



Computer Fundamentals

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Lecture 10



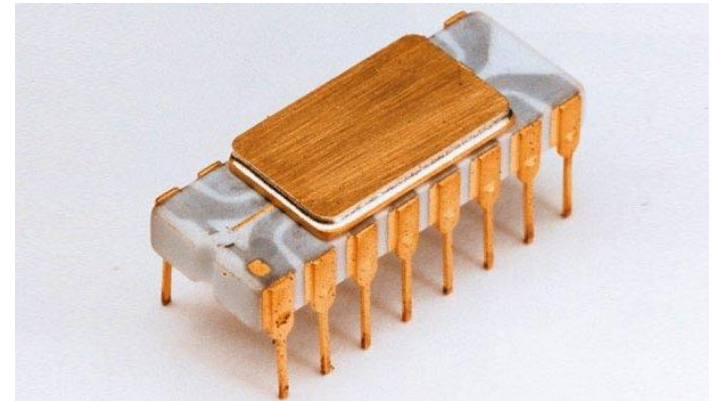
Outline

➤ Modern CPUs



Intel 4004

- The 1st commercially available microprocessor
- Introduced in 1971
- 4-bit CPU
- 2250 transistors
- 740 kHz max clock rate
- Packaged in 16-pin ceramic package
- As powerful as ENIAC
 - ❑ Which had 18000 vacuum tubes and occupied a large room
- Targeted use: Calculators
- Cost: less than \$100



Source: <https://www.linkedin.com/pulse/intel-4004-italian-job-edoardo-piccari>



Intel 4004 (cont.)

- Busicom, Japanese calculator manufacturer
 - ❑ Demanded from Intel to develop 16 separate IC's
 - ❑ For a line of new calculators
- Chief designers
 - ❑ Federico Faggin
 - ❑ Ted Hoff
 - ❑ Masatoshi Shima
- Intel known only as memory manufacturer at that time
 - ❑ Was quite small
 - ❑ Lacked resources to do all 16 chips
- Ted Hoff came up with the idea
 - ❑ Do all 16 on a single chip
- Later realized that 4004 could have other uses



Intel Pentium IV

- Introduced in December 2001
- Single core CPU
- 55 million transistors
- 32-bit processor
- 2 ALU's
- 3.8 GHz max clock rate
- For PC's and low-end workstations
- Introductory cost: around \$600



Source: <https://www.amazon.com/Intel-Pentium-2-6Ghz-SL6PP-Socket/dp/B004NKB7GE>

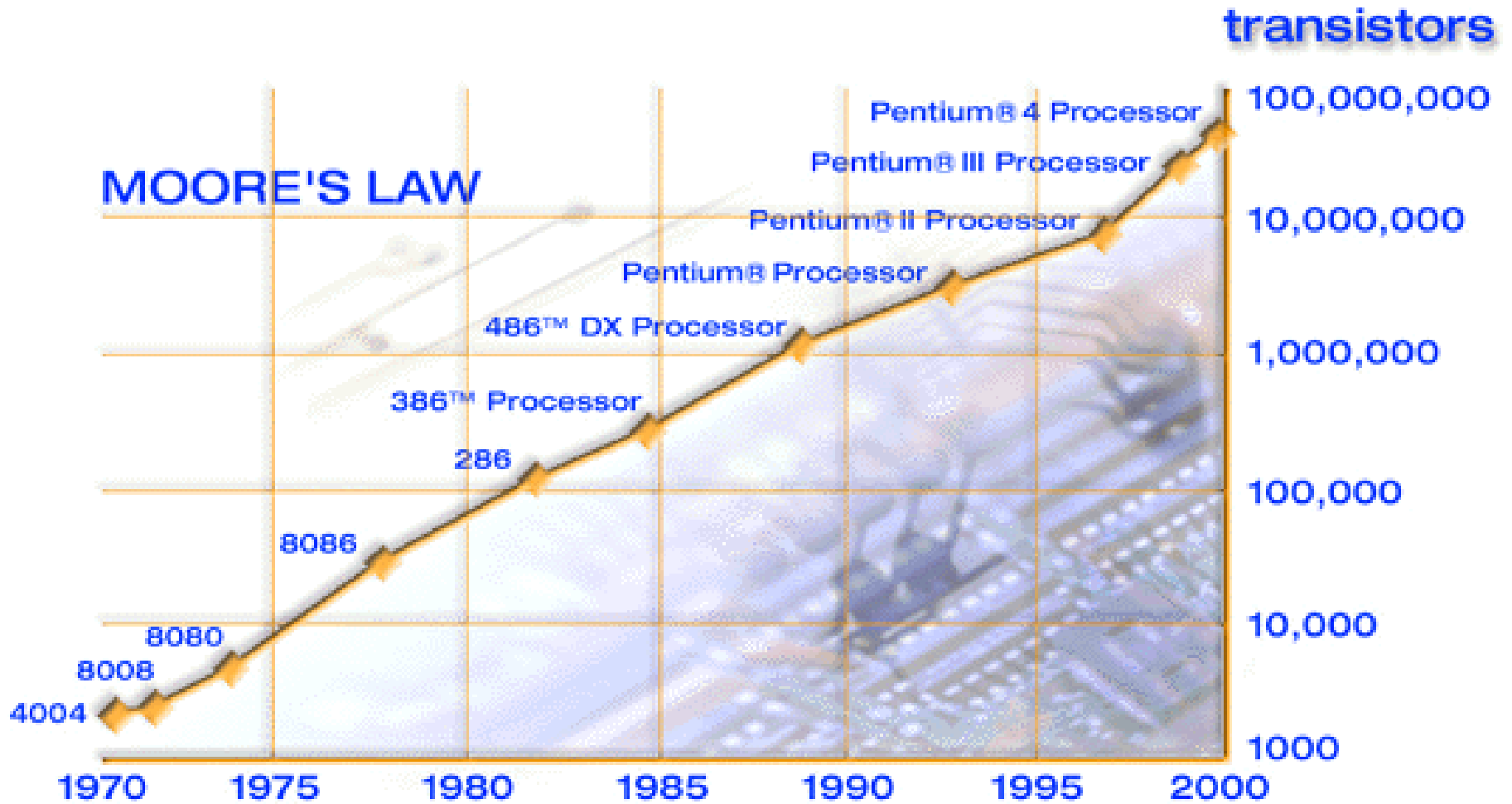


Moore's Law

- Gordon Moore, one of the founders of Intel
 - ❑ Predicted that
 - The number of transistors on an IC OR the capability of microprocessors
 - Will double every year
 - ❑ Later modified it to 18 months
- Still holds true
- In fact, time required for doubling is contracting
 - ❑ Closer to a year now



Moore's Law (cont.)





Word Length

- 4004 dealt with data in chunks (words) of 4-bits at a time
- Pentium IV deals with data in chunks of 32-bit length
- New processors deal with 64-bit chunks at a time



Clock Frequency

- 4004 worked at a clock frequency of 740 kHz
- Pentium IV worked at 3.8 GHz
- Latest processors have clock frequencies in GHz
- Higher clock frequency results in more power
 - ❑ If both processors have same design
 - ❑ Example: PowerPC & Pentium 4 microprocessors at same frequency
 - Former performs better due to superior design



Enhancing Performance

- Computing capability of microprocessor
- Can be enhanced in different ways
 - ❑ By increasing clock frequency
 - ❑ By having a more effective caching algorithm and the right cache size
 - ❑ By adding more functional units (e.g. ALU's, FPU's etc.)
 - ❑ Improving architecture (registers, bus etc.)



Looking Inside the Processor

➤ Architecture

❑ Determines

- Location of CPU parts
- Word size
- Number of registers
- Pipelines

❑ Main difference between CPUs



Microcomputer Processors

➤ Intel

- ❑ Leading manufacturer of processors
- ❑ Intel 4004 was worlds first commercial microprocessor
- ❑ IBM PC in 80s powered by Intel 8088
- ❑ Well known Intel processors
 - Centrino
 - Itanium
 - Pentium IV
 - Xeon
 - Core i7





Microcomputer Processors (cont.)

- Advanced Micro Devices (AMD)
 - ❑ Main competitor to Intel
 - ❑ Originally produced budget products
 - ❑ Current products outperform Intel
 - ❑ Designed processors
 - Sempron
 - Athlon FX 64
 - Athlon XP





Microcomputer Processors (cont.)

➤ Freescale

- ❑ A subsidiary of Motorola
 - Apple computers primarily have Freescale
- ❑ Currently focuses on Linux market

➤ IBM

- ❑ Historically manufactured mainframes
- ❑ Series of high performance microprocessor called POWER
 - Performance Optimization With Enhanced RISC (POWER)
 - Named as POWER1, POWER2, up to recent POWER9



Comparing Processors

- Frequency of processor
- Size of cache
- Word size
- Speed of system bus



Advanced Processor Topics

➤ RISC processors

- ❑ Reduced Instruction Set Computing
- ❑ Smaller instruction sets
 - May process data faster
 - Processor capable of executing those instructions using fewer cycles
- ❑ IBM Power, iPhone, iPad and several Android based-systems

➤ Parallel Processing

- ❑ Multiple processors in a system
 - Computational task is broken down in several subtasks
 - Processed independently
- ❑ Symmetric Multiple Processing (SMP)
 - Processors share common memory
 - Number of processors preferably a power of 2 (divide and crush)
- ❑ Massively Parallel Processing
 - Thousands of processors
 - Mainframes and super computers



Extending Processors Power

- Standard computer ports
 - ❑ Keyboard and mouse ports
 - ❑ USB ports
 - ❑ Parallel
 - ❑ Network
 - ❑ Modem
 - ❑ Audio
 - ❑ Serial
 - ❑ Video



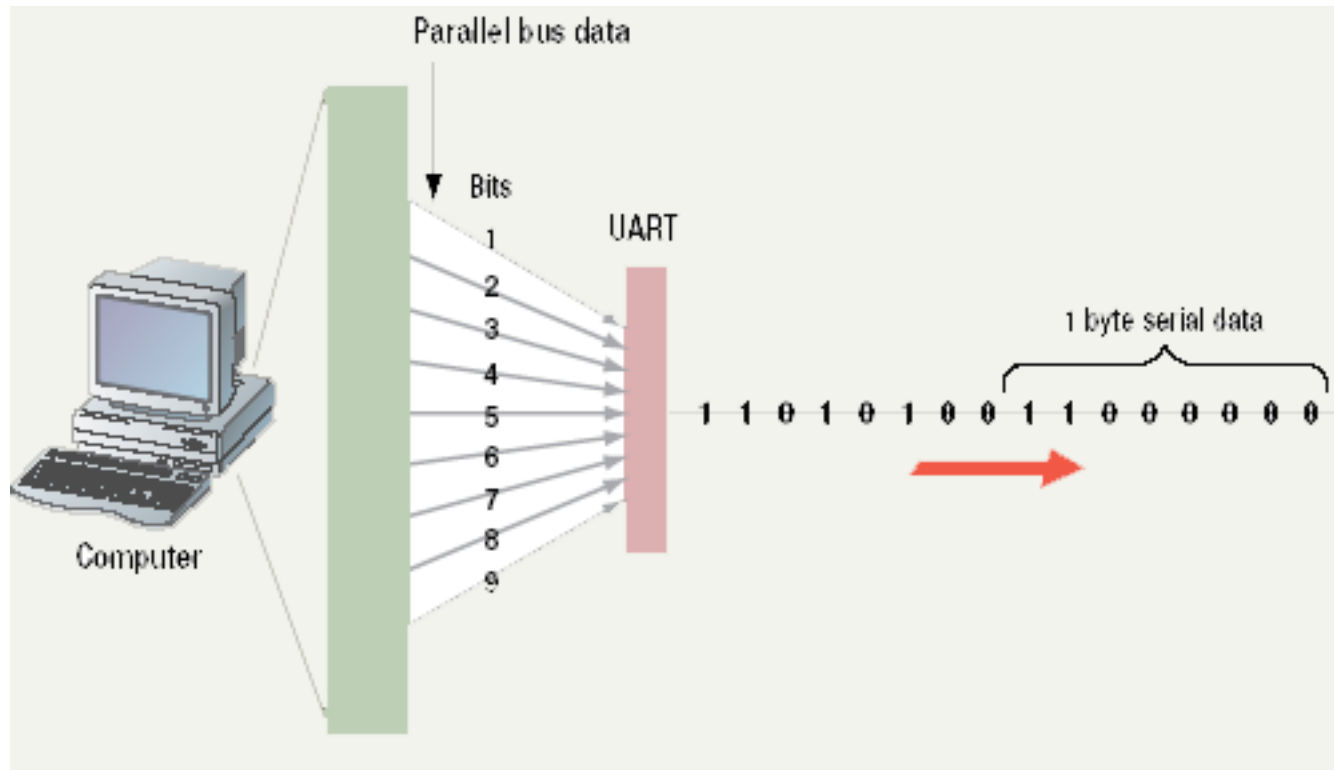


Extending Processors Power (cont.)

- Serial and parallel ports
 - ❑ Connect to printers or modems
 - ❑ Parallel ports move bits simultaneously
 - Made of 8 - 32 wires
 - Internal busses are parallel
 - ❑ Serial ports move one bit
 - Lower data flow than parallel
 - Requires wires for control and ground purposes
 - ❑ Universal Asynchronous Receiver/Transmitter (UART)
 - Converts from parallel to serial and vice versa
 - ❑ Why USB based on serial architecture?
 - Serial architecture provides higher clock rate than parallel
 - Parallel interface support low frequencies
 - Otherwise bits arrive with lag, causing errors

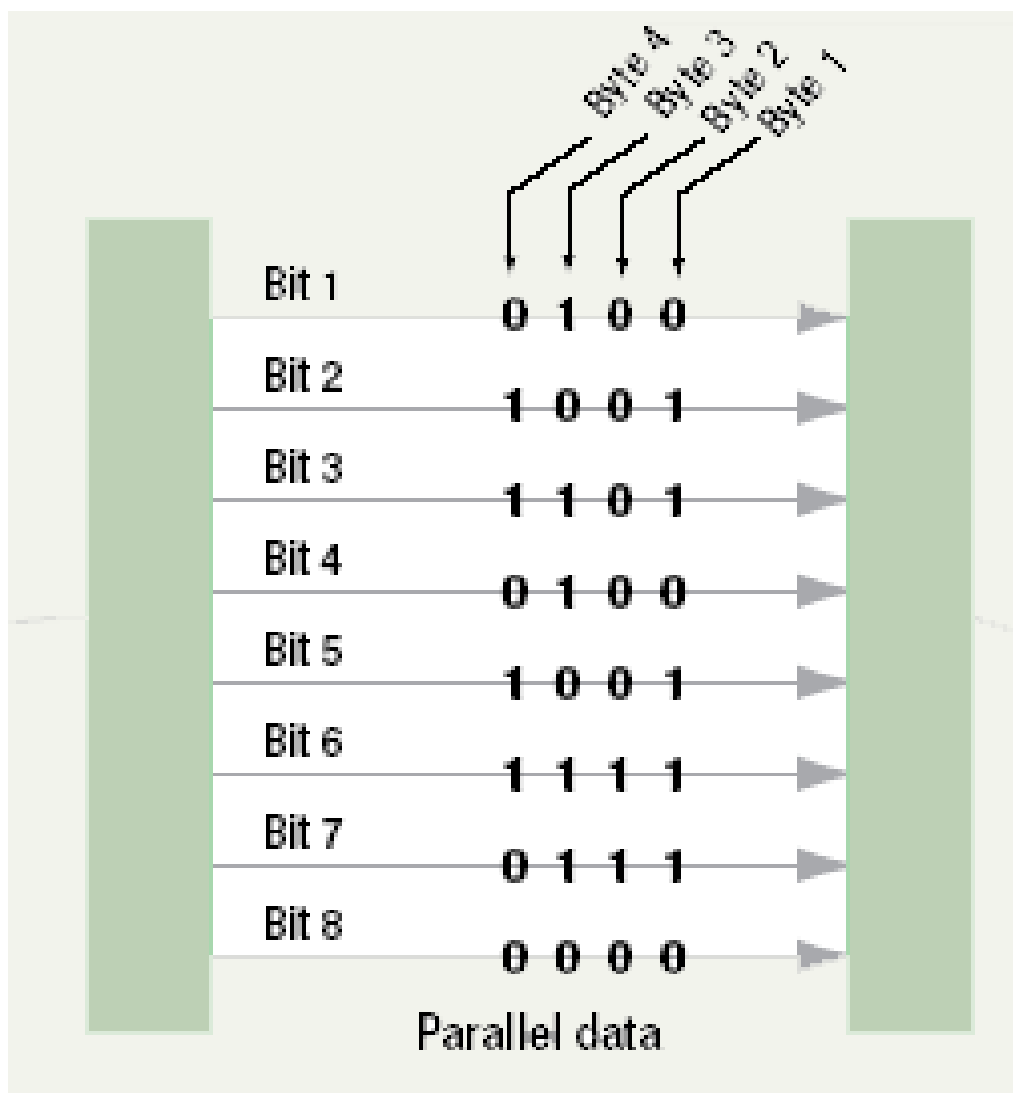


Serial Communications





Parallel Communications





Extending Processors Power (cont.)

➤ SCSI

- ☐ Small Computer System Interface
 - Set of standards
 - Physical connection between computers and peripheral devices
 - For transferring data
- ☐ Supports dozens of devices
- ☐ External devices daisy chain
- ☐ Fast hard drives and CD-ROMs

➤ USB

- ☐ Universal Serial Bus
- ☐ Most popular external bus
- ☐ Supports up to 127 devices
- ☐ Hot swappable

➤ FireWire

- ☐ IEEE 1394
- ☐ Cameras and video equipment
- ☐ Hot swappable
- ☐ Port is very expensive



Specialized Expansion Ports

- Expansion slots and boards
 - ❑ Allows users to configure machine
 - ❑ Slots allow addition of new devices
 - ❑ Devices are stored on cards
 - ❑ Computer must be off before inserting
- PC Cards
 - ❑ Expansion bus for laptops
 - ❑ Standardized by PCMCIA
 - Personal Computer Memory Card International Association
 - ❑ Hot swappable
 - ❑ Small card size
 - ❑ Three types
 - I for memory
 - II for network adapters
 - III for hard drives
- Plug and play
 - ❑ New hardware detected automatically
 - ❑ Prompts to install drivers
 - ❑ Non-technical users can install devices





Microcontrollers

- A type of microprocessor systems
- Not very powerful, not expensive
- Found embedded in
 - ☐ Video games
 - ☐ VCRs
 - ☐ Microwave ovens
 - ☐ Printers
 - ☐ Autos, etc.
- Complete CPU on a chip
- Direct input/output capability and memory
- Specialized application-specific components
- More than 90% of the microprocessors are microcontrollers
 - ☐ Manufactured for embedded computing applications
 - ☐ In 2000, 365 million microprocessors and 6.4 billion microcontrollers manufactured