CSN-101 (Introduction to Computer Science and Engineering)

Lecture 7: Evolution of Computer Hardware, Moore's Law, Operating Systems

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Piazza Class Room: https://piazza.com/iitr.ac.in/fall2019/csn101

[Access Code: csn101@2019]

Moodle Submission Site: https://moodle.iitr.ac.in/course/view.php?id=45

[Enrollment Key: csn101@2019]

Plan for Lecture Classes in CSN-101 (Autumn, 2019-2020)

Week	Lecture 1 (Monday 4-5 PM)	Lecture 2 (Friday 5-6 PM)
1	Evolution of Computer Hardware and Moore's Law, Software and Hardware in a Computer	Computer Structure and Components, Operating Systems
2	Computer Hardware: Block Diagrams, List of Components	Computer Hardware: List of Components, Working Principles in Brief, Organization of a Computer System
3	Linux OS	Linux OS
4	Writing Pseudo-codes for Algorithms to Solve Computational Problems	Writing Pseudo-codes for Algorithms to Solve Computational Problems
5	Sorting Algorithms – Bubble sort, selection sort, and Search Algorithms	Sorting Algorithms – Bubble sort, selection sort, and Search Algorithms
6	C Programming	C Programming
7	Number Systems: Binary, Octal, Hexadecimal, Conversions among them	Number Systems: Binary, Octal, Hexadecimal, Conversions among them
8	Number Systems: Negative number representation, Fractional (Real) number representation	Boolean Logic: Boolean Logic Basics, De Morgan's Theorem, Logic Gates: AND, OR, NOT, NOR, NAND, XOR, XNOR, Truth-tables
9	Computer Networking and Web Technologies: Basic concepts of networking, bandwidth, throughput	Computer Networking and Web Technologies: Basic concepts of networking, bandwidth, throughput
10	Different layers of networking, Network components, Type of networks	Network topologies, MAC, IP Addresses, DNS, URL
11	Different fields of CSE: Computer Architecture and Chip Design	Different fields of CSE: Data Structures, Algorithms and Programming Languages
12	Different fields of CSE: Database management	Different fields of CSE: Operating systems and System softwares
13	Different fields of CSE: Computer Networking, HPCs, Web technologies	Different Applications of CSE: Image Processing, CV, ML, DL
14	Different Applications of CSE: Data mining, Computaional Geometry, Cryptography, Information Security	Different Applications of CSE: Cyber-physical systems and IoTs

Forth Generation – 1971 - 1980

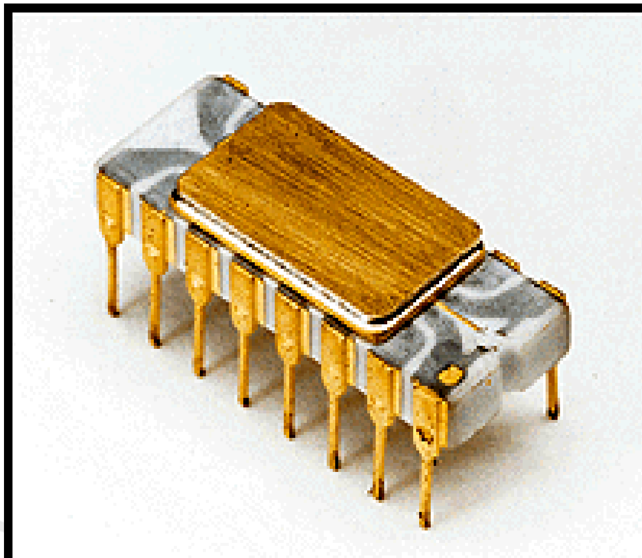
- Very Large Scale Integrated (VLSI) technology based
- MICROCHIPS!
- Getting smaller and smaller, but we are still using microchip technology
- Very cheap
- Portable and reliable
- Use of PCs
- Pipeline processing
- No AC required
- Concept of internet was introduced

Microchip

- Very Large Scale Integrated Circuit (VLSIC)
  - Transistors, resistors, and capacitors
- 4004 had 2,250 transistors
- Pentium IV has 42 MILLION transistors
  - Each transistor 0.13 microns (10^{-6} meters)

The First Microprocessor – 1971

- Intel 4004 Microprocessor
  - The 4004 had 2,250 transistors
  - four-bit chunks (four 1's or 0's)
  - 108Khz
  - Called "Microchip"



The Intel 4004, it was supposed to be the brains of a calculator. Instead, it turned into a general-purpose micro-processor as powerful as ENIAC.

Birth of Personal Computers - 1975

- Altair by Micro Instrumentation and Telemetry Systems (MITS)
  - 256 byte memory
  - 2 MHz Intel 8080 chips
  - Just a box with flashing lights
  - cost $395 kit, $495 assembled

Generations of Electronic Computers

- Evolution of Electronics
  - Vacuum Tube → Transistor → Integrated Circuit → Microchip

	First Generation	**Second Gen.**	**Third Gen.**	**Fourth Gen.**
Technology	Vacuum Tubes	Transistors	Integrated Circuits (multiple transistors)	Microchips (millions of transistors)
Size	Filled Whole Buildings	Filled half a room	Smaller	Tiny - Palm Pilot is as powerful as old building sized computer

Fifth Generation – 1980 - onwards

- Ultra Large Scale Integration (ULSI) microprocessor based
- Microprocessor chips having ten million electronic components
- Development of true artificial intelligence
- Development of Natural language processing
- Advancement in Parallel Processing
- Advancement in Superconductor technology
- More user-friendly interfaces with multimedia features
- Availability of very powerful and compact computers at cheaper rates

Moore’s Law

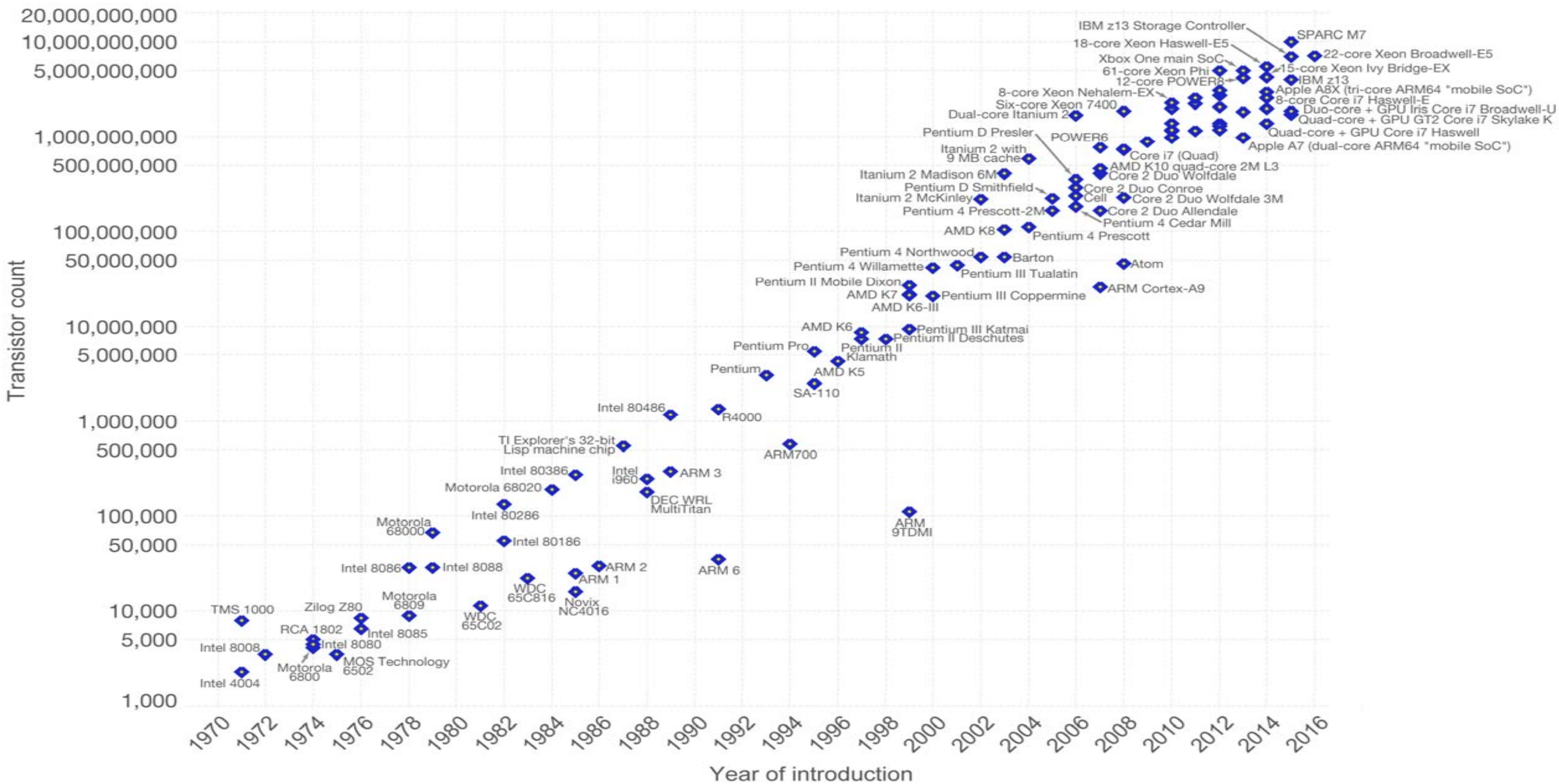
- At the 1975 IEEE International Electron Devices Meeting, Gordon E. Moore, co-founder of Intel, proposed that :
  - Number of transistors on an IC doubles every year.
  - 10 years later, he revised it:
    doubles every 18 months

Technology Growth Graph

Moore's Law – The number of transistors on integrated circuit chips (1971-2016)

Our World in Data

Moore's law describes the empirical regularity that the number of transistors on integrated circuits doubles approximately every two years. This advancement is important as other aspects of technological progress – such as processing speed or the price of electronic products – are strongly linked to Moore's law.

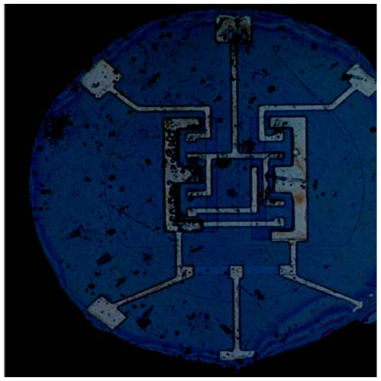


Data source: Wikipedia (https://en.wikipedia.org/wiki/Transistor_count)
The data visualization is available at OurWorldinData.org. There you find more visualizations and research on this topic.

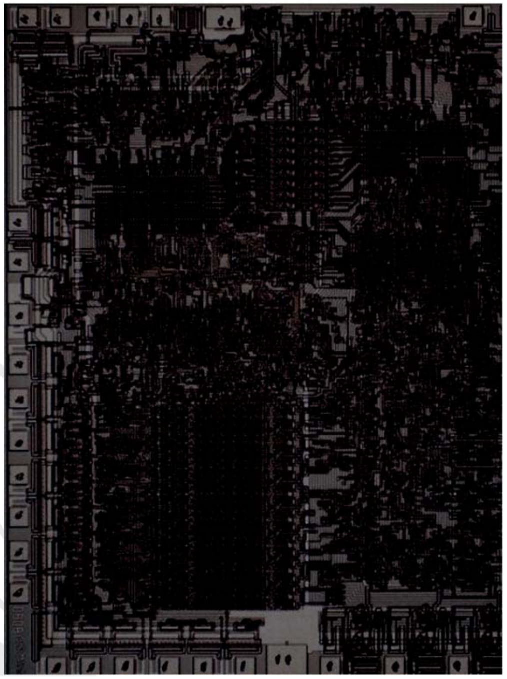
The Road of Chips along Moore's Law

First IC-Jack Kilby,1958

First planar transistor-Jean Hoerni,1959



First IC with multiple Transistors - Robert Noyce, 1961



First IC,
1 transistor,
1958

Intel's 8080
5000 transistor, 1974

The number of transistor increasing between years 1958 - 1974

Main supporting reasons of Moore's Law

- **Heat Dissipation**: Direct access to heat generating sources
- **High device yield**: No fundamental obstacle for achieving device yield of 100%
- Manufacturers wishing to keep up with the law and the competition among them
- Customer Demand for better products
- Successive technologies provide better design tools

Useful Facts

- It is an **observation or conjecture not** physical or natural law
- The circuit density or capacity of semiconductors doubles every **eighteen months**
- Circuits per chip = $\mathbf{2^{(year-1975)/1.5}}$

The Current Limitations

- Circuits can not be reduced beyond atomic size
- In April 2005, Gordon Moore stated in an interview that the projection cannot be sustained indefinitely:

  "It can't continue forever. The nature of exponentials is that you push them out and eventually disaster happens"

End of Moore's Law..

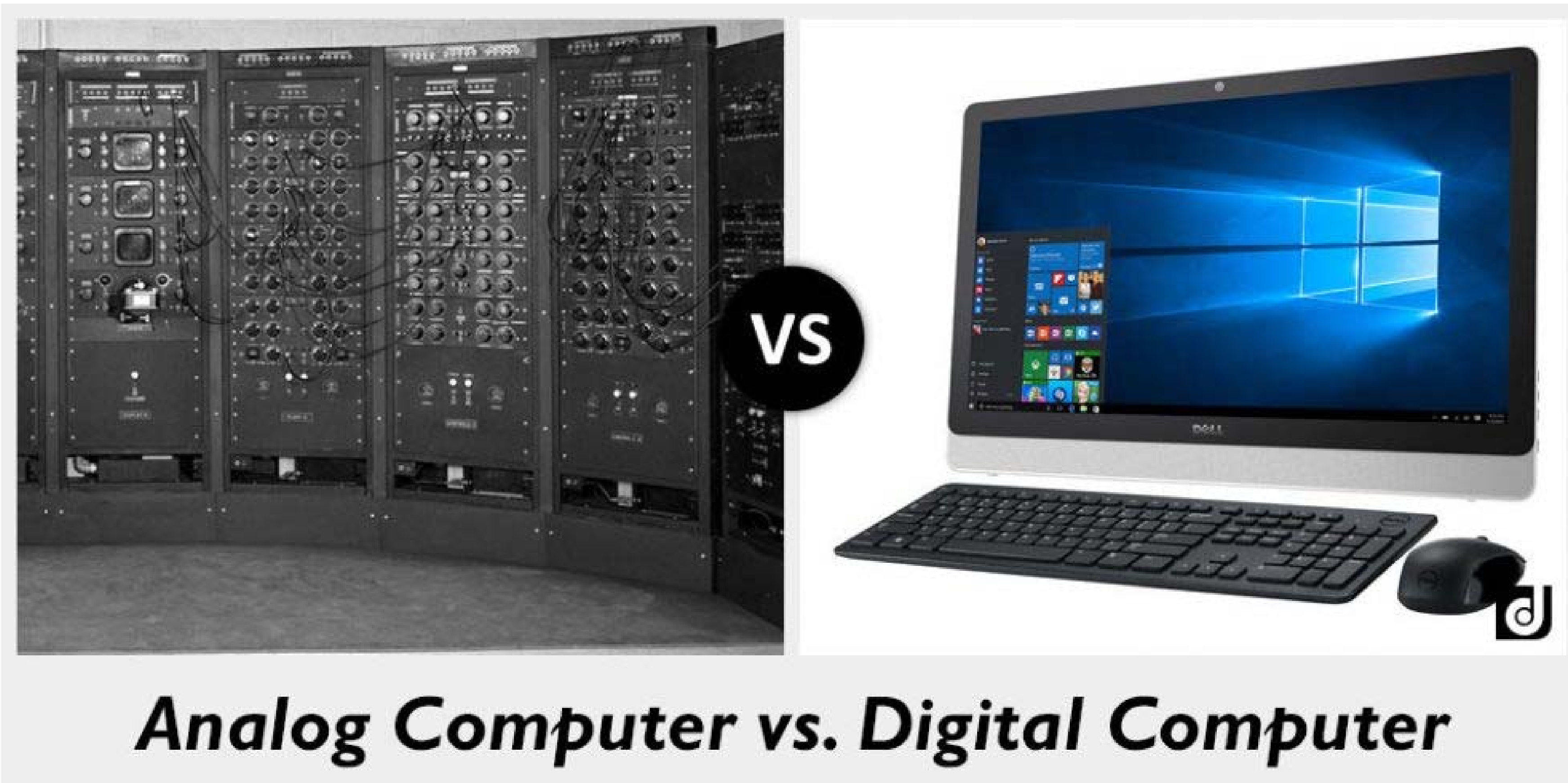
- MIT Technological Review published article confirming death of Moore's Law
- After more than 50 years of miniaturization, the transistor could stop shrinking in just five years. That is the prediction of the 2015 International Technology Roadmap for Semiconductors (ITRS)
- Mooreslaw.org says the following:

"**The limitation which exists is that once transistors can be created as small as atomic particles, then there will be no more room for growth in the CPU market where speeds are concerned**"

Moore’s Law

- Moore’s Law is slowing down, some believe it will end by 2030s
- Economic indicator for the semiconductor fabs for half a century
- Some believe the end of Moore’s Law would led to new innovations in IC manufacturing

Analog Computer vs Digital Computer:



Analog Computer vs Digital Computer:

- Analog systems were once favored by engineers who lacked modern digital technology to run calculations on
- With progress in digital technology, analog computing died out in the late 20th century, though many of its ideas carry on in music synthesizer designs
- Modern electronic computers are virtually all digital and express their models in terms of 1s and 0s
- Analog computers haven't died out, however. Oscilloscopes, of the kind used by electrical and sound engineers, are examples of analog computer technology

Analog Computer vs Digital Computer:

- Perhaps the most ubiquitous example of an analog computer in the world is the brain itself. Brains are actually a combination of digital and analog systems. While the firing of a single neuron can be regarded as a simple on/off function, the communication between neurons is accomplished chemically by means of neurotransmitters that vary in concentration and intensity
- The basic difference between analog and digital computers lies in the different approaches they take to handling data. Analog computers are able to deal with continuously varying inputs for complex phenomena such as voltage changes and temperature fluctuations. Digital computers must have their inputs reduced to a simple binary language in order to accurately model the world.

Operating Systems

Types of OS:

Operating System can also be classified as

- Single User Systems
- Multi User Systems

Single User Systems:

- Provides a platform for only one user at a time.
- They are popularly associated with Desk Top operating system which run on standalone systems where no user accounts are required.
- Example: DOS

Multi-User Systems:

- Provides regulated access for a number of users by maintaining a database of known users.
- Refers to computer systems that support two or more simultaneous users.
- Another term for *multi-user* is *time sharing*.
- Ex: All mainframes and are multi-user systems.
- Example: Unix

Topic to be covered in Linux OS:

- Linux Operating System Concepts
- Basic Commands: General Purpose Utilities
- System Administration Commands
- Manual and Online help for commands
- Linux Directories
- File Permission / Access Modes
- Grep Command
- Vi Editor
- Sed and Awk Commands
- Shell Scripting / Programming

Continued to Next Class…