Background

2 Computers

2.1 What is a computer?

- PCs, desktops, laptops, tablets, smartphones, etc.
- Hardware – the parts you can see and touch
- Software – applications (apps), programs that run on the computer – email, browser, word processor, etc. Usually has to be reloaded after the computer has been restarted.
- Firmware – software that is embedded in the computer hardware – runs 'instantly' after the device has been turned on, eg. Electronic tablet operating system.
- Operating System (OS) – provides the connection between the applications and the hardware. eg. Windows (Microsoft), OSX (Apple), iOS (Apple iPhone, iPad), Android (Google), Unix (various), Linux (Public)
- Servers – 'secure server' – what does that mean?
- Memory – hardware that stores programs and data. Can be volatile (data disappears when power is turned off) or non-volatile (data does not disappear when power is turned off).
- Working memory – RAM (fast, volatile)
- Storage – disks, memory cards, DVDs, USB drives (slow, non-volatile)

2.2 What is it for?

- Computers process (manipulate) data. Data can be in many forms – text, photos, sound, temperature – anything that can be measured and rendered in a digital form.

- Conventionally there are three main parts:
    - Input device – keyboard, memory card, camera …
    - Processor – ranges from a simple processor chip that runs your washing machine through to a powerful multi-processor computer that might be used to simulate the Earth's climate.
    - Output device – screen, printer, permanent storage …

2.3 How does it work?

- A smartphone contains about 2 billion transistors. (The human brain has about 85 billion neurons)
- Each transistor is a switch that is either on or off and is used to store one bit of data (off = 0, on = 1). Multiple switches are used to form computer memory. Memory may be used to store binary codes.
- Some of the codes are used to represent programs and some to represent data. (Sometimes it is possible for these to become mixed up and this gives rise to bugs or they may be deliberately mixed up, often resulting in a hack.) The computer cannot tell the difference between programs and data.
- The processor part of a computer resides on a chip that reads the program codes (typically one at a time) and acts according to what the code represents. There are often many hundreds of different codes that might cause, for example:
    - Two pieces of data representing numbers to be added and the result placed in memory somewhere.
    - A piece of data representing a letter of the alphabet to be sent to a printer.
    - A response to a key press on the keyboard then store the code for that key somewhere.
- The processor in a smartphone can perform many trillions of these operations every second.

2.4 Programs (Apps)

- A program (or app) is essentially a set of instructions that a computer can follow to process some data and produce a result (output) that might control some device, such as a screen or a car or just about anything you like.
- A program is written using a programming language that converts human-readable instructions into computer-readable codes that can be stored in the computer for the processor to read and act upon (execute).
- Programming languages – there are many, but ones we might be concerned about include:
    - Java (can be automatically loaded from websites)
    - JavaScript (found on web pages)
    - Macros (as found in Word and Excel files)

2.5 Terminology

- Binary – method of representing numbers using only the digits 0 or 1. Also known as base 2.
- Compare to octal (base 8), decimal (base 10) and hexadecimal (base 16).

- Bits (binary digits) – components of a binary number (0 and 1). Nearly all computers operate using bits (exceptions: quantum computers).
- Byte (8 bits).
- Prefixes – kilo, mega, giga, tera, peta. (see below)
- Digitise – convert analog data into a digital (typically binary encoded) format.

2.6 Virtual computer

Also known as a virtual machine (VM), it is software that emulates a computer, running on a computer.

A VM is often used to test software that might compromise the main computer, or it might be used to run a foreign operating system such as a Windows VM on an Apple Mac or a Unix VM on a Windows PC.

Whilst a malware infection on a virtual computer theoretically should not be able to cross over to the host system, it sometimes can.

2.7 Appendices

2.7.1 Binary and hexadecimal numbers

Decimal	Power of 2	Binary	Hexadecimal
0	2^0	0	0
1	2^0+1	1	1
2	2^1	10	2
3	2^1+1	11	3
4	2^2 = 2×2	100	4
8	2^3 = 2×2×2	1000	8
10	2^3+2	1010	A
15	2^4-1	1111	F
16	2^4 = 2×2×2×2	10000	10
17	2^4+1	10001	11
32	2^5	100000	20
64	2^6	1000000	40
128	2^7	10000000	80
255	2^8-1	11111111	FF
256	2^8	100000000	100
512	2^9	1000000000	200
1024	2^{10}	10000000000	400

2.7.2 Prefixes

Name	Symbol	Normal meaning	Computer meaning	Example
Kilo	K (k)	Thousand (10^3)	1024 (2^{10})	Kilobyte (Kb, KB)
Mega	M	Million (10^6 = 1000^2)	1024^2	Megabyte (Mb, MB)
Giga	G	Billion (10^9 = 1000^3)	1024^3	Gigabyte (Gb, GB)
Tera	T	Trillion (10^{12} = 1000^4)	1024^4	Terabyte (Tb, TB)
Peta	P	Quadrillion (10^{15} = 1000^5)	1024^5	Petabyte (Pb, PB)

2.7.2.1 Visualising computer storage

Quantity	Equivalent to
1 Byte	1 character, a digit or a single letter – eg “a”
1 Kilobyte (KB)	2 or 3 paragraphs of text, a shortish email
1 Megabyte (MB)	200 pages of text, a small book, a small photo. 1CD = 700 MB.
1 Gigabyte (GB)	4500 books, 30 minute video, 7 minutes of HD TV video. 1 Bluray disk = 25 GB
1 Terabyte (TB)	About 1500 CDs, 100 hours of HD TV, 40 Bluray disks.
1 Petabyte (PB)	6 billion photos on Facebook,

Note:

- Memory sizes are usually quoted in bytes – 1 Gigabyte (1 Gb) = 1 073 741 824 bytes.
- Network and Internet performance is quoted in **bits** per second (bps or BPS) not **bytes** per second – 1 **byte** = 8 or 10 **bits**, depending on the technology. A 10 megabit per second Internet connection would transfer only about 1 megabyte per second. Cynics might say this is done to make the figures look better ☺.

2.7.3 Links

- http://asciitable.com/
- http://binaryhexconverter.com/