorter electrical paths, giving higher performance
- ✦ Smaller size gives increased flexibility
- ✦ Reduced power and cooling requirements
- ✦ Fewer interconnections increases reliability

Growth in CPU Transistor Count





Intel

✦ 1971 - 4004

- First microprocessor
- All CPU components on a single chip
- 4 bit

✦ Followed in 1972 by 8008

- 8 bit
- Both designed for specific applications

✦ 1974 - 8080

- Intel's first general purpose microprocessor



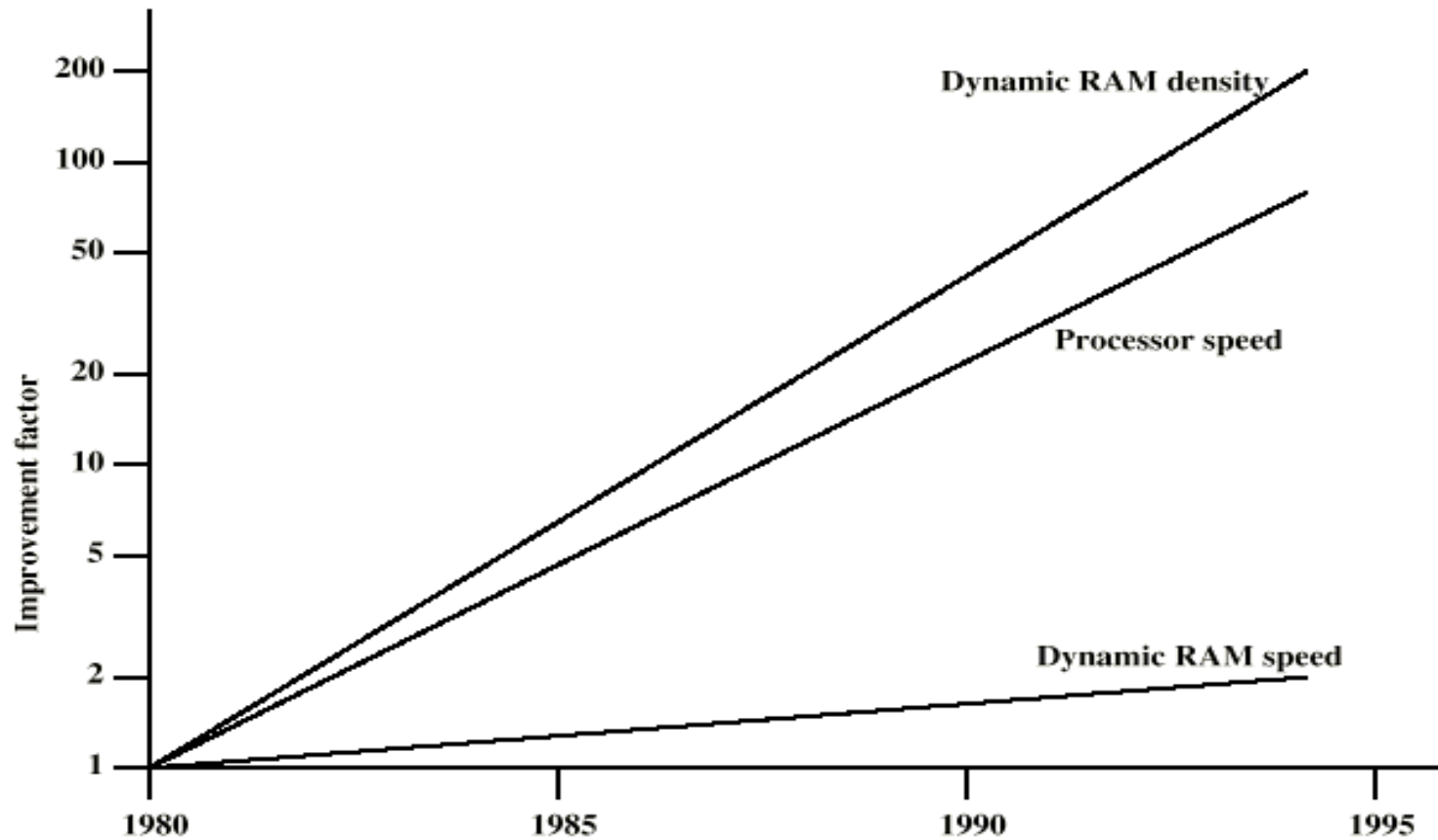
Speeding it up

- ✦ Pipelining
- ✦ On board L1 & L2 cache
- ✦ Branch prediction
- ✦ Speculative execution

Performance Mismatch

- ✦ Processor speed increased
- ✦ Memory capacity increased
- ✦ Memory speed lags behind processor speed

DRAM and Processor Characteristics





Solutions

- ✦ Increase number of bits retrieved at one time
 - Make DRAM “wider” rather than “deeper”
- ✦ Change DRAM interface
 - Cache
- ✦ Reduce frequency of memory access
 - More complex cache and cache on chip
- ✦ Increase interconnection bandwidth
 - High speed buses
 - Hierarchy of buses

Pentium Evolution (1)

✦ 8080

- first general purpose microprocessor
- 8 bit data path
- Used in first personal computer – Altair

✦ 8086

- much more powerful
- 16 bit
- instruction cache, prefetch few instructions
- 8088 (8 bit external bus) used in first IBM PC

✦ 80286

- 16 MByte memory addressable
- up from 1Mb

✦ 80386

- 32 bit



Pentium Evolution (2)

✦ 80486

- sophisticated powerful cache and instruction pipelining
- built in maths co-processor

✦ Pentium

- Superscalar
- Multiple instructions executed in parallel

✦ Pentium Pro

- Increased superscalar organization
- Aggressive register renaming
- branch prediction
- data flow analysis
- speculative execution



Pentium Evolution (3)

✦ Pentium II

- MMX technology
- graphics, video & audio processing

✦ Pentium III

- Additional floating point instructions for 3D graphics

✦ Pentium 4

- Note Arabic rather than Roman numerals
- Further floating point and multimedia enhancements

✦ Itanium

- 64 bit

✦ See Intel web pages for detailed information on processors



Internet Resources

- ✦ <http://www.intel.com/>
 - Search for the Intel Museum
- ✦ <http://www.ibm.com>
- ✦ <http://www.dec.com>
- ✦ Charles Babbage Institute
- ✦ PowerPC
- ✦ Intel Developer Home