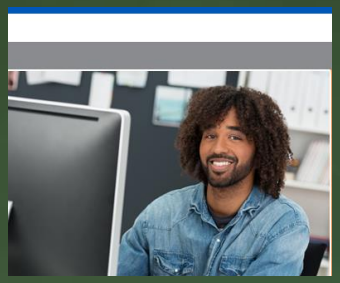
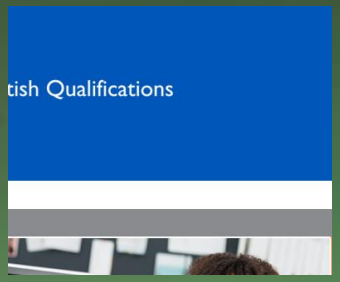
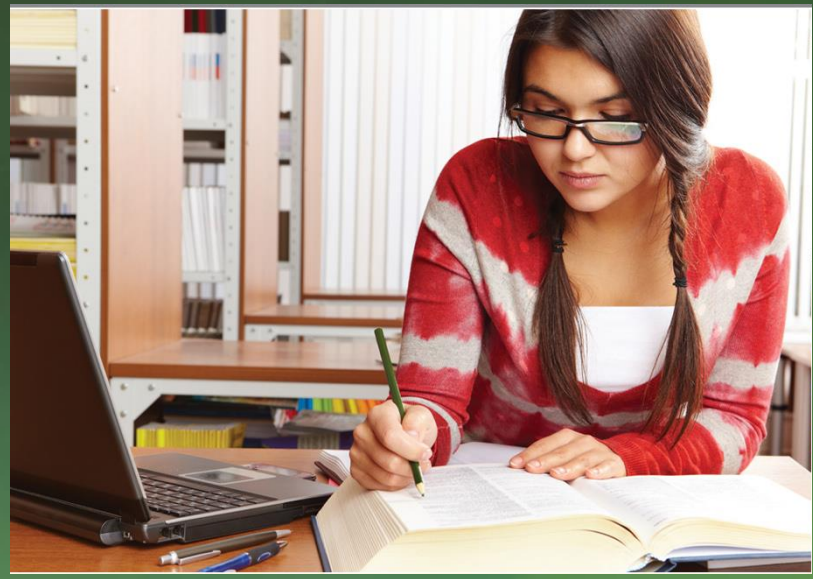
Awarding Great British Qualifications







Computer Systems

Topic 2: Environments, Functions of components and Health & Safety

Scope and Coverage

This topic will cover:

- The computer as stand-alone device
- The computer as networked device
- The network as internetworked component
- The architecture and components of a computer
- The architecture and components of a network
- Risks to computers, networks and humans

Learning Outcomes

By the end of this topic students will be able to:

- Explain the role of computer systems in different environments
- Compare different types of computer systems
- Build and configure a computer system to meet a design specification

Computing Environments

Computing Environments

- As we have seen, there are many types of computer
- There are also many differences in:
  - Users (skills, needs, expectations, etc.)
  - Applications (usage, functionality, performance)
  - Environments (scale, security, resilience, etc.)

Some are mutually exclusive, others overlap

Computing @ Home

- From the 1940s – 1970s, computing was for ‘work’.
- That changed in mid-1970s with first ‘home’ kits
- 1976: Apple 1 appears at ‘Homebrew’ Computer Club

  http://www.computerhistory.org/revolution/personal-computers/17/312

  http://www.atariarchives.org/deli/homebrew_and_how_the_apple.php
- Other early players were:
  - Atari (https://www.atari.com/about-us/)
  - Commodore (https://www.commodore.ca/commodore-history/chronological-history-of-commodore-computer/)
  - Sinclair (http://www.computinghistory.org.uk/det/896/sinclair/)

Computing @ Home

- These were not like (or called) ‘Personal Computers’
- Called micro-computers, home-computers etc
- Main use was for basic games such as ‘Pong’ and ‘Space Invaders’ – amongst many, many others…
- http://www.computinghistory.org.uk/det/4007/Atari-PONG/
- http://www.ponggame.org/
- http://www.classicgaming.cc/classics/space-invaders/history.php
- Get a full games listing here:
- https://www.video-games-museum.com/en

Computing @ Home

- Then came basic applications like word processors, spreadsheets, calendars, planners etc
  - ‘WordStar’ and ‘WordPerfect’

http://www.computernostalgia.net/articles/HistoryofWordProcessors.htm

‘VisiCalc’ and ‘Lotus 1-2-3’

https://www.poynter.org/reporting-editing/2015/today-in-media-history-lotus-1-2-3-was-the-killer-app-of-1983/

There was life before MS Office!

https://www.thewindowsclub.com/history-evolution-microsoft-office-software

Even now there are alternatives to MS Office:

- Apache OpenOffice (https://www.openoffice.org/)
- LibreOffice (https://www.libreoffice.org/)

Computing @ Home

- Then in 1980s came the IBM ‘PC’ and all the ‘PC clones’
- Followed by MS Windows, then MS Office and other stuff
- From then on, Microsoft dominates the home computer
- Apple remains a niche player for graphic designers, artists and other high-end users

Computing @ Home

Summary of domestic computing: 1970s onwards…

Computing @ Work

- Computing at work has a much longer history
- By 1950s, computing was heavily used by the larger corporations, governments and universities
- 1951: First ever UK commercial computer was ‘LEO’
- http://www.leo-computers.org.uk/
- http://www.telegraph.co.uk/technology/news/8879727/How-a-chain-of-tea-shops-kickstarted-the-computer-age.html
- This trend grew fast until it ‘trickled-down’ to smaller companies so by 1980s almost every organization used computers

Computing @ Work

- Organisations have different needs than individuals
- Organisations want the following from computing:
  - Efficiency – to drive down costs by cutting staff
  - Power – to increase speed of business processes
  - Scalability – so the technology grows with business
  - Return on Investment – costs must recoup savings
  - Flexibility – so it can support/replace/enhance man aspects of the organisation – not just local issues

Computing @ Work

- Computers are very good at calculations
- They never get tired and never make mistakes – assuming the software is written correctly
- They are infinitely faster and more reliable than human ‘computers’ on basic computations
- No surprise then that early adopters were banks, insurance firms and other organizations with large ordering, supplying and logistics workloads

Computing @ Work

- Typical applications included:
  - Stock control and logistics
  - Calculating invoices, wages and supplier payments
  - Computing bank balances and insurance premiums
- Also used heavily for:
  - Scientific calculations in university research
  - Government statistics of all kinds

Computing @ Work

- Huge advances in hardware technology:
  - Data storage (core memory, hard disk, tape, etc.)
    http://www.computerhistory.org/timeline/memory-storage/
  - Processor speeds
    https://www.computerhope.com/history/processor.htm
  - Communications & networking
    http://www.computerhistory.org/timeline/networking-the-web/
  - Plus, advances in software:
    http://www.computerhistory.org/timeline/software-languages/

Computing @ Work

Summary of organisational computing: 1950s

Computing @ Play

- We have already seen that the key reason most people bought a computer in the 1970s and early 1980s for the home was to play games
- However, as we entered the 1980s and the ‘PC’ arrived, people started to use it more for ‘proper’ reasons like spreadsheets and word processors
- This was largely because PCs were expensive and most people needed to justify such a large expense

Computing @ Play

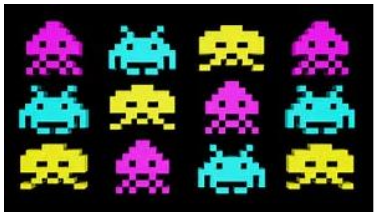
- Alongside the PC (which still supported a wide range of games as well as ‘proper’ applications) we see the emergence of ‘games consoles’
- The PC is a general-purpose computing device that allows you to play a game, type a letter or do the weekly shopping budget on a spreadsheet
- By contrast, the games console is a specialised device whose only function is to play games – it is thus very good at it – with optimised processors and graphics

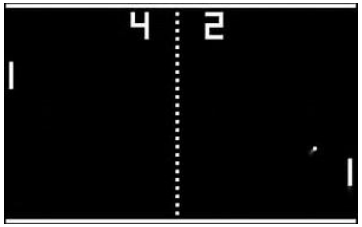
Computing @ Play

- The games industry went through various ‘generations’ as technology developed
  http://www.mobileindustryreview.com/2017/02/34149.html
  - Atari
  - Nintendo NES
  - Sega
  - Sony PlayStation
  - Microsoft Xbox

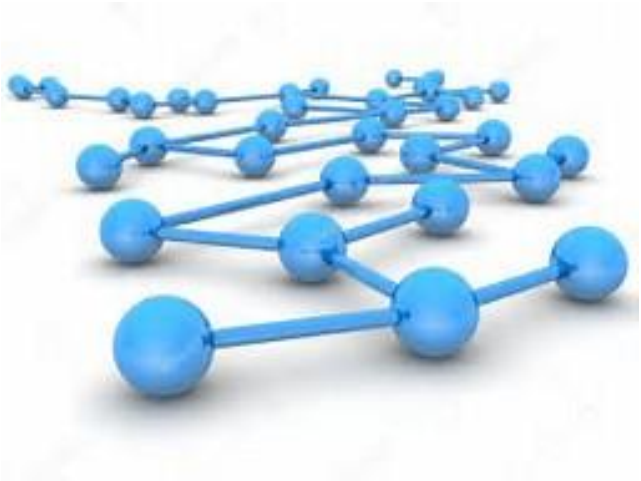
Computing @ Play

Summary of computer gaming: 1970s





Computing gets Connected



Computing Gets Connected

- No computer is an island!
- Networking computers brings many benefits:
  - Communication – email, chat, video conferencing, webinars
  - Sharing – email attachments, websites, FTP upload/download
  - Resource utilisation – networked printing, storage space
- Plus some risks:
  - More access points means more security risks
  - Networking permits faster and further transfer of malware
  - More technical skills required to set up and manage

Computing Gets Connected

- Any device with a NIC (Network Interface Card) and suitable software can be networked…
  - Server
  - Desktop PC
  - Laptop/Netbook
  - Games Console
  - Smartphone
  - ‘Smart’ TV
  - IP Telephones

Computing Gets Connected

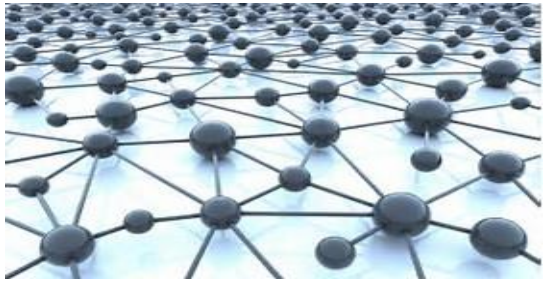
- The technology that supports this networking and inter-connectivity is complex and a fully detailed discussion is beyond the scope of this module
- There are whole modules just on networking, but…
  - There are WIRED technologies
  - There are WIRELESS technologies
  - There are different TOPOLOGIES of networks
  - There are different TYPES of network

Are you Wired?

- WIRED
  - Ethernet cable
  - Twisted Pair wire
  - Fibre Optic
- WIRELESS
  - Wi-Fi & WiMAX
  - Bluetooth
  - Mobile (5G)
  - Satellite

What Shape are You in?

- Every network has a ‘topology’ (shape/arrangement)
  - Star
  - Ring
  - Bus
  - Mesh
  - Tree
  - Hybrid



Definition of *topology* in English:

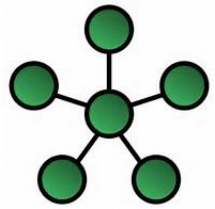
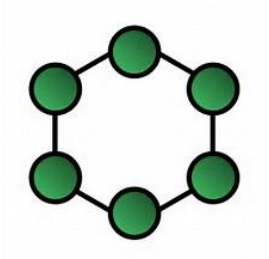
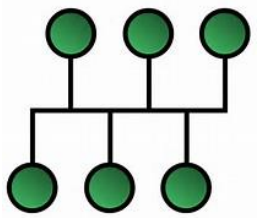
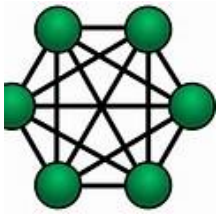
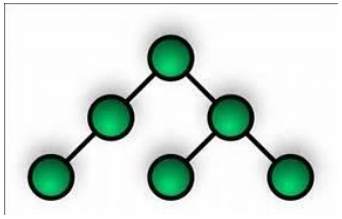
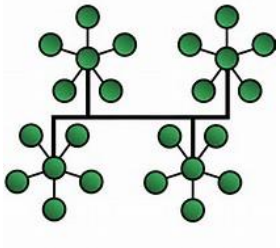
topology

The way in which constituent parts are interrelated or arranged.

‘the topology of a computer network’

https://www.lexico.com/definition/topology

What Shape are You in?

- Star 
- Ring 
- Bus 
- Mesh 
- Tree 
- Hybrid 

Network Classification - PAN

Personal Area Network (PAN)

- Connects computer (and other) technology close to one person (within physical reach – say on a desktop or in car)
- Connects PC, PDA, smartphone, headsets and peripherals
- Typically uses wireless technology such as:
- Bluetooth: https://www.bluetooth.com/
- ZigBee: https://zigbeealliance.org/
- Z-wave: http://www.z-wave.com/
- Closely related to ‘smart’ buildings and ‘home automation’

Network Classification - LAN

Local Area Network (LAN)

- Can be wired (Ethernet) or wireless (Wi-Fi)
- Physically close connectivity, but larger scale than a PAN
- Typically for a single building, single site or college campus
- For example, your college network or a home network
- Usually owned and run by one organisation – the host
- Can be extended, connected to other LANs and partitioned:
- Bridges & Switches
- Virtual LANs

Network Classification - MAN

Metropolitan Area Network (MAN)

- Spans a city, large campus or other geographical are
- In scale, it sits between a LAN and a WAN in size
- Single company or co-operatively managed
- Can involve the interconnection of many LANs across a city
- Offers a single city-wide network
- Can blend wired and wireless technologies
- Related to ‘smart’ cities and public Wi-Fi hotspots
- Examples: Connecting all emergency services in a city

Network Classification - WAN

Wide Area Network (WAN)

- The next step up from a MAN
- Covers physically large distances – national or international
- Links up office branches, campuses etc. over long distances
- Uses a range of technologies, such as leased telephone lines, fibre optic cables, satellite links, microwave links, **Frame Relay** and **Asynchronous Transfer Mode (ATM)**
- A WAN is defined by geographical size, not its technology
- The Internet is actually the worlds biggest WAN!

Network Classification - Intranets

- A ‘walled garden’ or private network for a single firm
- Available only to members of staff on the ‘inside’
- Provides access to wide range of internal IT resources:
  - Databases
  - Websites (Internal)
  - Email
  - Scheduling and Diary functions
  - Specialist software

Network Classification - Extranets

- Still a private ‘walled garden’ with tight security, but:
- Selected external partners, suppliers and customers are allowed (limited) access to the company’s internal systems and data
- Like a guest list, if your name isn’t down, you don’t get in!
- Allows common data and software applications to be shared without the outside world having access
- Useful for multi-company projects – such as big construction projects – where distinct organizations need to work closely together

Compare to a VPN (Virtual Private Network)

Network Classification – The Internet

- The mother of all networks - the world's biggest WAN
- A 'network of networks' (short for 'Internetworking')
- A logical concept comprising many different connections and technologies – the 'plumbing' of the information superhighway!
- Not the same as 'The Web' or other 'services' like email, Skype etc.
- The Internet is like the physical road or railway network.
- The Web is like a coach or train service that runs on it.

Classification Summarisation

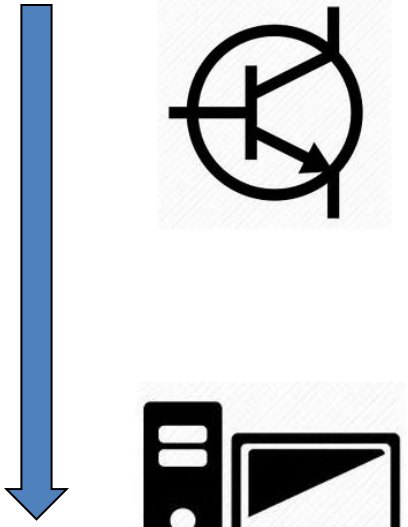
What's Inside the Box?

What's Inside the Box?

- All computers are physical (electronic) devices
- Thus, they are constructed from components
- Some parts are very small, others quite large
- The organisation and connections between the components is known as 'computer architecture'
- Computer architecture defines:
  - The physical layout inside the computer
  - The functions and behaviour of the computer

What's Inside the Box?

- 'Computer Architecture' can be applied at different levels of abstraction:
  - Transistor
  - Logic Gate
  - Digital Circuit
  - Component
  - System



What's Inside the Box?

- Just as there are different types of components and computers, so there different types of architecture:
- 'Classic' (sequential processing, one CPU)
  - The 'one instruction at a time' model
- 'Instruction Pipelining' (parallel processing, one CPU)
  - The 'assembly line' model
- 'Multi-Core' (parallel processing, multiple CPUs)
  - The 'concurrent work-streams' model

What's Inside the Box?

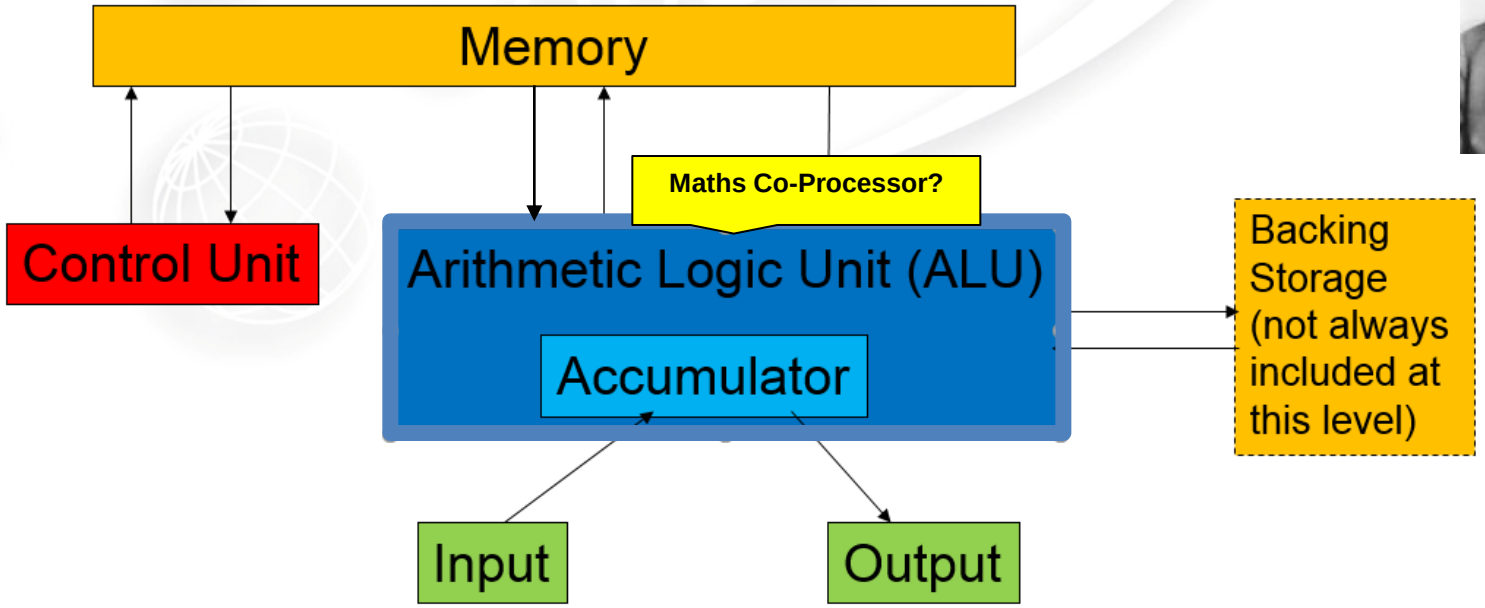
- They are all permutations of layout that unify:
  - Memory units
  - Processing units
  - Input/output units
  - Data
  - Instructions
  - Addresses

  } The bits that make up a computer

- The commonest architecture is 'von Neumann'

What's Inside the Box?

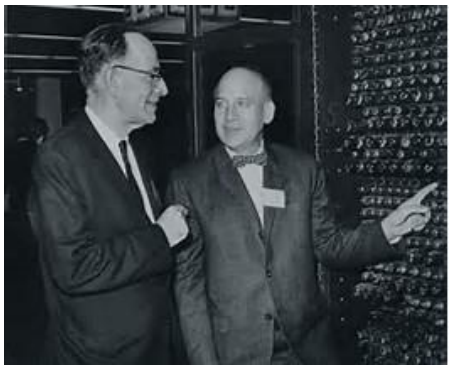
- Von Neumann Architecture

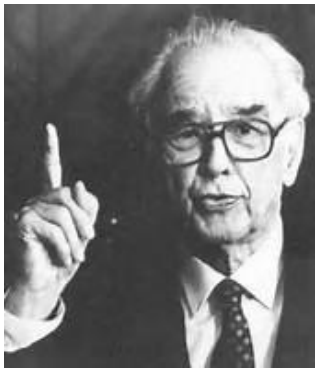


http://www.computinghistory.org.uk/det/3665/john-von-neumann/

What's Inside the Box?

- Von Neumann was not the only researcher…
- Eckert & Mauchly, Turing, Zuse, Atanasoff and others
- http://www.computinghistory.org.uk/det/2576/J-Presper-Eckert-and-John-Mauchly/
- https://www.npl.co.uk/famous-faces
- http://www.computerhistory.org/fellowawards/hall/konrad-zuse/
- http://www.columbia.edu/~td2177/JVAtanasoff/JVAtanasoff.html





Introducing the CPU

- Central Processing Unit (‘processor’ or computer ‘brain’)
- Some items are **inside** the CPU…
  - **Arithmetic & Logic Unit (ALU) or Maths Co-Processor**
  - **Control Unit**
  - **Registers**
  - **Cache Memory**
- Some items are **outside** the CPU…
  - **Main Memory (RAM)**
  - **Read Only Memory (ROM)**
  - **Secondary Storage (Hard Disk, DVD etc.)**

Meet the Mother…

- All these items (except secondary storage) placed on a ‘motherboard’ – some inside the CPU chip, others in their own chips.
- May also have ‘maths co-processor’ for performance.

Back to the Brain…

- Better to define what a CPU **does**:
  - The CPU is the part of a computer that carries out (stored) programmed instructions on (stored) data
  - The CPU controls the rest of the computer system, including: read-only memory (ROM), main memory (RAM), secondary or backing storage (e.g. hard disk), input and output devices

Number Crunching…

- The heart of the computer is the CPU
- The heart of the CPU is the ALU…
  - **Arithmetic and Logic Unit**
    - Performs arithmetic and logical operations
    - Always addition and negation of integers
    - May include multiplication
      - Otherwise, does repeated addition
    - Does not do subtraction
      - Does negation and then addition instead

Number Crunching…

Arithmetic and Logic Unit (continued)

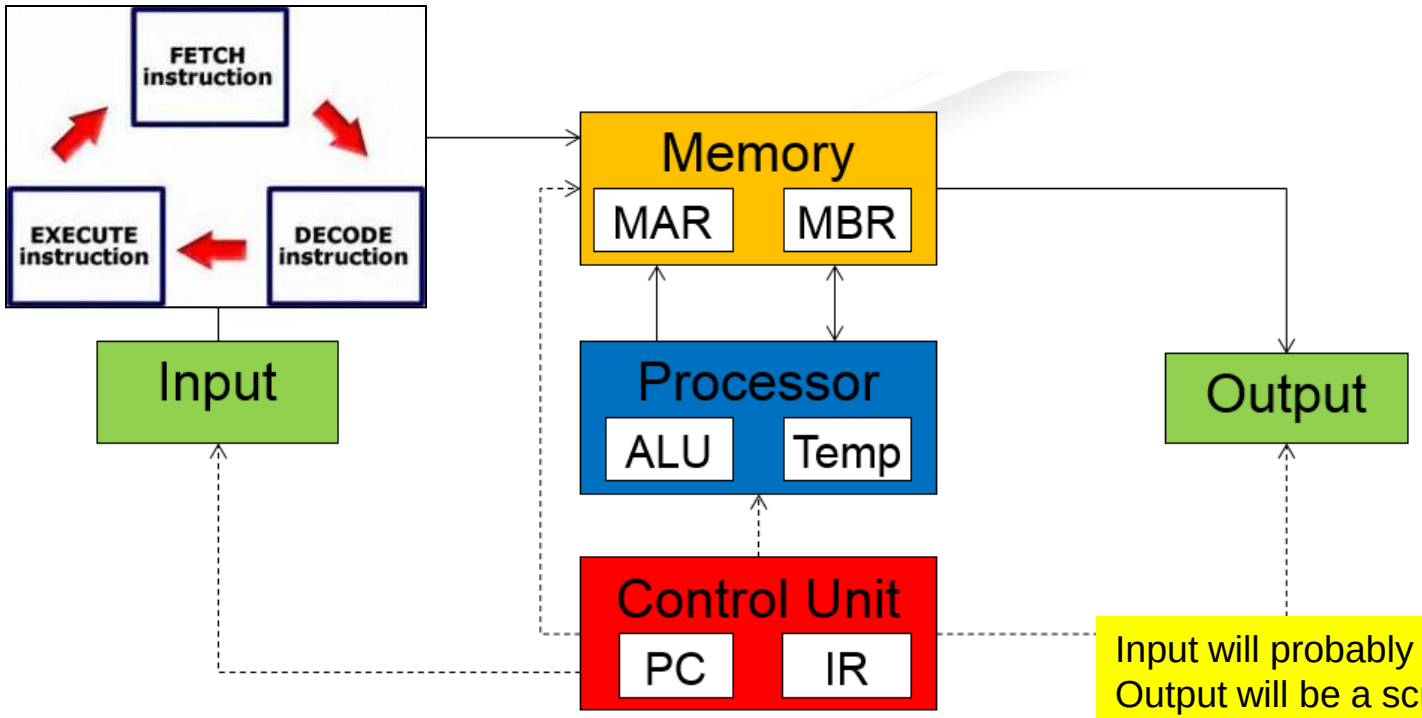
- Does division (or repeated subtraction instead)
- May do floating point numbers as well
- Also does AND, OR, NOT and possible XOR
- Largely defines the rest of the CPU's architecture
- So, a 64-bit accumulator implies a 64-bit processor

The Brain's Brain…

- The CPU itself is actually controlled by a 'control unit'
  - Handles the instructions contained in the program
  - In general, the input is the next instruction
  - The outputs are control signals to other parts of the CPU or the rest of the computer
  - More detail is given in the student workbook for you to read in private study

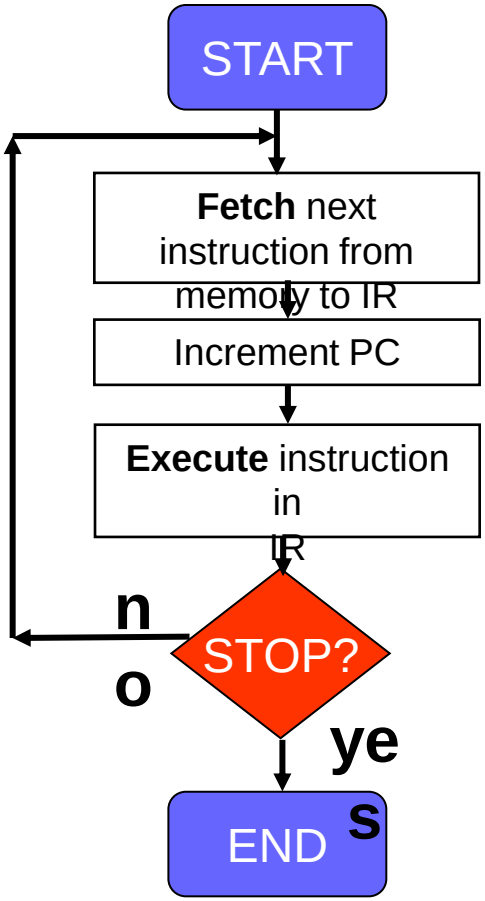
Putting Von Neumann together…

- The processing loop



Fetch Execute Cycle

- Defines how instructions are retrieved and carried out inside the processor
- Sometimes called the ‘Instruction Cycle’ or the ‘Automatic Sequence Control’



CPU Components

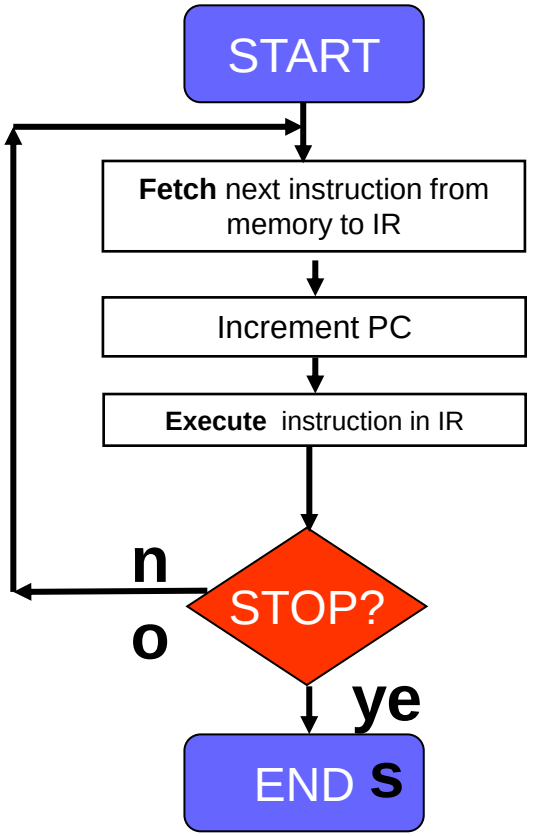
- The Fetch-Execute cycle uses several components…
  - **Program Counter (PC)**
    - Holds memory address of next instruction
  - **Memory Buffer Register (MBR)**
    - Holds data and instructions traveling to/from memory
  - **Memory Address Register (MAR)**
    - Holds memory address locations of data and/or instructions to be read/written to memory

CPU Components

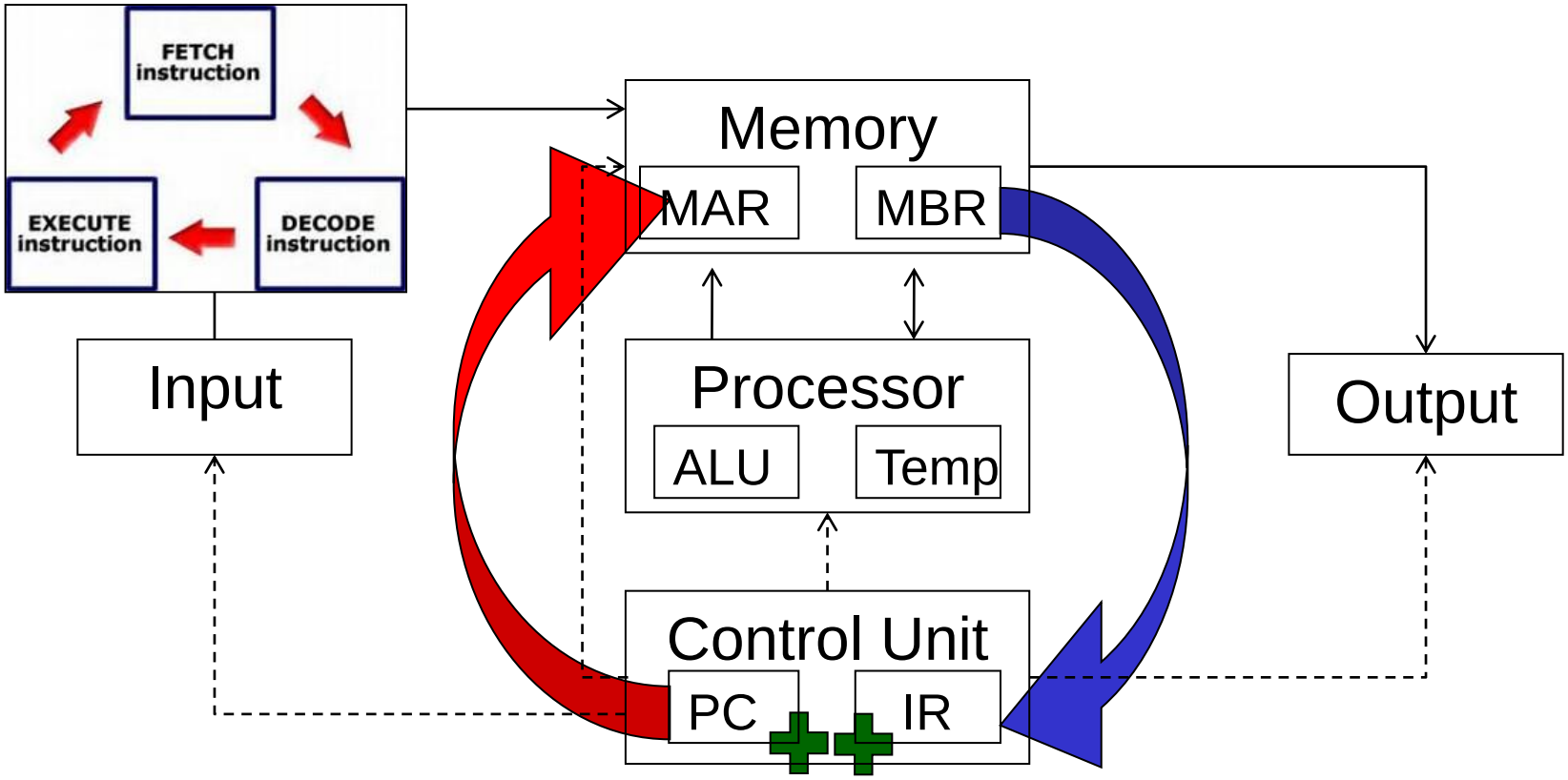
- There is also…
  - **Instruction Register (IR)**
    - Holds the instruction which is to be executed
  - **General Purpose Registers (TEMP)**
    - ‘Working areas’ for data processed by the ALU
    - At least one – the Accumulator

Fetch Stage

- Copy contents of PC into MAR - value of PC presented via address bus
- Increment PC - point to next required memory access address
- Copy instruction from MBR into IR via data bus - instruction retrieved from memory - placed in IR

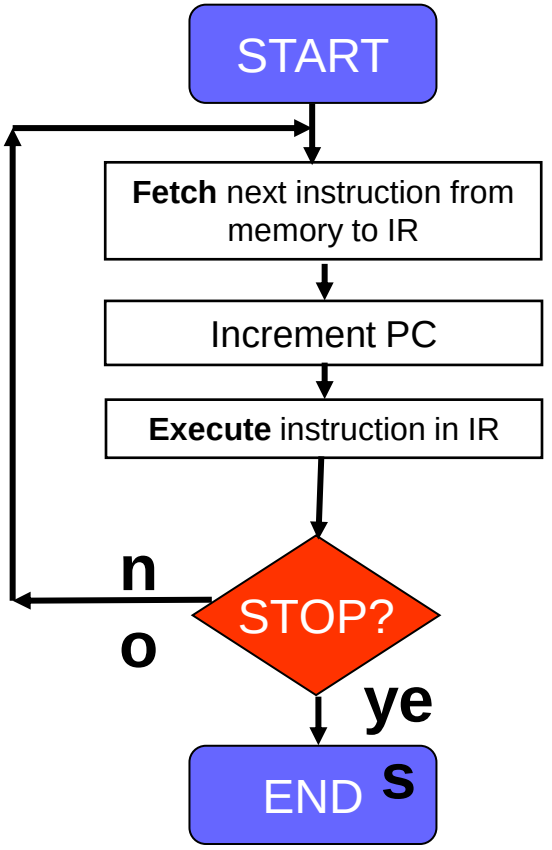


Fetch Stage

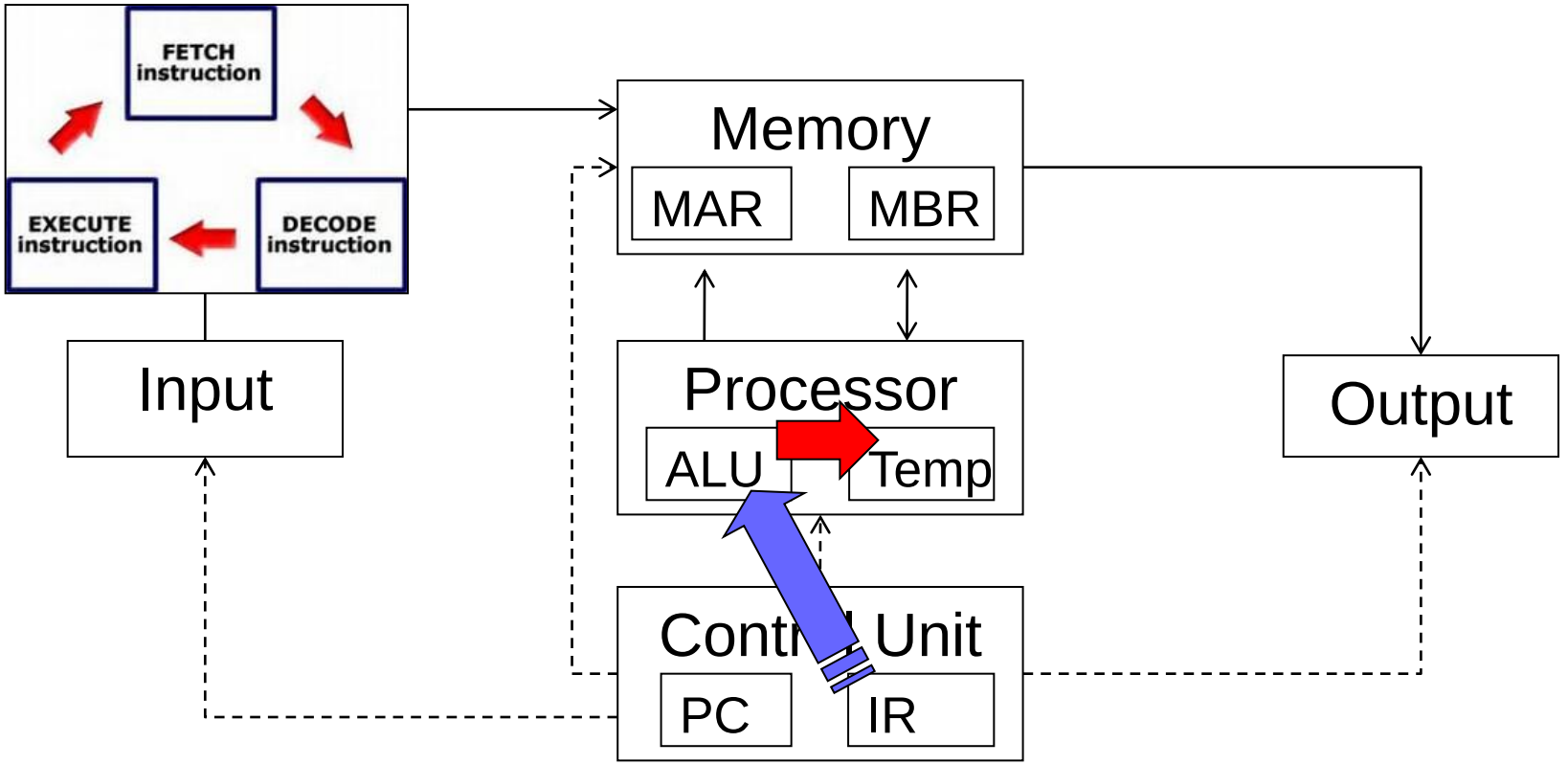

FETCH instruction
DECODE instruction
EXECUTE instruction
Memory
MAR
MBR
Input
Processor
ALU
Temp
Output
Control Unit
PC
IR

Execute Stage

- Decode instruction from IR
- Run instruction in IR - may require getting data from memory
- Location pointed to by PC – increment PC++
- Unless current instruction is STOP, repeat cycle



Execute Stage



Fetch-Execute Animations

https://scratch.mit.edu/projects/2145440/

http://www.nku.edu/~foxr/CIT130/tutorials/fetch-execute.html

Watch these two animations to reinforce your understanding.

Staying Safe

Health and Safety – For People

Mains Electricity

- Can cause anything from unpleasant to fatal shock!
- Usually only occurs inside power supplies
  - Most computers operate at 12v or less
- Ensure mains is OFF and UNPLUGGED
- Wait for capacitors in power supplies to discharge.

Hot Components

- Some components inside a PC are hot enough to cause burns.
- Turn off power and wait for components to cool down before handling.

Health and Safety – For People

Lifting and Carrying

- Some computer equipment is heavy
- Get proper manual handling training and get assistance if necessary

Trip Hazard

- The biggest cause of accidents
- It is very easy to put something on the floor and then forget about it
- Keep work area floors clear and tidy
- Move anything that might be a hazard

Health and Safety – For Computers

- Computer components are expensive and delicate
- Particularly susceptible to electric shocks

Electrostatic Discharge (ESD)

- Discharge electrostatic by touching a suitable earth point
- Or use an ESD wrist strap or ESD mat (see below)
- Particularly important if you are wearing man-made fibre clothing

Health and Safety – For Computers

Power Surge

- Caused by plugging or unplugging components when power is on
- Turn-off power and unplug before working inside a PC

  Note:
  - Powering down a PC from Windows does NOT switch it off completely
  - There is still power on the motherboard and inside the Power Supply Unit (PSU)
  - You may see a light on the back of the PSU or on the motherboard, but if not, do not assume that there is no power
  - Switch off the computer at the wall and unplug

References

History of Computing, Environments & Applications

- http://www.computerhistory.org/timeline/
- http://www.computinghistory.org.uk/

History of Computer Gaming

- http://www.museumofplay.org/about/icheg/video-game-history/timeline
- http://www.computerhistory.org/timeline/graphics-games/

Computer Networking

- https://www.lantronix.com/resources/networking-tutorials/
- https://www.cisco.com/c/en/us/solutions/small-business/resource-center/connect-employees-offices/networking-basics.html
- Computer Hardware & Architecture
- https://www.bbc.co.uk/bitesize/guides/zthbgk7/revision/1
- https://www.intel.com/content/dam/www/public/us/en/documents/white-papers/ia-introduction-basics-paper.pdf

Health & Safety Advice

- http://www.hse.gov.uk/

Awarding Great British Qualifications

Topic 2 – Environments, Functions of components and Health & Safety

Any Questions?