Computer Science Principles

Unit 4: Computer Systems and Networking

LECTURE 9: COMPUTER SYSTEMS

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Objectives

- This Big Idea focuses on computer systems and networks: what they are, how they work, and how they can be used to help you speed up your programs. One of the biggest connectors of computer systems is the Internet, and a great deal of this guide also covers how the internet works.

Unit Overview

Exam Weighing:

- 11-15% of the AP Exam
- Practically, this translates to about 10 questions on the test.

Overview

LECTURE 1

Topics

Introduction

- What is a computer?
- Modern Computer Thinking
- History of computers
- Computer types
- Computer System
- Hardware and Peripherals
- Software

Topics

Computer System (Hardware)

- Motherboard
- Processor
- Memory
- Disks

Peripherals

- Input Devices
- Output Devices
- Future Peripherals

Software

- System software
- Application software

What is a Computer?

LECTURE 2

What Is A Computer?

- A computer is an electronic device, operating under the control of instructions (software) stored in its own memory unit, that can accept data (input), manipulate data (process), and produce information (output) from the processing.
- Generally, the term is used to describe a collection of devices that function together as a **system**.

Devices that Comprise a Computer System

What Does A Computer Do?

Computers can perform four general operations, which comprise the information processing cycle.

- Input
- Process
- Output
- Storage

Information Processing Theory - Computer Analogy

Modern Computer Thinking

LECTURE 3

Why Is A Computer So Powerful?

- The ability to perform the information processing cycle with amazing speed.
- Reliability (low failure rate).
- Accuracy.
- Ability to store huge amounts of data and information.
- Ability to communicate with other computers.

Cognition
Visualization
Data fusion
Perception
Preprocessing
Decision
Interaction
Integration
CONCEPTS
THEORIES
PARADIGMS
MODELS
METHODS
TOOLS
Dimensionality
Complexity
Unsupervised
Gaussian P.
Regularization
Python
Reinforcement
Bayesian p(x)
Supervised
Graphical M.
Scaling
Church
Representation
Entropy/KL
Semi-Superv.
Neural Nets
Aggregation
Anglican
No-free-lunch
Vapnik-Chernov.
iML
Kernel/SVM
Evolution
Julia
Multi-Task Learning
Transfer Learning
Multi-Agent-Hybrid-Systems
Data Protection, Safety and Security and Privacy Aware Machine Learning (PAML)
Application, Validation, Evaluation, Impact – Social, Economic, Acceptance, Trust

Networking

Computer Networking
REMOTE COMPUTING
TELECOMMUTERS
Mobile Professionals
Dial Up
ISDN
Branch Office
WAN
Portable Window Tablets
Network
Cross Platform Desktop
LAN
WIRELESS TERMINALS AND INFORMATION APPLIANCES
Wireless LAN Based Desktop PCs
SERVERS
Microsoft Window Or Unix
UNIX X-TERMINALS
OS\2 PCs
INTERNET
Web Computing
UNIX WORKSTATIONS

Internet

Mobile
Storage
Applications
CLOUD COMPUTING
Server
Database
Private cloud
Public cloud
Hybrid cloud

Intelligence

Multimedia

Settings
Messages
Camera
Music
Organizer
Internet
Search
Business
Calendar

History of Computers

LECTURE 4

Computing Tools

SECTION 4-1

1 2 3 4 5 6 7 8 9

LL0
LL1
DF
CF
CIF
Ln
L
CI
C
D
LL2
LL3

0cm 1 2 3 4 5 6 7 8 9 10
0cm 1 2 3 4 5 6 7
90

Computing Machine

SECTION 4-2

Mechanical Calculator

Difference Engine

Charles Babbage
Analytical Engine

Electronic Computers

SECTION 4-3

1st Generation: Vacuum Tube

- Vacuum tube computers, now termed first generation computers, are programmable digital computers using vacuum tube logic circuitry.
- They were preceded by systems using electromechanical relays and followed by systems built from discrete transistors.
- Later entries in this list may have been built using transistors in addition to vacuum tubes.

The Vacuum Tube Supercomputer Centre

Access from freeway

Private rail yard

CPU cooling towers

Bios Building

Central Processing Unit

Control Building

Bus Building

I/O Building #1

512 GB System RAM

Power supply - 6 steam turbines @ 1.8 GVA each

Cooling pond/ coal delivery

Oil storage farm

Network Interface Building

I/O Building #2

Clock/ Control Buildings

VTSC

The ENIAC computer, University of Pennsylvania, 1945

Penn

ENIAC

Cost: about $486,000

Size: over 100 feet long, filling a 30 ft. x 50 ft. room.
Height: 10 feet. Depth: about 3 feet. Weight: about 30 tons.

Penn

2nd Generation: Transistor Computer

- A transistor computer, now often called a second-generation computer, is a computer which uses discrete transistors instead of vacuum tubes.
- The first generation of electronic computers used vacuum tubes, which generated large amounts of heat, were bulky and unreliable.

3rd Generation: Integrated Circuits

- In 1961, the development of the integrated circuit by Robert Noyce of Fairchild Semiconductor, was the hallmark of the **third** generation of computers.
- Transistors were miniaturized and placed on silicon chips, called semiconductors, which drastically increased the speed and efficiency of computers. Instead of punched cards and printouts, users interacted with third generation computers through keyboards, and monitors and interfaced with an operation system, which allowed the device to run many different applications at one time.
- Computers for the first time became accessible to a mass audience because they were smaller and cheaper than their predecessors.

4th Generation: Processor-based Computers

- The period of fourth generation was from 1971-1980. Computers of fourth generation used Very Large Scale Integrated (VLSI) circuits.
- VLSI circuits having about 5000 transistors and other circuit elements with their associated circuits on a single chip made it possible to have microcomputers of fourth generation.

Version 3 Unix

- 1969: Version 1 ran PDP-7
- 1971: Version 3 Ran on PDP-11's
  - Costing as little as $40k!
- < 50 KB
- 2 man-years to write
- Written in C

PDP-7

PDP-11

Subject	1st generation	2nd generation	3rd generation	4th generation	5th generation
Period	1940-1956	1956-1963	1964-1971	1971-present	present & beyond
Circuitry	Vacuum tube	Transistor	Integrated chips (IC)	Microprocessor (VLSI)	ULSI (Ultra Large Scale Integration) technology
Memory Capacity	20 KB	128KB	1MB	Magnetic core memory, LSI and VLSI. High Capacity	ULSI
Processing Speed	300 IPS instructions Per sec.	300 IPS	1MIPS (1 million inst. Per sec.)	Faster than 3rd generation	Very fast
Programming Language	Machine, Language	Assembly language & early high-level languages(FORTRAN, COBOL, ALGOL)	C,C++	Higher level languages,C,C++,Java	All the Higher level languages,,Neural networks,
Example of computers	UNIVAC, EDVAC	IBM 1401, IBM 7094, CDC 3600,D UNIVAC 1108	IBM 360 series, 1900 series	Pentium series,Multimedia,	Artificial Intelligence, Robotics

Quantum Computers

SECTION 4-4

Quantum Computer

What is quantum computing?

- Quantum computers could spur the development of new breakthroughs in science, medications to save lives, machine learning methods to diagnose illnesses sooner, materials to make more efficient devices and structures, financial strategies to live well in retirement, and algorithms to quickly direct resources such as ambulances.
- But what exactly is quantum computing, and what does it take to achieve these quantum breakthroughs? Here's what you need to know.

A new kind of computing

- We experience the benefits of classical computing every day. However, there are challenges that today's systems will never be able to solve. For problems above a certain size and complexity, we don't have enough computational power on Earth to tackle them.
- To stand a chance at solving some of these problems, we need a new kind of computing. Universal quantum computers leverage the quantum mechanical phenomena of **superposition** and **entanglement** to create states that scale exponentially with number of **qubits**, or **quantum bits**.

Even for simple molecules like caffeine, the number of quantum states in the system can be enormous

Quantum Computer

Quantum computing fundamentals

- All computing systems rely on a fundamental ability to store and manipulate information. Current computers manipulate individual **bits**, which store information as binary 0 and 1 states. Quantum computers leverage quantum mechanical phenomena to manipulate information. To do this, they rely on quantum bits, or **qubits**.
- Here, learn about the quantum properties leveraged by qubits, how they're used to compute, and how quantum systems scale.

Quantum Properties

Three quantum mechanical properties — superposition, entanglement, and interference — are used in quantum computing to manipulate the state of a qubit.

Superposition

- Superposition refers to a combination of states we would ordinarily describe independently.
- To make a classical analogy, if you play two musical notes at once, what you will hear is a superposition of the two notes.

Quantum Properties

Three quantum mechanical properties — superposition, entanglement, and interference — are used in quantum computing to manipulate the state of a qubit.

Entanglement

- Entanglement is a famously counter-intuitive quantum phenomenon describing behavior we never see in the classical world.
- Entangled particles behave together as a system in ways that cannot be explained using classical logic.

QUANTUM ENTANGLEMENT

An entangled pair of electrons

The entangled electrons are separated.

An observer sees electron A as “spin up”. Electron B must now be “spin down”. The change in electron B occurs instantaneously.

Quantum Properties

Three quantum mechanical properties — superposition, entanglement, and interference — are used in quantum computing to manipulate the state of a qubit.

Interference

- Finally, quantum states can undergo interference due to a phenomenon known as phase.
- Quantum interference can be understood similarly to wave interference; when two waves are in phase, their amplitudes add, and when they are out of phase, their amplitudes cancel.

Quantum complexity theory
Quantum algorithms
Quantum computing theory
QEC theory
Architecture-aware algorithm implementation
Programming languages
Quantum programming
System Organization
Quantum computer architecture
QEC and FT implementation
Classical control
Interconnection topologies and floor planning
Quantum computer microarchitecture
Qubit interconnect technologies
Qubit storage and gate technologies
Technology building blocks

Other Paradigms

SECTION 4-5

Neural Tensor Layer

$$U^T f\left(e_1^T W^{[1:2]} e_2 + V \begin{bmatrix} e_1 \\ e_2 \end{bmatrix} + b \right)$$

DDR3 DRAM Chips
30 GiB/s
14 GiB/s
DDR3 Interfaces
30 GiB/s
Weight FIFO (Weight Fetcher)
30 GiB/s
Control
Control
14 GiB/s
PCIe Gen3 x16 Interface
14 GiB/s
Host Interface
10 GiB/s
Unified Buffer (Local Activation Storage)
Systolic Data Setup
167 GiB/s
Matrix Multiply Unit (64K per cycle)
Control
Accumulators
Activation
Instr
167 GiB/s
Normalize / Pool
Off-Chip I/O
Data Buffer
Computation
Control
Control
Control
Not to Scale

Snapdragon
X20 LTE modem
Wi-Fi
Hexagon 685 DSP
Qualcomm
Aqstic Audio
System Memory
Adreno 630
Visual Processing
Subsystem
Qualcomm
Spectra 280 ISP
Kryo 385 CPU
Qualcomm
Secure Processing Unit

GPU Core0
GPU Core1
GPU Core2
GPU Core3
Tempest CPU
Tempest CPU
Tempest CPU
Tempest CPU
L2
Vortex CPU
Vortex CPU
CC Fabric
ISP
NPU
Video Processor
Depth Engine
HEVC En/Decoder
Control MCU
Secure Enclave (SEP)
Sys Cache
Always-on MCU
Storage Controller
Audio Subsys
IMC
Display Engine

Classification of Computers

LECTURE 5

Classification of Computers
By Type
By Size
By Purpose
Analog
Digital
Hybrid
Micro
Mini
Mainframe
Super
General Purpose
Special Purpose

Personal Computers

SECTION 5-1

Type of Computer	Description	Advantages	Disadvantages
Mainframe computer	Mainframe computer is an extremely large. It is use in banks or government department. These computer store large amount of data.	It is capable of making big job which make use of there fast processing speed. Good at solving difficult problem solving and would take ages for the small computer to do.	Mainframe are so large that they could take the whole room. It's very difficult to set up. Expensive to operate and maintain and require professional staff to look after them .
Personal Computer(PC)	This is a general-purpose computer made up of different part or component. •Monitor •Keyboard •Mouse •Processor and storage	Most of the spare part are often cheap because they are very standardised. They often have much faster processor than laptops with the same price. They have fewer problem with overheating than a normal laptop because there size are bigger.	It has many wire hanging around and it difficult to be with separate components. File have to be copied and stored on portable disk especially if you went to a cafe you will need for your laptop.

Type of Computer	Description	Advantages	Disadvantages
Laptop or notebook	This is a computer where everything or component are in one unit. This meant that we can travel anywhere with this device.	It’s portable. You can work anywhere especially if they can connect to Wi-Fi.	They can be lost and stolen easily. Battery power is limited. Laptop can be more compact so they can overheat easily.
Tablets	It kind of like a laptop but smaller and again portable. The biggest difference is that it s user interface is all through touch.	It is very portable and also easy to use. Quick to switch on. There are thousand of downloadable apps.	Not all have 3G or 4G. Can’t make phone calls. Touch screen can be difficult to type.

Type of Computer	Description	Advantages	Disadvantages
Personal Digital Assistance (PDA)	This is a small handheld device or computer with a touch screen popular in the 1998-2004. Some of the PDA have keyboard behind or underneath the screen. These machine have develop very fast. This is use for writing email, notes , GPS and other functions.	Extremely portable it can fit in your pocket and bags. Web and Email connectivity. They often have Qwerty keyboard which is easy to use	The keyboard are very small so people who with big thumb would find it very difficult to type. Screen are to small and difficult to read long documents.
Smartphones	This is an advance mobile, it run on solid stade drive which cannot be stored in the laptop or pc. This has lots of feathers such as Web browser, high resolution touch screens, GPS, Camera and media players.	Online access to data. Better web browser than a simple mo line phone. Just one device can finish task at home or work.	Similar to PDAs due to their size. The cost of these smart phone are similar to laptop.

Network Computers

SECTION 5-2

Internet Age

- An umbrella term for the 21st century, in which information travels around the world in seconds and is made available to people in more countries than ever before.
- It is also a moniker for high-speed communications, the convergence of computers and consumer electronics (CE) and wireless devices. See Web 2.0 and digital convergence.

20 35

Internal Cluster
Multi-cloud Without Changes
Google Cloud Platform
User
CMD Line
Web UI API
Job & Data Workflow
Automated Job Placement, Cost optimization
amazon web services
Auto-scaling, Benchmarking, Compliance, Reporting tools
Windows Azure

Mobile Computing

SECTION 5-3

Mobile Computing

- Mobile computing is **human–computer** interaction in which a computer is expected to be transported during normal usage, which allows for transmission of data, voice and video. **Mobile computing involves mobile communication, mobile hardware, and mobile software.**
- Communication issues include ad hoc networks and infrastructure networks as well as communication properties, protocols, data formats and concrete technologies. Hardware includes mobile devices or device components. Mobile software deals with the characteristics and requirements of mobile applications.

15:55
5321
steps
120
118
33%
7%
10%
25%
122
70
01▾66
5.2
11:35
00:24:55
John
11:42
GROWTH DYNAMICS
2010
2011
2012
2013
2014
2015
2016
2017
Wearable Technology
Is The New Businesses

Bots Responsive Computing

SECTION 5-4

AI and Bots

- Earlier this month the Voxpro team spent a very productive week in New Orleans at Collision. It was a fantastic opportunity to interact with some of the fastest growing startups in the world, as well as some of the most established yet disruptive global tech companies. The week also was really eye opening in terms of learning about key emerging trends affecting the global tech community. Some of the most talked about topics were AI and Machine learning, so we'd like to share some of the takeaway points we learned from the event in an effort to decode the technology.
- There is a lot of talk about **AI (Artificial Intelligence), Machine Learning and Bots**, and what effect they could have on companies. Let's take a crash course on these important topics, and separate the hype from fact.

AI and Bots

- **AI is an Artificial Intelligence (AI)** and is usually defined as the science of making computers do things that require intelligence when done by humans. AI has had some success in limited or simplified, domains.
- **Machine learning is a type of Artificial Intelligence (AI) that provides computers with the ability to learn without being explicitly programmed.** Machine learning focuses on the development of computer programs that can change when exposed to new data.
- A bot or “chatbot”, short for chat robot, is **a computer program that simulates human conversation, or chat, through artificial intelligence**.
- Why are these important for businesses to sit up and take notice? Because bots and machines are getting smarter and smarter every day, and can automate fairly boring and repetitive tasks. As bots get smarter, the tasks can become increasingly more difficult and the bots will ‘learn’ to do harder and more complex work.

AI and Bots

- A good example of this is letter sorting in the post office. For many years, letters were sorted by hand, but computers developed and were used to ‘read’ the writing on letters, making it thousands of times faster to process mail. There are many similar innovations that we take for granted today.
- If you’ve ever used Siri or Google Voice on your phone, then that is the result of millions of hours of programming allowing a computer to understand human speech and giving you back a smart answer (most of the time).
- Have you ever wondered how Amazon can ‘predict’ what you want to buy when you go shopping online? They are using a complicated AI recommendation engine.
- Have you had your card blocked when you go aboard? Visa and MasterCard use AI to recognize patterns out of the ordinary, and try to detect when there is a break in the normal pattern.

General AI agents with platforms
Developer access available now or announced
Siri
Apple
Now
Google
Alexa/Echo
Amazon
Cortana
Microsoft
Viv
Viv Labs
Messaging platforms
iMessage
Apple
Messenger
Facebook
WhatsApp
Facebook
Slack
WeChat
Tencent
Kik
Allo
Google
Telegram
Twilio
Line
Naver
Skype
Microsoft

Amazon Alexa

http://alexa.amazon.com

- **Amazon** was in force in Collision, integrating into many apps and platforms. One of the more interesting ones was their integration with Ecobee, a smart home thermostat.
- No need to press any buttons, just ask “Alexa, turn the heat on”.

Amazon Alexa

http://alexa.amazon.com

- Whether we like it or not, bots and AI are here to stay. Every company, including **Voxpro** should be looking at how they can integrate this new technology into their company because there is so much to be gained from utilising this technology- not least the fact it enables your people to engage with work that is more engaging and higher up the value chain.
- As the technology progresses, it will become more and more normal that we'll interact with a machine to help us perform our daily tasks. We already do it every day with our phones, so why not embrace it in other areas of our life with an intelligent assistant that can take away needless tasks from our lives and makes us more productive!

www.X.ai

- Meet Amy, your digital assistant. Amy works in the background of your email, helping you to schedule calendar meetings, without the back and forth that usually happens.
- How Amy works is that you CC Amy (amy@x.ai) on your emails and she will work with whoever you are trying to set up a meeting with to find the right time for both attendees. Great service and it’s free! www.X.ai

Blippar

- Blippar is an app that allows the phone to ‘see’ the world around it and tag it. Used primarily by automotive brands, it is used by consumers to look at a picture of a car, and then the system recognizes the car, and gives the viewers a ‘look inside’ that particular brand.
- Blippar uses AI to recognize brands, images and even people. You can try it on www.blippar.com

Computer System

LECTURE 6

A Computer System

All the different parts of a computer, including the devices you plug into it, are known collectively as 'a computer system'.

Monitor (Output)

A monitor, or visual display unit (VDU), displays the information generated by a computer. Touch-screen monitors also allow input from the user.

Webcam (Input)

A webcam enables live video communication over the Internet. Webcams are often integrated within computers.

Optical Disc Drive (Storage)

CD, DVD and Blu-ray disc drives are used to read information on the associated optical discs. To write (record) information onto an optical disc, a writer is required. The optical disc must also be writable (R) or rewritable (RW).

Speakers (Output)

Speakers are used to output sound.

Base Unit (Processing)

A base unit stores the motherboard, Central Processing Unit (CPU), Random-Access Memory (RAM) and other essential components.

Printer (Output)

A printer creates physical copies of on-screen data and information.

Scanner (Input)

A scanner is used to convert physical objects, usually printed images and text, into digital images.

Computer System

A computer system consists of three primary units:

- Input units – accept data
- Processor unit – processes data by performing comparisons and calculations
- Output units – present the results

Processor Unit

Two main parts:

- CPU – where the actual processing takes place; and
- Main memory – where data are stored.

The contents of main memory can be transferred to auxiliary storage devices such as hard disks, floppy diskettes, zip disks, compact disks, or USB flash disk.

CPU
Memory
Input and Output
Control bus
Address bus
Data bus
System bus

Central Processing Unit

The microprocessor, the brains of the computer. Referred to a CPU or processor

- Housed on a tiny silicon chip
- Chip contains millions of switches and pathways that help your computer make important decisions.

Processing Units

SECTION 6-1

status register
register file
priority encoder
vector rom
shifter
Booth multiplier
register count
control logic
MDRW
IR
IR_prefetch
MDRR
MAR
DOUT
DATA
ADDR

Control Unit

Control Unit: is the “boss” and coordinates all of the CPU’s activities.

- Uses programming instructions, it controls the flow of information through the processor by controlling what happens inside the processor.
- We communicate with the computer through programming languages.

Examples: COBOL, C++, HTML, Java Script or VisualBasic.net

Model of Control Unit

Arithmetic/logic unit (ALU):

- Performs arithmetic computations and logical operations; by combining these two operations the ALU can execute complex tasks.
  - Arithmetic operations include addition, subtractions, multiplication, and division.
  - Logical operations involve comparisons.

A
B
Control
& Carry
ALU
OUT
CCU
Computer
Control
Unit
IN
ACC
OUT
Load
Enable
DATA-IN
DATA-OUT
OP CODE

Cache Memory

- **Cache memory**, also called CPU memory, is high-speed static random access memory (SRAM) that a computer microprocessor can access more quickly than it can access regular random access memory (RAM). This memory is typically integrated directly into the CPU chip or placed on a separate chip that has a separate bus interconnect with the CPU.
- The purpose of cache memory is to store program instructions and data that are used repeatedly in the operation of programs or information that the CPU is likely to need next. The computer processor can access this information quickly from the cache rather than having to get it from computer's main memory. Fast access to these instructions increases the overall speed of the program.

Cache Memory

SECTION 6-2

Main Memory
Bus
Cache
CPU Core

Main
Memory
Index Data
0 xyz
1 pdq
2 abc
3 rgf
Cache
Memory
Index Tag Data
0 2 abc
1 0 xyz

Client
Cache
Memory
Resource
Coherency
Client
Cache

Increasing order of
access time ratio
Register
Memory
Cache
Memory
Main Memory
Primary Memory
Magnetic Disks
Auxillary
Memory
Magnetic Tapes

Shared Memory Model

- In computer science, shared memory is memory that may be simultaneously accessed by multiple programs with an intent to provide communication among them or avoid redundant copies.
- **Shared memory** is an efficient means of passing data between programs. Depending on context, programs may run on a single processor or on multiple separate processors.

Core 0
Core 1
Core 2
Core 3
L1 Cache
TLB
L1 Cache
TLB
L1 Cache
TLB
L1 Cache
TLB
L2 Cache
L2 Cache
Hardware Prefetchers
Hardware Prefetchers
Off-chip Memory Interconnect

Main Memory
Physical addresses
IOMMU
MMU
Device addresses
Virtual addresses
Device
CPU

P
P
P
$
$
$
Bus
Main Memory
I/O

System Architecture

SECTION 6-3

Basic PC System

Intel® Pentium® 4 Processor
6.4, 4.2 or 3.2 GB/s
DDR400/333 SDRAM
AGP8X
2.0 GB/s
82875P MCH
DDR
6.4 GB/s
DDR
Communication Streaming Architecture/GbE
Intel® Hub Architecture
Dual Independent Serial ATA Ports
150 MB/s
6 Channel Audio
10/100 LAN Connect Interface
ICH5/ ICH5R
133 MB/s
PCI
Hi-Speed USB 2.0 8 Ports
Legacy ATA 100
Intel® RAID Technology (ICH5R only)
BIOS Supports HT Technology

Major PC System Components

I/O Device Controller
Other Devices
I/O Channel
CPU and Main Memory
I/O Device Controller
I/O Channel
I/O Device Controller
Disk 0
Disk 1

Computer Input Devices

- Keyboard
- Mouse/Trackball
- Joystick
- Light pen
- Pointing Stick
- Touchpad
- Touch screen
- Bar code reader
- Scanner
- Microphone
- Graphics Tablet
- Digital Cameras

Output Unit

- After the data has been processed, the results are output in the form of useful information.
- Output units such as monitors and printers make the result accessible for use by people.

Computer Output Devices

Monitor: screen that display information such as text, numbers, and pictures-softcopy.

Printer: gives you information from the computer in printed form – hardcopy.

Speakers: allow you to hear voice, music, and other sounds from your computer.

Modem: allows you to use your computer to communicate with other computers.

Mainframe Computer System

Computer Hardware
System Software
File Mngnt Tools
Operating System
Utilities
Compilers
Assembler
Debugger
Application Software
Word Processing
Spreadsheets
Graphics
Communications
Databases
Games

Hardware and Peripherals

LECTURE 7

What is hardware?

- Hardware is the general term that is used to describe physical artifacts of a technology.
- A computer's hardware consists of electronic devices; the parts you can see and touch.

1 Speakers
2 Modem
3 Microphone
4 RAM
5 CPU
6 Keyboard
7 Mouse
8 CD-ROM drive
9 Diskette drive
10 Hard drive
11 Printer
12 Ports
13 Monitor
14 Expansion board

Micro-Processor

SECTION 7-1

Central Processing Unit

- A **central processing unit** (CPU), also called a central processor or main processor, is the electronic circuitry within a computer that carries out the instructions of a computer program by performing the basic arithmetic, logic, controlling, and input/output (I/O) operations specified by the instructions.
- The computer industry has used the term "central processing unit" at least since the early 1960s.
- Traditionally, the term "CPU" refers to a processor, more specifically to its processing unit and control unit (CU), distinguishing these core elements of a computer from external components such as main memory and I/O circuitry.

Intel® Core™ i9 X-series Processor
intel
CORE i9
X-SERIES
FOR A GREAT
VR
EXPERIENCE
intel
CORE i9
X-series
intel
CORE i9
X-series

UNLOCKED INTEL® CORE™ X-SERIES PROCESSOR FAMILY

Processor number[1]	Base clock speed (GHz)	Intel® Turbo Boost Technology 2.0 frequency[2] (GHz)	Intel® Turbo Boost Max Technology 3.0 Freqency[3] (GHz)	Cores/ threads	L3 cache	PCI express 3.0 lanes	Memory support	TDP	Socket (LGA)	RCP Pricing (1K USD)
i9-7980XE NEW	2.6	4.2	4.4	18/36	24.75 MB	44	Four channels DDR4-2666	165W	2066	$1,999
i9-7960X NEW	2.8	4.2	4.4	16/32	22 MB	44	Four channels DDR4-2666	165W	2066	$1,699
i9-7940X NEW	3.1	4.3	4.4	14/28	19.25 MB	44	Four channels DDR4-2666	165W	2066	$1,399
i9-7920X NEW	2.9	4.3	4.4	12/24	16.5 MB	44	Four channels DDR4-2666	140W	2066	$1,199
i9-7900X NEW	3.3	4.3	4.5	10/20	13.75 MB	44	Four channels DDR4-2666	140W	2066	$999
i7-7820X NEW	3.6	4.3	4.5	8/16	11 MB	28	Four channels DDR4-2666	140W	2066	$599
i7-7800X NEW	3.5	4.0	NA	6/12	8.25 MB	28	Four channels DDR4-2400	140W	2066	$389
i7-7740X NEW	4.3	4.5	NA	4/8	8 MB	16	Two channels DDR4-2666	112W	2066	$339
i5-7640X NEW	4.0	4.2	NA	4/4	6 MB	16	Two channels DDR4-2666	112W	2066	$242

1. Intel processor numbers are not a measure of performance. Processor numbers differentiate features within each processor family, not across different processor families. See intel.com/products/processor_number for details.

AVX-512 Port Fusion
Dedicated AVX-512 unit
uncore
32K Instruction Cache
BPU
Legacy Decode Pipeline
Decoded ICache
MSROM
Micro-Op Queue
Allocate/Rename/Retire/Move Elimination/Zero Idiom
Scheduler
1M L2 Cache
32K Data Cache
Port 2 LD/STA
Port 3 LD/STA
Port 4 STD
Port 7 STA
Port 6 INTEGER ALU INTEGER SHIFT BRANCH 1
Port 0 INTEGER ALU DIVIDE BRANCH 2 VEC FMA VEC MUL VEC ADD VEC ALU VEC SHIFTER
Port 1 INTEGER ALU INTEGER MUL SLOW LEA FAST LEA VEC FMA VEC MUL VEC ADD VEC ALU VEC SHIFTER
Port 5 INTEGER ALU FAST LEA VEC SHUFFLE VEC FMA VEC MUL VEC ADD VEC ALU
INTEGER represent GPR scalar instructions.
VEC represent floating point and integer vector instructions.
SLOW LEA represent a lea with 2 registers and displacement, all other lea versions considered as FAST LEA
BRANCH1 is primary branch and more capable than BRANCH2

Skylake-X and Kaby Lake-X processors

More core options:
18, 16, 14, 12, 10, 8, 6, and 4

Rebalanced Intel® Smart Cache hierarchy[1]

Intel® Turbo Boost Technology

Intel® Hyper-Threading Technology (Intel® HT Technology)

Discrete graphics

Support for up to four-channel DDR4

DMI

Intel® X299 Chipset

Update: Intel® Turbo Boost Max Technology 3.0[2]

Support for overclocking with extreme edition and "X" SKUs

Integrated memory controller:
Up to four channels DDR4 2666[2]

Up to 44 lanes PCIe* 3.0

Power = 140W[3]
Socket: LGA 2066

See product specifications for features supported on the SKUs
1. Rebalanced cache hierarchy. See next slide for details
2. Only available on SKUs **7820X, 7900X, 7920X, 7940X, 7960X, 7980XE**
3. On SKUs 7800X, 7820X and 7900X. 7640X and 7740X SKUs have 112W TDP

Processor Socket

- The **processor socket** (also called a CPU socket) is the connector on the motherboard that houses a CPU and forms the electrical interface and contact with the CPU.
- Processor sockets use a pin grid array (PGA) where pins on the underside of the processor connect to holes in the processor socket.

Socket 1
Socket 2
Socket 3
Socket 6

Table 4-1. Processor socket types

Socket type	Manufacturer	Status	Processor types
Slot A	AMD	Obsolete	Athlon
Slot 1	Intel	Obsolete	Pentium II, Pentium III, Celeron
Socket 370	Intel	Obsolete	Pentium III, Celeron
Socket 423	Intel	Obsolete	Pentium 4, Celeron
Socket A (462)	AMD	Obsolescent	Athlon, Athlon XP, Duron, Sempron
Socket 478	Intel	Obsolescent	Pentium 4, Celeron D
Socket 754	AMD	Obsolescent	Athlon 64, Sempron
Socket 775	Intel	Current	Pentium 4, Pentium D, Celeron D
Socket 939	AMD	Current	Athlon 64, Athlon 64/X2, Sempron

HDMI/DVI
ASSEM
USB_LAN
All Solid
Socket 1155

Processor Cooling

- Computer cooling is required to remove the waste heat produced by computer components, to keep components within permissible operating temperature limits.
- Components that are susceptible to temporary malfunction or permanent failure if overheated include integrated circuits such as central processing units (CPUs), chipset, graphics cards, and hard disk drives.

Processor Cooling

- Components are often designed to generate as little heat as possible, and computers and operating systems may be designed to reduce power consumption and consequent heating according to workload, but more heat may still be produced than can be removed without attention to cooling.
- Use of heatsinks cooled by airflow reduces the temperature rise produced by a given amount of heat. Attention to patterns of airflow can prevent the development of hotspots. Computer fans are widely used along with heatsink fans to reduce temperature by actively exhausting hot air.
- There are also more exotic cooling techniques, such as liquid cooling. All modern day processors are designed to cut out or reduce their voltage or clock speed if the internal temperature of the processor exceeds a specified limit.

GIGABYTE
Thermaltake
Water3.0
SATA Express

Mother Board

SECTION 7-2

Motherboard

- A **motherboard** (sometimes alternatively known as the main circuit board, system board, baseboard, planar board or logic board,[1] or colloquially, a mobo) is the main printed circuit board (PCB) found in general purpose computers and other expandable systems.
- It holds and allows communication between many of the crucial electronic components of a system, such as the **central processing unit** (CPU) and memory, and provides connectors for other peripherals.
- Unlike a backplane, a motherboard usually contains significant sub-systems such as the central processor, the chipset's input/output and memory controllers, interface connectors, and other components integrated for general purpose use and applications.

What is a motherboard?

- A **motherboard** is the *central circuit board* making up a personal computer.

A motherboard

Daughter Board

- A daughterboard (or daughter board , daughter card , or daughtercard) is a circuit board that plugs into and extends the circuitry of another circuit board.

ComputerHope.com

ASUS P5AD2-E Motherboard

Motherboard Form Factor

Form Factor	Length	Width
ATX	12.0” (30.5cm)	9.6” (24.4cm)
Mini ATX	11.2” (28.4cm)	8.2” (20.8cm)
Flex ATX	9.0” (22.9cm)	7.5” (19.1cm)
Micro ATX	9.6” (24.4cm)	9.6” (24.4cm)
ITX	8.5” (21.5cm)	7.5” (19.1cm)
Mini-ITX	6.7” (17cm)	6.7” (17cm)
Nano-ITX	4.7” (12cm)	4.7” (12cm)

Memory

SECTION 7-3

Memory

Volatile Memory:

- Random Access Memory (RAM)

Non-volatile memory:

- Read Only Memory (ROM)
- Solid-State Memory
- Flash Memory

Random Access Memory (RAM)

Memory on the motherboard that is short term; where data, information, and program instructions are stored temporarily on a RAM chip or a set of RAM chips. Known as the main memory.

- This memory is considered volatile.
- The computer can read from and write to RAM.

Read-Only Memory (ROM)

- Memory on the motherboard that is long term; where the specific instructions that are needed for the computer to operate are stored.
- This memory is nonvolatile and your computer can only read from a ROM chip.

BIOS - ROM

- The instructions remain on the chip regardless if the power is turned on or off.
- Most common is the BIOS ROM; where the computer uses instructions contained on this chip to boot or start the system when you turn on your computer.

CPU
Register
Cache
Level 1
Level 2
RAM
Physical RAM
Virtual Memory
Temporary
Storage
Areas
Storage Device Types
ROM/
BIOS
Removable
Drives
Network/
Internet
Storage
Hard
Drive
Permanent
Storage
Areas
Input Sources
Keyboard
Mouse
Removable
Media
Scanner/
Camera/
Mic/
Video
Remote
Source
Other
Sources

Types of Computer Storage
CPU
RAM
Cache
Primary storage
CD-RW
USB thumb drive
Tape drive
Hard drive
Secondary storage
Off-line storage
ComputerHope.com

Computer Memory
Internal/Main/ Primary
External/ Secondary
ROM (Non-Volatile)
RAM (Volatile)
HDD
SSD
Compact Disc
USB Flash Drive
SRAM
DRAM
SDRAM
RDRAM
DDR SDRAM
DDR1
DDR2
DDR3
DDR4

Mask ROM
Flash EPROM
EPROM
Erasable
programmable ROM
ROM
PROM
Programmable ROM
EEPROM
Electrically Erasable
Programmable ROM

BIOS Bootstrapping Flow

Load basic filesystem drivers

The bootloader must load and run the primitive filesystem "drivers" that give it the ability to read, at the very least, the filesystem it is located on.

Load and read configuration file

With support for the filesystem loaded, the bootloader can now read the list of operating systems from the disk and prepare it for display.

Load and run supporting modules

If the configuration file specifies that additional modules are required, they're loaded and run accordingly.

Display operating system menu

The bootloader displays a list of operating systems for the user to choose from (if applicable), and optionally allow for specifying parameters and settings.

Load the selected OS

The bootloader can now load and execute the kernel, handing off control of the PC to the OS and ending its role in the boot process.

- Regardless of the computer or operating system, standard ("IBM-compatible") desktop PCs and laptops all power on and start up using one of two ways: the traditional BIOS-MBR method and the newer UEFI-GPT method, used by the latest versions of Windows, Linux, and Mac OS X on newer PCs, laptops, and tablets.
- This article summarizes the process by which traditional BIOS PCs load an operating system, covering the basics and details of the BIOS, MBR, and bootsector.

BIOS VERSUS CMOS

BIOS	CMOS
A nonvolatile firmware that initializes hardware during the booting process and provides runtime services for operating systems and programs	A special memory chip in the motherboard that stores and holds the BIOS configuration settings
Basic Input Output System is the long form	Complementary Metal Oxide Semiconductor is the long form
Nonvolatile	Volatile
Initializes hardware while booting up the computer and provide runtime services for OS and programs	Stores all BIOS settings

Visit www.PEDIAA.com

Secured Boot: legacy vs. modern

Legacy boot

- BIOS starts any OS Loader, even malware
- Malware may start before Windows

Modern boot

- The firmware enforces policy, only starts signed OS loaders
- OS loader enforces signature verification of Windows components
- Result—malware unable to change boot and OS components

Advanced options
System Restore
Use a restore point recorded on your PC to restore Windows
Command Prompt
Use the Command Prompt for advanced troubleshooting
System Image Recovery
Recover Windows using a specific system image file
UEFI Firmware Settings
Change settings in your PC's UEFI firmware
Startup Repair
Fix problems that keep Windows from loading
Startup Settings
Change Windows startup behavior

UEFI Boot Flow

Figure 1-2. Framework Firmware Phases

UEFI
UEFI-enabled OS
UEFI Shell
Option ROMs
Legacy OS
Platform Initialization
DXE Driver
UEFI Driver
...
UEFI Driver
UEFI Driver
BDS
Compatibility Support Module
CPU PEI Modules
C/S PEI Modules
Hardware
PI
Modular components

Operating system
Extensible Firmware Interface
Firmware
Hardware

Type of RAM

- SRAM: Static RAM
- D-RAM: Dynamic RAM
- DDR-RAM: **Double Data Rate** Synchronous Dynamic Random-Access Memory, officially abbreviated as DDR SDRAM, is a double data rate synchronous dynamic random-access memory class of memory integrated circuits used in computers.
- RD-RAM: **Rambus DRAM** (RDRAM), and its successors Concurrent Rambus DRAM (CRDRAM) and Direct Rambus DRAM (DRDRAM), are types of synchronous dynamic RAM developed by Rambus from the late-1980s through to the early-2000s. The third-generation of Rambus DRAM, DRDRAM was replaced by XDR DRAM.

Static RAM (SRAM)

Address line
Transistor
Storage
capacitor
bit line
Ground

WL
V_{DD}
$\overline{Q}$
Q
$\overline{BL}$
BL

SRAM	DRAM
1. SRAM has lower access time, so it is faster compared to DRAM.	1. DRAM has higher access time, so it is slower than SRAM.
2. SRAM is costlier than DRAM.	2. DRAM costs less compared to SRAM.
3. SRAM requires constant power supply, which means this type of memory consumes more power.	3. DRAM offers reduced power consumption, due to the fact that the information is stored in the capacitor.
4. Due to complex internal circuitry, less storage capacity is available compared to the same physical size of DRAM memory chip.	4. Due to the small internal circuitry in the one-bit memory cell of DRAM, the large storage capacity is available.
5. SRAM has low packaging density.	5. DRAM has high packaging density.

Main Memory
64 bit lines
CPU
Register File
Level 1 I-Cache
Level 1 D-Cache
Level 2 Cache
128 byte cache lines
4 Kb SRAM buffer
16 Mb chip
4K Rows of 4Kb each
8-way interleaved byte addressable memory.
System Disk
16 MB Databurst DRAM Cache
320 GB SATA Drive

A Typical Memory Hierarchy

- Everything is a cache for something else…

Access time	Capacity	Managed By
1 cycle	1 KB	Software/Compiler
2-4 cycles	32 KB	Hardware
10 cycles	256 KB	Hardware
40 cycles	10 MB	Hardware
200 cycles	10 GB	Software/OS
10-100us	100 GB	Software/OS
10ms	1 TB	Software/OS

Cache Memory

- **Input- Output operations are very slow.** CPU speeds are quite high compared to the access time of main memory. Thus the processor performance is limited by the slow speed of the main memory. To speed up fetching of instructions to CPU, a buffer or cache (pronounced as cash) is used. Normal RAM is expensive and is not fast enough to match the speed of CPU. To reduce the processing time, certain computers use costlier and higher speed memory devices to form a buffer or cache. This technique uses a small memory with extremely fast access speed close to the processing speed of the CPU. This memory is called cache and it stores data and instructions currently required for processing. Cache memory thus makes main memory appear much faster and larger than it really is. It improves the memory transfer rates and thus raises the effective processor speea.
- The CPU searches cache before it searches main memory for data and instructions. **Cache is physically located close to the CPU and hence access to cache is faster than to any other memory.**

Pros and Cons of Cache Memory

Advantages of Cache Memory :

1. Cache memory is faster than main memory.
2. It stores the program that can be executed within a short period of time.
3. It consumes less access time as compared to main memory.
4. It stores data for temporary use.

Disadvantages of Cache Memory :

1. It is very expensive.
2. Cache memory has limited capacity.

L1 built in
L2 built in
Both caches can be built into CPU chip.
CPU
CPU & L1
L2
CPU and L2 cache can be on same multichip module.

L1 cache (built into chip)
CPU
Backside bus
Main memory (DRAM chips)
L2 cache (SRAM chips)
System bus (frontside bus, local bus)

Thread Stack
Thread Stack
Heap
JVM
CPU
CPU Registers
CPU
CPU Registers
CPU Cache Memory
CPU Cache Memory
RAM - Main Memory
Computer

Types of Random-Access Memory(RAM)

Main Memory (DRAM)

- The main memory in a computer is called Random Access Memory. It is also known as RAM. This is the part of the computer that stores operating system software, software applications and other information for the central processing unit (CPU) to have fast and direct access when needed to perform tasks. It is called "random access" because the CPU can go directly to any section of main memory, and does not have go about the process in a sequential order.
- RAM is one of the faster types of memory, and has the capacity to allow data to be read and written. When the computer is shut down, all of the content held in RAM is purged. **Main memory** is available in two types: **Dynamic Random Access Memory (DRAM)** and **Static Random Access Memory (SRAM). Usually, main memory is based on DRAM technology.**

DYNAMIC RAM (DRAM) MEMORY TECHNOLOGIES

Type	Year of Intro.	Maximum Clock Rate	Bus Width	Peak Bandwidth	Volts
FPM	1990	25MHz	64 bits	200 MBps	5v
EDO	1994	40MHz	64 bits	320 MBps	5v
SDRAM	1996	133MHz	64 bits	1.1 GBps	3.3v
RDRAM	1998	400MHz (x2)	16 bits	800 MBps	2.5v
DDR SDRAM	2000	266MHz (x2)	64 bits	4.2 GBps	2.5v
DDR2 SDRAM	2003	533MHz (x2)	64 bits	8.5 GBps	1.8v
DDR3 SDRAM	2007	800MHz (x2)	64 bits	12.8 GBps	1.5v
DDR4 SDRAM	2012	1600MHz (x2)	64 bits	25.6 GBps	1.2v

Solid State Memory

- **Solid-state storage** (SSS) is a type of computer storage media made from silicon microchips. SSS stores data electronically instead of magnetically, as spinning hard disk drives (HDDs) or magnetic oxide tape do.
- Solid-state storage can be found in three form factors: **solid-state drives** (SSD), **solid-state cards** (SSC) and **solid-state modules** (SSM). An important advantage of solid-state storage is that it contains no mechanical parts, allowing data transfer to and from storage media to take place at a much higher speed and providing a more predictable lifespan for the storage media. Because there are no moving parts, SSDs produce far less heat than HDDs.

Solid State Memory

- In addition to providing faster and more consistent input/output (I/O) times, solid-state storage media offers the same levels of data integrity and endurance as other electronic devices, and requires less power and cooling than its electromechanical equivalents. It also generally weighs less.

Memory getting faster
to "feed" the CPU
HDDs becoming
cheaper but not
faster
CPU SRAM
Cache
DRAM
NVM
HDD
Tape
Gap is widening
Throughput (MB/S)
Cost ($/GB)
10^6
10^5
10^4
10^3
10^2
10^1
10^0
10^{-1}
10^0
10^1
10^2
10^3
10^4

REIMAGINING THE DATA CENTER MEMORY AND STORAGE HIERARCHY

SOFTWARE / DRIVER INTERFACE
HOST BUS
HOST BUS ADAPTOR
CONNECTOR
DEVICE INTERFACES
SOLID STATE CONTROLLER
NAND FLASH INTERFACE
SOLID STATE MEDIA
SOLID-STATE DISK
HOST BUS ADAPTOR
SOLID STATE CONTROLLER
SOLID STATE MEDIA
SOLID-STATE STORAGE

NVMe SSD
960 PRO
M.2
www.samsung.com/ssd
SAMSUNG ELECTRONICS CO., LTD.
1TB
P/N: MZVKP1T0HMJP
Model: MZ-V6P1T0 2016.08
PSID:1DZLL851J5A1S0FRNGTHQPFJW6EGR4G2
S/N: S3DSNY0H800004Y RATED: DC+3.3V 2.7A
EUI64: 0025385861000 1D2 MSIP-REM-SEC-MZ-V6P1T0
SAMSUNG

MOS Memory Tree
RAM
(Read Acces Memory)
ROM
(Read Only Memory)
FeRAM
MRAM
PRAM
DRAM
SDRAM
PROM
MROM
FP, EDO
SDRAM
VRAM
WRAM
SGRAM
RDRAM
DDR, DDR2
VCRAM
FCRAM
XDR-DRAM
MM-DRAM
PSRAM
NVRAM
Fast/Slow SRAM
SSRAM
QDR-SRAM
EEPROM
FLASH
NOR
NAND
EPROM

TOSHIBA

NAND vs. NOR - Cell Structure

	NAND	NOR
Cell Array		
Layout		
Cross-section		
Cell size	$4F^2$	$10F^2$

Characteristic	NAND Flash MT29F2G08A	NOR (Q-Flash) MT28F128J3
Random access read	25µs (first byte) .03µs each for remaining 2111 bytes	.12µs
Sustained read speed (sector basis)	23 MB/s (x8) or 37 MB/s (x16)	20.5 MB/s (x8) or 41 MB/s (x16)
Random write speed	~300µs/2112 bytes	180µs/32 bytes
Sustained write speed (sector basis)	5 MB/s	.178 MB/s
Erase block size	128KB	128KB
Erase time per block (typ)	2ms	750ms

Solid State Hard Disc

(Direct Access)

Memory Stick

(Direct Access)

Flash Memory

(Direct Access)

Micro Flash Memory

(Direct Access)

Typical NAND flash pages and blocks

I/O Channels

SECTION 7-4

AMD
Athlon XP
Processor
266/333MHz FSB
DDR
266/333
/400
KM400
North Bridge
Integrated
UniChrome™
2D/3D Graphics
Display/
Optional
AGP
2X/4X/8X
Network Interface PHY
V-Link 533MB/Sec
VT6103
10/100Ethernet
PCI Slots
33MHz,
32-bit PCI
VT8235
South Bridge
AC-Link
LPC
UDMA / ATA
33 / 66 / 100 / 133
Direct
EPROM
Or LPC
6X USB 2.0
VT1211
LPC
Super
I/O
Serial / IR
Parallel
Floppy Disk
Keyboard
Mouse
VT1616
AC'97 Audio Codec
MC-97
Modem Codec

Serial ATA

- Serial ATA (SATA, abbreviated from Serial AT Attachment) is a computer bus interface that connects host bus adapters to mass storage devices such as hard disk drives, optical drives, and solid-state drives.
- Serial ATA succeeded the earlier Parallel ATA (PATA) standard to become the predominant interface for storage devices.

6644948 APOLLO SYSTE
12-013 1469
DELOCK 89270
Stk: 1
Tested to comply with FCC standards
MADE IN TAIWAN
RoHS

IBM PCIe LP 8 Gb 2-Port Fibre Channel Adapter

PCI-E 16X slot
4 solid capacitors
LED Power Indicator
SATA 15PIN
6PIN power supply port
4PIN power supply port
USB3.0 interface

Secondary Storage

SECTION 7-5

secondary memory
sequencial access memory
Direct access memory
megnetic tape
Megnetic disk
Optical disk
Flash memory
Zip disk
winchestor disk
CD-ROM (Compact disk read only memory
CD (compact disk) 650 MB(80 MIN)
DVD (digital versatile disk) 4.7 gb to 17 gb (1hr.20 min)
BRD (blu ray disk) 25gb to 50gb
Sd card secure digital card) (8mb to 256gb)
pendrive (8mb to 512gb)
CD-R (COMPACT DISK RECORDABLE)
CD-RW (COMPACT DISK READABLE WRITEABLE)

Hard Disk

Main engine axis
Head
Disc
Head supporting arm
Controller chip
Head engine
Internal cabling
Interface connector
Jumpers
Power supply connector

Logic View

Non-volatile Secondary Memory

3.5" SATA Hard Disk Drives (HDDs) and Solid State Drives (SSDs)

2.5" SATA HDDs and SSDs

3.5" IDE HDDs

2.5" IDE HDDs

mSATA SSDs

1.8" MicroSATA SSDs

Compact Flash Cards

CFast Cards

Spindle
Platters
Actuator Arm
Actuator Axis
Actuator
Read/Write Head
Power connector
SATA connector
Jumper

Form Factors

Past and present HDD form factors							
Form factor	Status	Length [mm]	Width [mm]	Height [mm]	Largest capacity	Platters (max)	Capacity Per platter [GB]
3.5"	Current	146	101.6	19 or 25.4	6 TB (2013)	5 or 7	1000
2.5"	Current	100	69.85	5, 7, 9.5, 12.5, or 15	2 TB (2012)	4	694
1.8"	Current	71	54	5 or 8	320 GB (2009)	2	220
8"	Obsolete	362	241.3	117.5			
5.25" FH	Obsolete	203	146	82.6	47 GB (1998)	14	3.36
5.25" HH	Obsolete	203	146	41.4	19.3 GB (1998)	4	4.83
1.3"	Obsolete		43		40 GB (2007)	1	40
1" (CFII/ZIF/IDE-Flex)	Obsolete		42		20 GB (2006)	1	20
0.85"	Obsolete	32	24	5	8 GB (2004)	1	8

2.5”
2.5”
1.8”
mSATA
NGFF
9.5 mm
7 mm
9.5 mm
7 mm
5 mm
4.85 mm
2.3 mm

Hard drive read/write head

Storage SoC
Read/Write Head
Interface Controller
Read Channel
Preamp
Disk Platter
VCM
Memory
Hard Disk Controller
Motor Controller
Spindle Motor

Master
Slave
Cable Select
Master w/ CL
Slave w/ CL
C.S. w/ CL

Optical Storage

SECTION 7-6

Optical storage devices

Compact Disc (CD)
Capacity: 700 MB
Available from 1982

DVD
Capacity: 4.7 GB
Available from 1995

Blu-ray Disc
Capacity: 25 GB
Available from 2006

Optical disk milestones

Optical disk recording got its start with CDs. 2nd generation DVD was followed by the current 3rd generation BluRay and HD-DVD era. In the 4th generation, recording capacity 100 times that of DVD will be achieved.

Optical Discs

- Use laser technology to read and write data on silver platters
- Compact Disk (CD) can store 650MB to 800MB of information and data. CD-ROM (Read Only Memory) can only read data from a CD-ROM.
- You can store data on a CD only if you have a CD Burner and CD-R (writable) or CD-RW (rewritable) CD.

DVD (Digital Versatile Disk)

- DVD (Digital Versatile Disk) is the size of a regular CD and can be played in a regular in a DVD movie player.
- DVD can store 4.8GB to 8.0GB of information and data. DVD-ROM is readable only (a movie DVD).
- You can store data on a DVD only if you have a DVD Burner and DVD+R/DVD-R (writable) or DVD-RW (rewritable) DVD.

Blu-ray

- Blu-ray or Blu-ray Disc (BD) is a digital optical disc data storage format. It was designed to supersede the DVD format, and is capable of storing several hours of video in high-definition (HDTV 720p and 1080p) and ultra high-definition resolution (2160p).
- The main application of Blu-ray is as a medium for video material such as feature films and for the physical distribution of video games for the PlayStation 3, PlayStation 4, and Xbox One.
- The name "Blu-ray" refers to the blue laser (actually a violet laser) used to read the disc, which allows information to be stored at a greater density than is possible with the longer-wavelength red laser used for DVDs.

Slots and Bays

SECTION 7-7

South Bridge
North Bridge

Intel Core 2
Processor (CPU)
Front Side Bus
RAM Modules
(System Memory)
RAM Module
RAM Module
RAM Module
RAM Module
DDR2
Channel A
DDR2
Channel B
Northbridge
chip
PCI Express x16 Graphics
(Graphics card)
DMI Interface
BIOS (Flash memory)
Serial ATA ports
USB Ports
Southbridge
chip
Power Management
Clock Generation
PCI Bus

RIMM MODULE

RDRAM (Rambus) - 184-pin - Chips covered with metal heat sink.

SIMM MODULES

DRAM - 30-pin SIMM

FPM - 72-pin SIMM

DIMM MODULES

DDR4 - 284-pin DIMM

DDR3 - 240-pin DIMM

DDR2- 240-pin DIMM

DDR - 184-pin DIMM

SDRAM, FPM, EDO - 168-pin DIMM

Types of RAM with different pins

Note, as well as the different number of pins, the different spacing of the slots in the connector-edge

MicroDIMM (rare)

72 pin SODIMM (rare)

144 pin SDRAM SODIMM

200 pin DDR SODIMM

200 pin DDR-2 SODIMM

100 pin DIMM printer RAM

30 pin SIMM

72 pin SIMM

168 pin SDRAM DIMM

184 pin RAMBus RDRAM RIMM

184 pin DDR DIMM

240 pin DDR-2 DIMM

Internal computer video expansion card

PCI slot 2

PCI slot 1

PCIe 2.0 x16_2 slot (blue, single at x 16 or dual at x8 link)

PCIe 2.0 x4_1 slot

PCIe 2.0 x1_1 slot

PCIe 2.0 x16_1 slot (gray, at x 8 link)

Top of Connector
SAS HDD (SFF-8482)
No notch, backside pins

SATA HDD
Notch separates power
and signal

SATA PM connectivity: one port, one cable, four drives; 4-ports = 16 drives

Applications
Operating system/File system
Upper driver layers
Legacy SATA
SATA Express/ AHCI
SATA Express/ NVM Express
AHCI driver
NVM Express driver
AHCI host bus adapter
PCI Express root port
Host chipset
Configurable SATA port or PCI Express lane
SATA Express connector
Legacy SATA device
SATA PHY
SATA link
SATA transport
SATA controller
OR
PCI Express PHY
PCI Express link
PCI Express transport
AHCI controller
NVM Express controller
PCI Express SSD device

SATA Device
SATA PHY
SATA Link
SATA Transport
Device Controller

PCIe Device
PCIe PHY
PCIe Link
PCIe Transport
Device Controller

e SATA Port

Serial ATA

PS/2 Port
Mouse
Keyboard
Serial Port
Used for PDAs and serial devices.
Parallel Port
Used for printers and data.
Game Port
Joysticks and Midi Input
All Replaced by USB!

Port	*2-Channel*	*4-Channel*	*6-Channel*	*8-Channel*
Blue	Line In	Line In	Line In	Line In
Lime	Line Out	Front Speakers	Front Speakers	Front Speakers
Pink	Mic In	Mic In	Mic In	Mic In
Orange			Center/Subwoofer	Center/Subwoofer
Black		Rear Speakers	Rear Speakers	Rear Speakers
Grey				Side Speakers

Keyboard Port
Mouse Port
Serial Port
Parallel Port
Video Port
USB Ports
RJ-45 Port
Line in Jack
Microphone Jack
Line out Jack

USB 1.0 / USB 2.0

Type A

Type B

Mini-A

Mini-B

Micro-A

Micro-B

USB 3.1 Gen 1 fka USB 3.0

TypeA SuperSpeed

Type B SuperSpeed

Micro-B SuperSpeed

USB 3.1 Gen 2

Type-C

- 1 Gigabit Ethernet via Intel I219-V
- 8-channel audio via Realtek ALC1220
- 2 USB 2.0 via Z270
- 4 USB 3.0 via Z270
- 1 USB 3.1 via Asmedia ASM2142 controller (Type A)
- 1 USB 3.1 via Asmedia ASM2142 controller (Type C)

Keyboard

SECTION 7-8

Keyboard Standards

IBM/PC keyboards

- **Original IBM PC Keyboard (1981)** - 83 keys
- **Updated IBM PC Keyboard (1984)** - 84 keys
- **AT Keyboard** - 84 keys
- **AT Enhanced Keyboard** - 101 keys
- **US Traditional Keyboard** - 101 keys
- **Enhanced European Keyboard** - 102 keys
- **Windows Keyboard** - 104 keys
- **Windows-based Laptop Keyboard** - 86 keys

Apple keyboards

- **Apple Keyboard with Numeric Keypad** - 109 keys
- **Apple Wireless Keyboard** - 78 keys
- **Apple MacBook Air laptop** - 78 keys

Key Scan Code

- A scancode (or scan code) is the data that most computer keyboards send to a computer to report which keys have been pressed. A number, or sequence of numbers, is assigned to each key on the keyboard.
- USB keyboards use a new set of scancodes, mostly specified in the USB standard. All computers that recognize USB keyboards recognize these new scancodes.

101-Key Keyboard Position Codes

Key Position Codes

Position	Scancode	Position	Scancode	Position	Scancode	Position	Scancode	Position	Scancode	Position	Scancode
1	0x0e	23	0x3c	45	0x13	67	N/A	89	0x6a	111	N/A
2	0x16	24	0x43	46	0x1a	68	N/A	90	0x76	112	0x07
3	0x1e	25	0x44	47	0x22	69	N/A	91	0x6c	113	0x0f
4	0x26	26	0x4d	48	0x21	70	N/A	92	0x6b	114	0x17
5	0x25	27	0x54	49	0x2a	71	N/A	93	0x69	115	0x1f
6	0x2e	28	0x5b	50	0x32	72	N/A	94	0x68	116	0x27
7	0x36	29	0x5c	51	0x31	73	N/A	95	0x77	117	0x2f
8	0x3d	30	0x14	52	0x3a	74	N/A	96	0x75	118	0x37
9	0x3e	31	0x1c	53	0x41	75	0x67	97	0x73	119	0x3f
10	0x46	32	0x1b	54	0x49	76	0x64	98	0x72	120	0x47
11	0x45	33	0x23	55	0x4a	77	N/A	99	0x70	121	0x4f
12	0x4e	34	0x2b	56	0x51	78	N/A	100	0x7e	122	0x56
13	0x55	35	0x34	57	0x59	79	0x61	101	0x7d	123	0x5e
14	0x5d	36	0x33	58	0x11	80	0x6e	102	0x74	124	0x57
15	0x66	37	0x3b	59	N/A	81	0x65	103	0x7a	125	0x5f
16	0x0d	38	0x42	60	0x19	82	N/A	104	0x71	126	0x62
17	0x15	39	0x4b	61	0x29	83	0x63	105	0x84	127	N/A
18	0x1d	40	0x4c	62	0x39	84	0x60	106	0x7c	128	N/A
19	0x24	41	0x52	63	N/A	85	0x6f	107	0x7b	129	N/A
20	0x2d	42	0x53	64	0x58	86	0x6d	108	0x79	130	N/A
21	0x20	43	0x5a	65	N/A	87	N/A	109	0x78	131	0x20
22	0x35	44	0x12	66	N/A	88	N/A	110	0x08	132	0x28
										133	0x30

- Control keys
- Function keys
- Typing (alphanumeric) keys
- Navigation keys
- Numeric keypad
- Indicator lights

Mouse

SECTION 7-9

Computer Mouse

- A computer mouse is a hand-held pointing device that detects two-dimensional motion relative to a surface. This motion is typically translated into the motion of a pointer on a display, which allows a smooth control of the graphical user interface.

Type of Computer Mouse

Types

- Mechanical mice
- Optical and laser mice
- Inertial and gyroscopic mice
- 3D mice
- Tactile mice
- Pucks
- Ergonomic mice
- Gaming mice

Logitech
Gaming Software
Middle Click (Button 3)
Middle Click (Button 3)
Restore Default Zoom
Right Click (Button 2)
Left Click (Button 1)
CTRL + C
Switch Profile
F10
CTRL + V
Next tab in Browser (C
Prev tab in Browser (C
CTRL + W
Back (Button 4)
Profiles
Profile 1
Profile 2
Profile 3
Profile 4
Profile 5
Pointer Settings
DPI Sensitivity Levels
1
Number of levels
800
0
0
0
0
Assign Default
200
5700
Report Rate
Choose a polling rate for your mouse (reports per second)
125
200
250
333
500
1000
Advanced
Power Mode
Power Saver
Restore Defaults
Logitech

Model Name	EC1 eVo Black	EC1 eVo White	EC2 eVo Black	EC2 eVo White	AM	AM-FG	FK	MiCO
Color	Black	White	Black	White	Black	White	Black	Black / Pink / Light Blue
Surface	Rubber	Glossy	Rubber	Glossy	Rubber	Glossy	Matte PP	ABS
Buttons	5	5	5	5	5	5	5	3
Left/Right	Right	Right	Right	Right	Left/Right	Left/Right	Left/Right	Left/Right
Sensor	Avago 3090	Avago 3090	Avago 3090	Avago 3090	Avago 3090	Avago 3090	Avago 3090	Avago 3305
DPI	450 / 1150 / 2300	450 / 1150 / 2300	450 / 1150 / 2300	450 / 1150 / 2300	450 / 1150 / 2300	450 / 1150 / 2300	450 / 1150 / 2300	400 / 800 / 1600
Report Rate	125 / 500 / 1000 Hz	125 / 500 / 1000 Hz	125 / 500 / 1000 Hz	125 / 500 / 1000 Hz	125 / 500 / 1000 Hz	125 / 500 / 1000 Hz	125 / 500 / 1000 Hz	500 Hz
Lift Distance	1.5mm ~ 1.8mm	1.5mm ~ 1.8mm	1.5mm ~ 1.8mm	1.5mm ~ 1.8mm	1.5mm ~ 1.8mm	1.5mm ~ 1.8mm	1.5mm ~ 1.8mm	1.8 ~ 2.0mm
Length	129mm	129mm	122mm	122mm	125mm	125mm	125mm	104mm
Width (top)	64mm	64mm	60mm	60mm	60mm	60mm	60mm	49mm
Width (medial)	60mm	60mm	56mm	56mm	58mm	58mm	55mm	59mm
Width (Bottom)	69mm	69mm	65mm	65mm	64mm	64mm	64mm	51mm
Height	41mm	41mm	41mm	41mm	38mm	38mm	36mm	35mm
Weight (w/o cable)	97g	97g	93g	93g	88g	88g	85g	68g

Mechanical Mouse

Trackball Mouse

Ergonomic Mouse

Optical Mouse

Razer Laser Mouse

Mouse Connection

- Serieal
- PS/2
- USB
- Wireless
- Blue Tooth

Lagava
lagava

L1
L3
L2
Screen
L6
L4
L5
Li: 6 IR-Leds

MouseOut
MouseEnter
MouseUp
MouseOver
MouseDrag
MouseDown

Power Supply

SECTION 7-10

CORSAIR
VS650

1 x 20+4 PIN
(20 Pin or 24 Pin)
Included

1 x P4 12v
Included

1 x Floppy
Included

3 x SATA
Included

3 x Molex
Included

If you need any of the following connectors please tell us!
This power supply does not include them

Dell AT 6 Pin Aux
Not Included

HP Video 4 Pin
Not Included

PCI-E (PCI Express)
Not Included

ATX 20-pin
power connector

ATX 4-pin 12V
power connector

Molex 4-pin
peripheral connector

6-pin
auxilliary connector

6-pin PCI Express
power connector

Serial ATA
power connector

ATX 24-pin
power connector

Berg 4-pin
peripheral connector

8-pin PCI Express
power connector

Software

LECTURE 8

Bringing the Machine to Life – What is Software?

- Software is a set of electronic instructions that tells the computer how to do certain tasks. A set of instructions is often called a program.
- When a computer is using a particular program, it is said to be running or executing the program.
- The two most common types of programs are system software and application software.

DATA
2590
2970
3260
Real-world tasks
APPLICATION SOFTWARE
SYSTEM SOFTWARE
Useful output
SALES

Application Software
Spreadsheets
Word processors
Databases
Computer Games
Internet Browsers
System Software
Operating System
Utilities
Hardware
CPU, disks, mouse, printer, etc.

Application Software vs. Operating System

SOFTWARE
System Software
Application Software
Operating Systems
Utility Programs
Disk Defrag
Firewall
Language Translators
Assembler
Compiler
Interpreter
Library Programs
General-Purpose Applications
Word Processor
Spreadsheet
Special-Purpose Applications
Web Browser
Accounts Management
Bespoke Applications

UTILITY SOFTWARE
HYPERVISORS
BOOTLOADERS
GNU
BIOS
MULTI THREADING
LINKERS
SYSTEM SOFTWARE
Bio-tech
PSP
SYSTEM INTERNALS
KERNAL PROGRAMMING

System Software

- System software exists primarily for the computer itself, to help the computer perform specific functions.
- One major type of system software is the operating system (OS). All computers require an operating system.
- The OS tells the computer how to interact with the user and its own devices.
- Common operating systems include Windows, the Macintosh OS, OS/2, and UNIX .

Application Software

- Application Software consists of programs that tell a computer how to produce information
- Application software tells the computer how to accomplish tasks the user requires, such as creating a document or editing a graphic image.

Application Software

Word processing programs
Database management
Graphics programs
Web design tools and browsers
Communications programs
Entertainment and education
Spreadsheet software
Presentation programs
Networking software
Internet applications
Utilities
Multimedia authoring

System Software

SECTION 8-1

Operation Systems

An operating system (OS), in its most general sense, is software that allows a user to run other applications on a computing device. While it is possible for a software application to interface directly with hardware, the vast majority of applications are written for an OS, which allows them to take advantage of common libraries and not worry about specific hardware details.

The operating system manages a computer's hardware resources, including:

- Input devices such as a keyboard and mouse
- Output devices such as display monitors, printers and scanners
- Network devices such as modems, routers and network connections
- Storage devices such as internal and external drives

The OS also provides services to facilitate the efficient execution and management of, and memory allocations for, any additional installed software application programs.

Functions of Operating System
01 Memory Management
02 Device Management
03 Processor Management
04 Security
05 Error Detection
06 Coordination Between S/w and User
07 Job Accounting
08 File Management

Application Software

SECTION 8-2

Application Software

Application Software consists of programs that tell a computer how to produce information. Some of the more commonly used packages (Office tools) are:

- Word processing
- Electronic spreadsheet
- Database
- Presentation graphics

Word Processing

- Word Processing software is used to create and print documents. A key advantage of word processing software is that users easily can make changes in documents.

Spreadsheets

- Electronic spreadsheet software allows the user to add, subtract, and perform user-defined calculations on rows and columns of numbers. These numbers can be changed and the spreadsheet quickly recalculates the new results.

Microsoft Excel - College Resources and Expenses3

College Cash Flow Analysis

Resources

	Freshman	Sophomore	Junior	Senior	Total
Financial Aid	$ 5,025.00	$ 5,326.50	$ 5,646.09	$ 5,984.86	$21,982.45
Job	1,525.00	1,616.50	1,713.49	1,816.30	6,671.29
Parents	2,600.00	2,756.00	2,921.36	3,096.64	11,374.00
Savings	1,100.00	1,166.00	1,235.96	1,310.12	4,812.08
Total	$ 10,250.00	$ 10,865.00	$ 11,516.90	$ 12,207.91	$44,839.81

Freshman Resources

Expenses

	Freshman	Sophomore	Junior	Senior	Total
Clothes	$ 540.00	$ 572.40	$ 606.74	$ 643.15	$ 2,362.29
Entertainment	725.00	768.50	814.61	863.49	3,171.60
Miscellaneous	355.00	376.30	398.88	422.81	1,552.99
Room & Board	3,480.00	3,688.80	3,910.13	4,144.74	15,223.66
Tuition & Books	5,150.00	5,459.00	5,786.54	6,133.73	22,529.27
Total	$ 10,250.00	$ 10,865.00	$ 11,516.90	$ 12,207.91	$44,839.81

Freshman Expenses

Database Software

- Allows the user to enter, retrieve, and update data in an organized and efficient manner, with flexible inquiry and reporting capabilities.

Presentation Graphics

- Presentation graphic software allows the user to create documents called slides to be used in making the presentations. Using special projection devices, the slides display as they appear on the computer screen.

CLASSIFICATION:

The classification of application software are:-

1. INFORMATION WORKER SOFTWARE
2. CONTENT ACESS SOFTWARE
3. MULTIMEDIA SOFTWARE
4. EDUCATIONAL SOFTWARE
5. ENTERPRRISE SOFTWARE
6. SIMULATION SOFTWARE
7. PRODUCT ENGINEERING SOFTWARE

Business Intelligence
Billing & Service Provisioning
Content/Document Management
CRM, Marketing & Sales Software
Database & File Management
Dev. Tools, IT Asset Mgmt & App. Testing
Accounting
Telecommunications
Retail
Insurance
Govt / A&D
Education & Computer Based Training
Electronic Design Automation
Engineering, PLM & CAD/CAM
Enterprise Resource Planning
Other Verticals
Entertainment
HR & Workforce Management
Messaging, Conferencing & Communications
Multimedia, Graphics, Digital Media
Networking & Connectivity
Security
Storage & Systems Management
Supply Chain Management & Logistics
Web Analytics
Wireless
Financial Services
Healthcare

Summary

LECTURE 9

Summery of Introduction to Computers

- A computer system has three main components: **hardware**, **software**, and **people**.
- The equipment associated with a computer system is called hardware.
- Software is a set of instructions that tells the hardware what to do.
- People, however, are the most important component of a computer system - people use the power of the computer for some purpose. In fact, this course will show you that the computer can be a tool for just about anyone from a business person, to an artist, to a housekeeper, to a student - an incredibly powerful and flexible tool.

Summery of Introduction to Computers

- **Software** is actually a computer program. To be more specific, a program is a set of step-by-step instructions that directs the computer to do the tasks you want it to do and to produce the results you want.
- A computer **programmer** is a person who writes programs. Most of us do not write programs, we use programs written by someone else. This means we are users - people who purchase and use computer software.