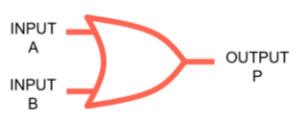


Computer Systems

Keyword	Definition
Hardware	The physical components that make up a computer system
Software	The non-physical programs that are stored by and run on a computer system
RAM	Random Access Memory
ROM	Read-only memory
Truth Table	Shows all possible combinations of inputs and the outputs they create
Logic Gate	AND, OR, NOT and XOR – used to build physical circuits
Embedded Computer	A single microprocessor that includes RAM, ROM and a CPU

Binary logic – OR gate

If either input is 1 (True) then the output is 1 (True)
Otherwise the output is 0 (False)



A	B	P
0	0	0
0	1	1
1	0	1
1	1	1

Logic statement: $P = A \text{ OR } B$
Or: $P = A+B$

Logic Diagram

Truth Table

Logic Gates and Symbols

Logic gate	Logic symbol	Example with logic symbols	Meaning
AND	.	$A.B$	A AND B
OR	+	$A+B$	A OR B
NOT	—	\bar{A}	NOT A
XOR	\oplus	$A\oplus B$	A XOR B

Compiler

A compiler translates a high-level language into machine code

- The code written by the programmer is called the source code



Binary logic – OR gate

If **just** one input is 1 (True) then the output is 1 (True)
Otherwise the output is 0 (False)



A	B	P
0	0	0
0	1	1
1	0	1
1	1	0

Logic statement: $P = A \text{ XOR } B$
Or: $P = A\oplus B$

Logic Diagram

Truth Table

Assembler

When assembly code is written it first needs to be translated into machine code

- An assembler translates assembly code to machine code



Binary logic – AND gate

If both inputs are 1 (True) then the output is 1 (True)
Otherwise the output is 0 (False)



A	B	P
0	0	0
0	1	0
1	0	0
1	1	1

Logic statement: $P = A \text{ AND } B$
Or: $P = A.B$

Logic Diagram

Truth Table

Binary logic – NOT gate

If 0 is input it outputs 1 (True)
If 1 is input it outputs 0 (False)



A	P
0	1
1	0

Logic statement: $P = \text{NOT } A$
Or: \bar{A}

Logic Diagram

Truth Table

Embedded vs Non-embedded

Feature	Embedded system	Non-embedded system
CPU speed	Typically slow	Typically very fast
Software	Has one purpose and cannot install new software	New software can be installed
Storage	Programs stored on ROM	Programs stored on hard drives
Reliability	Typically very reliable – e.g. a microwave should not have a bug that changes defrost to full power	As it runs many software programs it may be less reliable and need restarting the device

Operating System (OS)

Responsible for managing:

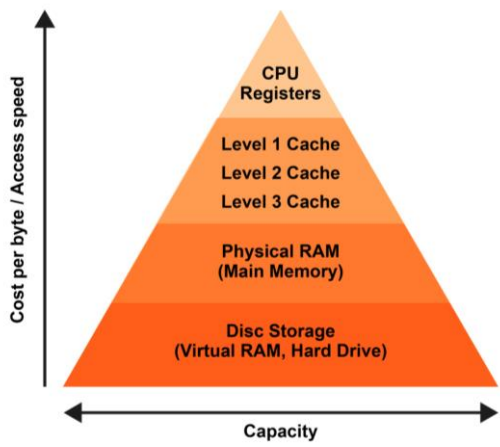
- Processor(s)
- Memory
- Input/Output (I/O) devices
- Applications
- Security

Utility Software

- Encryption software
- Defragmentation software
- Data compression
- Disk clean-up tools
- Disk formatters
- Anti-virus software

Computer Systems

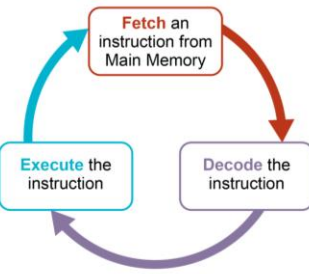
Levels of Cache memory



Fetch – Decode – Execute cycle

The CPU operates by repeating three operations:

- **FETCH** – causes the next instruction to be fetched from main memory
- **DECODE** – decodes the instruction to work out what the instruction is
- **EXECUTE** – the instruction is executed



This process is then repeated...

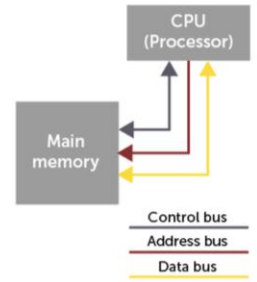
Secondary storage devices

- Blu-ray drive
- DVD drive
- CD drive
- Tape drive
- Removable flash media / USB stick / SD card

Buses

A bus is a set of parallel wires connecting two or more components of the computer

- When the CPU wishes to access a particular main memory location, it sends the address requested to memory on the **address bus**
- The data in that location is then returned to the CPU on the **data bus**
- Control signals are sent along the **control bus**



Memory and Storage

Main memory	Secondary storage
Volatile (RAM)	Non-volatile
Very fast to read/write	Slow to read/write
Expensive per GB	Cheap per GB
Stores data and programs currently in use by the computer system	Permanently stores data to be used when needed
Directly accessible by CPU	Not directly accessible by CPU

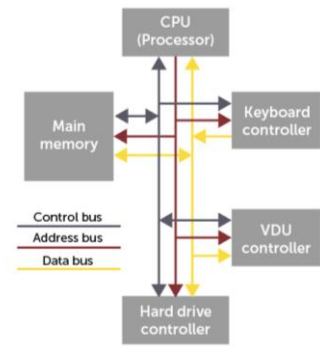
RAM vs ROM

Characteristic	RAM	ROM
Size	Typically 4 GB – 32 GB	Typically 4 MB – 8 MB
Used to store	Running programs and operating system	BIOS and bootstrap
Read ability	Yes	Yes
Write ability	Yes	No
Volatile	Yes	No

External buses

The CPU is also connected to the external Input-output device controllers by means of the system bus

- Only one device can transmit along a bus at any one time
- The address bus is one way only, from the CPU
- What about the data bus?



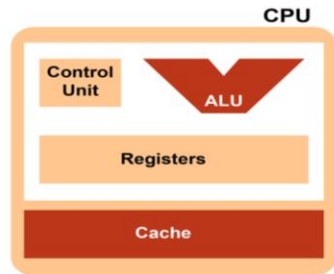
Components of the CPU

The CPU has two major components called the

- Control Unit
- Arithmetic-Logic Unit (ALU)

There are also registers that are used to carry out these operations

- A register is a very fast memory location in the CPU itself
- Cache is located on the CPU – it is slower to access than registers but faster than RAM



Storage methods

Magnetic: Mechanical parts move over the disks surface to read and write data magnetically, or a drive head reads a magnetic tape

Optical: Lasers read and write data using light

Solid State: Data is recorded onto solid memory chips without any moving parts



Storage types

Primary storage

- RAM and ROM

Secondary storage

- Hard Disk Drive (HDD)
- Solid State Drive (SSD)

Offline secondary storage

- Compact Disc (CD), Digital Versatile Disc (DVD) or BluRay
- Flash memory, SD cards
- Removable HDD or SSD
- Magnetic tape

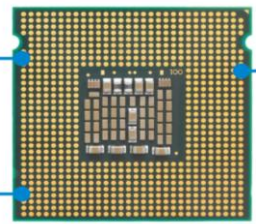
Factors affecting CPU performance

Clock speed

Cycles per second measured in hertz (Hz)

Cache size

Memory on the CPU that is faster than RAM but slower than registers



Number of cores

The number of duplicate processing units (cores) placed in one CPU