

Components/Processor Registers

Mother

The central interface for all the components of a PC. Everything connects to the motherboard via slots, wires, readouts and connectors.

Components/Processor Registers (cont)

Processor (CPU) A combination of registers than manipulate data between the registers. The speed of a processor is measured in the number of instructions it can complete per second (Hz). Modern computers speed is measured in GHz.

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Components/Processor Registers (cont)

Secondary Storage Used to store programs and data. It can be partitioned to allow for dual-booting multiple operating systems.

Components/Processor Registers (cont)

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Components/Processor Registers (cont)

Processor Structure



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Components/Processor Registers (cont)

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Components/Processor Registers (cont)

Arithmetic The ALU carries out arithmetic
Logic Unit calculations and comparisons.

(ALU) The result of any calculation is sent to the Accumulator

Components/Processor Registers (cont)

Control The CU controls the operation of
Unit the hardware, inc. input and
(CU) output devices, it controls the
Fetch-Decode-Execute cycle.



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Components/Processor Registers (cont)

Clock The clock is the part that regulates the cycle of the CPU. It provides a regular pulse of high voltage then low voltage. This high-low transition is a cycle, each cycle is an instru-

Components/Processor Registers (cont)

Program This register holds the address

Counter of the next instruction to be

(PC) executed, the PC is automatically implemented to the next instruction, unless the previous instruction was a jump.

Components/Processor Registers (cont)

Memory Buffer Values fetched from Register (MBR) memory are sent to MBR.



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Components/Processor Registers (cont)

Memory Address Register The location in memory of the current instruction/data

being fetched.

(MAR)

Components/Processor Registers (cont)

Current Instru-The instruction currently ction Register (CIR)

being executed/decoded

Components/Processor Registers (cont)

Data Carries the data between memory Bus and the MBR



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Components/Processor Registers (cont)

Address

Carries the memory location of the instructions/data being received.

Components/Processor Registers (cont)

Control A bus with 2 states, set or enable, Bus which govern if the data bus is

reading or writing to memory

Components/Processor Registers (cont)

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Components/Processor Registers (cont)

Fetch Decode Execute

Components/Processor Registers (cont)

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Components/Processor Registers (cont)

Fetch

The PC contents are copied to the MAR Instruction at address in MAR → MBR

MBR → CIR



Decode

Instruction is decoded into:

- Operand → The data to preform an instruction on
 - 2. Op-Code → The instruction



Execute

Instruction executed

If data is being committed to memory, its

held in the MBR

Cycle repeats until stop instruction

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Components/Processor Registers (cont)

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Components/Processor Registers (cont)

Factors affecting Processor Performance

Components/Processor Registers (cont)

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Components/Processor Registers (cont)

Multiple Cores The increase in number of cores, allows for a greater throughput of data. If the software is threaded - can use multiple cores - it will divide up tasks to the different cores. **However**, it must be coded in, else it will use the single core.

Components/Processor Registers (cont)

Cache Size

Cache is a small amount of very fast memory. Repeatedly used instructions and data is stored in the cache for quick access. The bigger the cache, the more can be stored on it thus reducing processing time

Components/Processor Registers (cont)

Clock Speed The clock regulates the instruction execution rate. The faster the clock, the more cycles completed per second.

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Components/Processor Registers (cont)

Pinelining

Where the stages of the F-D-E cycle are 'stacked' so that they can be processed at the same time. While one instruction is being fetched, the previous is being decoded. This may not necessarily increase processing time but throughput is increased.

lssues

- If an instruction requires the result of a previous instruction, the CPU will remain dormant
- → leading to 'bubbles'/pipeline stalls in the pipeline.
- Jumps
 lead to the pipeline having to be flushed due to the change in instructions

Hyper-Threading → Where the CPU is intelligent enough to fill the bubbles caused by pipeline stalls with other non-dependant instructions from separate threads.

Components/Processor Registers (cont)

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Components/Processor Registers (cont)

Processor Architecture



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Components/Processor Registers (cont)

Components/Processor Registers (cont)

Von-Neuman The Von-Neumann architecture is commonly used in most PCs. It stores both programs and data in the same memory. Using the F-D-E cycle, it carries out a single instruction at a time.

Pros

- + More Robust than Harvard (older)
- + Single Storage

Cons

- Each Instruction takes 2 cycles (fetch/decode and execute)
- Cannot implement pipelining

Components/Processor Registers (cont)

Harvard

The Harvard architecture stores programs and data in **separate** memory and uses the control unit at the centre of the structure. Generally used in embedded systems.

Pros

- + Can complete an instruction in a single clock cycle (assuming pipelining is used)
- + Modern
- + Can implement pipelining

Cons

- Separate Memory

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Components/Processor Registers (cont)

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Components/Processor Registers (cont)

Components/Processor Registers (cont)

RISC/CISC

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Components/Processor Registers (cont)

CISC CISC (Complex Instruction Set Computing)

- One instruction can complete an entire sequence more complex
- Higher Power Consumption
- Powerful
- Generates more heat

Components/Processor Registers (cont)

RISC RISC (Reduced Instruction Set Computing)

- Only one value fetched/stored per instruction cycle
- Less Power Required
- Used in smaller devices (Smartphones)
- Generates less heat requires less cooling methods

Components/Processor Registers (cont)

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Components/Processor Registers (cont)	Components/Processor Registers (cont)	Components/Processor Registers (cont)	
Flynn's Taxonomy	=	SISD	Single Instruction, Single Data-s-
			tream
			Single Core CPUs
			NB:
			No parallelism
			Single CU, fetches single instru-
			ction



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Components/Processor Registers (cont)

SIMD Single Instruction, Multiple Data-streams
GPUs

NB:

- One instruction preformed on many data-streams
- Naturally parallelised operations
- Examples: Fractal Rendering, Graphics Processing (hence GPUs)
- each pixel is independant

Components/Processor Registers (cont)

MIMD Multiple Instructions, Multiple Data-streams

Multi-core CPUs

NB:

- Multiple autonomous processors simultaneously executing different instructions on different data
- Uses either one shared memory space or a distributed memory space.

Software Generation

Specific Application A piece of software that has a specific purpose, such as order entry, payroll, stock management etc. It may be **Bespoke** (made to order) or **Off-the-shelf** (designed to be used in a variety of situations).

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Software Generation (cont)

General Purpose Application An application that allows the user to produce their own solution to a problem. Most are sold as a package/a license.

Examples

- Word Processing
- Desktop Publishing
- Spreadsheets
- Database Management
- CAD/CAM
- · Presentation Software

Specific Examples

- Microsoft Office
- Adobe Suite

Software Generation (cont)

Open
Source vs.
Closed
Source

Open Source → Source code is readable to anybody and freely modifiable.

Closed Source →

Executable only, source code is kept hidden.

Pros of OS

- Free (usually)
- Community Coding/Bug
 Fixing Usually faster than any closed-source
- Customisable
- Freedom to do what you like

Pros of CS

- Professional Development
- · Lower security risks
- Well documented and customer support

Software Generation (cont)

Translator Software Software that convert one programming language into another. There are 3 catagories: Compilers, Interpreters and Assemblers.

Assemblers > Convert
Assembly into machine
specific machine code.
Assembly language consists of
mnemonics that represent
different instructions. It is
converted to binary (machine
code)

Interpreters → Checks and executes code line by line.

Compiler → Checks all the codes syntax, semantics and logic and then converts the code into Object code (usually machine code or similar low-level). The compiled code is usually what is distributed.

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Software Generation	(cont)
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Software Generation (cont)

Stages of Compilation

Software Generation (cont)



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Software Generation (cont)

Lexical Analysis



Software Generation (cont)

Firstly the code is striped of anything uneeded such as comments and redundant whitespace

The code is then divided into Lexemes (the smallest 'unit' of code).

Tokens are then assigned to each lexeme indicating what it is. Some token examples:

- Identifiers for variables, subroutines, classes etc.
- Keywords new, if, for, while etc.
- Operators +, , / , == etc.
- Literals fixed numbers and strings
- Symbols {}, (), ; etc.

Errors are caused when a lexeme cannot be assigned a token

Software Generation (cont)

Syntax Analysis



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Software Generation (cont)

The stream of tokens generated is then analysed to check they match the rules of the language. Tree data structures are often used in this process.

An example of valid syntax would be:

String word = "Hello, World!";

Datatype Literal Operator StringLiteral
Symbol

Errors occur when a series of tokens cannot be matched to a rule, such as multiple datatypes.

Software Generation (cont)

Semmantic Analysis



Software Generation (cont)

The stage where code is checked for logical errors. For example:

- Datatype mismatch assigning a String to
- Undeclared Variables, or out of scope variables
- Multiple variable declarations
- Array out of bounds with an integer literal.

Errors occur when one of the rules are broken. NB Not all semantic errors can be caught during compilation. For example accessing an array with a integer variable is logically fine, but the integer value may be out of bounds causing a run-time error.



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Software Generation (cont)

Intermediate Code Generation/Optimisation



Software Generation (cont)

The code is then converted into intermediate code (Java to Java bytecode, where it remains until use - not all languages do this)

Intermediate code is machine independent

The code is then optimised, so that it runs faster and requires less resources, but still having the same output.

Software Generation (cont)

Machine Code Generation/Optimisation



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Software Generation (cont)

The final stage of compilation is the conversion to machine code. This process has to be repeated for each processor as it is machine dependant. Specific optimisations are also done on the separate processors as code that works well with one instruction set may not work as well with another.

Libraries, Linkers and Loaders



Library → Generic name for a collection of programs used in development. Some languages have native ones. Saves time as the developers don't have to create their own code.

Linker → Combines object and library filesLoader → Loads the object code into memory to be executed

Testing Strategies

Black Box (Alpha) Testing that examines the functionality of a application, without looking at its internal code/structures.

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Testing Strategies (cont)

White Box Tests the internal structure/workings of a application rather than its functionality (opposite of black box)

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Testing Strategies (cont)

Top Testing of modules and sections of Down code that aren't yet implement. Testing the behaviour between

modules.

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Testing Strategies (cont)

Top Testing of modules and sections of Down code that aren't yet implement. Testing the behaviour between

modules.



Testing Strategies (cont)

Up

Testing each part of the application individually then testing the parts that rely on the section/module.

Testing Strategies (cont)

Usability (Beta) Testing how easy a system is to use by testing it with real users. It shows how somebody without a working knowledge of the application would use the system and any problems they might find.

Testing Strategies (cont)

Test A range of test data must be used to

Data properly test a system. It should include:

- Normal Data
- · Boundary Data
- Standard Incorrect Data incorrect data that could easily be entered
- Standard invalid data e.g. text into numeric fields
- Extreme data data that would never be entered normally, used to test the limits of a system



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ООР		OOP (cont)	OOP (cont)	
at	'blueprint', a combination of ttributes and methods that create n object.	Object An instance of a class.	Encaps Where attributes and methods ulation are wrapped in their objects. Access modifiers control how the methods and the attributes can be accessed, whether that be by any class, or only within its own class.	
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OOP (cont)

Inheri tance A relationship among classes where a child class shares method-s/attributes with its parent class. The child classes can also have their own independent attributes/methods but all child nodes share the ones inherited from the parent.

OOP (cont)

Abstract Class A class which contains attributes and methods like a normal class, but the class itself cannot be instantiated. An example is an Animal, you can write an abstract class, but you cannot create just an Animal.

OOP (cont)

Polymo rphism

A feature of a programming language that allows routines to use variables of different types at different times. For example, overloading constructors which behave differently depending on their parameters



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Web Technologies

HTML (Hypertext Markup Language) The standard language for displaying webpages. A HTML document starts with <!DOCTYPE html>

<html>

It consists of tags which are opened and closed <tag></tag>, Each document has a head and a body.

Web Technologies (cont)

<h1>{{ml}}<h2>...

Web Technologies (cont)

Link Text

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Web Technologies (cont)

Web Technologies (cont)

Normal Paragraph text

Web Technologies (cont)

CSS (Cascading Style Sheet) The standard way to style webpages, whether internal or externalised. Externalised stylesheets allow developers to keep design and content

completely separate.

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Web Technologies (cont)

JS (Java Script) JS is an interpreted code that adds interactivity to websites. It works on virtually all hardware and is used on nearly all websites. For example there are currently 300,000 JS repos on Github, Java has 200k

Web Technologies (cont)

Search Engine Indexing A search engine searches through webpages, for certain keywords and phrases. Problem Indexes are used, when a new document (webpage) is added, the words/phrases are tokenised, and added to the list.

Web Technologies (cont)

PageRank Algorithm Google's algorithm that calculates the weighting of webpages. All pages have an initial rank, but for each link, it gives a certain amount to the webpage linked. Other algorithms are also used to give pages different rankings depending on what the user is searching for.



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Web Technologies (cont)

Client-Side Processing Processing preformed in the browser, usually JS. This allows user entered data to be checked before sending it to the server, which reduces the load on the server. For example, ensuring an email has an @, or a password is a certain number of characters. Anybody can view the code for client-side processing, so its best for just verification

Web Technologies (cont)

Server- Processing performed on the Side server. The code is only Processing viewable to people with access to the server-files. It

processes requests and serves a webpage based on

the requests

L.O.R. (*) Question

Data Protection

Act

8 Principles:

 Personal data must be obtained lawfully and fairly

P.D. must be held for a specified purpose

3. P.D. must be adequate, relevent and not excessive

4. P.D. must be kept **up-to-date** and **accurate**

5. P.D. must not be kept longer

than necessary

P.D. must be processed in accordance with data subjects rights

7. P.D. must be kept securely

8. P.D. must not be transferred

outside the EU without

permission



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L.O.R. (*) Questions (cont)

Computer Misuse

Act

Level 1: Unauthorised Access

- Accessing secure parts of a computer, that they are unauthorised to access
- In organisations, accessing secure parts that are beyond your rights.

Level 2: Unauthorised Access with intent to commit a Crime

• Level 1 + intent to commit another crime.

Level 3: Unauthorised Modification

Includes intent to:

- Impair the operation of any PC
- Prevent or hinder access to a program
- Impair the operation of any program or reliability of data.

L.O.R. (*) Questions (cont)

Copyright,
Designs &
Patents Act

Protects individuals/organisations intellectual data. It protects:

- Income for the authors -Allows the author to license the data.
- Cost of creating the product
- some products can cost thousands to produce
- Quality of Produce pirates often alter products to bypass security
- Alteration Protection Altering programs can have unintended aftereffects.

L.O.R. (*) Questions (cont)

Regulation of Investigatory Powers Act This act allows government agencies, to request access to secure information. It makes provisions for:

- Interception of communication
- Acquisition and disclosure of data
- Surveillance
- Access to electronic data protected by encryption.



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L.O.R. (*) Questions (cont)
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L.O.R. (*) Questions (cont)

Moral/Ethical/Social Issues

L.O.R. (*) Questions (cont)

Computers in the Workplace

• Big Brother concern - an employer could watch over employees

Reduced Productivity employees can do multiple
things at once, which may
reduce productivity as
employees may 'waste' time



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L.O.R. (*) Questions (cont)

Automated
Decision
Making

Computers are starting to have the ability to make decisions based on input data. Usually it can be better than any human making the same decision. The issue is what happens when the wrong decision is made, who is to blame?

L.O.R. (*) Questions (cont)

Al This is the one of the biggest issues, as Al use is rising among recent years.

The issues are the same as automated decision making, but more issues arise when you consider cognitive/when is a computer considered alive?

L.O.R. (*) Questions (cont)

nment

The increase in use of computers = more RAW materials Another issue is the disposal of old parts/devices.

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L.O.R. (*) Questions (cont)

Censorship

Moral concerns are raised at whether the internet should be censored, would it be restricting the freedom of information. The issues arise when considering adult content, and piracy.

L.O.R. (*) Questions (cont)

Monitoring Behaviour It is possible to monitor what individuals are using a computer for, there is a moral issue when considering how much should an individual be monitored, and the issues based on a persons privacy.

L.O.R. (*) Questions (cont)

Personal Inform-

ation

Rises a privacy concern. Computers can now monitor peoples information and collect it. When does this become a

breach of privacy.



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L.O.R. (*) Questions (cont)

Breaking the law (C.D.P.) but people do it anyway.

L.O.R. (*) Questions (cont)

Offensive Computers are general

Material

purpose, what people do with them can be considered offensive/morally wrong e.g. cyberbullying, which can have drastic

Data Structures

Array A data structure used to whole elements of the same data type.



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Data Structures (cont)

1D An Array with a single dimension,Array i.e. it only has a given length

Data Structures (cont)

2D An array with 2 dimensions. It is
Array commonly used to represent
coordinates or a table, with the
indexes relating to rows/columns

Data Structures (cont)

3D An array with 3 dimensions. It is

Array used for representing 3D space so is also used for coordinates a lot.



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Data Structures (cont)

List

A data structure where each element in the list points to the next one. This makes is very easy to add/remove/reorder elements as only the pointer needs to change each time.

Data Structures (cont)

Queue

A First In, First Out (FIFO) data structure.

When coding a queue, there must be the possibility to:

- Check if the queue is full
- Read/Remove/Return an element from the front of the Q
- Place a new element at the end of the Q

Data Structures (cont)

Circular The end of a queue linking back

Queue to the beginning.

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Data Structures (cont)

Stack A First In, Last Out (FILO) data structure.

When coding a stack, there must be the possibility to:

- · Check if the stack is full/empty
- Read/Remove/Return an element from the top of the stack (pop)
- Add a new value to the top of the stack (push)

Data Structures (cont)

ph A set of nodes/vertices connected by edges.

Data Structures (cont)

Direction- A graph where the edges al-Graph have a direction.



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Data Structures (cont)

Bi-Directional A graph where the edges have 2 way directions. ↔

Graph

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Data Structures (cont)

ees A tree is a simple un-directed graph which contains no loops. A tree has a root where all other nodes/edges originate from

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Data Structures (cont)

Binary A tree where each node has a

Tree maximum of 2 sub-nodes. Nodes
with no child nodes are called
leafs, and the edges, branches.



Data Structures (cont)

Hash A table where the index system is Table the data the person is looking for,

but

Input/Output/Storage

Input A device (piece of computer

Device hardware equipment) that is used to provide data and control signals to an information processing system such as a computer or information appliance. Examples of input devices include keyboards, mouse, scanners, digital cameras and joysticks.

Input/Output/Storage (cont)

Output is any device used to send data

Device from a computer to another
device or user. Most computer
data output that is meant for
humans is in the form of audio or
video. Examples include monitors,
projectors, speakers, headphones

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and printers.



Input/Output/Storage (cont)
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Input/Output/Storage (cont)		
Memory		

Input/Output/Storage (cont)



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Input/Output/Storage (cont)

HDD/Ma gnetic Information is held in blocks consisting of tracks and sectors. Each block contains the same amount of information, therefore information is more dense closer to the centre.

Rotation Speed

- A HDD consists of a very fast spinning disk (5400 7200 rpm)
- A reading head is suspended above the disk due to the Bernoulli effect
- Due to fast speeds, the housing **has** to be evacuated

Capacity vs Cost

- Largest HDD avaliable ~ 12TB.
- Roughly 3p per GB. (£0.00000-0000027915 per Byte)

Input/Output/Storage (cont)

SDD/Flash

A storage medium that has no moving parts. It uses a data controller to control the read/write of data. 2 rules of the data controller:

- You can combine pages to form a block, but a block cannot overwrite individual pages
- 2. Before writing to a memory location, the page previously allocated must be erased.

Pros

- Low Latency Time
- Fast Transfer speed

Cons

More Expensive

Capacity vs Cost

- Largest: ~4TB
- Roughly 30p per GB (£0.00-0000000291625 per Byte)

Input/Output/Storage (cont)

Disc/ Optical A storage medium that uses binary pits to encode data. A laser is beamed at the disk and uses the diffraction of the light to detect a 0/1 (trough/peak).

Read-only: A laser is used to burn the disks, the data cannot be changed

Re-Writable: A dye is used where if a high temp is used, it will go opaque (creating a peak - 1) and if a higher temp is used it goes transparent (a trough - 0). The disk is now reusable.

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Input/Output/Storage (cont)

Speeds

Solid State: 200 to 2500 MB/s

Hard-Drive: 1030 MB/s
Optical (x1 Speeds):
- Blue-ray: 4.29 MB/s

- DVD: 1.32 MB/s - CD: 0.15 MB/s

Input/Output/Storage (cont)

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Input/Output/Storage (cont)

RAM The 'working' area of the computer.

Programs and data currently in use is stored in the RAM. On startup the BIOS loads the OS into the RAM.

Characteristics

- Random Access allows data items to be read or written in almost the same amount of time irrespective of the physical location of data inside the memory.
- Volatile → emptied on power down
- •~1-16GB

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Input/Output/Storage (cont)

ROM A permanent area of storage. The contents cannot be altered by software. Contents of ROM is written at manufacture

Characteristics

- · Read-Only Access
- Non-Volatile > retains data at power down
- Mainly used to store firmware or application software in plug-in cartridges.
- ~4MB
- Examples of ROM: Bootloader (BIOS/UEFI),

Input/Output/Storage (cont)

BIOS/UEFI Basic Input Output

System/Unified Extensible
Firmware Interface The BIOS
is preforms the hardware
initialisation during the
bootup, and provides runtime
services between the OS and
hardware. UEFI was
designed to be the successor
to the BIOS

Input/Output/Storage (cont)

Virtual Memory When the RAM is full, the OS uses some of the secondary storage as Virtual Memory. This means the computer can continue to run. Pages (blocks of data) are transferred to the virtual memory when not needed thus freeing up space, and returned to RAM when they are needed.



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Operating System

Operating System

Software that provides:

- Process Management
- Memory Management
- Device Management
- User Interface
- File Management

Fundamentally its software that manages/interfaces computer hardware and software

Operating System (cont)

Kerne

The very core of the OS that provides the interface between the user and the hardware. Applications use the kernel to send/receive data from hardware.

Operating System (cont)

Memory Management A OS must manage the computers memory including adding/removing programs and data from RAM, allowing multiple programs to be run at the same time. The OS also reallocates memory when it is no-longer in use (i.e. when a program is closed)

Paging vs Segmentation & Virtual Memory

- Segmentation. →

 Memory is split into
 variable sized blocks, and
 programs are segmented,
 with each segment being a
 logical divider. A segment
 table then maps segments
 onto memory blocks.
 Generally slower than
 paging due to the
 placement algorithm
- Paging. → RAM is split into fixed sized blocks frames. Programs are split into same-sized blocks pages. Any page can be placed in any frame, easy to allocate as all equal size.
- If the RAM is full. Pages are transferred to the secondary storage acting as memory - Virtual Memory. Pages are moved in/out as needed.
- Thrashing → is when pages are being constantly swapped between RAM and V.Mem. It can cause speed issues as the secondary storage's speed
 RAM's speed.



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Operating System (cont)

Interrupts

Interrupts are a form of error checking. If an error occurs, the interrupt is stored in a priority queue. After the next instruction has been executed, the interrupt queue is checked for any interrupt and the processor runs a set of instructions called the Interrupt Service Routine (ISR), with each interrupt having its own ISR. Before the ISR is run, the current values in the registers are stored, so that the processor can return to its previous position. Examples of interrupt types are:

- I/O Interrupt
 A status of a channel has changed, Occurs when an IO operation is complete or a device is ready.
- Timer Interrupt
 Allows the processor to preform tasks at intervals
- Program Check → Most commonly memory access violations - accessing memory that doesn't exist or is not in
- Machine Check
 when hardware

Operating System (cont)

Process Involve Management switchi

Involves the scheduling and switching of programs and threads. Modern PCs have 'multitasking' but it is just clever scheduling.

Operating System (cont)

Scheduling Techniques

First Come, First Served

As the name suggests.

· Poor Efficiency

Round Robin

Each process has a set number of processing time. Processor switches in a circular fashion

- · Easy Implementation
- · Can be inefficient
- Time can be lost waiting for inputs

Shortest Job First

The process with the shortest processing time is processed

 Long Process can be waiting a long time processor starvation

Shortest time remaining

The process with the shortest remaining processing time is processed. If another job with a shorter time remaining arrives, it will switch

- · Short jobs executed quickly
- · Starvation can still occur

Multi-Level Queue

Processes are given a priority when they arrive, dep. on their time remaining, process type and memory size.

Important jobs processed first

Multi-Level Feedback Queue

Same as a MLQ but the processor can change the priority of a process, most likely due to a process taking up too much processing time.

- Stops starvation
- · Allows interactivity
- · Priorities can be changed



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Operating System (cont)

Operating System (cont)

Device Management The OS can make devices acessible to other programs through the use of Device Drivers. It is a piece of software that controls the hardware and provides the interface so that programs and the OS can use the device. Devices cause interrupts on the processor and depending on its priority is when the interrupt is processed.

Waterfall Method



Each of the stages are classified as *milestones*. Following the methodology strictly would mean the system is developed flowing down the waterfall. Another version exists where there is iteration back up the steps.

Types of OS

Embedded

- Mostly hidden in devices, generally within the hardware themselves.
- · Built into objects
- · Have a dedicated purpose
- Little/no user interface
- Fully Autonomous
- Use limited resources only whats required

Multi-Tasking

- Several programs/processes at the same time (concurrent).
- Can either be process management or through parallel processing
- Most General Purpose OS' are now Multitasking

Multi-User

- Must be a multi-tasking OS too
- Several users accessing the processor/programs/resources at the same time.
- Usually a round robin approach.
- · Shared processing.

Real-Time

- Inputs being processed under strict time limits. For requirements:
- **1.** Support Non-Sequential programs
- 2. Handle parallel and unpredictable events
- **3.** Produce responses within the time limit
- **4.** Have fail-safes to guarantee response time

Distributed

A collection of independent nodes, each with its own hardware. The OS presents the systems as an individual. For example: AI; Weather Forecasting; Online Shopping. Each may have the main system on one server, and other things processed on another. The pros of this are that it reduces the load on one computer, and if one fails, it may be able to continue.



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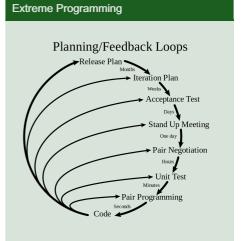


1.Determine objectives Progress 2. Identify and resolve risks Progress 2. Identify and resolve risks Progress 2. Identify and resolve risks Progress 4. Plan the next iteration Release Release 3. Development and Test

The method starts in the centre and spirals outwards. The purpose is to eliminate/reduce any project failures by constantly returning to each of the milestones. The review stage is where the client is consulted with to determine the progress.



This development methodology requires minimal documentation, but requires a high amount of involvement of the client as a prototype is created, then reviewed then improved upon.



This is one on the agile approaches to software development. It allows for client changes throughout the life cycle and the constant review of progress and client involvement give it its name as 'extreme'.

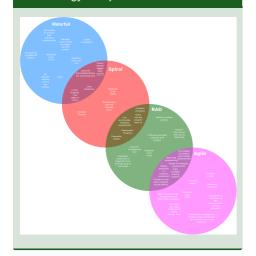
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Methodology Comparison



Programming paradigms

Object Code is divided into objects

Orientated which possess state and behaviour. Follows the principles of encapsulation, abstraction, inheritance and

polymorphism.

Programming paradigms (cont)

Logic The code consists of a series of rules which define a scenario.

Answers can be obtained by asking questions in a specific format.



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Programming paradigms (cont)

Data Query Languages Queries to a database or other data structure are specified by what is wanted rather than how to get it.

Programming paradigms (cont)

Scripting Co

Code is written to automate processes rather than create entire applications. Scripting languages are often embedded into other systems.

Programming paradigms (cont)

Procedural

Allows structured programming with sequence, selection, iteration and recursion. Code can be made modular with the use of procedures.



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Programming paradigms (cont)

Functional

Code is divided into isolated functions. There is no global state, only arguments and return values are important. Closely linked to mathematics.

Programming paradigms (cont)

Assembly Languages

One to one correspondence between lines of code and processor instructions. Unlike raw machine code however, you can have variable names and labels.

Compression

Lossless Compressing a file without the

loss of data



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Compression (cont)

Lossy

Compressing a file by removing redundant data.

Compression (cont)

Run RLE identifies repeating
Length patterns of data and stores a
Encoding copy of the information and
(RLE) how many times it occurs in
succession.

Compression (cont)

Dictio Uses a substring search to match nary-strings in the file to be compressed to those stored in a dictionary. If a match is found then the string is substituted for the dictionary index. If no match is found, the string is

added to the dictionary



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Encryption and Hashing

Symmetric Encryption that uses the same Encryption key to both encrypt and

decrypt.

Uses: Encrypted Harddrives

Encryption and Hashing (cont)

Asymmetric Encryption where different Encryption keys encrypt and decrypt the

data.

Uses: Online transactions

Encryption and Hashing (cont)

ication

ClientServer
Key and uses the public key to
Communer
Co

The server decrypts the session key with the **private**

key **↓**

Client-Server now communicate using **symmetric encryption with the session**

key

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Encryption and Hashing (cont)

Private The private key consists of 2 very large prime numbers Key

Encryption and Hashing (cont)

Key

Public The public key is the product of the 2 prime numbers making the private key. As no efficient non-quantum integer factorisation algorithm exists, it is practically impossible to crack the private key by brute force.

Encryption and Hashing (cont)

Using an algorithm to map data of any size to a fixed size. Unlike encryption, hashing cannot be undone, it is therefore a lossy process.

Uses:

- Rapid data access in a hash table
- Error checking and corruption detection - such as downloads
- · Password verification the plain-text password would not have to be stored

A good hash algorithm.*

- Same message = Same hash
- · Quick to compute
- Impossible to generate a message from the hash
- A small change = a big hash change
- Impossible to find 2 messages with the same hash

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Databases

Database A structured system to hold

Databases (cont)

Relational a database structured to

Database recognize relations between stored items of information.

Databases (cont)

Flat File A flat file database is a

Database database that stores data in a plain text file. Each line of the text file holds one record, with fields separated by delimiters, such as commas or tabs.

While it uses a simple structure, a flat file database cannot contain multiple tables like a relational database can.



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Databases (cont)

Entity Any item about which data is stored e.g. Student, Pizza, Stock etc.

Databases (cont)
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Attribute A feature of the entity

Databases (cont)

Foreign A unique identifier to each record

Key held in the relational database.



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Databases (cont)

Composite A combination of 2+ fields
Primary Key that act as a primary key

Databases (cont)

Foreign A way to build a relationship

Key between 2 tables, the foreign key
is another tables primary key

Databases (cont)

Secondary A key that is indexed to allow
Key for faster searching. There
can be multiple secondary
keys and they don't have to
be unique.



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Databases (cont)

Inner Combining columns from one+
Join tables by using values common to

each.

SELECT table1.column1, table2.column2... FROM table1 INNER JOIN table2

ON table1.common_field = table2.common_field;

Databases (cont)

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Databases (cont)

Normal Forms



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Databases (cont)

 \equiv

Databases (cont)

 1NF • Each row is unique - it has a primary key

- Each column has a unique name
- No columns with similar or repeated data (i.e. choice1, choice2 etc.)
- Each data item cannot be broken up any further no commas in the data

Databases (cont)

2NF • 1NF

• If the primary key is a composite of attributes (contains multiple columns), the non-key attributes (columns) must depend on the whole key.

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Databases (cont)

- 3NF 1NF
 - 2NF
 - There are no non-key attributes that depend on other non-key attributes

Databases (cont)

 \equiv

Databases (cont)

CRUD



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Databases (cont)

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Databases (cont)

CREATE INSERT INTO tableName (fieldNames) VALUES (values)

Databases (cont)

READ SELECT fieldNames FROM tableName WHERE fieldName = value ORDER BY fieldName

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DELETE FROM tableName

where fieldName = value

Databases (cont)

UPDATE UPDATE tableName SET

fieldName = value WHERE fieldName = value

DROP tableName

Databases (cont)

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Databases (cont)

DESTROY



Databases (cont) ACID Principles (Transactions)		Databases (cont)	Databases (cont)
		=	Atomicity Transactions are either done or not done. Never partially applied
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Databases (cont)

Consis Referential Integrity and other tency constraints must be adhered to

Databases (cont)

Dilation Transactions preformed simultaneously must have the same result as if they were preformed sequentially

Databases (cont)

Durability Transactions that have been committed must be done fully and remain so.



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Databases (cont)	
	≡

Databases (cont)

Concurrent Accessing

Databases (cont)



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Databases (cont)

Concurrent Access Is ensuring that more than one user can at least view data at the same time.

Databases (cont)

Record Making a file read-only to

Locking anybody else who opens the file
while changes are being made.

Databases (cont)

Deadlock

When 2 separate transactions lock the file the other transaction needs, thus both are in a state of waiting.



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Databases (cont)

Serialisation Create a clone of the data item, so the user can make changes, then upload a copy of the clone to the database. This will ensure that no updates or changes can be lost due to uploading a copy of the local version.

Databases (cont)

Timestamp Ordering A non-lock way of concurrent access, so multiple people can access the data at one time. The main process is that the lower timestamps occur first.

Networks

Standard

A definition or a format that has been approved by a recognised standards organisation. **de jeur** (by force of law) or **de facto** a standard that has just been accepted over time



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Networks (cont)

Protocol An agreed-upon format for exchanging data between devices. It determines:

- The error checking used
- · Compression method, if any
- · How the sender will indicate end of transmission
- · How the receiver will indicate the data has been received.

Networks (cont)

LAN Local Area Network

- Geographically Small (buildings/a
- Equipment is generally owned by the company/people using it
- · Generally Faster
- Uses layers 1 and 2 devices hubs/switches

Networks (cont)

WAN Wide Area Network

- · Geographically remote (across a country/between continents/the w.w.w.)
- · Connects LANs together with third party telecommunication equipment
- · Slower speed than LAN
- Uses layer 3 devices routers/multi-layer switches



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Networks (cont)

Network Topologies

Bus Topology

- All devices connected to a central cable (backbone)
- Devices have equal rights
- Collisions can occur if multiple devices send data at once

Star Topology

- A hub at the centre of the network. Requests are sent to all other devices connected to is
- The hub reads the packets and determines the MAC address of the recipient

Ring Topology

- A token is passed around the ring until one of the devices requests to use it.
- The token is filled with the frame of data
- It is passed around the network to each device until it reaches the recipient
- Recipient acknowledges the data has arrived.

Networks (cont)

Client-Server

- One entity (client) requests services from another (server)
- Server stores security information e.g. logins and permissions.

Pros

- + Centralised control
- + Single data storage
- + Easy backing up and restoring
- + Remote access
- + Can define security rights and permissions

Cons

- Too many requests can cause congestion
- If the server fails, whole network goes down
- Expensive to install and manage
- Requires professionals to install and manage

Networks (cont)

Peerto-Peer

- All computers have equal rights and act as both a client and server
- Popular applications include the BitTorrent Network, and BitCoin

Pros

- + Easy to set up
- + More reliable as central dependencies are eliminated
- + No-need for a system administrator as every user is the admin of their machine
- + Cheaper to implement and maintain.

Cons

- Difficult to administor as there is no central dependency
- Less security therefore viruses and other malware can easily be transmitted
- Data recovery is difficult as there is no central storage, each computer requires ots own backup system
- "(Lots of movies, tv shows and music are transferred using P2P, via torrents)"



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Networks (cont)

Packet Switching A message/data is broken into a number of parts (packets) which are sent independently, over whatever route is optimum for each packet, and reassembled at the destination.

Pros

- + Efficient use of a network
- + Can easily circumvent broken sections of a network
- + Network only has to increase slowly as demand does

Cons

- Time taken to rebuild packets is variable - an issue for time-sensitive data
- Not good for small data.

Networks (cont)

Circuit Switching Communication where a dedicated channel (or circuit) is established for the duration of a transmission.

Pros

- + Data arrives in order sent
- + No additional information has to be added e.g. headers

Cons

- Portion of the network is unavailable while in use
- Data is easily intercepted.

Networks (cont)

Domain A system that converts the web
Name address: www.website.somSystem ething into the IP address of the
(DNS) host server.

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Networks (cont)

MAC Address Unique 6-byte identifier that is given to NICs. Assigned to the NIC by the manufacturer.



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Networks (cont)

IPv4

Most commonly used IP version. Its a 32-bit system, so there are 2³² addresses available.

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Networks (cont)

IPv6 IPv6 is a 128-bit address, so there are 2¹²⁸ addresses available.



Networks (cont)		Networks (cont)	Networks (cont)
	≡	TCP/IP Stack	≡
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Networks (cont)

Application Layer

Networks (cont)

The Application layer ensures the data is sent in an understandable format by the recipient. It formats the data to meet the standards of the protocol.

Networks (cont)

Transport Layer



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Networks (cont)

The transport layer takes the data and splits it into data packets. Each one is given a number, specifying the order so it can be reconstructed. The port number is also added depending on the application being used for example HTTP is port 80.

Networks (cont)

Network Layer

Networks (cont)

The network layer is where the IP of the sender is attached, so the recipient can send a message saying the packets were received. It also attaches the recipients IP. This is also the layer where the Time To Live (TTL) is added to the header. It governs how many times the packet can hop before deleting itself, this ensure infinite loops don't occur.



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Networks (cont)

Networks (cont)

Networks (cont)

Link Layer

◆

This is the layer where the MAC address of both the sender and recipient is attached, allowing the packets to be directed to a specific NIC.



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Networks (cont)	Networks (cont)	Networks (c	Networks (cont)			
Internet/Network Protocols	≡	HTTP (Hypertext Transfer Protocol)	Defines how webpages are transferred from server to the client. The HTTP will make a request to the IP and the server responds with a webpage. There are 8 different HTTP commands including GET, POST and CONNECT*			

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Networks (cont)

HTTPS (Secure Hypertext Transfer Protocol) Connects via a different port and encrypts the data between the HTTP and the

TCP protocols.

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Networks (cont)

FTP The protocol used to download (File and upload files. Most modern Transfer browsers have built in FTP

Protocol)

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POP3 Allows emails to be received (Post from a server. The protocol Office connects to the email server, Protocol downloads a local copy then 3) deletes them from the server.



Networks (cont)	
SMTP (Simple Mail	Used for
Transfer Protocol)	sending emails

Networks (cont)				
SSH	Remote-access protocol, allows			
(Secure	secure communication between			
Shell)	a client and server			

Networks (Co	1111)
CSMA/CA	Is a transmission protocol
(Carrier	that prevents packet collis-
Sense	ions. Once it receives a
Multiple	packet, it checks whether the
Access	channel is clear, if it is not
with	available it will generate a
Collision	random wait time, when it will
Avoidance)	check again.
	If a packet is larger than the
	permitted size is needed to

permitted size is needed to be sent, a *handshake* needs to occur first - the RTS/CTS (Request to Send/Clear to Send) protocol. This protocol only occurs when the packet is larger than the threshold.



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Networks (cont)		Networks (cont)	Networks (cont)
	≡	Network Security	≡
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Networks (cont)

Virus A embedded program intended to cause damage to a PC. It copies itself onto the disk and hides itself. It attempts to duplicate itself and spread to other computers.

Networks (cont)

Worm A virus but it is contained within its own program.

Networks (cont)

A non-self-replicating virus hidden in a downloaded file, and unleashed on execution.



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Networks (cont)

Ransom Ware A trojan/worm that encrypts data and then charges the owner to decrypt it.

Networks (cont)

Firewall

The purpose of a firewall is to control the traffic flowing in and out of a network. It can be hardware or software based, and sometimes is a combination of both. It can be setup to block individual website addresses or specific computers.

Networks (cont)

Proxy Server f a user requests a service from the network, it is first passed to the proxy, before the proxy server then performs the request on the behalf of the network user. If the resource is banned the request can be rejected, There is never any direct contact between user and resource, as the proxy acts as a "middle man".



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Networks (cont) Networks (cont) Networks (cont) \equiv WPA/WPA2 **Network Hardware** It requires you to enter a password when accessing a network. It acts as layer of protection. By OllieC (OllieC) Published 20th February, 2019. Sponsored by CrosswordCheats.com cheatography.com/0lliec/ Last updated 12th June, 2017. Learn to solve cryptic crosswords! Page 81 of 100. http://crosswordcheats.com



Networks (cont)

 \equiv

Networks (cont)

It receives a signal from a node and transmits it to all the other nodes. It is cheap and effective for small networks but for larger networks causes too many collisions

Networks (cont)

A switch has a small amount of internal memory, that allows it to generate a look-up table. When data is sent the switch finds the appropriate node. Unlike a hub, it doesn't send the data to all the nodes, just the receiver.



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Networks (cont)

Router

A device that forwards packets from one network to another.

Networks (cont)

Gatewa

The entrance and exit of networks. The main use is to connect multiple networks with different architectures

Search Engines

Overall Search engine

Ill Crawling the web with 'spiders'
TF-IDF (Term Frequency Inverse Document Frequency)
The PageRank algorithm Other

factors, such as domain name, page age, mobile friendliness

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Search Engines (cont)												
4	7	4	4	4	4	4	4	4	4	4	4	
L												

Search	Engines	(cont)

Page PageRank works by counting the
Rank number and quality of links to a
page to determine a rough estimate
of how important the website is.
The underlying assumption is that
more important websites are likely
to receive more links from other
websites.

Data Types

Integer A whole number



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Data Types (cont)

Real/Float

Float is a term is used in various programming languages to define a variable with a fractional value.

Numbers created using a float variable declaration will have digits on both sides of a decimal point. This is in contrast to the integer data type, which houses an integer or whole number.

Data Types (cont)

Boolean A value with a True or False condition - can possibly use 0/1 instead

Data Types (cont)

Character A single keyboard/unicode character

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Data Types (cont)

String A set of characters, used to store text

Data Types (cont)

Date/Time A representation of time. Can be represented in either text

or number format

Data Types (cont)

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Data Types (cont)

Number Bases

Data Types (cont) Binary Groups of bits in 1 and 0 (2 (Base possible values). It uses positional

2)

numbering but with powers of 2, not 10 (denary numbers - normal)

Data Types (cont) **0→0000→0** Hexadecimal (Base 16) 1 → 0001 → 1 2 → 0010 → 2 $3 \rightarrow 0011 \rightarrow 3$ **4→**0100**→**4 5**→**0101**→**5 6 → 0110 → 6 $7 \rightarrow 0111 \rightarrow 7$ 8**→**1000**→**8 9**→**1001**→**9 10 **→** 1010 **→** A 11**→**1011**→**B 12**→**1100**→**C 13**→**1101**→**D 14**→**1110**→**E 15**→**1111**→**F



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Data Types (cont)

Normal number formats with the (Base positional numbering in powers of 10)

Data Types (cont)

Sign &

A form of showing negative Magnitude binary numbers where the first bit is the sign (0 = +ve, 1 = ve). Immediately you have reduced the range of values as one of the bits is reserved

for the sign.

Data Types (cont)

A improved way of showing negative numbers. If the first bit is Comp a 1, it is taken as the negative version, and all following numbers are added to it. If it is a zero, it behaves just like a negative number.

> To change a normal +ve binary number to twos comp. 4 Flip the bits, and add 1 4 E.g. 01101010 = 106 10010101 (Flip the bits) 10010110 = +1 10010110 = -106

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Data Types (cont)

Fixed Point Binary A method of showing floats. The decimal is **fixed** so there is a set amount of integer bits and a set number of fractional bits. The fractional parts follow the same positional numbering (powers of 2) but the negative versions i.e. 2⁻¹, 2⁻², etc.

Data Types (cont)

Point Binary A method of showing binary composed of 2 parts: the mantissa, and the exponent. The mantissa is the actual number, and the exponent is the number of units to move the floating point up or down by.

10101011 | 0011 Mantissa | Exponent

1.0101011 x 2 ⁰⁰¹¹
1.0101011 x 2³
1.0101011

 $\rightarrow \rightarrow \rightarrow$

1010.1011 = 10.6875

The rule for powers:

→

4

(Decrease the power, per jump right)

Data Types (cont)

Underflow

When **very** small numbers, and the boundary of what the computer can store is reached. For example, 128⁻¹ x 128⁻¹ requires 14 bits to be stored.

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Data Types (cont)

Overflow

A calculation that results in a number too large to be stored. For example, any numbers past x10¹⁰⁰ on most calculators

Logic Gates

Half Add two single bits, produces an Adder output S, and a carry signal C. It consists of an AND gate (C) and a XOR gate (S) in parallel.

Logic Gates (cont)

Adder

Full adders are a combination of 2+ half adders. Where the C of both half adders, connects to a OR gate (Cout) and the sum of one connects as the input of another. Basically treating the first HA as another input.



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Logic Gates (cont)

Basic Takes a set and a reset signal. The Flip- idea is that the FF stays in one Flop state until the change signal is sent.

Logic Gates (cont)

D (Data) Stores the signal it receives if it

Type Flip is enabled. It takes in an extra

Flop input D.

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