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Getting to know your unit

Information technology (IT) systems are involved in almost everything we do in society and have a significant role in our way of life. IT systems have benefitted our society in many ways, such as communication, finance, medicine and farming. Having a good understanding of how to effectively select and use appropriate IT systems for both personal and business use will put you in a strong position when considering higher education or getting a job in the IT industry.

You will be learning about hardware and software and how they come together and interact with each other to form an IT system. You will also be learning about the relationship between users and systems and the decisions that businesses and individuals need to make. You will be exploring issues related to using IT systems and their impact on us as individuals and also how they affect business practices.

In this unit, you will draw on your learning from across your programme to complete assessment tasks set by your teacher.

This unit will give you a fundamental and synoptic understanding of all areas of IT, which will support progression to an IT-related higher education course.

Assessment

You will be assessed internally using Pearson set assessments..

How you will be assessed

This unit be will be assessed by a Pearson set assignment.

Throughout this unit, you will find assessment practice activities that will help you to work towards your assessments. Completing these activities will not mean that you have achieved a particular grade, but you will have carried out useful research or preparation that will be relevant when you come to complete your final assignment.

In order for you to achieve the tasks in your assignments, it is important to check that you have met all of the Pass grading criteria. You can do this as you work your way through each assignment.

If you are aiming for a Merit or Distinction, you should also make sure that you present the information in your assignment in the style that is required by the relevant assessment criteria. For example, Merit criteria require you to review and justify and Distinction criteria require you to evaluate.

The assignments set by your teacher will consist of a number of tasks designed to meet the criteria in the table. The first assignment is likely to require you to provide a detailed plan of how IT infrastructure could be implemented by an organisation to meet most of its identified needs. The second and third assignments are likely to draw on your knowledge in order to evaluate your recommendations for data and information use and the policies you have developed.

Assessment criteria

This table shows you what you must do in order to achieve a Pass, Merit or Distinction grade.

Pass	Merit	Distinction
Learning aim **A** Explore how IT infrastructure meets the needs of organisations and their stakeholders		
A.P1 Explain ways in which software can meet the needs of an organisation and its stakeholders. **A.P2** Explain ways in which hardware can meet the needs of an organisation and its stakeholders. **A.P3** Explain ways in which the use of data connections and networks can meet the needs of an organisation and its stakeholders. **Assessment practice 1.1**	**A.M1** Analyse how IT infrastructure can impact an organisation and its stakeholders. **Assessment practice 1.1**	**A.D1** Evaluate how IT infrastructure can impact an organisation and its stakeholders. **Assessment practice 1.1**
Learning aim **B** Understand how organisations make use of data and information		
B.P4 Explain ways in which data is used in an organisation. **B.P5** Explain ways in which information is used and distributed by an organisation, both internally and externally. **Assessment practice 1.2**	**B.M2** Analyse how data and information are used in an organisation, both internally and externally. **Assessment practice 1.2**	**BC.D2** Evaluate the impact of the use of data and information on an organisation, its stakeholders and related policies. **Assessment practice 1.2**
Learning aim **C** Develop policies for the use of IT within an organisation		
C.P6 Describe internal and external threats, to data and information, in an organisation. **C.P7** Describe procedures to be implemented in an organisation to allow them to protect data and information. **C.P8** Describe procedures to be implemented in an organisation to allow them to operate in legal, moral and ethical ways. **Assessment practices 1.3 & 1.4**	**C.M3** Analyse how threats, and mitigation of those threats, impact an organisation and its stakeholders. **C.M4** Analyse how suggested procedures that ensure an organisation works in a legal and ethical way would impact on an organisation and its stakeholders. **Assessment practices 1.3 & 1.4**	**BC.D3** Justify decisions and approaches taken when developing policies. **Assessment practices 1.3 & 1.4**

Getting started

Information technology impacts on our lives on a daily basis. We rely on computers to perform even basic tasks such as telling the time.

List any devices that you use. Add those that you are aware of but have never used. Update the list as you learn about other types of technology.

Learning aims

In this unit you will:

A} Explore how IT infrastructure meets the needs of organisations and their stakeholders

B} Understand how organisatons make use of data and information

C} Develop policies for the use of IT within an organisation

A} Explore how IT infrastructure meets the needs of organisations and their stakeholders

Skills

- Analysis and decision-making
- Formal written communication

This section introduces you to how information technology (IT) is used to meet the infrastructure requirements of organisations.

Purpose and functions of organisations

The organisations you will explore will cover a range of sectors and you will learn how to apply your knowledge and understanding in vocational-based scenarios. Let us begin by considering different types of organisation, their purposes and functions, and the infrastructure they need to operate successfully.

Purpose and differences of organisations that provide a service and/or a product

Organisations are defined by different sectors. Sectors can mean the type of ownership, as outlined in Table 1.1 on the next page. Sectors can also mean the purpose of the organisation. For example, an organisation can make a product, or it can sell products made by another organisation. Organisations can also provide a service. Some organisations offer both products and services, as shown in Table 1.2 on the next page.

Infrastructure requirements driven by the priorities of an organisation

'Infrastructure' refers to the services and facilities that an organisation needs to function. For example, for a country to function, it requires a whole network of infrastructure such as water, sewage, transportation, electricity, etc. Of course, there are many countries around the world, and even remote parts of the more developed countries, which still do not have what most of us consider to be basic infrastructure.

In terms of IT systems, the infrastructure required for the systems to function include electricity, IT equipment (both hardware and software) and trained staff. Each organisation will have its own infrastructure requirements, depending on its aims and priorities.

Table 1.1 Examples of organisation sectors by type of ownership

PRIVATE		PUBLIC		NOT-FOR-PROFIT	
Type	**Example**	**Type**	**Example**	**Type**	**Example**
Sole trader	• Decorator • Gardener • Photographer • Pilates instructor • Childminder • Taxi driver	Government department	• Department for Education • Ministry of Defence	Charitable trust	• Oxfam • Save the Children International • WWF
Partnership	• Accountants • Solicitors • Dental practice			Voluntary	• International Voluntary Service • Voluntary Service Overseas
Private limited company	• Estate agent • Formula One				
Public limited company	• HSBC Bank • Pearson • Rolls-Royce Holdings PLC • Manchester United PLC				
Cooperative	• Crédit Agricole Group • NTUC Income				

Table 1.2 Examples of organisation sectors by type of service or product

Makes products	Sells products	Provides a service	Sells products and services
Pirelli	Amazon	Car mechanic	Car-servicing garage
Samsung	eBay	Gardener	Hair salon
L'Oréal	Walmart	Domestic cleaner	Airline
		Babysitter	

Identification and definition of features and characteristics of key task infrastructure

Organisations have several functions in order to operate efficiently, such as those outlined below.

- **Manufacturing of products** – this could be anything from a rubber washer to an aeroplane and all the components in between.
- **Delivering services** – this refers to the process of giving a service, such as a shop assistant, healthcare staff, window cleaner, tailor.
- **Supply chain management** – the stages that goods pass through between the producer that makes them and the retailer that sells them.
- **Marketing and sales** – this involves the promotion of a product or service, including brochures, advertisements, meeting potential and existing customers. The actual selling of the product or service is not automatically the role of marketing personnel. Sales can be managed in many different ways, especially through online sales such as Amazon. Of course, staff are still required to process those sales and, in this example, may also provide assistance with overdue deliveries, returns and out-of-stock items.
- **Customer relations** – this deals with, for example, resolving customer queries and complaints, seeking feedback to improve products or services, and developing ideas.

Key terms

Outsource – when a function is undertaken by specialists, such as accountants, deliveries, managing IT systems, etc.

Overheads – the costs incurred by organisations for staffing, premises, equipment, etc.

Procedures – step-by-step processes used to ensure actions are consistent and standardised. For example, accessing files within a computer system.

Policies – rules by which individuals and organisations must abide. For example, restrictions for passing on sensitive information.

Stakeholder – there are two types of stakeholders: internal (those within the business, such as its employees) and external (those outside the business, such as customers and anyone with an interest in the business). Stakeholders may have a financial or even an emotional interest in the business.

- **Resource management** – this can include selecting and buying equipment, negotiating prices and managing stock.
- **Staff recruitment** – this is often undertaken, or overseen, by Human Resource (HR) departments in larger organisations. HR are responsible for managing the people in the organisation, including their welfare, job roles, progression opportunities. Smaller organisations may use recruitment agencies or rely on internal managers or the owner of the business to select staff and recruit.
- **Staff management** – this is a major function of organisations, no matter how small. Without staff, the organisation would cease to function. Managing staff is a skill and it is time consuming. Staff who are content in their work will be more motivated to succeed. Staff require the support of smooth operating systems, such as technology, to undertake their daily duties effectively and efficiently.
- **Support** – such as administration, organising meetings or travel; it can also include IT support (such as telecommunications) and computer infrastructure (such as managing and developing websites).
- **Financial** – this can include accounting, raising invoices, and paying bills and wages.

While this list and other aspects will apply to many large organisations, smaller businesses may **outsource** some of these functions due to limited staff numbers and potentially reduced **overheads**.

To function efficiently as an organisation, it is vital that robust systems are in place and employees work to clearly defined **procedures** and **policies**. You will learn more about these later.

Digital devices, their functions and uses

This section is about the features and uses of digital devices in IT systems to meet the needs of organisations and their **stakeholders**.

Although IT devices are becoming more sophisticated at a rapid pace, businesses have been reliant on multiple digital technologies to manage their practices for quite a long time. Many of us are unaware that computers are relied upon for the functioning of familiar everyday items, such as:

- ovens
- watches
- washing machines
- cars
- tractors
- hearing aids
- motorcycles
- aircraft
- medical equipment
- heating systems
- lighting.

Skills

- Analysis and decision-making
- Formal written communication

Digital devices that form part or all of IT systems

A number of digital devices make up standard IT systems for both personal and business use.

Multifunctional devices

Multifunctional devices (MFDs) are also known as AIOs (all-in-ones). MFDs perform several different purposes. They include printers that not only print, but also scan, photocopy, fax and email.

Personal computers (desktops and laptops)

Personal computers (PCs and laptops) are those that are general purpose and available in a range of sizes, levels of power and capacity. Sales of laptops have increased significantly recently, as they have become more affordable. They operate as **standalone computers** and are very often lightweight and portable. Personal computers include laptops and netbooks (a generic term for smaller, lighter laptops), as well as static tower PCs.

PCs first appeared in the late 1970s, when 'micro-computers' were launched onto the market. Until that time, computers were large pieces of equipment, often filling entire rooms dedicated solely to computer systems. Technology has developed so rapidly that we now expect computers to be **AIO** or **MFD** devices.

PCs combine multiple digital functions, as well as being able to run our daily lives. In later units, you will look at the features and uses of digital devices to store large amounts of data produced in spreadsheets and databases to meet the needs of organisational infrastructure. Organisations also use PCs to store enormous amounts of data and to manipulate images, music and videos.

Mobile devices

Mobile device is a term given to any digital device that can be carried around easily and is usually Wi-Fi enabled. Examples of mobile devices include smartphones, modular smartphones, specialist phones, tablets, laptops and wearable computers. They typically weigh less than 150g, whereas the typical cell phone in the early 1990s weighed almost twice as much. They can fit into a pocket or bag comfortably. Examples of manufacturers of mobile devices include:

- Huawei
- Apple
- Microsoft
- LG
- Samsung.

Mobile devices such as these have become a must-have personal item, enabling us to keep in touch while on the move. Since the introduction of smartphones for general sale from IBM in 1994, we have had a world full of information at our fingertips. With the introduction of smartphones came touchscreens and the ability to access email and the internet on our phones. As you can imagine, flagship models displaying the latest technology are quite expensive.

Early smartphones were ahead of their time as we did not have the wireless infrastructure that we have today. You might liken this to the invention of the telephone by Alexander Graham Bell; he had a phone, but who could he call? When smartphones were first invented, the internet was a much smaller place and far fewer people had the internet at home or owned smartphones.

Modular smartphones

As its name might suggest, a modular smartphone comprises different components that can be replaced or upgraded. The aim is to reduce waste in what has become a 'throw-away world' and reduce repair costs. They are also intended to be more comfortable to use. Two such examples are produced by Fairphone and Motorola.

Specialist phones

These phones are made to assist people with particular, specialist needs: for example, larger buttons on keypads for partially sighted users and those working in challenging conditions, such as extreme cold or heat, wet conditions or where hygiene is important.

Key terms

Standalone computer – a computer not reliant on any other computers or digital devices to function; therefore, it can be used independently.

AIO – an all-in-one (AIO) device is one that is multifunctional. They are also known as MFDs.

MFD – a multifunctional device, such as a smartphone, includes a camera that connects to the internet or a printer that also scans and photocopies. They are also known as AIOs.

▶ Who might use or benefit from a specialist phone?

Tablets

The arrival of Microsoft's first tablet in 2000 was an evolution of the portable hand-held device generally known as a PDA (personal digital assistant). Since then, tablets have developed significantly as a hand-held alternative to a laptop. Tablets are generally smaller and can be used for many purposes. They have grown in popularity because, with the rise of internet shopping and browsing, they are quick, accessible and convenient to use. For those users who produce spreadsheets and office software, PCs and laptops are usually the more favoured option.

Laptops

Laptops are chosen predominantly for home use over desktop PCs because of their portability and for space-saving reasons. Laptops are often also the favoured option for many organisations. One reason is that they are portable so they can be used by employees who work remotely or at different locations. Data stored on the laptop can be accessed remotely and stored on a central server using the internet.

Link

You will learn more about servers below, see next page and also page 20.

Wearable computers

The term 'wearable computers' covers a range of mobile devices such as smartphones, smartwatches, fitness trackers or user interfaces such as Google Glass (an optical head-mounted display controlled by gestures). Wearable computers are capable of storing and processing data and are designed for accessibility and convenience.

While popular for personal use, wearable computers also have uses within different industries. For example, virtual reality (VR) and augmented reality (AR) can be used in education or as part of a training programme. A wearable computer can be used to monitor a patient's health, for example monitoring their heart rate and sending an alert if it senses a change. Police forces may wear body cameras clipped to their clothing to collect evidence of criminal activity. An increasing number of organisations use the cloud to store their data and wearable computers allow their employees to have easy access to this data wherever they are.

Although wearable computers are defined as those worn under or over clothing, computerised devices can also be implanted into the body, such as biomedical implants and brain implants.

▶ Who's in control?

Servers (physical and virtual)

Servers are powerful computers that provide network services, such as network applications, storage and other resources. The local area network could be made up of a series of cables that connect the server to other computers and could also provide virtual connections via the internet. Your place of study will probably have a network that operates in one of these ways. A network infrastructure connects the computers to the server, which manages logical access to the resources.

Servers are used, not only to store data files centrally so that several people can access them, but also to store software centrally to relieve storage space on individual PCs. As all the data are stored centrally, it can be backed up from one location. Servers also allow shared access to devices such as printers and scanners. They authenticate users and perform account management for users.

You may have heard of, or use, the cloud. The cloud is a term used to mean servers that are geographically separate from the user. These servers often offer a storage service.

Link

You will look at some options for cloud servers in the section *Online systems* (page 44).

Entertainment systems

Entertainment systems are multifunctional, comprising sound and vision. They manage music and video files, which contain large amounts of data and can quickly reduce the available capacity of a PC or mobile device. Entertainment systems can be operated from a central server, known as a digital media server. Recently central servers for home use have simpler to use and much more affordable.

Entertainment systems often combine the facility to record, and many provide facilities for editing and mixing digital (music or video) files. Many connect to the internet and interact with other peripheral devices. The most familiar of these systems, which vary considerably in size and price, include:

- televisions
- projectors
- DVD players/recorders
- Blu-ray players
- personal video recorders (PVR)
- set-top boxes (STB)
- media stations
- sound systems.

Link

For more information about peripheral devices, see *Peripheral devices and media* (page 15).

Smart televisions can be defined as entertainment systems, in addition to PCs, tablets and many other digital devices. The digital world now makes it possible to have devices and systems that provide a wide range of entertainment options, which not so long ago would have required multiple devices.

Larger entertainment systems include those you might have seen at concerts or the theatre.

Research

Research how the digital revolution began and what led to the creation of the World Wide Web.

Begin your search in the mid-1900s.

You can extend your search to the developments that have arisen through space travel, by searching https://www.nasa.gov.

Digital cameras

Digital cameras capture two different types of images:

- **still** – images that do not move (photos). They occupy much less storage space than moving images
- **video** – moving images that comprise a series of frames to make a film. Videos include sound and can be edited to include subtitles. It is also possible to capture single frames from a video as a still image.

Digital cameras encode digital images by breaking a picture into tiny squares called pixels. The images are then stored on a memory card. The resolution of the image

Key terms

SD card – the name given to the memory card used in digital cameras and some other portable devices. SD stands for secure digital.

SLR camera – a single lens reflex camera provides exactly the same photograph as seen in the viewfinder.

Digital SLR camera – known as DSLR cameras. They have a much larger, better-quality sensor, capturing a better image than traditional cameras which capture the image onto film.

GPS – the global positioning system (GPS) is an accurate worldwide navigational and surveying facility. It uses the signals from orbiting satellites to work out the position of the device.

captured is a count of how many pixels are used to make up the image. A high-resolution image may contain several million pixels (one million pixels = one megapixel). A modern digital camera uses between ten and 20 megapixels for an image. Several digital devices have camera functions, for example smartphones and tablets, and can store photos on the hard drive or an **SD card**. **SLR cameras** are becoming increasingly popular again with the development of digital SLRs. **Digital SLRs** (DSLRs) are especially popular for specialist photography, because of the high quality of the images produced, depending on the quality of the camera lens.

Special-effect lenses and interchangeable lenses can be bought for DSLR cameras, for example:

- wide angle
- fish-eye
- macro (for close-up photos)
- multifaceted (for starburst effects)
- zoom (for long-distance photos).

Navigation systems

Navigation systems are those that use **GPS** or the Global Navigation Satellite System (GLONASS) to navigate to locations. In addition, they can provide information about:

- traffic congestion
- roadworks
- accidents
- weather
- points of interest.

Navigation systems can be standalone, such as TomTom or Garmin products. These products are portable and can be fitted into vehicles to enable the driver to navigate. Many vehicles now come with a factory-fitted GPS, either as standard or as an extra. Some motorbikes also come fitted with navigation systems.

You may have a navigation system integrated in your smartphone that enables you to find your way around while driving, cycling or walking.

Data capture and collection systems

Data capture and collection systems, also known as electronic data capture (EDC), take information and collect it to perform a specific task.

▶ A data capture system

Examples are:

- barcode scanners for fast data entry, such as at checkouts and for courier services
- RFID (radio frequency identification), such as that used to track security tags in retail goods
- sensors, such as those used in cars to aid parking
- weather stations, which use sensors to measure weather patterns, rainfall, temperature and wind speed.

Other ground-breaking systems include those used in medical scanning machines such as magnetic resonance imaging (MRI), dual-energy X-ray absorptiometry (DEXA) and computed tomography (CT) scanners. Data capture and collection systems are used in clinical trials to gather data for analysis.

Communication devices and systems

With such a diverse mix of systems and devices in information systems today, communication is essential. Communication devices and systems allow digital devices to communicate with each other, whether in the same room or on the other side of the world. The growing demands of digital devices to interact with each other and with the cloud has resulted in the resilient global communications we see today. Some of the devices and systems used for communication are:

- **Satellites** – these operate without cables by using satellite dishes as a two-way method of transmitting data (this is an option for remote areas where **broadband** is not available).
- **Wi-Fi (IEEE 802.11** wireless) – connects devices without wires using high frequency radio waves.
- **FTTC** (fibre to the cabinet) – fibre-optic broadband offers speedier broadband connections than copper cabling alone. With FTTC, the customer's local cabinet has fibre and the last section of the connection to the premises is traditional copper.
- **FTTP** (fibre to the premises) – fibre-optic broadband offers even speedier broadband connections than FTTC.
- **4G/LTE/5G** – these are high-speed mobile data networks offering connectivity while on the move at speeds up to 50 **Mbps**.
- **Bluetooth** – this is often used for personal area networks (PANs) to connect peripherals such as headsets, mice, keyboards and bar code scanners to PCs and mobile devices.

The function and use of digital devices

We would probably feel lost without the digital technology we now take for granted. Although technology is a global phenomenon, it is still not available or accessible to everyone. Some of the areas of modern life that have benefitted from digital devices are discussed below.

Education and training

You are using digital media to access this study text and you may even be a learner who has a virtual teacher. Education and training has experienced many changes with the evolution of digital technology. Now learners can *interact* with their learning materials as well as reading them. Interacting with study materials can help the learning process by making it easier to understand concepts.

Link

For information about iris and fingerprint recognition systems, see http://find biometrics.com.

For more about data capture and collection systems used in clinical trials, visit http://www.bioclinica.com and http://journal.frontiersin.org.

Key terms

Broadband – a high-speed transmission technique, whereby a wide band of frequencies is used to transmit messages. It commonly refers to internet access via a range of networks including DSL, Wi-Fi, 3G, 4G and 5G. Today, broadband is a very familiar term in the UK and all of our digital devices, such as smartphones, games consoles and internet-enabled televisions, use broadband to connect to the internet and share data all the time.

IEEE 802.11 – refers to a set of rules, or protocols, relating to the LAN (local area network).

Mbps – megabits per second, the speed for downloads and uploads. MBps refers to megabytes per second, used in reference to file size.

Link

Bluetooth is another method for transferring information between devices. It is discussed in more detail in *Input devices*, page 16.

Link

For more on social media, see **Unit 3: Using Social Media in Business**.

Research

Investigate examples of where social media has positively impacted on society. Summarise the methods used and the impact on individuals.

Reflect

What would your life be like without the digital devices you use every day? How would you arrange to meet up with friends? How would you do research for a college project? How would you put together an assignment for college?

Personal use

Most of us take digital devices for granted. Everything appears to be at our fingertips, such as ordering food, buying clothes, searching for information, and streaming music and television programmes. However such devices can let us down ornot work as quickly as we would like.

Social use

Some critics say that we spend too much time using social media. Some claim we are losing the ability to communicate face-to-face and are developing bad habits in the language we use, and the shortcuts we take, when emailing and texting. However, there are also benefits. For example, it can be quick and easy for parents to keep in touch with their children and vice versa; and long distance relationships can be maintained more easily and cheaply. Distances can appear significantly reduced, particularly when you consider how astronaut Tim Peake communicated easily with friends and family over Christmas 2015 from the International Space Station.

In late 2019 an unknown virus began to attack citizens in Asia, rapidly spreading by early 2020 across the globe, killing tens of thousands of people within just a few months. Attempts to prevent the newly identified Covid-19 pandemic from decimating whole communities included enforcing social distancing and isolation. Thankfully with the internet and social media, most people were able to keep in touch during such unprecedented times.

Retail use

Retail operations have been made much simpler by digital devices. For example, through the use of credit and debit card readers for payment transactions and, more recently, contactless payment for smaller purchases. Technology enables retailers to capture data through their systems, which monitor stock levels as items are sold. The system can automatically re-order stock based on popularity, seasons and likely demands due to religious festivals, etc.

Research

The volume of unwanted data that we are bombarded with was claimed in 2011 to be the equivalent of around 174 newspapers per day. Explore the amount of internet traffic there is nowadays; read the article on The Zettabyte Era at www.cisco.com.

Discussion

In small groups, share your experiences of any part-time work you might do or your experiences as a customer. What IT systems are involved in performing work tasks and transactions? Which systems replace older manual methods? Can you identify any businesses that still rely on manual methods even though those methods have more usually been replaced by technology? Discuss the advantages and disadvantages of the digital and manual methods.

Organisational use

Organisations use digital devices to support an extensive range of functions. For example:

- business operations, such as stock control, project planning, account management, storing customer and supplier records and transactions, and preparing marketing material

- radio-frequency identification (RFID) is used in stock control, race timing systems and personal digital assistants (PDAs), with integrated barcode scanners for stock control
- car parks can use automatic number plate recognition (ANPR) cameras for crime prevention and enforcement, while traffic control can capture accidents and driving misdemeanours
- many international border controls use fingerprint recognition systems for biometric entry and authentication systems.

Internal and external dissemination of information is speeded up by the use of digital devices. Customer invoices and supplier payments can be dealt with rapidly as opposed to typing out invoices or writing cheques and relying on the postal system. Information about current trends and competitor activities is also more readily available using technology.

Creative tasks

Some organisations carry out their own creative tasks, such as producing marketing materials, to cut costs or for rapid turnaround. Smaller organisations may not be able to afford brochures and marketing materials, for example a gardener or hairdresser who wants to promote their business to the local area. With technology and a selection of software to choose from, leaflets or marketing information can be produced and even emailed, all at little or no cost and with rapid dissemination.

Peripheral devices and media

This section explores the features and uses of peripheral devices and media in IT systems to meet the needs of individuals and organisations.

Peripheral devices used with other digital devices to form part of an IT system

A peripheral device is **hardware** that is auxiliary (supplementary) to the computer. If you can touch it, then it is hardware (and is therefore not **software**, although it may contain software).

There are different types of peripheral devices:

- **input** devices
- **output** devices
- **storage** devices – these store information externally from the computer and provide extra memory
- **communication** devices, for example, Wi-Fi, Bluetooth, radio and serial ports.

Input devices

Input devices interact with or send information to the computer. They may pass data to the computer, but do not store data. The following are all examples of input devices that can be connected via a cable or wirelessly to a digital device.

- **Keyboards** – these can be connected to a computer, laptop, tablet or smart television. Using the keys, users transmit instructions or input data into the digital device.
- **Touch screens** – these have become almost an essential since the birth of tablets. Many laptops have touch screens, which enable us to perform operations without using the mouse or keyboard, such as drag and drop, scrolling, etc. Touch-screen

Skills

- Analysis and decision-making
- Formal written communication

Key terms

Hardware – computer equipment that you can physically touch. It includes computers and other digital devices themselves and also peripheral devices such as the keyboard, monitor and mouse.

Software – applications or programs that are installed onto a digital device. They enable us to carry out certain functions such as word processing or creating spreadsheets, using media, accessing websites or playing computer games.

options were first introduced to laptops as early as 2008, while conflicting reports claim touch screens were invented as early as the mid-1960s. These are now commonplace on a range of devices.

- **Pointing devices** – the most obvious pointing device is the mouse, which allows users to make selections on a computer screen. Other pointing devices include the stylus, which is shaped like a pen; when the tip is used with a touch screen it can be used to write, draw or edit with greater accuracy than fingers.
- **Touchpads** – these are usually located at the front of a laptop and is used as an alternative to a mouse, dragging the finger or fingers over the pad to perform actions.
- **Graphics tablets** – these enable users to hand-draw images and even trace as if using paper and pencil.
- **Microphones** – most laptops, tablets and, of course, mobile phones have built-in microphones that enable users to verbally communicate or record sound.
- **Scanners** – many printers have built-in scanners, but, on a larger scale, scanners used in hospitals, for example, are also input devices, capturing data. Scanners use light to make digital copies, such as documents using 2D scanners, while body scanners rely on 3D imaging.
- **Cameras** – digital cameras capture images or video (as discussed on page 12).
- **Sensors** – there are many types of sensor, such as motion sensors that use infrared to detect movement or magnetic field sensors to detect cars at traffic lights. Sensors input data about the physical environment. As well as motion and magnetic fields, they can be used to detect temperature, sound, moisture or humidity, pressure, gas, light or pH.
- **Webcams** – these are video cameras that transmit moving images through an internet connection. Webcams make it possible to see friends and family on the other side of the world.

The following are types of connection commonly used by input devices.

- **USB** – a Universal Serial Bus (USB) is a form of connection used for many peripheral devices. USB flash drives are data storage devices. A Wi-Fi dongle, which is a USB peripheral, can also transmit a Wi-Fi connection It can be attached to a digital device such as an internet-enabled television to connect it to the internet.
- **Bluetooth adaptors and wireless dongles** – these contain radio communication hardware and will have some degree of **firmware** on them. They connect to other devices with similar connectivity, which may allow a connection to the internet. A Bluetooth dongle is commonly used to add Bluetooth capability to connect to a device such as a mouse or headset. Bluetooth adaptors transmit data over short distances and rely on software to connect to another device, whereas a wireless dongle contains firmware and connects to a USB port.

Key terms

Firmware – means the low-level controls built into a device that enable the device to carry out instructions given by the user. For example a remote control requires firmware to instruct it on what is required, such as turning on or dimming a light

Output devices

Output devices provide information to the user from the computer. They perform a function using data or software stored in a computer. The following are all examples of output devices that can be connected via a cable or wirelessly to a digital device.

- **Screens** – these are classed as output devices as they provide the user with a representation of the data being input or retrieved from a file or the internet. They are crucial to human interaction with computers, because otherwise we would not know what was stored on the digital device or be able to access the internet through it. Screens show us how we are interacting with the digital device via the input device.

- **Projectors** – these are similar to monitors as they are visual displays of whatever is being accessed on a digital device. Projectors are used to project the digital display onto a white or silver screen. They are mostly used to project films in cinemas (commercial and home) and for presentations to large groups of people, where there are too many people to gather around a small computer monitor.
- **Printers** – are available in 2D and 3D options. Conventional printers (2D) are used to reproduce text and images according to instructions, which they receive from any digital device. The printer receives data from the digital device, which it replicates on paper. The 2D printer is a familiar sight in many homes and most organisations. The till receipt you receive after making a purchase is printed from a 2D printer. Three-dimensional printers are used to produce objects using materials such as plastic, and even chocolate, from instructions that they receive from any digital device. 3D printing is now becoming more widely used and affordable. Invented in the 1980s, but slow to come to market due to high cost, the scope of 3D printing is almost unimaginable: for example, model making, manufacturing prostheses, etc.
- **Speakers** – a sound card converts digital signals into analogue signals, which are then converted into audible sound by the speakers. They are used to listen to music or videos and enable users to hear people in other locations during web conferences.
- **Actuators** – these are mechanical devices used to convert energy into movement. For example, to enable CCTV to capture movements of traffic and individuals.
- **Motors** – these are fundamental to the operation of a computer. Computers get hot and require a fan to prevent overheating and the fan needs a motor to enable it to operate.
- **Accessibility devices** – examples are alternative keyboards, sip-and-puff systems, wands and sticks, and braille embossers. They provide alternative ways of communicating with a computer.

Storage devices

Storage devices are peripheral devices that are used for storing data in order to:

- save space on your computer's hard drive
- transfer files physically rather than over the internet
- share files with another person or another digital device physically (if a network connection is not available)
- back up data in order to protect against damage or loss.

The following are examples of storage devices.

- **USB flash drives** – these can store smaller amounts of data that you wish to keep a copy of, or they can be used for temporary storage when moving data from one digital device to another.
- **Memory cards** – provide high-capacity memory storage in a small space. They are most commonly used in small digital devices, such as cameras, particularly for storing still images.
- **Hard drives** (internal and external) – external hard drives are used to back up data or to store large amounts of data. Digital devices, such as laptops and tablets, have limited storage space on their internal hard drives: by storing data on an external hard drive, you can increase your storage capacity.
- **Optical drives/discs** – DVDs (digital versatile disks) are a form of optical disk technology. They are most commonly used to store films. Blu-ray is an advancement on DVD technology that uses different wavelengths and materials to realise a massive increase in storage capability.

Link

For more about USBs see page 31.

- **Magnetic tape drives** – the data are stored on a long strip of narrow plastic tape, which has a thin magnetisable coating. It is commonly used in cartridges and cassettes. Magnetic tapes can be used to store large quantities of data. However, magnetic tape drives record data in a sequential order. This means you need to scroll forwards and backwards if you want to find a particular piece of data. This makes magnetic tapes useful for archiving data that doesn't need to be accessed instantly.

Storage devices are often used as both input and output devices (they are known as I/O devices), which means that you can copy or transfer the data from the device as well as onto it. Some storage devices will not allow you to reuse them, so that you cannot change the data that is stored on them. These devices are read only.

Accessibility devices

Accessibility devices provide alternative input and output options for using digital technology when standard methods are not an option, for example because of a physical impairment. They are also referred to as adaptive technologies. The following are examples of accessibility devices.

- **Voice or speech recognition software** – this software allows users to give instructions to digital devices or to input data using their voices (rather than fingers). It is particularly useful for anyone with a visual impairment or physical impairment to their hands. Examples of this kind of software are Express Scribe Free, Speakonia and Dragon. Many digital devices now have a 'personal assistant', which is controlled by your voice, such as Siri on Apple® iPhones and Cortana on Microsoft® products.
- **Screen readers** – this software will read aloud the words or content of the computer screen. This is particularly useful for people with visual impairments. The screen reader will read the words on the screen and also read out **alt text** for images and other media.
- **Touch screens** – as well as being an interactive and useful way for anyone to input data into a mobile digital device, touch screens can be of particular benefit for anyone who is unable to use a keyboard easily.
- **Keyboards with big keys** – these are useful for visually impaired people or for those who find it physically difficult to use standard keyboards.
- **Ergonomically shaped keyboard and mouse** – these can benefit people who suffer with **RSIs** (repetitive strain injuries) when using a standard keyboard and mouse for long periods.
- **Screen magnifiers** – these benefit people with visual impairments as they make it easier for them to read what is on the computer screen.
- **Screen overlays** – these are helpful for people with visual impairment or conditions such as dyslexia, as they make the text easier to read by changing features of the screen, for example the background colour. The screen overlay option in Microsoft Windows 10 is an example of a built-in accessibility option.
- **Eye motion sensors, head motion trackers, sip-and-puff systems, wands and sticks, or light operated mouse and keyboard** – these accessibility devices/adaptive technologies make certain tasks possible for people with significantly limited physical movement or paralysis. The choice of these devices will depend on the specific impairment of each individual. For example, sip-and-puff systems are used by sucking and blowing on a straw-like tube to send signals to perform operations. Generally these are operated by users who have limited or no upper body movement and cannot use their as hands, arms, etc.

Link

Find out more about free screen readers at www.usabilitygeek.com.

Key terms

Alt text – alternative text for an image or other media, for example on a web page or in an e-book. The alternative text is read by screen readers to tell the user what the image or other media depicts. Alternative text therefore needs to be descriptive and concise.

RSI – pain inn muscles and nerves caused by repetitive movements and overuse.

▶ Adaptive technology in action

- **Braille embossers** – these are printers that produce documents that are embossed as well as or (instead of using ink) and so can be read by people with visual impairments.
- **Keyless cars** – this technology can be convenient for anyone, but it is also particularly useful for people with dexterity difficulties.

As you will learn later in this unit (see page 90), legislation exists to prevent people and businesses from putting barriers in the way of anyone accessing technology.

Manual and automatic data processing

You may have heard the saying that what comes out of a computer is only as good as what goes in. Loosely speaking this is true. However, computers can read through optical character recognition and can write through output of data. Also, some of what comes out of the computer could be 'created' by the computer. Output is generated by the software, which was written by a person.

A computer has no decision-making capability unless it is programmed in. A computer will only do exactly what it is told to do. Consider, for example, a simple calculator, which is a basic form of computer. It is very easy to assume that the answer a calculator gives must always be right. However, if the calculation or the figures that are put into it are wrong, then the answer will also be wrong. (The calculator will calculate correctly the figures put into it, but it will not know if these are the wrong figures.)

Despite the limitations, we would struggle to imagine life today without computers and their capacity to process enormous amounts of data rapidly.

Now consider examples of different types of data processing, both manual and automatic, that are performed by businesses.

Manual

The following are examples of some possible manual processes:

- keying in mail and telephone orders
- entering customer details from paper forms
- processing sales (checkout operators at a supermarket)
- marking exam scripts
- entering or collecting survey responses.

Research

Research where gesture recognition technology is used or how it could be used.

Discussion

The late Stephen Hawking was one of the world's most famous people who relied on adaptive technology. You and your peers may know someone who requires specialist software or adaptive technology.

In a small group, list as many different types of adaptive technology as you can name, and describe what they do.

Explore other limits to accessibility and seek out options that exist but that are new to you.

Link

For more about accessibility legislation, see *Accessibility of IT systems*, page 91.

Tip

In your assessment, ensure that what you put into the computer is what you want to get out. Make sure that you always proofread your work or ask someone to help you do this, as a fresh pair of eyes often spots things you might miss. You will also need to be exact when writing programming code, so make sure to check everything you write.

Automatic

Automatic data processing is data collection or processing carried out by a computer, sometimes with very little human input. The following are examples of uses of automatic data processing:

- smart meters (measuring electricity and gas)
- seismometer (used for predicting and measuring earthquakes)
- satellites (such as the Hubble telescope, observatories such as Mauna Kea and in the search for extra-terrestrial intelligence (SETI))
- processing of ATM transactions
- race timing systems (**RFID**)
- bitcoin mining.

Key term

RFID – radio-frequency identification.

Characteristics and implications of storage media used to form part of an IT system

Earlier, you considered the use of servers to store data. They are often used as central locations for software applications, which are accessed by multiple users via networked computers, rather than installing the software on individual computers. Servers are most commonly used by businesses and organisations, such as schools and colleges, because they allow large numbers of people to share data, software and resources easily.

- Storage devices, including USB flash drives, DVDs, CD-ROMs and external hard drives, are most commonly used by individuals. Many businesses prevent the use of personal or transportable storage devices as they pose a risk to the business of computer viruses being spread across devices. There is also the risk that data will be lost if it is only stored on one standalone storage device.
- Businesses usually have formal procedures in place for storing media centrally over a network so that other employees can gain access to information that needs to be shared. Certain protocols will also exist about the structure of that stored data so that it can be located easily by anyone using the network and for routine back-ups.
- Businesses use servers to store data on fixed disks. They usually also use a system called RAID (redundant array of independent disks) to spread data across a number of different physical disks. This has the advantages of both increased speed and managing redundant data, providing more disk space if configured in the correct way. If a file needs to be accessed, it may be spread across ten disks, which means that each physical disk only needs to read a tenth of the file and this can happen simultaneously, cutting down read times by a factor of ten. If one disk fails, the data can be reconstructed using the data from the remaining good disks.

Magnetic-based drives, including hard drives, floppy disks and magnetic tapes

Magnetic storage has evolved considerably since the days of floppy disks. Although low cost, it lacks durability compared to alternatives. However, developments have vastly increased the storage capacity, it is reusable and it can back up data without interruption at times convenient to the user.

Solid state drives have fewer moving parts than other types of drive and are therefore less likely to be damaged if dropped. They are faster and more lightweight than alternative drives. However, they also have a shorter lifespan, limited storage and a higher cost than alternatives.

While fairly fast and low cost, an optical disk has limited storage capacity when compared to a Blu-ray disk.

Computer software in an IT system

This section is about the concepts and implications of the use of, and relationships between, hardware and software that form large- and small-scale IT systems. You will also consider the impact of IT systems on individuals and organisations.

Types of operating system

An operating system is the **platform** that enables software installed on a digital device to work. It includes the necessary functions that act as an **interface** between the hardware and the software. You will probably know about some of the operating systems that exist, such as those developed by Microsoft (Windows), Apple (iOS), Android and ChromeOS. These systems operate with graphical user interfaces (**GUIs**). You may also have heard of DOS (disk operating system), which was the first, most commonly installed, operating system on PCs.

Real-time operating system

A real-time operating system (RTOS) is a system that processes data in current (real) time, for example, RTLinux and Windows CE.

Embedded operating system

Embedded software is used to control a machine or device and is built into the hardware. You are likely to be oblivious to the software because it performs its tasks in the background. Examples include bathroom mirrors that have sensors to detect temperature, moisture change and prevent misting, and are also available as Bluetooth-enabled; medical equipment such as pacemakers and cochlear implants; everyday items such as cars, telephones and televisions.

Single-user single task

Single-user single task operating systems can only run one user application at any one time (such as on a basic mobile phone), unlike a smartphone, which runs several software applications at the same time.

Single-user multi-tasking

Single-user multi-tasking operating systems deal with multiple applications running at the same time, which is what smartphones use. For example, when you are using spreadsheets, word processing, surfing the internet and listening to the radio on your PC at the same time, you are demonstrating that the operating system you are using is single-user multi-tasking.

Multi-user

A multi-user operating system, for example Unix, enables several users to operate the same, or different, software applications at the same time, for example through a server. Cloud servers enable multiple users to contribute to the same document, such as a spreadsheet, at the same time.

The role of the operating system

You have started to learn how operating systems manage many different functions. Operating systems also have functions to manage, in addition to running applications, and you will explore five of these here.

Skills

- Analysis and decision-making
- Ability to work in a legal, moral and ethical manner
- Using critical thinking

Key terms

Platform – the operating system that enables applications or programs to operate on a digital device.

Interface – a point where two (or more) systems meet and interact. In computing, an interface is a device or program enabling a user to communicate with a computer.

GUIs – graphical user interfaces are those that allow users to interact with a digital device using graphical icons.

Research

How do operating systems that do not run on a GUI principle work?

Theory into practice

1. Keep a log of your computing activities over the course of at least one day.
2. Specify which types of operating system relate to each activity, each time you use a different digital device.
3. Share your list with a peer and discuss whether you agree about which type of operating system is being used in each case.

Link

For more information about NOS services, including the programming language used for early operating systems on different platforms, visit http://computernetworkingnotes.com.

Discussion

How do you know whether your data and IT system is protected?

Discuss this in a small group. Consider what you can do to protect your data and IT system from cyberattacks.

Link

For more information about the types of memory that digital devices use, see Memory and storage in **Unit 8: Computer Games Development**.

Key term

Driver – a routine program used to operate peripheral devices, such as monitors and keyboards.

Networking

A networking operating system (NOS) controls access to resources and devices on a network. Networking operations include tasks such as managing remote printing, user management and backing up files.

Security

Operating systems that manage security run ongoing checks for attacks on the system and its software. They gather data, which is analysed and collated to form huge amounts of intelligence about the health of the IT system. Manufacturers of software collate this data to help combat cyberattacks. They also use it to develop new software or to adapt existing software to make it more secure against attacks.

Memory management

Operating systems require memory to run and, the larger the IT system, the greater the memory needed to run all its functions. This is the reason why multi-user operating systems run from a server (or collection of servers), because otherwise the computers would fail to operate efficiently. For an operating system to function, there has to be sufficient memory for its application workload to enable it to work out how best to use the memory it has for conducting each task.

Multi-tasking

The modern operating systems of today continually multi-task. Think of your classroom PC – it is constantly scanning for viruses, maybe allowing you to research on the internet, while also editing your assignment work on a document and playing a selection of music, all at the same time. The operating system provides you with information about your system, such as how much storage remains or how much battery life is left, in addition to the management of the applications you are running. However, a PC can, in fact, only do one thing at a time! So, how does it multi-task?

Multi-tasking is managed by the operating system by allowing each process access to a tiny amount of processor time in turn. This happens so fast that it appears to be doing it all at once. The downside to all of this is that there is only so much processing power and memory to go around, so things can begin to slow down when you are using lots of applications at once.

Device drivers

The operating system manages your peripheral devices by using a **driver** to link the digital device with peripherals such as printers.

Factors affecting the choice and use of user interfaces

User interfaces (UIs) provide a communication link between a computer's operating system and the user, whether the device is operated by using GUIs or by writing a sequence of programming code to perform each action. You will now consider the factors that affect the choice of UI, depending on the intended use.

Graphical

The majority of PC users are probably very familiar with using graphical user interfaces (GUIs), as Microsoft has a significant market share in supplying software and operating systems for personal and public use. As previously mentioned, GUIs allow users to operate a computer through the selection of graphical icons. Therefore, GUIs enable users to operate their devices effectively without needing programming knowledge and

▶ Examples of GUIs

with limited computing skills. However, because of this, GUIs require significantly more memory and power to operate than other UI methods.

Apple describes GUI functions as 'WIMP computing' (windows, icons, menus and pointer) and could be said to have revolutionised the way in which we use computers and digital devices. WIMP computing has made computer usage accessible to billions of people of all age groups by being an intuitive, easy-to-use UI, whereby users can perform multiple actions with little or no prior knowledge or training.

Command line

The command line is the starting point shown on a computer screen where programming code is typed, informing the operating system what to do next. Essentially, the computer is operated via the inputting of text, specifically commands. A command line UI provides more flexibility than a pre-programmed GUI, but requires the user to have knowledge of the OS-specific commands to use it. The advantage of a command line UI is that it can be used to operate lower specification computers.

Menu-based

Menu-based UIs provide alternative methods to perform functions, through a menu, and require less memory than GUIs. They may provide additional options to those of a GUI but require user knowledge about which menu provides each function. Users who are less familiar with the software, or who are risk averse, are more likely to prefer GUIs to menu-based UIs as a way to navigate and operate their devices.

Adapted

Factors that influence the choice of UI include the ability to adapt it, for example the options routinely provided by Microsoft for adapting the colour, font size and positioning of GUIs on the desktop. The ability to adapt a UI is an important factor for users, particularly if they have specialist needs such as a visual impairment.

Link

You will learn more about accessibility guidelines and current legislation in *The role of current legislation*, page 87.

Factors affecting the choice of operating system

You have already begun to learn about some of the features of operating systems. These features will help you make a choice about which operating system is likely to be most suitable to meet your needs.

Most people will want to have access to a single-user multi-tasking operating system so that they can carry out more than one function at the same time, because such digital

devices are more powerful and useful. PCs used by individuals and businesses will be single-user multi-tasking. Some businesses may also have access to a multi-user operating system for collaborative working, which will be accessed via a server or the cloud.

If you are planning to become a **software developer**, **data engineer** or an IT technician who solves network and security issues, you will need to interact directly with the operating system by using operating system tools and sometimes the command line. There are often quite accessible graphical interfaces in a modern server operating system. Microsoft Windows can almost be exclusively managed by a graphical interface, as can modern implementations of Linux. A networking device such as a Cisco Router, however, is programmed solely by the command line through a **terminal window**.

However, if you (or a future customer of yours) interact with the digital device for the purposes of administration or leisure pursuits, then the operating system used will need to be configured for efficiency and usability. For a relatively new digital user or for someone who has little interest in anything more than basic functions that are simple to use, save time, enhance daily living or simply for entertainment, then a WIMP-style GUI operating system is likely to be the appropriate choice.

Key terms

Software developer – someone who contributes to producing computer programs (software applications) or computer games.

Data engineer – someone who designs and produces database programs known as information systems.

Terminal window – also referred to as a terminal emulator, this is a window (or graphical user interface) devised by Microsoft for accessing command lines.

How interfaces affect features and performance of computer systems

User interfaces (UIs) are the front-facing link between humans and computers. The command line is the point at which the user enters command text sequences to instruct the computer to perform a task. In the early days of PCs, the only way to operate the computer was to input a lengthy command, known as a string, at the initial prompt, which showed on the screen when the computer was turned on.

UIs have been revolutionised by the use of graphics (GUIs), so users do not need to input command line code. GUIs provide prompts and directions so that even the most novice user can operate a digital device with little or no training. Possibly the most important and influential impact of GUIs in computer software is their universal accessibility, which enables billions of users to interact with technology by:

- increasing levels of technological skills even without formal training
- providing creative and effective ways for users who are mentally or physically disabled or who have specific sensory impairments to interact with computers.

GUIs have extended the use of technology to the masses. It is crucial to design interfaces that are intuitive to the user; the demands on the storage and performance of the device are significant when compared with pre-interface options.

Factors affecting use and performance of an operating system

The amount of data you want your digital device to process at any one time will affect the performance of the operating system. A device that is running multiple applications and performing numerous operations, especially simultaneously, will use considerable amounts of memory and processing power (for example, a device streaming music and videos, while also editing a presentation). In contrast, on a device used entirely for administrative purposes, producing spreadsheets and word processing documents will use significantly less memory and processing power. In both examples, the operating system is single-user multi-tasking, but, the smaller amount of memory required and the fewer applications running simultaneously, the faster and more effectively an operating system can perform.

The amount of data analysis performed will increase the memory usage. A PhD student performing complex mathematical analyses on copious amounts of data for a major research project will require considerably better operating system performance than a bookkeeper of a small business who has relatively small amounts of new data at any one time.

Hardware specifications – the specifications for the hardware required to meet the demands and purpose – will vary according to multiple factors: for example, memory requirements for both input and output needs, and speed at which data are processed. The more demand on the device, the greater the demand on its performance. For example, you will probably have noticed when the performance declines when you are using a laptop. This can be due to a number of factors, such as too many programs open simultaneously or software running in the background, such as antivirus.

The operating system has to interact with other systems and therefore it must be compatible. Some software will not run with different operating systems. In other words, they do not speak the same language. One such example is the difference between Apple iPhone and Android systems.

Utility software

Utility software is system software that runs alongside the operating system to distinguish between applications and to carry out routine tasks to maintain and optimise the system operation.

The purpose, features and uses of utility software

The purpose of utility software is to undertake routine tasks. The following are all examples of features and uses of routine tasks carried out by utility software:

- security checks
- identifying and removing viruses using antivirus and anti-malware software
- cleaning up files
- software updates
- backing up data
- compression of files
- analysing disks
- disk fragmenters
- disk partitioners
- encryption
- file manager
- network utilities
- issuing warnings or alerts that updates or back-ups are required
- managing peripheral devices (such as cameras, printers and webcams).

Another use of utility software is to gather data to clean up the system and speed up performance by searching for junk data and purging it (removing it) to free up storage space. Utility software varies in the amount of memory it takes up according to its features.

Factors affecting the choice and performance of utility software

Factors affecting the choice of utility software depend on what the user expects to get out of their device in terms of performance. If the device is mainly for browsing the internet or talking to friends using voice over IP (**VOIP**), it may not require utility software such as a printer driver. Users will choose utility software based on their needs.

Key term

VOIP – voice over internet protocol.

Most digital devices come with integrated software update processes, but users need to decide whether they choose to add security and virus protection or to set up back-up utility software.

Factors that can affect the performance of utility software include the amount of memory available on the digital device for utility software, as mentioned above. Other factors include:

- bandwidth
- conflicts with other utility software (such as multiple antivirus applications running on one device)
- memory failures.

Application software

Application software is the software required to run your applications (programs) and the easy access apps on smartphones and other digital devices. The range of software is outlined below.

- **Communications software** – such as Skype, Apple's FaceTime, WhatsApp.
- **Computer-aided design (CAD)** – used in technical drawing, architectural design, etc.
- **Database management systems (DBMS)** – software that retrieves and manages data from a database and can also manipulate the data. You will learn more about associated systems later in *Section B: Understand how organisations make use of data and information* (see pages 54–77).
- **Digital graphics and animation** – computer software has revolutionised the design and production of digital graphics and, especially, animation. Sophisticated software is even readily accessible through smartphones, through apps such as Snapchat and Facebook.
- **Enterprise resource packages (ERP)** – these enable organisations to manage all their processes in an integrated manner, for example, purchasing, sales, stock control, accounting, etc.
- **Entertainment software** – possibly one of the most commonly used on a daily basis. Whether you are catching up with current affairs, watching films, using YouTube, listening to music, etc., they all rely on the relevant software to function.
- **Office software** – the two most commonly used systems are Microsoft (MS) and Apple. Microsoft dominates the global software market, although, in early 2019, Apple was reported to have overtaken Microsoft as the most valuable public organisation in the world. You are most likely to be familiar with Microsoft products, such as MS Excel, Word and possibly Access, plus others.

If you are studying computer programming, you may become familiar with programming software such as Windows Visual Basic, Python and Java.

The purpose, features and uses of application software

Since the development of application software, business processes have been greatly enhanced. Software applications enable businesses to cut costs, increase production and control quality through the use of automated digital processes and greater data processing power. There are also some businesses that benefit from the introduction of IT systems using application software that may not immediately occur to you.

These include:

- **farming** – software applications are used to manage harvesting, sorting, cleaning and packing produce
- **textiles** – software applications are involved in the design and manufacturing processes used to produce textiles.

Factors affecting the choice, use and performance of application software

One of the many reasons why Microsoft products have been so popular worldwide is their versatility and usability (ease of use). Businesses that need general office applications mostly favour those with which the majority of people are familiar (and most people are familiar with Microsoft's Office suite) and those with interoperability. When employing administrative staff, it is easier to only require previously learned skills, such as how to use Microsoft Office applications.

Apple products are most likely to be favoured by businesses in creative industries, such as advertising and graphic design. This is because the software that Apple initially designed had floating point processing power and excellent graphics capability that was more suited to creative processes. Since then, they have built on that reputation. Some users simply prefer the design of Apple software, although Microsoft Office operates on PCs and offers a version for Apple Macs. A great deal of industry-standard graphic, video and music production software is specifically designed for Apple Macs and takes full advantage of their unique capabilities.

▶ Home screens on different computers

The principles and implications of open source and proprietary operating systems and software

Behind all operating systems and software there is programming code, known as the source code. You may have come across this if you have looked at the source code of a web page in **HTML**. There are two types of source code that are generally created – open source and proprietary.

Open source

Open source code is a collaborative effort where more than one programmer contributes to the programming of the source code. It relies on peer review for testing its uses and functionality, and to fix any problems. Its main distinguishing feature is that the source code is open for use by anyone. Individuals can copy open source operating system and software code and, if they have the knowledge required, they can adapt it to their needs. Another distinguishing feature of open source software is that it is free.

Key term

HTML – stands for hypertext mark-up language and is used to create web pages.

Link

For more on HTML, see **Unit 6: Website Development**.

One of the drawbacks of open source software is that it can be copied and modified by:

- individuals who have a malicious intent
- expert programmers who do not share the same philosophy or responsibility for the software's integrity as its originators
- inexperienced programmers.

However, this risk can be mitigated by checking the source of the open source code you download. On the positive side, open source programming provides opportunities for individuals to be creative and share their knowledge and expertise globally and freely. It also gives access to sophisticated software to people who would not be able to afford the proprietary software. Developers of open source software do it 'for the love of good software', and bug fixes and feature developments are usually rapid.

Link

For more about open source, go to www.webopedia.com and search 'What is open source software?'

Proprietary

Proprietary source code for operating systems and software, unlike open source, is privately owned. Examples of proprietary operating systems and applications are those produced by Sage, Microsoft, Apple and Pegasus. Proprietary operating systems and software code will have been produced by more than one programmer as employees of a particular private company.

Proprietary operating systems, software specifications and code are kept secret within a company to avoid copies being made and to stop modifications being made by anyone other than the company's designated programmers. Individuals and businesses need to purchase the proprietary operating systems and software they intend to use, but they are only able to use the operating systems and software, not change the source code.

One of the main implications of using proprietary software is that it can be costly. Another is that it restricts development to particular employed or contracted programmers. However, because the developers have control over the code, they are able to gather data on problems that occur and can use it to correct programming issues. They are able to create code 'patches' that can then be delivered to registered users of the software. (Updates are also possible with open source software: developers develop the code and users upgrade.)

The features of common file types and formats

The data within a digital device is divided up into different file types, for different types of data. File types help the computer determine which software should be associated with the file (that is, which software will be used to access the file) and how or where it should be stored. File types are automatically assigned to routine files. There are many different types and formats used for creating files and these are identified by a suffix following a filename and a dot. For example, you may be aware that Microsoft Word files are identified as '.docx' in the current version, whereas the Word template file type is '.dotx'.

Other examples of file types include the following, which are used for different kinds of data:

- image file types include:
  - GIF
  - PNG
  - JPEG
  - RAW
  - SVG

- video file types include:
  - MPEG
  - AVI
- audio file types include:
  - MP3
  - WAV
- application software files are saved using different file types, the most familiar being:
  - DOC
  - RTF
  - XLS
  - XML
  - PDF.

Use and selection of file types and formats

There are a number of implications for IT systems, individuals and organisations depending on the use and selection of file types and formats.

The method used for storing a file will vary according to the type of data it contains, the software used to access it and the type of file produced. Therefore, decisions can be made about how you save a file in a different format depending on which will save memory, increase performance or, for example, retain the clarity of an image.

The implications of using and selecting some file types are discussed below.

JPEG

JPEG files can be opened by most software applications and take up less memory than many other file types because the file is compressed when it is saved, losing some data and, therefore, quality in the process. Therefore, JPEGs are particularly useful for attaching to emails, but the image quality might not be high enough for some purposes.

TIFF

TIFF files retain the quality of the image when saving, but TIFF files are not compatible with some software applications and so will not open and cannot be used in these applications. Therefore, it is not the most versatile file type.

RAW

RAW files are uncompressed files. RAW file types can be used for images that require editing, but they require the relevant sophisticated software to open and manipulate them. This can be done using free software such as Microsoft's Window Photos, Able RAWer and RawTherapee (www.lifewire.com). The RAW file types are mostly used by cameras, specifically DSLRs, and each manufacturer has its own proprietary RAW file type.

PNG and GIF

PNG stands for portable network graphics. PNGs are file types that support lossless data compression. GIF stands for graphics interchange format and is a lossless format used for both still and animated images. There are patented restrictions on using GIF files, whereas the PNG file types do not carry the same restrictions and so are more commonly used. PNG file types can also be used as an alternative to TIFF file types.

Link

You will learn about lossless data compression later in this unit in *Types of compression*, page 42.

Link

To learn more about image file types, visit the Windows website, windows.microsoft.com.

Link

To learn more about the difference between MP3 and MP4 files, visit www.differencebetween.com.

GIF file types do not support sophisticated animation. One of the benefits of using PNG file types, which were initially designed to replace the GIF format, is that software developers and web designers are not restricted by patenting laws as they might be when reading and writing other file types, such as GIF.

MP3 and MP4

The MP3 file type only stores audio files, unlike the MP4, which holds both audio and video data of fairly high quality. MP4 files with video are significantly larger than MP3 files. However, MP3 and MP4 are not protected file types, which has led to piracy.

DOC or RTF

Word processing documents can take the form of a document, such as Microsoft Word's DOC file type, or can be saved as a rich text file (RTF). Saving long and complex documents as RTFs is a useful tactic because they take up much less storage space than DOC files. It is especially useful if the files are to be shared with users who have newer versions of software or different software makes. However, if you wish to preserve heavily formatted material, including tables or graphics, you need need to use the correct software file type.

Pause point Think about what has influenced your choice of software and devices for your own personal use. What choices would you make now, based on what you have learned in this unit so far?

Hint Identify the devices and software you use and make a list. Analyse and evaluate the advantages and disadvantages of each item on your list. Then consider which devices and software you might choose now.

Extend Create a list of the software and devices used at your place of study. You might want to focus on a specific department. Identify the advantages and disadvantages of each in relation to its purposes and make suggestions for improvements. Compare with a peer and explain the reasons for your evaluations and recommendations.

Compatibility

Files of different types will not necessarily open in different software and may be incompatible. For example, you will not be able to open a spreadsheet in a word processing application and you may not be able to open a file saved in a later version of the software in an earlier version.

The implications of the use and selection of file types and formats for IT systems, organisations and stakeholders

When looking at the selection of file types and formats available to users, you need to consider how these impact on organisations and their stakeholders. For example, updates to systems can delay daily operations, affecting timing and, potentially, causing loss of business. Stakeholders, such as external customers, suppliers and employees, may struggle with changes to systems if the functions become less familiar or more complicated and, as you may have experienced, there may be problems with the smooth operation of a new system.

When making changes to IT systems, there could be problems with the interaction with other software and hardware. Technical knowledge will be required to ensure information is not lost, for example if it becomes inaccessible or corrupt. Moving from manual to automated systems is not necessarily a simple and swift transition and organisations may need to invest heavily in additional training for employees.

Connectivity

Connectivity is the ability to process digital data by connecting the operating system with applications and systems, and with each other.

Wireless and wired methods of connecting devices and transmitting data within and between IT systems

There are a number of different methods to connect devices and transmit data between systems wirelessly or using wired cables. Nowadays, we expect our portable devices to connect to the internet via Wi-Fi automatically. When on the move, we rely on our digital devices to detect wireless signals and prompt us if we need to connect manually by simply choosing the network available and inputting a security code, if needed.

However, connecting devices by wired cables was the only option when computers were first being adopted by businesses. Computers, printers, scanners and webcams were all joined together by cables. It was usual to see cables resting on desks and along the floor to join digital devices together or to a server.

Within IT systems, there is the need to connect peripherals and devices to perform input or output functions, such as printers, keyboards, mice, webcams, speakers and monitors. There are a range of both wired and wireless technologies that enable this.

Wired methods include:

- **USB** – this is the most prevalent wired connection in today's IT landscape; it is a bidirectional bus, which means it can both transmit and receive data, and a single port can provide connectivity for up to 127 individual devices; one big advantage of USB is that it can also provide power to peripherals
- **ethernet** – this is a system for connecting a number of computers to form a LAN or local area network
- **fibre-optic** – a flexible, transparent fibre, which permits transmission over longer distances and at higher bandwidths (data rates) than electrical cables; it is rapidly replacing copper cabling because it provides greater bandwidth over longer distances
- **HDMI and DVI** – these are the two main digital connectors used on computers and entertainment systems.

Wireless connection and transmission methods include:

- **bluetooth** – this is a wireless method often used to connect mice and keyboards, as well as audio devices such as headphones; its range is approximately 100 metres
- **mobile/cellular networks** – this is a communication network where the last link is wireless; the network is distributed over land areas called cells, each served by at least one fixed-location transceiver, but more normally three cell site or base transceiver stations.

Other wireless methods include **NFC** and **infrared** – NFC allows two digital devices to connect when at close range, for example the iPhone Airdrop facility.

Wireless connection and transmission methods, such as Wi-Fi and Bluetooth, allow wire-free connection to a network, which might be a corporate network or be through your phone using 'tethering' and the 3G, 4G or 5G mobile data network. In businesses, wired connections are the most common form as they offer enhanced speed and reliability compared with wireless networks and, in some cases, they offer increased security.

We take for granted the functions that our digital devices perform to enable them to connect automatically and **sync** with other devices for access and so that data can be

Skills

- Analysis and decision-making
- Ability to work in a legal, moral and ethical manner
- Interpersonal skills
- Self-management
- Communicating
- Self-presentation

Key term

NFC – short for 'near-field communication' is a method offering a low-speed connection between two electronic devices.

Infrared (IR) – is a short-range wireless mobile technology. It is limited because it requires 'line-of-sight' and also cannot penetrate walls.

Sync – is short for 'synchronise' or 'synchronisation', which means to match up and pull together, for example, to make sure that multiple devices have the same copy of the relevant files in many places.

Link

For more about early television remotes, go to www.earlytelevision.org.

shared between them. For example, although you might own multiple digital devices, you can sync your data into one storage place. This means that you can access files, images and contacts when you use your phone, tablet or even a smart television. Usually, cloud storage is used to achieve this syncing of data.

When video recorders and televisions first became available to the public at more affordable prices, in the late 1980s, remote controls were also connected by a cable.

Remote controls using radio transmitted signals were first employed by the military to control weapons in each of the world wars. Now all of our everyday remote controls for smart televisions and FreeView, Sky or Virgin boxes use infrared signals.

Key term

Bandwidth – the available amount of data transmission capability.

When the internet was originally available to the public in the early 1990s, wired cables were used to connect computers and telephone lines to enable access to the internet. The dial-up process was tedious, noisy and unreliable. At that time, considerably less data could be downloaded than these days due to the limitations of the **bandwidth**. The introduction of broadband enabled quicker internet access with a faster response time and it gave people the ability to download large quantities of data fairly rapidly.

Theory into practice

Interview your relatives, neighbours and anyone living in a different area of the country from your home.

1. Ask them about their experiences with technology and how they managed without it in the past.
2. Compare their responses and analyse the information according to, for example, their location, age group or gender.
3. What similarities and differences are there and what evaluations can you draw from your findings?

We now have access to many different internet-enabled digital devices, which we can operate wherever we are, assuming we have an internet connection. There are many different products available, which enable us to operate devices in our homes, even if we are on the other side of the world. We can turn the heating on and off, arrange for lighting to come on automatically or change the settings using our digital devices. If we are at home watching the television, we can use any internet-enabled device to change the television programme using an app, and use smart televisions to access the internet.

How the features of connection types can meet the needs of individuals and organisations

Link

For more about the census information on internet access, visit the Office for National Statistics, http://www.ons.gov.uk.

Even though broadband is widely available and possibly taken for granted by many, there are many areas, even in this country, where broadband is either not available, has limited bandwidth or is not wanted or cannot be afforded by householders. For example, in the UK, the government information gathered in the 2012 census reported that 80 per cent of households had internet access. This meant that one-fifth of all households did not, at that time, have internet access. It would be hard to imagine life without internet access, particularly in the UK.

Wired systems using cabling are still used to network computers together for shared access to servers, especially by businesses. In some cases, the connection to the internet is now shared with telephone lines through which broadband is received. In other cases,

Theory into practice

Imagine what your life would be like without internet access. Try living without any form of internet access for a whole day. Find alternative ways of living without it.

1. Keep a diary of what you did and the alternative methods you used.
2. Share with a peer.

it might be cable broadband. Alternatively, people can use mobile broadband as their only means of connecting to the internet.

Businesses transmit data to speed up their productivity and efficiency using a mixture of wireless and **hardwired** or cabled systems. For example, vehicle manufacturers such as Mercedes Benz monitor the performance history of their vehicles, which they gather remotely, directly from the vehicle. The vehicle also gathers data on its performance, which is analysed by the processor in the vehicle and provides updates to the driver. The collection and analysis of this data enables more rapid and accurate diagnosis of problems. The manufacturer is able to automatically schedule servicing or replacement of parts before they become worn out.

Since the introduction of **fibre-optic** cabling, 4G connectivity and now with the emergence of 5G, systems for accessing the internet and streaming videos have become more reliable, quicker and effective than before.

Fibre-optic wiring increases the broadband speed, enabling users to utilise multiple digital devices in their homes and offices without experiencing the latency, unreliability or slow download speeds experienced when using traditional broadband connections. Since reports suggest that households own at least three different internet-enabled devices, on average, the demands on instant and reliable connectivity are increasing.

The development of 4G has enabled us to use multiple applications on mobile devices and to have a swifter connection to the internet than previously experienced. As yet, neither 4G nor fibre-optic connections are available to everyone because they are dependent on where you are located in the country and each connection type comes at an increased cost.

Key terms

Hardwired – a permanent connection between components of an IT system with dedicated wired cabling. Modern buildings are often purpose-built with the cables integrated into the fabric of the building and internet connections are provided for direct connection of non-mobile digital devices such as PCs, servers and machinery.

Fibre-optics – a collection of very fine strands of silica glass, which use light to transmit data at high speeds.

Research

5G technology will dramatically improve network connection. It offers a faster, more stable, more secure connection. Research more about the features and services that 5G offers.

The implications of selecting and using different connection types

Recent advancements in technology may have made some internal cabling redundant (that is, internet cabling within houses and offices). However, in those areas of the country with limited bandwidth, the ability to access the internet via wires is still useful. Also, cables provide greater stability when using smart televisions and surround-sound systems and can be hardwired directly into the device.

It was not until the late 2000s that some homes and offices were being built with cables embedded into the building infrastructure, so many businesses still show signs of trailing wires between IT systems. Increased health and safety requirements have raised awareness of the potential hazard from trailing cables.

There is a greater demand from businesses to have reliable remote connectivity for employees to communicate remotely between offices and across the world. Increasingly, more employees work remotely and interact with customers and suppliers around the globe at any time of day.

Such considerations are important when choosing between different methods of connecting digital devices.

The type of usage is also an important consideration when selecting the method of connection. In a warehouse, where staff are constantly on the move picking stock or collecting orders, the use of Wi-Fi with handheld computers is an excellent fit. Likewise, using tablets to access live patient records at the bedside is better suited to a wireless technology, although security in this situation is a key concern, given the sensitive personal data that is being accessed. A business in the creative industry that produces advertisements, and that is often editing high resolution video and imagery, would benefit from cabled fibre to the desktop, offering maximum speed of data transfer.

However, most businesses are content with copper to the desktop as a middle ground of reliability and speed.

The impact of connection types on the performance of an IT system

Choosing a suitable connection type will impact on the performance of an IT system. This could mean the compatibility of the cables and their connectors to transfer data between digital devices or the ability of the software applications to interact effectively. For example, a business relying on the stability and speed of multiple systems to transfer large amounts of data, such as banks, government offices and the health services, will want the fastest broadband connection available, which is currently fibre-optic. At the London Stock Exchange, reports have suggested that, via changes to its connection types between companies with which it trades, the potential benefit to traders could be to the tune of £12 billion a year. The ability for finance houses to get data across the Atlantic milliseconds before their competitors cansignificantly affect the profitability of trade.

In some industries, the reasons for choosing a more expensive connection type are not as obvious and there can be potentially negative impacts of connection types on the performance of an IT system. For example, there can be very high levels of electromagnetic interference as a result of some processes, which would cause problems with traditional copper cabling. In these cases, the added expense of fibre to the desktop is a necessity to prevent data loss and network degradation.

Research

At www.lseg.com read more about how customers of the London Stock Exchange benefitted from the changes to connectivity made by the Stock Exchange, increasing customer access from 2 Mb to 10 Gb.

Skills

- Analysis and decision-making
- Selection of appropriate IT tools and systems
- Ability to work in a legal, moral and ethical manner

Networks

You have already started to consider what networking means and how or where it is used. You are now going to learn more about the concepts and implications for individuals and organisations of connecting devices together to form a network.

The features, uses and purposes of different networks

This section discusses the different types of network and their features, use and purpose.

- **Personal area network (PAN)** – this is a wirelessly connected network between an individual's digital devices such as their smartphone, laptop, printer and car. This kind of network is used by individuals to sync their data across their devices for personal or business use.
- **Local area network (LAN)** – this is a local network that provides a connection between digital devices within a small area or building. The organisation 'owns' the communication links (cabling, infrastructure, etc.) employed to support the network. It might be used to network two computers and their internet connection within an office.

- **Wide Area Network (WAN) and the internet** – a WAN uses telecommunications over a wider area than a LAN, with the potential to connect digital devices around the globe. The internet is a collection of WANs. This global potential enables businesses to connect with each other across wider geographical areas. The advantage of a WAN over a cloud system for users is that it will be self-contained and can be made more secure, which is why organisations such as police forces use it. To connect using a WAN, the user usually pays a subscription to the telecommunications provider. WANs originally only transmitted voice, but they can now also carry data. The link uses telecommunications infrastructure that is not owned by the organisation.
- **Virtual Private Network (VPN)** – this type of network provides a contingency for business expansion with little disruption to computing services. It works by using the internet to securely connect remote digital devices together. Therefore, it is useful for businesses whose employees work remotely around the country or at different sites internationally.

Theory into practice

1. Identify at least one example of where each network type is used in different businesses, other than the examples given. What reasons can you give why these businesses would connect using the means they do rather than alternative methods?
2. Share with a peer and explain your rationale to each other.
3. What have you learned from this activity? If you agreed entirely with each other, share with another peer or in a small group.

Factors affecting the choice of network

As with choosing an IT system, there are several factors that will influence the choice of network type. Some of these factors are discussed here.

User experience

- **Ease of use** – this is how easy the network is to use. Users are likely to choose networks that are easy for them to use or gain access to. For example, if certain types of network are hardwired in their building, they are more likely to adopt them. Smartphone users are also more likely to keep to the same mobile phone network provider because of familiarity with their service. Users do not like overcomplicated processes. A device that connects automatically to a data service is preferable to a complicated configuration process that requires complex passwords or keys.
- **Performance** – level of performance will be more important to some users than others, depending on the purpose of the digital device. As in the examples above, a video editing studio would require far more from their connection method than a corner shop. For example, if a user has to use an internet connection regularly to download significant amounts of data, then the user might choose a 4G, 5G or fibre-optic broadband connection, whereas an occasional data user would be satisfied with a (cheaper) 3G service.
- **Availability** – there are limitations to the availability of some network services, such as fibre-optic services and even standard broadband or Wi-Fi. These depend on the locations of transmitters, especially in rural locations, and will affect the possible choices of network that a user can make.
- **Accessibility** – this determines whether a user can access data across a network, perhaps from a server or another device, or perhaps access information from an

Key terms

Intranet – a local network website where access is restricted to internal users, such as within an organisation.

Extranet – an intranet system that can be accessed by authorised external users to retain data security.

CPU – central processing unit, which acts as the computer's brain to process instructions.

Reflect

How would you make a choice of network for personal use? Make a list of reasons and rank these in order, with the most important being number 1.

How would you make a choice of network for your school or college using the same process?

Discuss your evaluations with those of a peer.

intranet or **extranet**. You may be familiar with using the intranet at your place of study, possibly for information and resources uploaded by your teacher and for uploading your assignments for feedback. Accessibility can also mean how suitable a network is for particular users with specialist needs or an impairment.

User needs

The needs of the user vary with what they need an IT network for, whether they are an individual setting up a network for personal use or a business. Individuals use technology for different purposes. You are likely to use your digital devices in different ways and for different reasons to those of your family members. A family may need to share a network, so will need one that meets the needs of everyone in the family.

A business will have similar considerations about network usage, which will depend on the size of the business, the number of employees and where they are distributed. If they have several office sites, they will want to transmit data and share files over the network, perhaps globally.

Specifications

Depending on the needs of the user or users, the specifications of the required network will also vary. Although office software is a fairly standard requirement, the versions installed will vary according to need. The performance of digital devices will also vary according to need: that is, the expected speed of connection, capacity and operating power required to undertake complex tasks will vary depending on the kind of business in question. For example, the specifications will be more demanding in a graphic design or music/film industry office than in one that is solely administrative.

Connectivity

An individual user might want to sync their digital devices together to share contact lists, files and photos and, according to usage, might want a more powerful broadband connection such as fibre-optic. However, someone else who just wants to use a tablet for browsing the internet or sending emails on occasions may prefer to pay a lower price for standard broadband.

As many businesses will need to connect to other offices across the country or globally for sales or suppliers, they will need to ensure that their access to the internet is very stable. Therefore, they will need to choose a stable network and connection type. Businesses will also need to decide upon the size of servers, their type and the performance power of digital devices to be used in the network, depending on their business needs.

Cost

Cost is another factor in the choice of network – the higher the specification, the greater the cost. Some businesses and individuals prefer to make up their own specification for an IT system, whereby each component part is costed according to its function and performance, for example different types of **CPU**. It is possible, in this way, to get the same specification IT system for less money. However, it requires more technical knowledge and practical experience to set up.

Efficiency

The busier our lives become, the greater the demands we put on the technology we use. We demand maximum efficiency. Just as we are no longer satisfied with dialling into the internet once we have tried broadband, the same will be the case for those who use fibre-optic connections because they are more efficient: that is, they can download more data in the same time period.

Compatibility

Our choice of telecommunications network will depend on its compatibility to communicate between a variety of digital devices. Any exchange of data will need to be in a format that each device understands. If a network is to be used to support workers who are constantly mobile, such as for quality control workers on a production line, then a fibre network is unsuitable. Some form of wireless technology would suit them better as they do not have a 'fixed base'. Likewise, Wi-Fi is likely to be unsuitable for a data analyst working with large data sets because the data need to be error free and available instantly.

Figure 1.1 Compatibility between devices is important

Implementation

The decisions we make about the types and makes of device we buy, and the telecommunications network providers we choose, will be influenced by the ease and simplicity to implement them (set them up).

- **Timescales** – for a business, time is money and the purpose of the installation will often dictate the timescale. A network installation in temporary buildings to accommodate seasonal demand needs to be installed quickly. For this purpose, wireless can be set up and running in minutes. However, for a permanent office, a more resilient structured cabling solution would be more suitable, although it would take many days to install properly. Similarly, for external communications, temporary circuits in copper can be installed much more quickly than a permanent fibre-to-the-premises installation.
- **Testing** – a business needs to be able to rely on its network infrastructure as it is often the core holding every other system together. A properly planned installation will take into account this element of testing and a business might specify that the installation is categorised and certified to meet international standards as a way of ensuring reliability. A business IT system will also need to be tested and this may take a long time depending on the demands for the system. For example, testing needs to be carried out between digital devices for connectivity, especially if overseas. An individual will need to test their IT system, even on a very small scale, such as using the internet or testing the time taken to upload and download data. If the download speed is too slow, they may choose to implement a different network.

Research

Human activity has had a devastating impact on wildlife around the globe. Many breeds are now extinct with many more critically close to extinction.

Digital technology is enabling environmentalists, scientists and conservationists to monitor numbers and movements of endangered species. Monitors and volunteers use radio receivers to capture data which is used widely to protect vulnerable species, improve habitats and educate communities.

Investigate:

- Range of technology used
- How devices link together
- Methods to capture and share data
- Examples of impact to prevent poaching and increase animal numbers

Begin by reading how foundations such as the WWF, Wildlife Act, Animals Asia and Bornfree use technology to protect wildlife.

Conclude by:

- Exploring charities in your country
- How you could be involved.

- **Downtime** – this is a period of time when the digital devices or networks are out of action, for example when the internet is unavailable, perhaps due to engineering works. Businesses and individuals want to avoid downtime as much as possible, so a network that has significant amounts of downtime would not be chosen or would be replaced quickly. When considering the implementation of a network, the downtime that might occur when upgrading infrastructure needs to be planned in advance so that the business does not lose money. It might be planned for night times when demand is low, or it might be carried out in phases so that parts of the network are unaffected while others are upgraded.

Key term

Encrypting – converting data into a code to avoid it being accessed easily by unauthorised users. Specialist software is used to encrypt data.

Productivity

Productivity means the speed at which instructions and data are processed, together with the quality of the outcome, for example the less downtime, the greater the productivity. The telecommunications network we choose is influenced by its performance and reliability, because we are likely to choose one that is more productive.

Security

Communicating over networks increases the risk to the security of that data. Simple precautions can be taken in the first instance, such as not sharing passwords and **encrypting** important or sensitive information. Businesses, as well as individuals, are likely to choose a network that provides them with an appropriate level of security for their needs.

However, there are many examples of breaches in data security, for example in February 2015, the personal details of TalkTalk customers were put at risk of identity theft.

Your place of study will have an IT security policy and, depending on the restrictions imposed on the intranet, you may not be able to access the intranet when off-site or when using other digital devices.

Safety tip

Treat your password like a bank card PIN number – do not share it with anyone.

The features of component parts of a network and how these affect the performance of an IT system

A network is often made up of a variety of different components working together. Examples are described below.

- **Router** – this is a device used to connect computer networks to the internet, using, for example, Wi-Fi or broadband. The performance is not consistent as it depends on the distance from the nearest exchange server. Therefore the closer you are, the higher the likelihood of increased download and upload speeds. If relying on Wi-Fi, the number and thickness of any barriers, such as walls, between the router and the user are also likely to affect performance.
- **Switch** – this is a hardware device that acts as an interface between data transmission and data receiving. For example, you may have a switch (box) to connect television aerials and internet cables around your home. However, the more devices connected, the greater the likely impact on performance.
- **Ethernet cables** – these are used to connect directly to the internet from the router and referred to as a wired network. They operate over the local area network (LAN) and, although limited by length of cables, can provide a more stable option than Wi-Fi.
- **Wireless access point (WAP)** – this is a connecting point for other Wi-Fi devices to a wired network. While it can service several users simultaneously, it can be affected by, not only user numbers, but downloads, weather conditions and radio frequency.

The demands of the network mean that the choice of components is critical, for example an enterprise network in a large company is unlikely to use products sold for the home market. A business needs their network to be resilient, and often auditable with redundant hardware to minimise the risks of failure, whereas a home user does not need the same level of resilience or auditing. For example, the failure of a core switch in a call centre employing thousands of people will result in those employees being unable to work and customers unable to contact the company. The failure of your network switch at home is often just merely inconvenient. An enterprise firewall will log attacks and allow intervention and traceability. However, these features are not needed for home use.

Issues relating to transmission of data

You have probably experienced issues with transmitting data on occasion. Perhaps the network connection has failed temporarily, or a file will not attach to an email. Sometimes the files will not attach because the **email host** you are using has an internal problem, rather than it being an issue with the file size.

This section looks at how the features and processes of data transmission affect the use and performance of IT systems.

Protocols used to govern and control data transmission for common tasks

In IT systems, protocols are essential to allow systems to communicate. A protocol is like a language, that is, it is a set of rules governing how the communication takes place. The use of international standards and protocols allows devices from different manufacturers and using different operating systems to work with each other seamlessly. The protocol will dictate how the transmission is initiated, how data are encoded and how terminated. Just as when speaking to someone you begin a conversation with 'Hello', follow with sentences using your chosen language and end with 'Goodbye', data transmission follows a set pattern. We will look at some common tasks and the specific protocols that are used.

Email

When sending an email, you do not need to know what type of device your recipient is using – it is enough to know their email address. Email, by its very nature, connects people and devices across the world and it is likely that an email will pass through devices of many different manufacturers and operating systems before being delivered. The common protocols used by email are:

- **Post office protocol (POP3)** – this is used to retrieve mail from a server by a mail client such as Mozilla's Thunderbird or Microsoft's Outlook.
- **Simple mail transfer protocol (SMTP)** – this is used to transmit mail to a server either from a mail client or another server.
- **Internet message access protocol (IMAP4)** – this is used to access mail on a remote server by a mail client (the main difference between POP3 and IMAP4 is that IMAP4 does not remove mail from the server but merely acts as a method of accessing the mail).
- **TCP/IP** – the full term is Transmission Control Protocol and Internet Protocol – the TCP delivers the data, and the IP obtains the delivery address. TCP is used for organising data in a way that ensures the secure transmission between the server and client, ensuring the data are kept integral.

Skills

- Analysis and decision-making
- Formal written communication
- Ability to select appropriate IT tools and systems
- Ability to work in a legal, moral and ethical manner
- Using critical thinking
- Using systems and technology
- Self-monitoring and development

Key term

Email host – an internet provider that offers an email service to its users.

Reflect

What are your experiences of connection failure and what do you think the reasons for it were? Is there anything you could do to prevent the situation happening again?

Voice and video calls over the internet

A common and popular way to communicate is to talk over the internet. There are a number of voice-over-the-internet applications, such as Skype, FaceTime, Micosoft Teams and Google Hangouts. They are especially popular because the basic functions are free to use. There are numerous providers offering paid-for voice-over-the-internet services, which may vary in the service they provide and any charges they make. However, the connections can be unstable or unreliable and applications are not always compatible between devices, for example FaceTime only communicates between Apple devices.

VOIP allows businesses and individuals to make financial savings by routing telephone calls over the IP network (the internet) instead of using standard phone lines. VOIP-enabled devices can often call VOIP addresses as well as phone numbers. The use of standard protocols such as **RTP** and SIP (session initiation protocol) allow VOIP services from many different providers to work together seamlessly.

Key term

RTP – real-time transport protocol.

FTP

FTP (File Transfer Protocol) is a set of rules that computers on a network, such as the internet, use to transfer files. Users log in to FTP servers in order to download or upload files.

Web pages

Information about almost anything is now accessible through web pages, and it is estimated that there were over one billion websites online in 2016. And by December 2019 that number was estimated to be 1.7 billion websites registered, although only around 200 million of them are active (https://techninjury.net). It is the ease of access combined with the interactivity and immersive aspect of web pages that have made them so widespread. Web pages began life called 'hypertext pages' because text had links to other pages (hyperlinks). The protocol used to transfer these pages therefore became http (hypertext transfer protocol). The http protocol describes how a web browser requests pages from a server using a GET command such as 'GET /index.html HTTP/1.0'. The server responds with a response code (you have probably seen the dreaded 404 response meaning File Not Found). The more normal response is 200, which means OK. A special version of http exists called https, which is a secure version used for applications such as banking and the transfer of sensitive data. HTTPS makes use of SSL (secure sockets layer) or TLS (transport layer security) to encrypt the data transfer using public key cryptography.

Security issues and considerations when transmitting data over different connection types and networks

As we become even more security conscious, those who specialise in hacking into IT systems strive to find alternative ways to break through security systems. Examples include the cyberattack suffered by Equifax in 2017, when the data of hundreds of millions of people were stolen from the credit reporting agency.

Link

For more about the cyberattack on Equifax in 2017, visit www.securityweek.com.

Businesses routinely transfer sensitive data across their data networks, and the security of these data must always be considered carefully. Sometimes simple encryption is employed and sometimes more sophisticated security is used, depending on the perceived risk of the data being transferred. For an internal corporate network, security must start at the physical level, as protection of the physical network prevents simple eavesdropping attacks. For example, it would be prudent to ensure that any network ports in public areas are not enabled. Similarly, links between sites need to be adequately

secured. A fibre link could be employed, as fibre is inherently secure because it cannot be 'tapped' in the same way that a copper cable can be. Once data leave a corporate network, then security is out of the business's control; because of this it is essential to consider how to protect these data when travelling over a public network, for example by email. Email is sent as plain text and is readable by any servers along the way. There are some secured networks, such as the government secure intranet (GSi) (for example, email addresses ending in .gsi.gov.uk) used by government departments, within which you can be assured of security.

Encryption and digital certificates allow security for data sent across public networks if this is essential. Tools such as PGP (pretty good privacy) allow easy access to encryption tools.

Factors affecting bandwidth and latency

Bandwidth is a measure of the data-carrying capacity of a network connection. This may be an external broadband connection or even an internal corporate network. The speed is measured in bits per second (bps) and is often quoted in megabits per second (Mbps). A connection speed of 10 Mbps means that a connection can theoretically carry 10 megabits of data each second. The performance of a connection is also sometimes expressed by quoting the **ping** time, which is calculated as the time taken to reach a destination and return (measured in milliseconds). A lower ping time is best; high ping times mean increased latency on your network. The bandwidth will impact on the speed at which data are transmitted and on other actions such as downloading or streaming of videos. Reasons for variation in bandwidth include:

- connection type
- the number of users will affect the performance: more users means greater demand
- the protocols used have differing maximum bandwidths; and the bandwidth is also affected by distance between a device and the router
- the distance from server, referred to before, and the distance from the main exchange and server will impact on performance
- the data/signal conversion rates will affect performance in accordance with the conversion speed of data being analysed and the signal being optimised to maximum efficiency
- the time of day (there are different loads at different times of day – for example, first thing in the morning, many people will be logging on to check emails)
- the distance to your nearest telecommunications exchange
- the volume of data being transmitted, and a risk of the network being overloaded
- whether hardwired (usually faster) or wireless.

These factors can result in increased **latency** of the system or connection.

Key terms

Ping – a test of end-to-end connectivity that times the return of an ICMP packet between two hosts.

Latency – the 'delay' experienced – for example, when playing online games. High latency results in you seeing the movements you made to a character a longer period of time after you made them.

The implications of bandwidth and latency on the use and performance of an IT system

If a business relies on international communications, it might be decided to transmit a large amount of data at a particular time because there will be greater bandwidth available, due to the daily peaks and troughs of international data links. A system with high latency can cost businesses enormous sums of money and loss of business. For example, an aircraft relying on stable and reliable connections with air traffic control could face a major disaster if the IT system was subject to increased latency, as critical systems like this rely on real-time control.

Link

Technological failure is often blamed for air disasters, whether it is the cause or not. To find out more about technical failures involved in air disasters, go to www.tibco.com.

Types of compression

Data can be compressed so that it takes up less space, and uses less bandwidth, when being transmitted across a network. There are two types of compression:

Lossy – Lossy means removing data, that is, data are lost in order to compress the file (make it smaller). As data are lost from the file this may result in loss of information. For example, if an audio file loses too much data, then it will not sound good. Image files saved in the file type JPEG will be lossy (they will contain less data and therefore be of a lower quality than the original RAW image file). The compression algorithm works to remove data that would be less noticeable. For example, in an MP3, it removes sounds that would be virtually inaudible due to the presence of other overpowering sounds – this is why some audiophiles often say that MP3s do not have the same feel. MP4 can store a greater range of digital files including audio, visual, images, text.

Lossless – Lossless is the opposite to lossy. It reduces the size of the data file by filtering out unnecessary data by reducing the number of **bits**, rather than by losing relevant data. In essence, it is squeezed rather than cut down. Lossless compression includes, for example, the compression of a file or files into a zip file. FLAC is an audio-coding format software for lossless compression of digital audio. GIF and PNG are lossless formats for graphics.

Link

For more information about file types, see *Use and selection of file types and formats*, page 29.

Link

Google developed WebP for Android combining both lossy and lossless compression. For more information, visit www.developers.google.com.

Key terms

Bit – short for binary digit. Bit is the smallest component of data represented as a zero (0) or a one (1).

Codec – a device or program that compresses data for faster transmission.

The applications and implications of data compression

Lossy compression is used, for example, in cameras and DVDs, and overwrites any previous formatting. Therefore it can reduce audio or visual clarity of the file. Applications for lossy compression include:

- MP3 and MP4
- WMA (Windows Media Audio)
- JPEG
- AAC (advanced audio **codec**), which is a newer addition popularised by Apple and considered superior to MP3.

Applications for lossless compression include:

- Windows Media Lossless
- FreeMp (free audio player).

Programs such as Microsoft Office include the option to compress a file as a zip file or to save as a different file type. Unlike lossy compression, lossless data can be retrieved and saved in other formats without loss of quality, as uncompression recreates a new file as it was.

The use and implications of codecs when using and transmitting audio and video in digital format

A **codec** is a device or program for encoding or decoding a digital data stream or signal. To compress a video stream would require a video codec, as the compression scheme differs from that of an audio codec. Codecs encode and decode data. Sometimes this results in the compression of data but sometimes it is just digitally encoded. Transmitting or storing encoded files is significantly quicker and takes up far less space than pre-codec. For example, smartphones have the capacity to store numerous videos, music, other audio and data files, and images.

Audio and visual codecs are revolutionary in the way that digital audio is compressed while retaining, and even improving, quality by removing unnecessary sounds or silences.

Compatibility is the main implication – you need to be certain that the intended recipient is able to decode the data in order to be able to view the video/listen to the audio. Another problem may be if there are bugs in the codec program itself.

Tip

Explore websites about Mauna Kea and the Hubble telescope to expand your understanding.

Case study

The sky's the limit

In the most remote group of islands in the world, the 'Big Island' of Hawaii is home to the world's largest and most powerful observatory. Situated about 2,000 miles from mainland USA, the observatory and its 13 telescopes are located on the volcano of Mauna Kea, which measures, at its peak, 32,000 feet from the ocean floor. The telescopes are used by researchers to study the universe.

The reason for choosing the highest volcanic peak in the world for situating these telescopes is due to the purity of the air and cloud conditions. This enables greater access to gather astronomical data for processing, some of which is undertaken at its headquarters in Hilo, the capital of Hawaii. However, due to location, the telescopes are exposed to extreme weather conditions including strong winds, rapidly changing temperatures and snow.

▶ The world's largest and most powerful observatory

These telescopes rely on digital technology to receive, transmit and analyse data that are collected as light and other waves. Surprisingly, scientists and astronomers rarely look directly through these telescopes as the information gathered by computers is invisible to the naked eye. The telescopes can be used to track satellites as well as identify stars and give scientists information about their speed, size, age and distance. Telescopes do not usually store data, but act as an interface, transmitting data to computers.

Satellites rely on technology when they transmit data from distances further away from Earth than can be observed by the telescopes on Earth. The software between all devices must be compatible or translatable for computers and scientists to interpret the results.

Probably the world's most famous telescope is the Hubble, which has been orbiting Earth since 1990. It is the 'length of a school bus and weighs as much as two adult elephants' (www.nasa.gov) and takes its energy from the sun. When it was first launched, it had problems with a mirror, which affected the clarity of images. This problem was fixed but, due to its age and technological advancements, the Hubble is going to be replaced. The Hubble transmits about 140 gigabits of data per week (http://hubblesite.org) but there are problems with gathering data because this is distorted by the Earth's atmosphere. Latest technologies will enable increased data transmission and overcome the problems with distortion for more accurate and frequent data gathering.

Check your knowledge

1. State what type of connectivity enables the transmission of data between telescopes and observatories.
2. Interpret the connectivity between a telescope, observatory and astronomers.
3. Give at least four factors that could affect transmission at Mauna Kea.
4. Describe the reasons for replacing for the Hubble telescope.

Pause point What have you learned about networks and transmitting data from this case study?

Hint Identify and list the different factors that affect networks and transmission of data. You can add to your list as you continue to gain new knowledge.

Extend What similarities and differences can you identify when comparing networks for data transmission at Mauna Kea with your own personal use?

Online systems

Many of us rely on the internet for work (communication, marketing and selling products or services) or in our personal lives (to communicate with friends and family through video calling and social media, to stream music and videos, and to browse and shop online). During any downtime of our IT systems our activities are interrupted, and this is not only frustrating but also costs businesses money due to loss of productivity. In this section, you will learn about the implications for individuals and organisations of using online IT systems.

First, you will learn about some of the features, impacts and implications of the use of online IT systems to store data and perform tasks.

The personal and professional uses and applications of cloud storage

Cloud storage operates like a virtual server, providing the user with connectivity (through any form of connection, usually an internet connection) to the cloud storage system selected, such as those provided by Microsoft, Google and Apple.
Cloud storage provides a massive amount of space by using numerous servers all linked together. You may have experienced problems attaching a file to an email when it exceeds your quota and so, instead, you might have used cloud storage applications such as Dropbox or Google Docs. These applications allow you to store files on a cloud storage profile to which you can give others access. This enables you to transfer large files to them.

Figure 1.2 Cloud storage allows you to store and access files across different platforms

Cloud storage is not an infinite resource and nor is it totally free. Some smartphone manufacturers have offers that are linked with cloud services. For example, Android handsets are linked with Google Drive, and Windows phones have additional space on OneDrive. Providers of cloud storage entice you to use them without making an initial payment, allocating you a limited and fairly small space. Then when you get close to exceeding the limit, you are sent alerts to increase the storage capacity for an additional fee, which is often an annual subscription payment.

Personal

If you have a smartphone, it is possible that you back up your data to the cloud, either by choice or automatically. Doing so provides a virtual back-up for your contact lists, emails, calendar, music, and image files. You might also choose to back up your data files from other digital devices, such as a PC, to the cloud rather than have a separate hard drive. This means that you can access your files anywhere, providing you have access to the internet.

Cloud storage can be especially useful for sharing photos of special occasions, which is made simple by uploading and sharing the link for the photos with those you choose to have access to view the images. Both the person uploading the photos and those receiving an invitation to view them are taken through each stage of the process in simple terms, making no assumptions about their technical knowledge or expertise. Images can be viewed on internet-enabled devices such as phones, tablets and smart televisions.

Reflect

Do you use cloud storage? If so, what do you use it for and how?

Professional

Many businesses also use cloud storage for back-up, enabling their employees to access files remotely and at any time. Cloud storage is especially useful for employees who travel on business, who may rely on numerous digital devices to carry out their business functions, as well as those who work from home,.

The UK government announced in March 2019 that cloud spending had more than doubled since 2014. As a consequence spending on cloud transition has reached more than £1 billion per year, reaching £1.3 billion in 2019 (techradar.com).

Theory into practice

Explain to someone who is less familiar with using the cloud (perhaps a family member or friend) how to use it, its advantages and possible disadvantages.

Reflect on how clear your explanation was. How could you improve on your articulation of a technical instruction to a less-technical individual?

The personal and professional uses and applications of cloud computing

Cloud computing provides access to software, resources and information via a virtual server, as with cloud storage. It is often referred to as being 'available on demand', although, of course, cloud computing also relies on having a suitable network connection, often to the internet. As there are increasingly more Wi-Fi hotspots available and more and more people have access to 4G or 5G devices, they are able to access files, chat to friends and browse the internet while on the move.

Link

One example of a cloud computing company is The Cloud. You can find out more about The Cloud by visiting https://www.thecloud.net.

Personal

Cloud computing saves people money and space on their own digital devices because they do not have to physically purchase and download software that then needs to be stored on their device. Instead, they pay a subscription to use whatever software and resources they wish, depending on the specification of their contracts. They need not bother themselves with downloads, upgrades of software, backing up their data or purchasing individual security software as this is all taken care of by the provider of their cloud computing service. You might imagine cloud computing as having a technical team on hand day and night looking after your system.

There are also lots of free cloud computing applications that only perform limited functions, but, used in combination, they can provide people with similar capabilities to paid-for cloud computing services. However, the users need to manage their applications a little more and ensure that they have adequate security on their devices. Examples of uses of the cloud include Google Docs and Office 365.

Professional

Although a cost is involved in cloud computing services, businesses may view the cost as significantly less than the cost of purchasing individual software and licences for each of their employees. Businesses also save time because preparing computers with the necessary software and making them ready to operate takes longer than if staff are given access to an online cloud computing service account. This approach to mass purchasing (in this case, of a cloud computing service) results in significant savings due to economies of scale, rather like the savings that can be made when purchasing in bulk through a cash-and-carry outlet.

Many businesses run their applications using cloud computing, rather than installing them onto a server or individual computers on their premises. One of the benefits to accessing applications through the cloud is that the demand on processing power and storage is never exceeded, whereas, on a local server, these often would be exceeded.

The use of cloud services such as Microsoft's Azure or Amazon Web Services (AWS) allows businesses to dynamically scale the available server capability to meet the demand. Retailers experience huge peaks of demand from events such as the Black Friday sales and the use of this scalable power ensures they do not lose out on sales when their own servers cannot cope with demand. They only pay for the power they actually use so they do not need to plan for or anticipate this demand.

Employees who use applications through a cloud computing service are able to collaborate on documents in a way that is not possible using traditional software that needs to be downloaded onto individual PCs. This is one of the biggest advantages of the cloud. Members of a team can, at the same time as each other, type into and update documents that they are working on together, so improving productivity and avoiding the need to have multiple versions of a document. All changes can be saved and tracked using one single document, rather than multiple versions that have to rely on an individual to coordinate, and that might result in discrepancies. The team members do not need to be in the same office to work on cloud-based documents but can make changes and contribute to content or structure while working remotely and in real time.

Working in this way does come with the risk that you expose the document to errors as there is no control over what changes are being made and you cannot easily undo large changes (as others may have made changes since you made yours). Therefore consideration should be given before setting up documents as to what their purpose

is and whether it is better to use cloud computing or to use the traditional method of one individual creating a document that is then uploaded and commented on by others (using cloud storage but not cloud computing). For example, if you are producing a textbook, it would be better to use the traditional method, so that version control is maintained. However, if a team of work colleagues are updating a log sheet indicating whether they are in the office that week or working from home, which is useful for everyone to be able to see in real time, this document could be created and managed via cloud computing.

The impact on and implications for individuals of using cloud storage and computing

Cloud storage and cloud computing provide flexible access to data and applications, although they can come at a price. As an individual, you may have limited cloud storage included in your telecommunications contract and can pay extra for increasing the storage limit on your mobile digital devices. For personal users who own many connected devices, the ability to use the cloud to keep all devices in sync is invaluable. Each user need only maintain a single calendar and have it available on their home and work PCs as well as on their smartphone. However, in terms of costs, applications such as Google Gmail and Google Docs are free, and they provide ample cloud storage and computing features for most personal use.

Using the cloud is not without its concerns, especially regarding security or downtime. Without access to the internet you will not be able to access your data, so to ensure constant access you need to pay for a reliable connection. You should use appropriate safeguards to store financial or sensitive information on the cloud, even if it is encrypted.

The impact and implications on organisations of using cloud storage and computing

There are obvious benefits to businesses of using the cloud storage and computing, which include the following:

- provides unlimited storage facilities
- reduces costs
- reduces the need for specialist in-house IT support
- enables employers to focus on core business objectives rather than technology
- provides flexibility in terms of meeting the needs of the workforce; for example, staff are able to hold virtual meetings using Skype, or make contact with customers using chatrooms and emails, and they can share files easily, as well as collaborate on files.

Managers need to compare the cost of using the cloud with the cost of purchasing and maintaining their own servers. They should also consider the benefits of knowing that the responsibility and expertise needed to maintain and develop the cloud does not sit with them but with the cloud computing service. A new start-up is probably unable to afford the initial expense of powerful servers and processing, and so they can use a cloud service to host their new platform without the worry that it will not cope. Amazon Web Services offer a range of plans where users are billed according to the actual bandwidth and processing power used. This allows the user to meet the demand without paying for something that may never be used if an idea does not take off. If a new business idea does take off, then the service will dynamically scale up to cope with the new traffic and demand.

However, as with individual use, concerns continue about potential loss of data and breaches in security. Businesses will have policies on what they perceive to be acceptable practice, such as:

- using business cloud computing/storage for professional use only
- contingency plans for periods of downtime
- what information is *not* to be stored on the cloud, such as financial and government documents
- whether to store sensitive data files using the cloud or to store locally on their own premises (where the security risk might be greater)

During any system maintenance or upgrading, the cloud provides a less disruptive option for businesses. However, it should be remembered that any downtime will impact on a business's ability to carry out its functions and any employees who are working remotely may also be affected during these periods, as they will not be able to access files stored on the cloud.

Systems that enable and support remote working

There are two important types of IT system that enable and support employees' ability to work remotely. These are virtual private networks and remote desktop technologies.

Link

To find out how to set up a VPN to access your office files remotely, visit www.sumac.com.

Virtual private networks (VPNs)

VPNs enable users to be part of a local area network (LAN) while they are physically located remotely. A 'virtual' tunnel is created across the public network (the internet). VPNs do not use the cloud, as the servers they connect to are physical. Instead, they provide access remotely through an internet connection.

There are many providers of VPNs offering secure, unlimited bandwidth, a few of which are listed here:

- ExpressVPN
- IPVanish
- VyprVPN
- CentreStack.

VPN systems enable users to become part of a remote network that tunnels across a public network. VPNs only work if the individual's device is recognised as operating online. If your device defaults to working offline when using it remotely, then until the settings are configured to recognise your online status, you will only view the files made available to view offline.

VPNs do not enable the same type of collaboration that cloud computing does. However, they do make it possible for employees to access all the files that they can access in the office, at home or while on the move.

Remote desktop technologies

Remote desktop technologies enable any authorised individual to access your system remotely. You may have experienced this if you have had problems when using a device, for example a smartphone. The support technician helping you may have asked for access to your phone to check for any faults or misunderstandings in how to operate the device. By accessing your device remotely, they are better able to deal with the problem quickly and satisfactorily. They might also provide remote training on how to resolve the problem or how to use the device.

Microsoft systems have the built-in Remote Desktop that allows technicians full control, with permission. There are also utilities such as TeamViewer, VNC (virtual network computing) and Chrome Remote Desktop that all allow remote access for free.

Theory into practice

Ask your teacher if they can demonstrate or ask a technician to demonstrate remote desktop technology to you. You can try out some of the free utilities at home, but make sure that you only give your details to a trusted friend. Alternatively, try asking your mobile phone or other digital device manufacturer if they can assist you with trying out a feature remotely. Of course, check whether there is a charge for this service first.

Tip

If you are a Barclays Bank customer you could try their Digital Eagles IT support programme, which uses remote desktop technology to support customers in how to use IT applications.

Theory into practice

If you are unsuccessful with experiencing remote desktop technology through the ways suggested above, try this activity with a peer. Agree upon a small IT problem to resolve, such as the exact procedure for logging on, accessing a file in the user area or connecting to the internet via Wi-Fi. Sit back-to-back with one of you describing the step-by-step instructions (the navigator role) and the other carrying out those instructions exactly as described (the pilot role). The pilot is not allowed to ask any questions or seek guidance.

Take turns by swapping roles. Reflect on the experiences and discuss what went well and what could be improved upon. Evaluate the advantages and disadvantages of using remote desktop technology compared to the pilot-and-navigator technique. Discuss what you have learned through this experience.

Computer repair services and software issues are also commonly dealt with remotely for both personal devices and business PCs. This way of working means that no time is wasted by physically having to take a device in for repair and perhaps sending it away to the manufacturer (which might mean a wait of several weeks, as was often the case in the past).

Factors affecting the use and selection of online systems

You started to learn about some of the issues involved when using online systems in the previous sections. In this section, we will look a bit more closely at factors affecting the use and selection of online systems.

Security

Breaches in security can occur when transferring data over an online network as well while stored on a particular online account. Internet websites that do not include 'https' at the beginning of their **URL** are less secure and should be used with caution. The 's' in 'https' stands for 'secure'. If you examine the URLs of websites, you will see that web addresses that include 'https' at the beginning display a padlock symbol to show that the site is secure.

The use of a VPN by remote employees puts them 'inside the corporate LAN' so that they have the protection of a company firewall and filtering despite being remotely located. VPN connections are by their nature encrypted and secured, and a number of different protocols are available that offer different degrees of security. Online systems and tools such as VPNs are essential for a business to maintain the integrity and security of their data and ultimately the confidence of their customers.

Tip

Most cloud computing and storage services, including free ones, are likely to be secure websites, but it is worth checking this before you sign up and certainly before you store personal files on such a service. You should also make sure that you understand the privacy policy when you store files on cloud services.

Key term

URL – stands for uniform resource locator and is the term given to the address of a website.

Cost

Although there is a cost involved in using online systems, and this can escalate as you become dependent on the cloud, there are also pay-as-you-go options and short-term contracts, as well as free applications for individual use. Small businesses are attracted by the pay-as-you-go options and often evaluate the benefits of cloud computing as greatly outweighing the costs involved, including the amount they can save on resources alone.

In addition to the costs advertised for servers and cloud applications, there are all the connected costs associated with operating 'in the cloud'. A business will need reliable and fast connectivity to support their employees, and there are the fees to register your identity on the internet and a domain name, such as mybusiness.com. Having mobile workers 'always on' while being mobile brings with it the demand for data plans with sufficient allowance for the expected use; however, this is often hard to forecast.

Ease of use

The accessibility and availability of online systems wherever you are means that both individuals and businesses can function without having to carry around numerous devices or files of paper, which could be lost or damaged.

If a system or service is not easy to use, then users will not use it. Therefore, if you want users, then you must ensure that your system is easy and intuitive no matter what device someone uses to access your service. Web applications are expected to be 'responsive', that is, to adapt the format of their user interface to the device used to access them. This might mean resizing icons and headers for smaller screens or changing the layout from a table to columns to be more appropriate for mobile users.

Research

Research the common connectivity technologies available in your region.

Features

Making a decision about which online system to choose will depend on the features it offers. Primarily, the security measures in place should be paramount, but also the type and quality of technical support available should be considered, along with the storage capacity. Any additional benefits offered should also be considered, such as low start-up costs, metered services or the ability to scale up and down the level of service you receive.

Link

In fact, the computing power of the Apollo 11 rocket was less than that of basic calculators used in the early 1980s. For more about moon technology, visit www.itpro.co.uk and read the 'Man on the Moon: Technology then and now' article.

Connectivity

To access the cloud, you will require internet access and therefore your choice of internet service provider will depend on stability and, of course, availability. Technology is advancing continually.

Access to the internet is available through many different technologies, each presenting different qualities that are more suited to different markets. Commonly available broadband connections include ADSL, FTTC, FTTP, satellite broadband and mobile broadband.

Emerging technologies

New technologies are emerging at a rapid pace. Consider that your personal smartphone will contain more computer processing capacity and software than the Apollo 11 rocket that landed on the moon in 1969.

Key considerations around emerging technology, which an organisation needs to be aware of, include:

- technology is always expected to be 'on'
- the exponential growth of data collection (big data) and the necessary processing and analysis of data
- the raw materials needed to manufacture IT equipment
- the environment needed to run electronic devices
- the infrastructure required for implementing and maintaining telecommunications and networks
- the cost of emerging technologies
- pressure on individuals to become **early adopters**.

You have already been learning a little about advancements in technology and probably will have experienced some first hand. This section is about the features of the new and emerging technologies and their implications for organisations and their stakeholders.

Key term

Early adopter – an individual who feels compelled to obtain the latest products and technology as soon as they become available. For example, robotic vacuum cleaners, smart TVs and watches.

Developments in digital devices

Smartphones are seen by many to be an essential piece of kit, enabling users to have access to more information than a twentieth-century individual could access in a lifetime. Organisations that issue their employees with smartphones incur additional costs, previously not required. They need to pay for the supply of the phone and connectivity costs, we well as insurance costs against loss or damage. In addition, risks of unauthorised access to organisational data are of concern and some organisations are still reluctant to go down this route if handling highly sensitive data.

Activity trackers have grown rapidly in popularity but so have the implications. New businesses have emerged using activity trackers to encourage users to exercise more and their data to be captured, analysed and monitored remotely. However, breaches in security have been reported where health data are used to target individuals with products and services or information about individuals sold to third parties.

Portable computing is on the increase. The use of portable devices, easy access to the internet and VPN means that many organisations can take advantage of utilising reduced premises with employees working remotely. A disadvantage is that ready access to emails, calls and messages regardless of location can impact on the lives of their employees outside their working hours. Conversely organisations can provide stakeholders with more rapid responses outside predetermined office hours and in emergency situations.

Developments in networks and connectivity

The emergence of 4G and now 5G promises significantly increased broadband networking. While 4G was viewed as a vast improvement, 5G offers 100 times the speed of 4G and, importantly, low latency. This appears to be of benefit all round to both organisations and stakeholders, with faster response times, the ability to share larger amounts of data, sales able to be executed faster, and manufacturing operations executed more quickly. It is also anticipated that safety and maintenance costs will be reduced. However, adopting 5G is not without implications. Of course mobile phone and network providers are capitalising on selling the latest, the fastest and the best. But the costs are high for both consumers and organisations. These costs are not only financial but potentially relate to the demands placed on users to be readily available and the damage to the environment in terms of carbon footprint. Additionally, there will be greater demands on signals due to physical barriers, such as obstructions caused by buildings, signal sharing, range and distance between devices.

Digital devices, such as smartphones, allow us to connect with vast amounts of information. Your smartphone, for instance, might use location services to make you aware of facilities such as restaurants in the area or they might be used to target you with advertisements about businesses in the area.

With the right software, we can be connected with our homes even while overseas. The Internet of Things (IoT) is the ability to interconnect computing devices. It has many advantages, such as enabling the automation of services within homes and buildings and of security systems, or the use of driverless cars. IoT and emerging technology will enable transport systems to run more efficiently by, for example, monitoring the time the driver arrives and the bus leaves. Not surprisingly the investment by organisations and stakeholders is considerable – and the concerns over security of data possibly greater.

Virtualisation is an essential part of cloud computing and as such minimises the number of computers required to perform an action, thereby reducing energy costs. However, it is hard to envisage living without technology and we are hungry for developments, demanding faster, bigger, better, cheaper and easier, the cost to the environment is hard to assess. While the reduction in energy costs might have caught your attention, implementation costs are high, as are security risks and limitations.

Unlike virtualisation, **containerisation** is a specific type of hardware virtualisation. Basically it splits physical resources into virtual machines. Computer code can be written virtually and run anywhere. Concerns have been raised about risk to data, although reports from, for example, IBM suggest that because the applications are isolated in their containers, malicious code is prevented from invading other containers. Security permissions can also be set to automatically prevent unwanted components from entering containers.

Research

Read this article about environmental costs by 2040: www.irishnews.com. Summarise the problems envisaged and think about what could be done about them.

Key terms

Virtualisation – to create a virtual version of a device or resource.

Containerisation – a virtualisation method used to separate several applications. The application bundles do not contain a copy of the operating system. Instead they use the host's operating system.

Developments in modelling and data interrogation

Key developments in modelling and data interrogation include:

Augmented reality (AR) – defined as technology that superimposes a computer-generated image on the user's view of the real world, an example being the holograms used in the first *Star Wars* films.

Virtual reality (VR) – which enables the user to immerse themselves in a computer-generated world. VR provides users with an experience they may never otherwise have, or even want, in the real world, for example parachuting or bungee jumping. VR has been used widely in educational settings to expose users to experiences, which might educate them on safety or apply problem-solving skills. VR is also being used to treat anxiety, phobias and depression by providing a safe environment.

Data warehousing – is a system for reporting and data analysis used in business intelligence. Business intelligence concerns the methods of gathering data on, for example, competitors, or for gaining insights into consumer spending and preferences.

Machine learning (ML) – which you may associate with artificial intelligence (AI) is 'the scientific study of algorithms and statistical models that computer systems use to perform a specific task without using explicit instructions'. The principles of AI are grounded in how we learn and how our brains (known as neural nets) build information based on previous learning. ML and AI are not actually the same thing although most AI involves ML. Examples of AI include medical diagnosis and speech recognition.

Link

You will learn more about using and interrogating data later in this unit and in **Unit 5: Data Modelling**.

Assessment practice 1.1 A.P1, A.P2, A.P3, A.M1, A.D1

You meet a fellow student, Kamelia, in the refectory and get chatting about the courses each of you are studying. Kamelia has just started a foundation degree course in zoology and hopes to specialise later in the study of amphibians. She has plans to set up a new organisation monitoring the number of amphibians and their habitats around the world.

She asks if you would help her to make a decision about the technology she should use and how to get the most out of it, while spending very little. With Kamelia's help, you produce a list of criteria identifying her needs:

- method for networking laptop, phone and camera
- connectivity enabling Wi-Fi access while in Malaysia, on field trips, and in the UK
- maximising storage space, especially images
- securing data against loss and attacks
- options for finding research material, storing, processing and printing findings
- ways to meet like-minded people.

Kamelia also tells you that she might be able to use part of a grant she has been given to purchase some software or technology, providing it adds value to what she already has. She also tells you she is colour blind and that English is not her first language. She wants to know if there is anything available now, or possibly being developed, to help her.

She will be learning more about photographing wildlife and possibly underwater photography, but she wants to make sure that the images retain their clarity. She also tells you that she will be studying when back in Malaysia as well as on the move and wants to be sure that she has sufficient bandwidth to send large files to her teachers for assessment.

As Kamelia admits to having a fairly basic understanding of computing concepts, she has asked if you would be able to:

- Identify options for a suitable IT infrastructure for her new organisation
- explain clearly what they are, including the necessary hardware required
- explain how the use of data connections and networks can help her, use diagrams to explain the concepts
- as a troubleshooting guide, produce a short checklist of simple things that are likely to go wrong and what to do about them.

Plan

- What is the task?
- What are the success criteria for this task?
- Are there any areas I think I may struggle with in this task?
- What resources am I going to need?

Do

- I have planned my time appropriately to do my research and complete the task.
- I can identify were and why I can make improvements.
- I set milestones and evaluate my progress and success at those intervals.
- I provide a glossary of common technical terms.

Review

- I can assess what went well and what I need to improve.
- I can explain why I went wrong or struggled in some areas more than others.
- I can identify what I have achieved by undertaking this task.
- I know what I need to learn next.

B} Understand how organisations make use of data and information

Understanding how organisations make use of our data and information is important. When we visit a website, we get asked to accept cookies. Have you ever thought what an organisation is doing with the data it is collecting about you?

An interesting study of data collection can be seen in China. In late 2019, China introduced the mandatory requirement for facial recognition of all mobile phone users. In addition, the country is significantly increasing the use of CCTV cameras at the rate of one for every two people by mid-2020. Furthermore, from 2018 China introduced a social credit system whereby citizens' behaviour is monitored, using street cameras in major cities, to report on all aspects of life. Data are gathered and analysed to report on good or bad citizen behaviour. For example, helping an elderly person across the road could increase your personal social credit score, or dropping litter could reduce it.

Figure 1.3 Simple data processing

Data and information in an organisation

This section is about how and why businesses use data and information at different levels of the organisation. The term data is plural for datum. Computer data are information that can be stored and used by a computer program. The term 'data' does not refer solely to numbers – raw data can appear in multiple forms, such as images, audio information or observations. The processing and organisation of raw data in a meaningful way provides information that can be used to make decisions. (See Figure 1.3.)

Organisations rely on gathering and using data in order to plan business strategy and operations. Imagine embarking on your own business venture. You will need an idea for the business and that idea will derive from data you have gathered and analysed. You will want to know what your competitors are doing and how they are doing it, and what the market itself will tolerate. The business term for this process is market intelligence.

Interrelationship (and differences) between data and information

There is an interrelationship between data and information, and this affects the information generated. Computer data need to be processed in order for the data to have meaning. Processing the data, usually by a computer, results in information. How the data are processed will affect the information that is produced. For example, a sales manager might use information resulting from data analyses of monthly sales to make decisions about new products. The managing director might process the same raw data for information to help them make decisions about how the organisation is performing. In small businesses, the whole process might be undertaken by just one person. The larger the organisation, the greater the likelihood that staff are employed to routinely gather data and perform the analyses. The more detailed the seeking and gathering of data, the more skills and expertise are required. Computers are invaluable at processing enormous amounts of data and at assisting in the analysis of data, but it is humans who interpret those results.

Features, characteristics and implications of the requirements for data and information

Strategic level is the high-level planning to deliver the organisation's objectives and vision. Managers and leaders need to use facts on which to make business decisions. Those facts rely on the results from data processing. Data provide information on, for example, changing markets, the impact of changes such as setting up new offices, or global and national trends; leaders will need to be kept informed about expenditure, emerging technologies or changes to government and global policy on which to base their decisions.

Key term

Cash flow – the movement of funds in and out of the organisation.

At **management level**, data processing focuses on operational activities – for example, customer data, such as customer preferences when shopping or locations or seasons where customer spend is higher or lower; employee data, including attendance, punctuality, sickness and for planning around annual leave to meet production needs; data about suppliers and their product quality and variety, in order to meet demand, price and reliability; or financial performance data such as **cash flow**, wages, profits and losses.

At the **operational level** is the day-to-day running of the business. Managers at this level need data and information, such as available resources, which can include anything from a paperclip to staffing, stock levels to ensure sufficient stock to manufacture or meet customer supply, customer numbers, which affect an organisation's profit and losses, cash flow to chase outstanding customer payments and pay suppliers, and avoid delays in future deliveries.

Small businesses will rely heavily on generally available software, such as MS Excel, Word and, possibly, Access. Today there are several accounting and project management software packages available, specifically developed with small businesses in mind, for example QuickBooks, Harvest, or Trello. Very often these have an entry level where there is either no cost, or a minimal fee. Larger organisations will most likely invest in additional specialist software such as customer relationship systems and management software, of which there are many.

Link

You will learn more about these systems in **Unit 2: Creating Systems to Manage Information**.

One such specialist system is known as the 'just-in-time' system. The purpose of this system is to reduce production times and integrate with customers and suppliers. While a basic system can be devised in a spreadsheet package, it relies on the developer to utilise accurate formulae in order to generate accurate information. A model for such a 'just-in-time' (JIT) system is shown in Figure 1.4.

Figure 1.4 Example of a 'just-in-time' system

Data used to define organisational requirements and devise IT systems and solutions

You have been learning a little about the data organisations use to make decisions. Now let us consider some examples of how the data have defined organisational requirements. Consider again your emerging business idea. You will need technology to get started and manage your business. To gather market intelligence you will rely on different sources, not just the internet. These sources will need to be checked for reliability and logged, perhaps in a spreadsheet, so you can return to the source. Information on possible suppliers will require a database of some sort. A fairly basic database can be generated using a spreadsheet package but more sophisticated ones use database packages.

Information will be used to determine what IT solution is best suited to the organisation. As an organisation grows it will invest more heavily in its IT systems, either those readily available, such as SAP, an all-in-one management package to track customer interactions with the organisation or a **bespoke** system to meet their specific requirements. A simple IT solution will probably meet the initial requirements of a small business or sole trader. Whereas the larger the organisation, the more complex the IT solution, involving combining the basic systems with specialist software.

Key term

Bespoke – means built specifically to a customer's requirements.

Data and information needs at different levels of an organisation

Data and information needs vary at different levels of an organisation. For example, they vary in relation to the following:

- **Sector and type of organisation** – a health service will need to manage records of patients and their ailments and treatments in addition to suppliers, staffing, premises, equipment, etc.

- **Size of the organisation** – as already discussed, the larger the organisation the more that data and information will be used to inform decisions. In addition, the larger the organisation the more data there are to manage. While the customer base might not necessarily be large, for example an organisation that sells to a specialist market might have a high volume of sales *per* customer, but not a high number of customers, the data generated will require sophisticated systems to capture, maintain and process the data into information. In the case of a medium or small business, managing data is equally important to the smooth operation of the business.

  Software businesses have recognised this with the introduction of simplified accounts packages for example. These packages simply and easily capture images of income and expenditure, automatically generating accounts and tax returns keeping it simple and less time consuming for small business owners. Similar, readily available software packages can be sourced for managing sales and stock control without having to work with designers on bespoke packages for managing data.
- **Services and/or products the organisation provides** – a car manufacturer will have different needs from a local beauty salon, not least because one produces products, the other provides a service. Both will work with suppliers of products and components but the range of products and equipment to manufacture cars is far greater than those used in a beauty salon. The investment is also likely to be considerably higher.
- **Aims and goals of an organisation** – an organisation can measure its success in delivering its aims and goals by using the information arising from the data. To do this, objectives and targets will be agreed, probably at strategic level, as will milestones to monitor progress – just as you will follow a similar process throughout your studies. Target dates must be agreed before embarking on any process or action in order to accurately measure, not at the end to confirm the timeframe has been met.
- **Defining the scope of a customer's needs** – the data gathered is likely to be from customer feedback, complaints, compliments and sales. We seem to be inundated almost daily by organisations seeking customer feedback but, providing the data are used and interpreted accurately, organisations can change business practices based on what their customers want or need.
- **Managing day-to-day tasks and services** – technology is **covertly** embedded in so many of the devices we use for daily tasks and services. For example, making a call, using a credit card, washing or cleaning. Loyalty cards have long been used to gather data on customer spending and preferences. Supermarkets, for example, use the data to target customers with offers and temptations to spend more on their preferred products or a product they have ceased to buy.
- **Ensuring the continuation and provision of a service and/or a product** – a classic example of where customer feedback ensured the continuation of a service or product is Coca Cola, when, in late 2012, Coca Cola was inundated with four times the usual number of customer calls per day because of its announcement that it was changing its recipe. Subsequently, Coca Cola withdrew its intention and reverted back to its original formula. Since then, regulations have changed regarding the amount of sugar used in soft drinks, and this has affected Coca Cola's recipe, but none of the later changes have been as dramatic as that 2012 intention.

Key term

Covert – hidden or secret.

In mid-2018, global brand Coca Cola again responded to threats of boycotting sales having changed the ingredients in their Mazoe drink. This is not the first time the global brand had to listen to mass public feedback when attempting to make changes to their ingredients. Another example is the come-back of vinyl records. In the early 2000s sales of vinyl records had become almost non-existent since the introduction of CDs. However, by 2019 vinyl sales were forecast to exceed those of CDs for the first time since 1986. As a consequence in 2018 Panasonic announced the resurrection of the turntable in response to vinyl's resurgence (https://qz.com).

- **Identifying and planning improvements** – for an organisation to retain its market popularity it continually has to strive for improvements.
- **Setting and developing policy** – every organisation, no matter how small, must have policies. Policies and their associated procedures are required for setting out how an organisation's employees and practices will operate within its rules and regulations. Examples include health and safety, disposal of harmful waste and recycling as well as internally set policies such as taking leave or procuring resources. Keeping up to date with changes to legal requirements is demanding, therefore signing up to internet alerts and feeds from government websites and assigning responsibility to key personnel is useful. Technology has generated its specialised legislation and regulations, in particular those to protect users and lay down rules for ethical practices.
- **Communication with staff, colleagues and/or customers** – this has become a much quicker process using technology. However, organisations usually rely on customer feedback to establish their customers' preferred methods of communication. Internet searches also generate data about customer traffic and preferences, although in some countries, such as the UK, the gathering of data and sharing it with unknown others is no longer legal without the permission of the individual. Your country will have its own regulations. Customers were being bombarded with organisations jostling for business but now customers can unsubscribe to websites to prevent further traffic. Nevertheless, the information generated from the data is useful to organisations in determining the relevance, currency and location of their organisational practices
- **Operational tasks** – planning out business practices relies on information from market intelligence and organisational objectives. These include shift working patterns for staffing and resources and tasks performed by IT systems such as routine back-up procedures and accountancy calculations. Planning and monitoring tools, such as those used for project planning, rely on information from previous successes and lessons learned in order to plan and run projects more successfully and efficiently.

Data source and data set requirements of organisations and IT systems

Data source means the origins of the data. A data set is a chunk of data that corresponds to one or more tables of data. For example, in a database where each column and each row contain a different, specific variable. Such data sets might be used to combine individual customer purchases of individual products, prices and timeframes.

Different organisations require different data sources and data sets. The following factors will affect their requirements.

- **Volume** (the quantity of data that is generated) – consider the volume of data generated when Coca Cola wanted to change tack. Even more so, imagine how

data were gathered and manipulated before access to computers. For international organisations, such as Interpol or the World Wildlife Fund (WWF), the sheer quantity of data is unimaginable.

- **Velocity** (the speed of generation of data) – any single item of data is actually old the minute it is received, therefore the *speed* at which it is received and processed can make the difference between an organisation growing and thriving, or going bust.
- **Variety** (the mixture of data to be processed) – limited variety will generate limited results. When you undertake any research you will appreciate how limiting the variety of data produces a limited or probably inaccurate picture. Consider the adverts claiming the percentage of users who preferred a particular shampoo or moisturiser. Look at the small print for the number of people who took part in the trial and then consider the questions you want to ask of the data. For example, what age group, what type of hair or skin, their ethnicity, location, income and lifestyle might also influence the results, as well as, importantly, how many declined to answer.
- **Veracity** (the quality and trustworthiness of the data) – limited data impacts on the results. So does the quality and trustworthiness of the data. For example, whether the source is first, second or third hand (someone else's interpretation) or hearsay. When using sources always go to the direct source where possible. For example, Wikipedia is not always reliable, unless you have checked the original sources, and the information held there is only as good as those who have contributed to it.
- **Value** (the financial and operational worth of the data) – it is easy to become precious about data that have been carefully and agonisingly sought and processed. However, the question remains whether or not the data are relevant and have value. An organisation needs data that add value to their business operations, and that value equates to financial reward, albeit through customer satisfaction. Some data are more relevant and therefore valuable than other data. The information may indicate refining a particular product is more cost-effective, profitable and roadworthy than inventing a whole new product, which will do the same thing but cost considerably more in time, effort and investment.

Online communities

It is highly likely that you belong to at least one online community. In this section, you will explore the features of online communities and the implications of their widespread use to generate, share and access data and information.

Ways of communicating and interacting with online communities

A wide range of digital devices, such as smartphones, gaming consoles and tablets, enable access to online communities.

Social media

Probably the most well-known worldwide social media website is Facebook and the second is Twitter. Despite concerns by many, and frequent media reports about the disadvantages, both of these websites are used by government departments, other public sector agencies, and most private sector organisations, enabling people to network around the world. Other popular social media websites include LinkedIn and Google+. Customers are resorting more and more directly to social media to contact companies, largely due the public 'naming and shaming' that can take place.

Link

For more about social media see **Unit 3: Using Social Media in Business**.

Link

For information about how to deal with 'scary news about social media', visit http://www.huffingtonpost.com.

Several TV documentaries challenge the way we think about the impact of using social media. For more information, visit the BBC website (www.bbc.co.uk).

Blogs, microblogs, vlogs

Blogs are like online journals, although they are normally for public viewing, and are contributed to and read by millions. There are blogs relating to numerous topics including gossip, hobbies, special interests and news articles. Computing and software manufacturers have blogs that provide information on use, research and development, and for responding to customer queries. (Social media are also used by businesses in this way.)

Microblogs are shorter posts than blog posts and therefore take up less storage space, but the primary reason for the popularity of services such as Twitter is the shorter time it takes to follow a microblog due to the nature of the 'snippets' of information posted.

A vlog is a video form of a blog. One such vlogging website is vlog.it, although YouTube also has a partner program for vloggers, which allows users to make money from their vlogs.

Link

For more about the YouTube partner program visit www.support.google.com.

Theory into practice

You may never have produced a blog, vlog or even a microblog before. Work with a peer to create one. You may have a blog app already installed on your smartphone, such as Apple Podcasts, PocketVideo or Vlog Camera. Other examples of downloadable software include Ghost and Pamela for Skype, which is free.

Wiki

A wiki is a website or database that is contributed to by a community of users who work together to add content about a particular topic. Wikis can be added to or edited by anyone, meaning the information cannot be assumed as reliable, current or accurate. The most famous wiki of all is Wikipedia, which encourages quality control from contributors by providing authentic sources.

Chatrooms

It is likely you have used a chatroom, perhaps as an alternative to a video call on Skype or WhatsApp. Chatrooms enable virtual meetings or social networks to take place, regardless of where individuals or groups are located. Google Hangouts is an example of a virtual meeting environment. Netmums Coffee House is another example that is used, primarily, by mothers to talk about issues relating to bringing up children. Chatrooms, however, are sometimes unfriendly places and there are inherent risks involved in using them. Chatrooms have been reported as being used for targeting children and used as a forum for bullying and trolling (https://itstillworks.com) particularly where the chatroom is private or unattended.

Research

Investigate by searching for potential dangers in using chatrooms.

Instant messaging

There are few individuals in this country who have not used instant messaging. Instant messaging can take place over the internet using an instant messaging app such as Facebook Messenger, Skype, or WhatsApp. Texting has become a way of life in the way we communicate, whether it is for pleasure or business. For example, some GP surgeries and hospitals use texting to remind patients about appointments. Instant messaging over the internet is usually free, unlike texting which normally costs a few pence. These instant messaging apps allow users to communicate quickly and privately with their

friends and family and to also send images and other files. Instant messaging (IM) apps are beginning to take over from short message service (SMS) messaging, due to their immediacy and chat-like presentation.

Podcasts

You may not have produced a podcast yet, but it is a very effective means for communicating audio information as an alternative to, or in addition to, text. News articles often provide a podcast alternative, which among other things enables access for someone with a visual impairment. Podcasts can be downloaded onto digital devices, such as a smartphone, so that they can be listened to at more convenient times. Podcast websites include PodOmatic and Podbean. Some podcast websites, such as ipadio, also translate the audio file into text which can then be printed.

Forums

An online forum is where individuals are invited to participate in a discussion, usually focusing on a topic in which they share a vested interest. Each forum member can contribute by posting their comments and opinions, which can be read later. Although interacting online using a forum or other methods, such as messaging and emailing, involves a transaction between each party, none are actually in real time, as is the case with a chatroom. Unlike a chatroom, the posted interactions to a forum can be difficult to order resulting in losing track of the flow of conversations.

You are likely to have been invited to join a virtual student forum at your place of study so that you can share ideas or ask questions of your peers. A forum can be localised to restrict access to users; therefore your school or college might have a forum as part of their intranet or extranet, perhaps using Moodle. Other forum websites include Yuku and Social Forum.

Link

For more about Moodle, visit https://moodle.org.

Theory into practice

With a peer or in a small group, identify an example of each type of online community and make notes about the purpose, impact and execution in each case.

Compare each one by analysing and evaluating their advantages and disadvantages for both individual and business use.

The implications for individuals of using and accessing online communities

Using and accessing online communities should be undertaken responsibly and can bring significant benefits to users. You will now explore some of the implications.

User experience

- **Ease of use** – most online communities are easy to use. Users are more likely to stay with communities that are easy to use, and that enable them to form online friendships easily. Although needing to do anything more than 'one click' is considered a nuisance, it can provide time for reflection before the user posts something that goes global and cannot be undone.
- **Performance** – the performance of online communities depends on the internet connection, the server load and its capability. It also depends on how simple and flexible it is to implement and use.

- **Availability** – the availability of an online community can be restricted (for example, closed user groups such as selected alumni of a college) or extended to widen the community. Online communities can be used to seek contact with lost friends or relatives, attract new business or get advice as well as social networking.
- **Accessibility** – for those individuals who have mobility difficulties or perhaps cannot travel far, online communities provide companionship, information and news updates. Adaptive or assistive technologies enable access to online communities for people who are not able to use a standard keyboard and mouse or keys on smartphones. Alternatives include speech recognition software, electronic pointing devices and sip-and-puff systems.

Link

For more on assistive technologies, visit Microsoft's accessibility pages at www.microsoft.com.

Meeting needs

Online communities provide many benefits, such as meeting the needs of individuals who might otherwise be isolated, lonely, or seeking information on topics of interest. They also enable users, perhaps with shared interests, to extend their social networks, or to keep in touch from remote locations. However, there are implications of meeting these needs, including:

- not every individual has access to technology or connectivity
- individuals with extreme difficulties or disabilities may not be able to fully interact with websites
- difficulties with accurate interpretation by speech recognition software of languages and colloquialisms (although further research is being undertaken); vastly improved tools include Dragon and other speech recognition software, speech analysis software, and app-based voice dictation.

Cost

Implementing an online community comes at a cost. Although individuals might have free access to social networking websites, revenue is obtained from businesses that promote their products and services on the website. Otherwise, the online communities could not afford to run the service to users for free. However, this advertising puts temptation in your way and may tempt you to purchase something you cannot afford or do not need. Some users experience a psychological need to feel connected to the community. This results in such users 'needing' better connectivity and spending more and more money on better connections, for example 4G.

Reflect

What are your experiences of using online communities? Where you encountered issues, how did you resolve them?

Compare your results with those of a peer. What strategies could you suggest in order to avoid any problems or potential issues in the future?

Privacy

The openness of the internet and the proliferation of scammers mean that it is potentially a very dangerous place. Identity theft and fraud are commonplace and so being careful with your data and the sites you visit is essential. However, there are some reputable websites, such as Skype, WhatsApp and Google, which endeavour to provide a more private and secure service.

Security

You can never be absolutely certain that your online communications are secure. You should remain vigilant and be aware of what is posted. Even if *you* are conscientious, there will be others who are less so and unscrupulous individuals who will exploit those who are careless or vulnerable. You also need to consider the consequences of posting inappropriate content online. Always remember that once posted, it is too late to reverse without someone having seen it. Potential employers often now look up an applicant's online community accounts to see what kind of person they are, and if they do not like what they see, they are not likely to hire you.

The implications for organisations of using and accessing online communities

The internet has opened up boundless opportunities for businesses to communicate. Online communities enable them to source suppliers and markets, to sell products or services, and to expand their operations on a much broader scale than ever before.

Employee and customer experience

Both employees and customers are able to benefit from a very different experience today than even ten years ago, and this is largely down to the use of online communities in business.

- **Ease of use** – This puts a massive amount of pressure on organisations. They need to ensure that their online presence is as user-friendly and 'modern' as their competitors'. This is a never-ending, and potentially expensive, battle. Customers can buy clothes, food or search for properties without leaving their homes.

  Employees are able to work remotely or at flexible times to meet the needs of customers who could be located anywhere around the globe. Online community systems are mostly simple to use for both customers and employees, regardless of any other IT skills they might have.
- **Performance** – If the internet is down, it can interrupt an interaction at a crucial stage, leaving employees or customers unsure of what to do next, even making a payment more than once. For example, an employee may be drafting an email that requires some refining before it can be sent to a customer, but it could have inadvertently been sent during interruptions in performance, or not sent, with drastic consequences.
- **Availability** – Many businesses expect employees to be available outside normal working hours to manage online communities. With customers and individuals being geographically dispersed, online communities enable contact across time zones.

  Consumers now expect businesses to respond quickly, day and night, so organisations need to be available through different devices, regardless of location or time. Organisations might, therefore, have to set up shift working patterns for their employees. A business can appear to be available and operating 24/7 without the cost of opening a store or even renting premises. Businesses may employ cheaper offshore labour to handle the quieter overnight periods, since responding to emails and social media can be anonymous making location immaterial.
- **Accessibility** – As an employee, accessibility to online communities provides opportunities for keeping in touch with colleagues and customers outside normal hours. Although this might seem unreasonable, if you are responsible for an entire sales transaction and a bonus awaits you as a result (such as for an estate agent or stockbroker), you are likely to be very happy to see it through.

  It should be remembered that organisations that only operate online restrict their services to those customers with access and IT skills. Additionally, potential customers, or those unfamiliar with technology and how it works, can become upset, angry or frustrated when told to 'go online' when they have no means to do so.

  Employers can provide adaptive or assistive technologies for any staff with disabilities in order to facilitate their ability to work and provide them with equal opportunities. One example of how an organisation has promoted itself as providing

Link

For more about how to keep your online communications private, visit www.securityinabox.org.

support with developing digital skills is Barclays Bank. Their 'Digital Eagles', Barclays employees trained to be digital advocates, provide assistance and training for communities, customers, children and businesses via a programme of local events on anything digital, including coding. One such community event is known as Tea and Teach (https://www.barclays.co.uk).

Customer needs

As life appears to be busier than ever, customers require greater flexibility to source and purchase products that can be sent to their homes *and* be easily returned if necessary. Customers have become much more discerning and therefore businesses are exposed to greater competition, particularly as online businesses are more far-reaching than local shops.

Organisations strive to retain their market share by seeking creative ways to make their business a priority website for customers. Customers are able to undertake research and easily make comparisons between products and services – and are right to do so. The websites at the top of a search list are there simply because they have paid more for their positioning within a search. but they may not necessarily be the ones that meet a particular customer's needs.

Customers now have a huge advantage in the increased availability of the marketplace, with stores being available 24/7. Access to global markets can be instant and fairly trouble-free over the internet. If you have a customer care department, then there is an expectation that you will be available online and that you will respond and be able to deal with queries instantly at any time of the day or night.

Theory into practice

With a peer or in a small group, devise a questionnaire to survey family and friends about their experiences and preferences when using or accessing online communities, and then analyse and evaluate the results.

Seek out some employers willing to be surveyed to compare the results with the outcomes from individuals (friends and family).

Costs

Although operating online may be cost-effective in many ways, and it certainly expands the range of businesses promoting their products and services, the problem is that it also brings increased competition, which drives down prices. There is so much choice and availability that businesses have to try to find ways of keeping costs down and productivity up.

Having a social media presence is not without cost for a business. As well as the need to pay staff to respond and update that presence, there is the additional cost of boosting the business's prominence in an online community.

Facebook provides tools for businesses to promote posts (advertisements) and boost their status for a fee. The tools that social media sites provide are incredibly powerful and allow, for example, a business to specifically target a particular age group (for example, teenagers aged 16–19), in a particular geographical area, who have shown they have a liking for a particular activity (for example, outdoor activities). The selection of the demographics is very detailed so, while not a cheap option for advertising, the chances of suitable returns are high as the business is specifically targeting only the audience it requires.

Implementation

An online community takes time to implement. Delays can occur at each stage of set-up.

- **Timescales** – Planning stages can take considerably longer than expected to convert an idea into a series of structured actions, text and images that will successfully link to the data that sits behind the web pages of an online community.
- **Testing** – During implementation, the online community will be tested. This will be carried out at numerous stages and will involve many different users.

Replacement or integration with current systems

If the online community is replacing one that currently exists, then users will be familiar with the current system and may be reluctant to engage with any change. During the replacement or integration with an existing community there may be a period of downtime and this inactivity can lose users to other communities. If the implementation is a total integration with an existing system, then the period of inactivity or problems encountered by users may be greater than replacement. Reasons for this may include:

- links between the two systems that may have been overlooked need to be changed
- it confuses existing users more than if they were starting afresh
- it does not sufficiently address or develop the community to expand on its features.

Productivity

A new online community should provide greater productivity by, for example:

- offering more features, for example accessibility
- being easier for users to interact with
- meeting user needs, such as links to similar businesses, economic performance, recruitment and training opportunities
- offering greater security
- offering more opportunities for activity by increasing popularity among users.

However, additional features might also attract a greater risk to the security of information. For example, competitors could gain a greater insight into company practices by having access to its employees in chatrooms.

Working practices

- Organisations suffer from loss of employee productivity by users engaging in social networking during working hours, despite policies against such use for personal interest. Some people have lost their jobs over their inappropriate use of social media at work, because they have overlooked the fact that posts, such as those on Twitter, are visible to everyone – including their boss.

Security

Security is always going to remain a risk no matter how sophisticated an IT system is. Reputable online communities have security policies regarding their use for the safety of their users. However, unless businesses ensure that their staff are fully aware of and understand the policies (which should be monitored for user compliance), breaches of security can occur very easily and without intention.

Reported breaches of data security in the first quarter of 2019 stated that breaches, exposing almost two billion records, had increased by more than 56 per cent compared with the same period in 2018. Breaches in security are the biggest contributor of lost business, accounting for 36% of the total cost.

Some breaches were a result of human error, but hacking was predominantly responsible.

Reflect

Have you ever used social media when you should have been participating in something else, perhaps in a lesson? How did you catch up with what you missed? If you relied on a friend to fill in the gaps, consider the time taken to do so, which was unproductive. Were you caught by your teacher? What were the consequences in terms of punishment but also in the time you needed to carry out the work you should have completed?

Link

You can find a template social media security policy at www.biba.org.uk.

For more about trends in breaches of data security, visit www.symantec.com.

Case study

Gaming is not always fair play

In April 2011, Sony's PlayStation network was interrupted following a major breach in security. Users of Sony's PlayStation and Music on Demand Service learned that the personal information of possibly as many as 77 million user accounts had been infiltrated (hacked). The data at risk included:

- user accounts
- passwords
- potentially 10 million credit card details
- names, postal and email addresses and birth dates.

The attack was identified as originating from an application server on Sony's network, originally disguised as a purchase and therefore not spotted by their internal security systems. Sony suffered a blow to its reputation and the risk of losing customers. Users were left without access to their systems until services resumed with security reassurances. Sony incurred more costs by offering extended subscriptions and limited free downloads to its customers by way of an apology.

In late 2014, Sony's customers experienced another security breach which led to employees filing lawsuits against the company for its inability to protect their personal data. Although there were only 47,000 records reportedly involved, the attack was aimed at hurting people by infiltrating their personal data for identity theft rather than their financial data.

Breaches of security can go undetected for long periods of time and it is not until threats are made to users or there are obvious signs of malfunction that the attack is revealed. The sources of attacks are difficult to identify with some being instigated by the organisation itself. One reported way was to infiltrate a business and steal legitimate credentials to access that business's network. Once inside the organisation, the criminals can try to reach the subnets containing point-of-sale machines, which they can then infect with scrapers to steal customers' card details.

Check your knowledge

1. Identify at least three different types of online community vulnerable to security breaches of personal data.
2. Explain what was unusual about Sony's second security breach, described above, compared with the first example given.
3. Describe the implications for organisations, customers and employees when security breaches occur.
4. Produce a list of ways in which security breaches can occur.

Pause point How often have you put your personal data at risk?

Hint Produce a list of online communities and networks that you belong to and complete it by adding ways in which you could reduce your risks.

Extend Describe or draw a procedure for using online communities safely and responsibly.

Using and manipulating data

Having explored some of the benefits and implications of IT systems used by organisations, you will now learn more about the uses, processes and implications for individuals and organisations of accessing and using data and information in digital form.

Sources of data

Source data are often referred to as raw data, which means that the data are unrefined and that something has to be done with the data to become information. There are two types of data sources: primary and secondary.

Primary

Primary data are data that the organisation has collected or produced itself.

Primary data might, for example, be a list of customers' details. This primary data can be input into a CRM in order for a mailshot containing a promotional leaflet to be generated, by merging their names and addresses, or to produce labels for envelopes.

Secondary

Secondary data are data that are 'bought in' or collected by someone else.

Secondary data includes data that are second-hand, as the data have already been through some sort of data-handling process. This could include, for example:

- research articles
- government reports
- journalist accounts
- reference materials.

Reflect

What are the main methods you use for getting information? Which do you use least and why?

Theory into practice

Revisit one of your recent assignments or activities from this unit. Explore a wider range of sources of data, which should include, at least, all the examples of secondary data given above and one additional source. Analyse the data and evaluate its usefulness. Consider the impact that your latest findings would have on the outcomes you produced for the assignment or activity. If they differ, why do they and what are the implications? If they do not differ, why not?

What have you learned by undertaking this activity? What will you do differently in the future?

Judging and ensuring the reliability of data

You cannot assume that everything you hear or read is reliable. One such example is when police investigations dismiss witness accounts that are purely hearsay and where there is no solid evidence to verify the information provided. An internet wiki is another example of where information can be dubious. You have probably noticed that Wikipedia invites individuals to provide reference sources to validate the data as reliable.

Using data generates an audit trail, just as you do when you produce your assignments. You will be expected to reference your sources to validate their reliability. You are guilty of plagiarism if you claim that any of the work is yours when it has been directly taken from other sources. Plagiarism is a serious offence.

Link

For more about factors affecting the quality of information see **Unit 5: Data Modelling**.

For more on reliability of data see *Methods of ensuring data accuracy*, page 71.

Reflect

How would you feel if you discovered that someone had copied your work or repeated something you had suggested and claimed that it was their idea?

Tip

Producing questions that generate the responses you need to answer a specific research question is quite difficult. Keep the questions simple and, if you are seeking opinions, avoid closed or leading questions that rely on yes/no answers. If you ask open questions (how, why …) consider how you are going to analyse the responses, as this will help you word the questions appropriately.

The characteristics and implications of methods of collecting data and opinions

Data can be gathered in many forms and, potentially, even without a person's knowledge or consent. This section focuses on different methods of gathering data and opinions.

Qualitative data are data that are based on categories, such as colour of hair or make of car. Quantitative data are data that are based on numerical measurements, such as height.

Observations

These are a qualitative method for collecting data. Researchers monitor users' behaviours or actions. Although observational research only provides information on current behaviour, it is an inexpensive and accurate way of collecting behavioural data.

Surveys

Surveys include instances where individuals are asked their opinions, perhaps about their experience with a hair product or a leisure event. Market researchers may approach people in busy shopping streets or centres, but these days more surveys are conducted over the phone or online. Online surveys save businesses time and money. They encourage users of websites to give feedback and opinions on products or services they have used voluntarily. Often this feedback can be used to rate those products or services. For example, Feefo is a global automated customer feedback facility and Trustpilot hosts reviews of businesses worldwide. Another such example is TripAdvisor, where customer reviews and ratings form the advice that users are given about hotels and restaurants.

Attempts are made by companies using online surveys to ensure the reliability of the data. Otherwise, a business may find themselves blacklisted by users. Surveys such as these have limited usefulness because it is difficult to measure and compare individual opinions as each person's experience is personal and biased.

Questionnaires

You may have completed questionnaires at your place of study, perhaps to provide information about your personal experience as a student and as a measure of your satisfaction with the quality of the teaching or facilities. Questionnaires tend to be more structured than surveys and, although they are still open to an individual's opinions, the data gathered can be more useful as it can be made quantifiable. For example, specific questions can be asked, and users can rank their answers from 1 to 5.

Regardless of method for gathering data, assurances should be given about the purpose for gathering the data and also about the use of any personal data that could identify the individual.

Focus groups

Using focus groups is a useful method of gathering information from groups of individuals with a similar interest, which, although they are often held on a face-to-face basis, only require each question to be asked once to each group. However, the information gathered can be less reliable where responses are skewed by the solidarity of a group or reticence to provide detail and be identified as the source of an opinion.

Interviews

Interviewers can gather information, or provide information, or both. An interview is a very powerful method of data collection as it is interactive and allows the interviewer to probe for clarity and gain a really clear understanding of the views canvassed.

The difficult part of this method is getting respondents to agree to be interviewed as it can be seen to be really quite intrusive. A systems analyst or developer can use interviews to excellent effect to gain an insight into a user's working life and therefore produce a system more ideally suited to their needs. An interviewer must be well prepared and knowledgeable about the intended outcome, as they may be called upon to provide information during the interview.

Reasons for ensuring data accuracy

Inputting accurate data is crucial to business operations. Unfortunately, we all make mistakes and cannot eradicate human error, which is why it is so important to ensure that procedures include checking data entry and that systems are designed to undertake validity checks.

With technology advancements and the reliance on having vast amounts of information just a click away, we are becoming less tolerant when we do not get the information we expect. This could be because we have typed in the wrong questions, or that the information received is inaccurate. For example, you may have seen blogs and sites such as Facebook inform readers that if there are any errors or omissions the site or the owner of the posting is not held liable (www.termsfeed.com).

Link

You will learn more about what data accuracy means in **Unit 5: Data Modelling**.

Theory into practice

With a peer, explore the implications of your medical records going missing or if they were inaccurate so that you were mistaken for another patient. What methods could be used to ensure that this did not happen?

Reflect

Identify an occasion when your information was inaccurate or not found, perhaps when you contacted a business about the guarantee on an item or to seek support using software or a device you recently purchased. Ask yourself what might have happened if the information was not located. If you were the employee searching for the information, what questions would you ask or what strategies would you try to locate the information?

Discuss your example and conclusions with a peer.

There are many reasons why data may be inaccurate. For example:

- careless data entry (spelling mistakes, inaccuracy)
- misheard or misread data
- duplications
- inadequate **data cleansing**
- omissions (gaps in data should always be avoided).

It is likely that you have wrongly dialled or stored a telephone number by missing out a digit or putting them in the wrong order. In business, it is vital that data are input accurately and that data are checked frequently. For example, if addresses of Amazon customers became jumbled or were entered inaccurately, then orders would not be received by the people who purchased them.

If a business orders the wrong stock or amount, they could lose custom or find that they have a large amount of stock that they cannot sell and for which they have paid in advance. Inaccurate data are useless data.

Key term

Data cleansing – ongoing checking of data for accuracy, currency and completeness.

Theory into practice

With a peer, produce a questionnaire that can be used to gather data on eating preferences of young adults. Select how you will gather your data and analyse the results. Compare with secondary sources and evaluate the outcome.

Share your experiences with your peers and identify what went well and why, and what you would change if you were to undertake this study again.

Methods of ensuring data accuracy

There are two methods for ensuring the accuracy of data: verification and validation.

Verification

Verification means checking the data against the original source to find inaccuracies. Another method is to enter the data twice and check against both versions. This could either be automatically using software that checks for errors, duplications or omissions or manually by reading and checking line by line.

Validation

This is the process of checking to confirm that something is proven to be accurate. It can be achieved by a number of methods or combinations of methods. For example, when entering data, proofreading against the original source is probably the most obvious method. However, when proofreading our own work we are inclined to see what we expect to see and not necessarily the errors. Getting someone else to check and validate is a better option. Validating the accuracy of the data may rely on other sources. For example, if someone passed on information about a friend or relative, you might not automatically believe them and want to validate through other sources.

Automatic error correction systems

Preprogrammed instructions, perhaps a macro or set of parameters, can be designed to check that the data make sense and appear reasonable. For example, if the parameters cover a range between 50 and 80 and the entry is 95, then this could be identified as an error. If the parameters expect specific data types, such as a postcode, then any inaccuracy will be recognised. This restriction is known as an **input mask**. Parameters can also be set to refuse blank fields so that omissions are not allowed, for example a field for a person's National Insurance number, which is unique to every individual.

The process of validation does not check for inaccuracies, just as a spellchecker in Microsoft Word cannot proofread. In other words, the program will check whether a word might be misspelled but it is not able to identify a wrong telephone number or a missing word. Each of these entries might be recognised as valid entries by a spellchecker, although they may be inaccurate.

Link

For more about validation and verification of data, see **Unit 5: Data Modelling**.

Key terms

Input mask – a database instruction that restricts or controls the type, format or amount of data entered.

Database – a collection of data, which can be in digital or paper form, such as a telephone directory.

Query – a way of interrogating data by applying a set of criteria.

Methods of extracting and sorting data

Digital **databases** enable the extraction and sorting of data with ease. Actually, any file containing a collection of data that can be manipulated in some way to provide an answer can be referred to as a database, for example using a spreadsheet to sort information numerically and alphabetically in either direction – that is, a list of numerical values can be sorted from low to high and vice versa, or words can be alphabetically sorted A–Z or Z–A.

Data can be extracted very quickly and simply using a filter. All data entries containing an exact match are filtered. This works with simple **queries** using a single criterion at a time.

To extract more complex data, constructs using more than one criterion require a more complex query and, for this reason, a dedicated database software program is more likely to be used as it will include the facility to construct queries using multiple criteria. A query can be created in a digital database using another query, which may be referred to as a nested query, rather than recreating a query that repeats the criteria already included in an existing query but requires a refined result.

For example, an existing query might interrogate a database to find all those customers who made a purchase in August 2016 and a new query might be designed using this query and then refining it by asking for all those customers in Birmingham who purchased during that period. Queries can be saved, so those you are likely to need again do not have to be recreated.

Link

For more about databases and queries, read **Unit 2: Creating Systems to Manage Information**.

Numerical and data modelling

The processes of numerical and data modelling are used in software engineering.

Numerical modelling

Numerical modelling is the process of producing a mathematical model to perform predetermined actions, such as calculations in a spreadsheet. An individual might design a numerical model to calculate their personal finances and manage their budget. A business will use numerical modelling to forecast sales, manage their cash flow and perform projections for future business growth.

Financiers will use numerical modelling for making assumptions about potential growth in stocks and shares or movements in interest rates. Numerical models use formulae and equations and the results can also be used to **amortise** payments over periods of time.

Key term

Amortise – gradually write off the initial cost of an asset over a period of time, because regular payments are made.

Data modelling

Data modelling means to create a conceptual image (a model) of the meaning of the data in order to help consider alternatives. Modelling the data in different ways enables the user to evaluate the usefulness of the model and how to justify decisions. Databases are set up to make use of a particular set of data and are modelled in a particular way so as to find out specific information. For example, your place of study needs to keep records of every student, which includes:

- personal details
- course studied
- progress
- study support.

The planning of a database is almost more important than the final product. A procedure is required for ongoing maintenance to ensure that the database provides the required information and initial testing should be carried out before any data are input into the database in case changes need to be made to the data model.

Databases can be planned out on paper and each of the features required needs to be defined to ensure that parameters are in place, so that the data, when entered and manipulated, are retained. Each line of entry is called a record and each of the records will be broken down into fields, for example:

- title
- first name
- last name
- house name/number.

Each field will need to be identified as a particular datatype, for example:

- text
- number (integers, currency, decimal).

Each field needs to have its parameters set, for example:

- format (capitals, lower case, numbers and/or letters)
- length (number of characters).

Link

For more about databases, queries and relationships, read **Unit 2: Creating Systems to Manage Information**. For more about data modelling, read **Unit 5: Data Modelling**.

One of the most important features of a database is to ensure that data are stored efficiently and robustly; the most effective databases minimise repeated and redundant data. Queries are used to perform database searches to provide the data required at any particular time.

The planning stage involves refining the database model so that data are stored in separate compartments (tables), which all have something in common so that they can relate to each other. Unlike a spreadsheet or word-processed table, which are usually single tables (flat files) and can become unwieldy, an effective database relies on relationships with other tables in the same database or from other databases.

Presenting data and results

The tables containing the raw primary data are known as the back-end of the database. These tables are usually protected and inaccessible to those inputting data, in order to avoid deletions and threats to data integrity. Routine actions are performed at the front-end, known as the dashboard.

Well-planned databases include a variety of methods and means of presenting the data and the results from the interrogation of data, through data modelling. These include:

- **Reports** – Combining text, images and numbers. Calculations can be performed by a database and presented in different formats in a report.
- **Forms** – Raw data can be merged into a predefined form, for example a registration form to be completed or signed by the person registering at a leisure centre.
- **Graphical representation** – Numerical data can be presented as a graph and integrated into a report.

Link

For more on user interfaces (dashboards) and presenting data, see **Unit 5: Data Modelling**.

Once the database has been set up properly and considerable thought has been given to anticipating what will be required from the raw data (that is, whether it has been modelled correctly), these actions can be performed very simply and easily.

The characteristics and implications of user interfaces for data collection and processing systems

You are likely to be familiar with systems that are designed to contain or gather and process data. You may have designed a database or possibly used one that was designed for a business, such as a customer database or a stock control database.

As databases become increasingly sophisticated, we are largely unaware of the philosophy involved in designing such a system. If you use a spreadsheet to manage your personal finances, this could also be viewed as a sort of database and you will have thought about how to structure it, that is, the headings for the columns and rows. You may use a filter or sort the data and, possibly, you will have included some formulae to perform calculations. You may have created a database using software such as Microsoft Access and begun to become familiar with the complexities of how to structure the database to ensure that it meets its intended purpose.

When you store the contact details of your friends and family in your phone, this information is contained in a database. As mobile phones have become more sophisticated, your input into gathering and storing this information becomes minimal. For example, recent smartphones can seek out content from messages and emails and then prompt you with a suggestion that new data should be added to existing records or that a new record be created.

Therefore, if you are designing a database system for storing a list of your contacts or for manipulating data for a research project, there are many aspects to consider long before structuring or implementing the system. You will explore some of these aspects now.

Ease of use

The intention of every database is to input, manipulate and extract data with ease. Basic requirements to ensure ease of use are things such as titling fields to avoid ambiguity or misinterpretation, for example using the term first name rather than Christian name, and last name rather than surname.

Accessibility

The dashboard is the user interface that provides users with shortcuts to access the database. For example, an icon might say 'data entry' and, when pressed, it will open the window to where new records can be entered.

Depending on the design of the dashboard, databases can be made accessible to the majority of users. Points to consider include:

- language and terminology
- colour
- size of dashboard, text and icons
- layout
- position (where the dashboard sits in relation to the monitor used)
- number of clicks to perform each action.

Link

For more about accessibility, see page 89.

Error reduction

User interfaces should be designed to reduce or prevent errors when entering data. If an input mask or other parameter has been implemented, a warning message should appear informing the user about why the data are being refused. Any attempt to delete or alter a record should be preceded by a warning.

Intuitiveness

A well-designed database should be intuitive to use and not require intensive training for daily use. The more sophisticated or bespoke databases often require considerable training over longer periods of time. Making the layout of an on-screen form match that of a physical form aids intuitiveness, as the system is immediately familiar.

Functionality

As database users and those requiring reports generated from the raw data expand their needs and review its capabilities, the database can be refined or expanded to become even more functional. For example, as a business increases its range of products or services, the database might need to be expanded or generate new reports. A business will input employee records and may expand the database to automatically generate salary adjustments based on appraisal outcomes.

This ongoing maintenance relies on the initial structure of the database being sufficiently well thought through during the design process as any changes can affect the integrity of the data.

Link

You will learn about how to maintain data integrity in **Unit 5: Data Modelling**.

Performance, usability and cost

User interfaces enable greater performance and usability by reducing the complexities and potential fear attached to using a database, particularly for users less familiar

Key term

CSV (comma-separated values) – is a file type that stores records in a line and presents data in plain text as individual fields, where each field is separated by a comma.

with technology. However, database software can be expensive, especially if designed specifically for a business using a bespoke system. Databases also demand greater storage capacity and performance from IT systems.

Compatibility

Using a database from a software suite, such as Microsoft Office, provides advantages in that the format of the data is compatible with other programs in the suite and is often recognised by other software packages. For example, the ability to export data using a **CSV** file type.

Case study

IT enterprise risk management for CESG Digital

CESG was the UK's national technical authority for information assurance and was the information security arm of GCHQ (Government Communications Headquarters). It was the definitive voice on the technical aspects of information security for the UK government. CESG worked in partnership with industry and academia, the Centre for Protection of National Infrastructure (CPNI), MI5 (the UK Security Service, which is the domestic counter-intelligence and security service) and MI6 (the Secret Intelligence Service, which is the foreign intelligence service).

In 2016 it was combined with two other security organisations to become the National Cyber Security Centre (NCSC). The team working on risk management needed a solution to create and share documents, so they put together a small enterprise IT service and the choices they made formed part of a series of blog posts. They initially set some overarching principles, which were, in summary:

- manage risk responsibly
- take decisions based on evidence, react promptly to events, and seek expert advice when needed
- be sensible when making technological decisions that result in risk
- record significant decisions.

The team did not have a separate risk management process, but they made sensible decisions throughout their project, based fundamentally on security. Basic initial principles included identifying:

- the needs of the users
- the information they expected to secure
- rules for how different types of data would be handled
- which decisions and risks could be taken in-team and those that needed escalating.

For each technological decision, they followed this process.

- They assessed each set of options or approaches against user needs.
- For each option that met user needs, they assessed how well it fitted with decisions made previously and how it measured up against the security factors that were most important for this particular decision.
- They made decisions based on assessments, with a preference for the most usable service that was acceptable against other criteria.
- They escalated the decision if they did not feel empowered to make it locally.
- They recorded the decisions made and tracked any risks that were not fully mitigated.

Case study *continued*

- They made sure that the right people were in their team, and they ensured that those people were trusted by accountable people (outside the team) to make decisions that they would support.
- All decisions would result from a range of viable options being considered, with decisions made on the basis of evidence and professional judgement.
- Important decisions would be discussed in the team, with two or more people being responsible for more challenging decisions.
- Risks would not be taken if the team did not feel empowered, informed or qualified to take them.
- Help would be sought when required from independent experts in specific areas.

The team agreed to follow this approach.

They used the Cloud Security Principles, the End User Device Security Principles, or asked some of their security experts what the most important security considerations were for any given decision, and they assessed the viable options against them. They also:

- recognised that security needs to be adequate for the purpose
- demonstrated why they made the decisions
- accepted that there will always be uncertainty
- ensured that the business understood the risks it was taking
- were careful to speak in plain English in all internal workings and external outputs
- acknowledged that everyone is part of the delivery team
- recognised that decisions are interconnected.

Because this was a new approach for CESG, they were missing some supporting tools to help track decisions and resulting risks effectively. They used documents to do this, but they recognised that they needed a web tool to help with this in the future as well as some tools to help produce summaries and to allow quick understanding of how much cumulative risk they were exposed to.

Check your knowledge

1. Why did CESG need a secure system?
2. How did they go about starting the project?
3. Name at least five factors that CESG believe were important when embarking on projects.

Discussion

Discuss this case study with your peers and identify further improvements for your information security procedures.

Pause point

What risks can you identify from CESG operations in the case study above and what procedures would you put in place?

Hint Read through the 14 Cloud Security Principles and on the Cloud Security Guidance page at ncsc.gov.uk.

Extend Draw a diagram that demonstrates how you have developed a procedure for protecting your data and information.

Assessment practice 1.2 B.P4, B.P5, B.M2, BC.D2

Mollie developed her love of baking and making preserves into a small cottage industry, making and selling homemade bread, jams and chutneys to the local community. As the demand for fresh, crusty bread and delicious, tasty bottled preserves made from locally grown produce grew, she found herself expanding her business and attending county fairs and specialist markets.

Mollie runs her business from home, using her large kitchen and range cooker to bake her bread and produce the preserves, the triple garage for storage and distribution, and the adjacent purpose-built shed for packaging orders. She has managed her business until now with little IT presence apart from a professionally developed website and, more recently, a smartphone. Business has continued to boom as orders have flooded in through the website, and Mollie has taken on extra help to assist with boxing up orders and taking them to the post office for despatch.

However, as her business expands she finds that most of her day is still taken up with cooking, she spends weekends at fairs, markets and sourcing local produce, and every evening is spent on business administration. This includes:

- responding to website enquiries
- placing orders with suppliers for packaging, jars and bottles
- writing packaging labels
- stocktaking
- updating customer records
- paying bills, issuing invoices and chasing outstanding payments.

Mollie has a laptop and printer and uses word processing to produce invoices. However, she keeps her account and stock records in a book and all her customer details on an index card system. She knows that there are probably more efficient methods, but she has not got the time to do her research into suitable options, nor will her business support any more hired help. Mollie is keen to introduce more automation to the business and is seeking your advice and guidance on what options are open to her. She is willing to invest in a new system or additional equipment to work with her existing IT equipment, which is fairly new. Naturally, Mollie wants to ensure that whatever choices she makes are cost-effective and will enable her to spend more time growing the business and less time on administration. She has set aside a small budget but is hoping to spend less than that. Your task is to:

- Explain to Mollie the ways in which data can be used in an organisation
- Explain ways in which information can be used and distributed by an organisation, both internally and externally
- identify the opportunities for automation that will enable Mollie's business to run more efficiently
- produce a list of recommendations
- explain the advantages and disadvantages of the options you provide and justify your decisions
- evaluate the potential impact of the use of data and information for Mollie's business.

Plan

- What is the task? What am I being asked to do?
- How confident do I feel in my own abilities to complete this task? Are there any areas I think I may struggle with?

Do

- I know what it is I'm doing and what I want to achieve.
- I can identify where I've gone wrong and adjust my thinking/approach to get myself back on course.

Review

- I can explain what the task was and how I approached it.
- I can explain how I would approach the hard elements differently next time (i.e. what I would do differently).

Pause point How do you ensure that you remain objective and advise Mollie on what is best in her situation?

Hint Explore how other small business owners use IT systems to run their operations. Search local directories for contacts – maybe you have a friend or relative who runs a small business or knows someone who does.

Extend What recommendations would you make to Mollie for developing a strategy for the use of IT in an expanding business over the next two years?

C} Develop policies for the use of IT within an organisation

Earlier you learned why organisations need policies, regardless of size of business. Policies are required to ensure compliance of rules and regulations. Each policy requires a clear procedure to set out steps on how to implement the rules relating to laws and regulations and internal practices.

Policies and procedures are also required to inform external customers, including suppliers, of an organisation's expectations. For example, wearing safety equipment when on construction sites, how to evacuate premises in an emergency or how to return faulty goods. In particular, organisations need policies on how to protect themselves and their users against breaches of security.

This section provides a range of the security policies an organisation needs. Each policy might cover more than one topic where relevant, providing all aspects are covered and associated procedures for avoiding, managing and dealing with risks are comprehensive.

Reflect

We are all guilty of some of these ways of putting data at risk. Consider which ones apply to you. Think about ways in which you could avoid putting data at risk in these ways in the future.

The characteristics of threats to data

There are a number of characteristic types of threats to data that you will look at in this section. First, consider these extremely common ways in which you, or any individual, may put business and personal data at risk.

Anyone can put data at risk by:

- using obvious passwords such as your favourite pet, place or date of birth
- disclosing passwords with other users
- leaving devices open to other users, such as not locking a PC when going to the toilet or not locking a mobile phone
- using the same login details for multiple website accounts
- posting information globally without thinking first as to whether it is sensible to do so
- using personal devices for business operations.

Key term

Malware – short for malicious software, is software created to steal data by gaining access to an IT system without the user's consent.

Viruses and other malware

You may have experienced a virus on your PC or smartphone. When normal performance is interrupted, suspicions about a virus or other **malware** are raised.

A virus is a form of malware. It is software designed to harm your IT system, not just access it for unlawful purposes. Viruses can be passed from one device to another, most commonly by devices such as USB sticks, through downloading software or via files from the internet. A virus can corrupt files and compromise the data.

Link

Find out more about threats to data security at http://ict4u.net.

Early signs that you may have malware in your IT system include annoying behaviour such as applications crashing frequently or the cursor behaving strangely.

Ransomware is a form of virus that attempts to hold companies to ransom by encrypting their data and then demanding a large sum of money to release the data. Even law enforcement can fall for these attacks. For example, in 2015 a number of US police departments suffered attacks and, despite security experts working to assist, they ended up paying the ransom demand to regain access to their systems. In February 2016, Lincolnshire council suffered an attack in which they were unable to access 300 of their machines.

Hackers

Hacker is the term used for anyone who attempts to access an IT system without permission of the owner/user. Hackers are not just groups or individuals who infiltrate secret data or perform identity theft – there is a more ethical side of hacking. Ethical hackers are employed by businesses to test out their defences and try to gain unauthorised access to systems with a view to then addressing the vulnerability to prevent real hackers gaining access intending to do harm.

Phishing

To phish is to attempt to fraudulently gain information by unlawfully making claims via phone or email that the user should share personal data or financial details. Examples of frequent phishing attacks are those pretending to be from banks (including HSBC and Santander) and well-known, trusted organisations (such as PayPal and MSN).

Accidental damage

It is very easy to accidentally lose data or at least think that you have. While applications such as those from Microsoft Office issue reminders to users to save files before closing, if the whole system crashes or there is a power cut before a file is saved, it could result in a loss of data (and waste of hard work and effort). Sometimes we think that we have lost a file when we have filed it incorrectly or saved it under an irrelevant name. Although software alerts us to think before deleting a file, if we are hurried or distracted, it is easy to overlook this. It is also easy to save over a file without thinking, which will permanently overwrite the previous file.

Research

Explore services that enable you to restrict nuisance calls and unsolicited emails or postal mail.

Tip

It is important to regularly save your work as well as ensuring that autosave functions are set up in applications that have that feature.

Research

Explore the options available for insuring your devices against security threats. Compare these with strategies that you can deploy for protecting your devices and data to avoid potentially unnecessary and costly insurance.

Link

For guidance on suitable strategies to protect against data threats, visit:

www.computerweekly.com

www.computerworld.com

www.cisco.com.

The impact of threats to data, information and systems on individuals

Users experience stress and time being wasted to varying degrees when threats to data occur. Some of these, such as phishing threats, can cause unnecessary anguish, especially to those users who are unaware of the source of these malicious emails and unwittingly share sensitive data.

If your personal device develops a virus, it will prevent or compromise the performance you expect from that device. The system might need to be taken to an expert to fix, leaving you without alternative means to work, potentially exposing your data to even greater risk. You may need to replace your device with a new one if it is deemed irreparable or too costly to repair.

Nowadays, photos are usually stored in digital image files rather than photo albums. The impact of this data becoming corrupted is often immeasurable to an individual: a lifetime of irreplaceable memories can be wiped out by a simple disk failure. Back-up solutions are becoming just as important for individuals as they are to businesses as our lives transition to the digital world.

The impact of threats to data, information and systems on organisations

When threats occur in organisations, they can impact on all users and the productivity of the business. Just as in the example of Sony's 2014 experience, businesses can face claims for damages from employees or customers and these threats can also result in loss of business. Even the smallest breach of data, regardless of its sensitivity, can be incredibly damaging to a business. Public confidence in any system is fragile and, once this is upset, it can take a great deal of time and money to restore confidence.

If your site is 'down', even just for maintenance, the public perception is that you are unreliable as a business, irrespective of whether or not this is actually the case!

Research

What other examples can you find of businesses exposed to data threats that impacted on the company's reputation? Share your findings with a peer or in a small group.

Case study

Travelex

Travelex is an online bank known for its foreign currency services (www.travelex.com), trading in over 80 countries, with its headquarters in London, UK. Transactions through Travelex are online and through more than 1000 ATMs worldwide, predominantly located within airports.

Since opening its first branch in 1976, technology has developed beyond most people's imaginations. Travelex currently uses a global computer network linked to ATMs, its website, and partners (such as banks, for example HSBC, Sainsbury and Virgin Money). Customers are now able to purchase foreign currency that can be sent direct to their home, or collected in cash or uploaded to currency cards. Stakeholders can also access Travelex through comparison websites to compare currency rates prior to undertaking their transactions.

▶ Travelex online banking

Travelex operates a complex computer infrastructure to enable requests for currency to be serviced. When a customer requests currency, the current daily rate must be accurately and immediately obtained in order to convert one currency to another. The right amount of currency must then be charged to the customer together with any fees, for example delivery charges or ATM charges. The computer system must then collect payment, which could be via a number of different means, such as debit or credit card through a digital machine or reader, bank transfer from the customer's own bank account to Travelex, or possibly cash. All transactions and customer details must be coordinated and any personal ID obtained for verification to ensure the transaction is not for money laundering.

When the transaction is complete the right amount of currency in a combination of denominations will be allocated to that customer. In order for that to happen, Travelex must ensure the currency is available or ordered from a third party. Therefore, Travelex will be linking electronically to their suppliers and other stakeholders.

However, as with any computerised system, it is at risk of being compromised and this is exactly what happened on New Year's Eve 2019 when hackers launched their cyberattack on the Travelex network. By early January 2020 Travelex were being held ransom for 6 million dollars, after being forced to turn off all computer systems and resort to using pen and paper. The company took down its websites around the world in an attempt to protect customers' data and contain the virus.

Check your knowledge

1. Explain what method or methods Travelex uses to transmit and process data between its stakeholders.
2. Describe or illustrate how Travelex communicates with its partners and stakeholders.
3. Give at least three examples of different digital devices used by Travelex customers.
4. Propose an approach for Travelex to manage transactions using only pen and paper.

Pause point What measures have you got in place should your computer system fail?

Hint Consider the back-up processes you carry out and how you would get access to your assignments, or your calendar or contact list.

Extend Devise a set of processes for diagnosing a system failure. Keep the process straightforward and systematic and swap with a peer to test out.

Research

Read more about how Travelex operates its global network. Try drawing your concept of the global system. Make proposals for the use of emerging technologies that could help Travelex to support its stakeholders in the future.

Reflect

What reasons can you suggest for needing to create read-only files? How might you restrict access to a file?

Link

For more about database access levels see **Unit 2: Creating Systems to Manage Information**.

Link

Explore some examples of recovery procedures and back-up plans. Search for the following articles on the internet:

'Developing Backup and Restore Procedures', https://technet.microsoft.com

'Recover system procedure', www.ibm.com

'HP System Recovery Procedures', www.support.hp.com.

Protecting data

Having explored some of the threats and their implications, you will now learn about some of the features, uses and implications of systems and procedures that are used to protect the data of individuals and organisations.

Processes and implications of techniques for protecting data and systems

Organisations have, or should have, processes in place for protecting data and systems. However, unless these are comprehensive, kept up to date and the policies are followed by all users at all times, the threats to data remain. Some simple processes and techniques for protecting data and systems include the following.

File permissions

Access to files can be restricted through the use of password protection or by setting the file as a read-only file, which prevents inadvertent editing, when sharing with colleagues who do not need to edit it.

Access levels

Giving users access to only those systems or applications that they need to fulfil their roles, and restricting the level of access they have, protects data because fewer people are able to put it at risk. For example, limiting permission to filter and query in a database, or making it so that permission is required to add records, will limit the number of people who can change or delete data accidentally.

Back-up and recovery procedures

Everyone should back up their data files regularly, regardless of the degree of usage. Most organisations will have a formal procedure that routinely backs up data on a very frequent basis. They may undertake incremental back-ups that only back up those files that have been amended since the previous back-up. A full back-up might be undertaken monthly, depending on the size of the organisation and the amount of data produced. Back-ups do not just back up files but also the contents of servers, systems and processes.

Systems often have automatic recovery procedures, such as the ability to undelete a file or recover a file following a premature software or system closure. Organisations should have a formal recovery plan that enables the system to return to a predetermined point from which operation can continue if the system fails. Larger organisations have full disaster recovery plans in place to minimise any disruption that might arise from things such as a natural disaster or criminal attack. These plans can sometimes even involve the maintaining of warm back-up sites that mirror the primary base of operations. Alternatively, they can have off-site back-ups and a contract with a disaster recovery company who will get the back-ups running on a mobile server farm within hours.

Passwords

Passwords should be kept secret, regardless of whom you may trust. Think of your passwords like your bank account details or PIN number, which you would not share. Weak passwords can be easily identified and are often repeated by users for different websites and purposes. Strong passwords should have between 12 and 14 characters, and use upper- and lowercase letters, numerals and symbols.

Link

See *The characteristics of threats to data*, page 77, for more on how not to use passwords.

Physical access control

Leaving your computer or device unattended and unlocked exposes your data to others, whether you are present or not. Locking, shutting down or removing the device protects your data from immediate access by anyone who happens to be passing by. Not logging out properly or fully from your system or an online account leaves your data exposed to potential risk. Organisations have restricted physical access to data centres and cabling for their computer systems.

Digital certificates

Digital certificates are unique codes that are assigned to you by a business to verify your identity when performing a transaction, such as a money transfer or requesting a bank statement. It is sometimes called a public key certificate and works in a similar way to a passport. Digital certificates are also issued by certificate authorities to facilitate SSL (https). These certificates encrypt information sent over the internet and identify those sites that are safe when undertaking transactions (www.entrustdatacard.com).

Protocols

Protocols are the agreement between devices regarding how a communication might take place. There are a range of protocols that are concerned with security. Secure data transfer relies on some form of encryption – for websites this is SSL or TLS, which uses public key cryptography.

There are also human operating protocols, such as policies for using equipment or creating passwords, but the difficulty is in remembering numerous ones for different systems, devices and actions. Common password rules include using a mix of letters, numbers and symbols in upper- and lowercase. Additional passwords are used by websites such as those performing financial transactions. It is not unusual for some users to store their passwords on their computer in a file or diary. Another option is to use a password vault, e.g. LastPass or 1Password.

Reflect

How secure are your user areas? What strategies do you use to remember your login details or various passwords? How could you improve the security of your data?

The features, characteristics and implications of using antivirus software to protect data

There are numerous organisations developing antivirus software in an attempt to keep our data and systems secure, including:

- Kaspersky
- McAfee
- AVG
- Symantec (Norton).

Antivirus software is designed to search out and stop attempts to corrupt your IT system or files using viruses or any malware. Different antivirus software will approach this in different ways, but common features include:

- real-time scanning to check files as they are saved or opened
- deep or full scans used periodically to check an entire storage device

- heuristic analysis to look for 'virus-like' activity as well as known viruses
- virus definition databases.

However, the more you expose your system to a wider network, the greater risk to your system. For example, your IT system and data are more exposed when you use cloud computing, but many people do use it because of the benefits.

Antivirus software manufacturers provide similar, yet different, types of protection, including seeking out updates to antivirus software via the cloud. Antivirus software needs to be working continually to check for threats and should be installed before commencing any computing operations. However, the constant scanning and checking for threats required by antivirus software increases the load on a system, including the CPU, memory and disk activity.

Research

With a peer or in a small group, share your experiences of antivirus software. Explore the advantages and disadvantages of at least six different types of antivirus software according to their features, prices, versatility and impact on other software and processes.

Theory into practice

Compare different types of antivirus software in terms of their features and what they cost. Compare those that you can download for free with those for which you pay a subscription. Evaluate which are most suitable to meet personal and business needs.

The features, characteristics and implications of using firewalls to protect data

Firewalls

A firewall performs a different function to antivirus software. It monitors the network traffic and decides whether or not to let the traffic in or out. It can protect the IT system from unauthorised access and can be both hardware and software. Hardware firewalls are usually part of the **router** whereas software firewalls are applications. Software firewalls, the likely choice for individuals, must be stored locally on the device, not on a network. They can be manipulated by users who may reduce the restrictions on traffic, or be turned on and off to speed up performance or allow access to prohibited websites. Like any software, updates should be installed whenever they become available.

Firewalls can use a variety of methods to protect a network, ranging from the basic port blocking, where the firewall simply refuses incoming access to the network, to the more advanced stateful packet inspection (SPI), where the firewall uses active connection data to look at where packets are from and decide whether the incoming data are legitimate and connected to an active connection. Firewall configuration is a skilled task that can easily have a major performance impact on a network if not done correctly.

Key term

Router – an electronic device that enables data to be transmitted between networks.

Reflect

What immediate actions will you take to protect your data from risk of loss or damage?

The features, applications and implications of encryption methods used to protect data

Stored data

Methods for encrypting data that you intend to store include using specialist software that can:

- create hashes, which are fixed-length signatures for the text
- use a key to crypt and decrypt messages (known as private key cryptography), therefore anyone with the key can access the contents of the message
- using a public key to allow one-way encryption of data that is decrypted using a matching secret private key.

Link

For more about data encryption methods visit http://datashieldcorp.com.

The implications of using encryption methods include:

- if the code or key is forgotten, then the data may never be decrypted
- the way in which the key is shared with those entitled to access the data can result in other risks to security.

Data during transmission

Data are often assumed to be secure when in fact they are not. For example, an email is sent in plain text between servers and can be read by anyone along the way. The encryption of data in transit is essential when communicating information that may be confidential or sensitive. As you have already seen, web pages make excellent use of encryption when using https (SSL or TLS). It might also be desirable to encrypt all network traffic to ensure security. Pretty good privacy (PGP) can be used to encrypt the contents of emails that can then be sent in plain text but would be unreadable to any unauthorised access without the appropriate decryption key.

If a break occurs during the transmission of encrypted data, the data may continue being decrypted and become exposed to threats. For example, when performing a bank transaction, data are encrypted and decrypted to protect the holder of the account. If that holder takes a break or becomes distracted, the data are accessible to others during this period. It is advisable therefore to avoid disruptions and breaks in such sessions and, especially, to avoid using public access devices for such transactions.

Discussion

Discuss this case study with your peers and identify further improvements for your information security procedures.

Reflect

Have you ever used any form of encryption method? What did you use and how did it work? Try using other methods. What have you learned from the experience that would help you when advising others?

Moral and ethical issues

What we use IT systems for and how we use or access them can raise **moral** and **ethical** issues. In this section, you will learn more about the implications for individuals, organisations and society in general of the moral and ethical factors of using information technology.

Key terms

Moral – principles about what is right and wrong behaviour.

Ethical – relating to the knowledge of moral principles: that is, how we behave.

The moral and ethical factors of the use of information technology

Our views about morality and ethics will differ depending on our cultural backgrounds. An example of morally and ethically poor practice relates to the ease with which payday loans can be activated online or over the phone, enticing vulnerable adults to sign up to high interest rate loans that they cannot afford to pay back.

Reflect

What are your principles and values? How do they compare with those of your peers? What influences your views of what is right and wrong?

Privacy

It is not unusual for someone to have onlookers when reading or writing messages or emails, or for someone to be listening in to phone calls. Some users are quite happy to share their devices but, morally, it is usually considered impolite to engage in others' conversations, whether verbally or digitally, without being invited. Equally, it is not appropriate to randomly capture images or record videos without the permission of those in the image or recording, let alone to post the content onto the internet without the permission of those involved.

It is not uncommon, however, for conversations to take place over mobile phones in public places without any consideration for others around, even if the content is somewhat sensitive or private in a business context. Likewise the use of multimedia in public places where others are subject to interference and noises, particularly in places designated as quiet areas, such as some train carriages, libraries or waiting rooms.

Personal details are often unwittingly shared with others in public areas by people working in professional situations. Examples include hotel receptionists repeating customer addresses and phone numbers during check-in and doctors' receptionists sharing patients' phone numbers and dates of birth to verify their identity.

As soon as you begin placing personal details online there will be concerns about privacy. Who is storing your data, where is it stored physically, who has access and how is it protected? While there may be legislation to protect your personal data, as discussed earlier in this chapter, it is useless if the holder of the data is not in the same jurisdiction as you. Wherever you choose to store your personal data, it is always worth taking note of the privacy policies listed on websites as to what you are agreeing to, that is, what they can do with your data.

Theory into practice

Keep a log for a day as you go about your daily activities, making notes about your regular habits when using any digital device. Note also how others behave and log the circumstances and location of each event.

Assess the impact of these actions and what the risks are regarding the potential invasion of privacy or inadvertent sharing of private data.

What changes will you make to how you will respect others' privacy in the future and what can you do to mitigate the risk of others inadvertently sharing your data?

Carry out this activity again in two or three weeks' time. Have you changed your behaviour? What else have you discovered from this activity?

Link

For impact on the environment, see, for example, under *Developments in networks and connectivity* (page 52).

Environmental

Factors of morality and ethics affect the environment. One well-known example is the disposal of IT equipment such as hardware and printer cartridges, which may be carcinogenic. The use of technology also impacts on the environment by draining natural resources and adding to our carbon footprint.

Despite this, the environment has also benefitted indirectly from technology because users can gain a better understanding of ways to improve and maintain the environment and those within it by sharing information globally – for example Google's involvement in Lush Lens (www.forbes.com). Another example is the use of plastic in manufacturing technological products. However, very recent studies are now recognising how technology can be used to help address plastic pollution by producing more biodegradable products (www.un.org).

Additionally, charities can promote their messages and seek funding from numerous sources. However, morally this method of promotion can also be considered as intrusive, especially when TV appeals are shown at mealtimes when they are likely to gain the attention of millions of viewers. Sharing images of those considered less fortunate than ourselves, especially where actors are used to portray misfortune, can be considered immoral.

Research

With a peer, identify at least five examples of risks to the environment due to immoral or unethical practice.

Search for case studies of questionable ethical practices involving technology. For example, claims of spying on consumers through the use of Amazon Echo and Google Home speakers, or the use of drone aircraft (e.g. www.researchgate.net/publication/290455692). You could start by searching government websites.

Unequal access to information technology

Another ethical and moral consideration is inequality regarding access to IT. Although much is being done to improve access to IT systems for all people, through adapted devices or assistive technology, there is still a large percentage of the world's population without any access to IT systems at all.

In 2015, it was estimated that almost half the population of the world had no access to the internet, but that does not indicate how many actually are without any technology. Google and Facebook both have initiatives to bring internet access to developing nations. In the more privileged countries, such as the UK and USA, a child without the latest technology can feel stigmatised and disadvantaged when compared with their peers.

According to https:wearesocial.com, at the start of 2019 there were 5.11 billion unique mobile users, an increase of 100 million in the last year. Regarding internet users, a record 4.39 billion shows an increase of 366 million compared with January 2018. This equates to 58% of the world's population.

Online behaviour and netiquette

There are differing opinions about how to behave online. You may have devised your own rules with peers and decided what is acceptable and what is not, such as the way you write messages; and you might start and sign off with terms of endearment that you would not use when communicating with your employer or teacher, for example.

Generally, you should follow some basic rules of **netiquette** regardless of cultural background:

- never use abusive language
- do not harass others with demands or personal questions
- if a third party is asked to join a discussion, give them access to the string of previous messages in a discussion
- get permission before sending other people's content to a third party
- do not share personal information (yours or other people's) insecurely or unnecessarily.

Key term

Netiquette – a word derived by combining internet (net) with correct behaviour (etiquette); it is especially related to online discussions and forums but also emails.

Tip

Read the online behaviour and netiquette protocols relating to the online communities you are using.

Theory into practice

Check if your place of study has a netiquette policy. Review the current policy and make recommendations for changes to reflect latest developments relating to moral and ethical behaviour.

Globalisation

As the world becomes more broadly interconnected by the use of IT, the moral and ethical issues appear to increase. For example, advertisers need to consider the impact of their promotional material on multicultural groups and economic situations.

Research

'The gap between rich and poor is still very large … 40% of the world's population live on less than $2 per day.' The richest 1% are twice as wealthy as the poorest 50% (www.lifegate.com). It may surprise you to learn that the US is one of the countries with the widest gap between rich and poor. The highest wealth distribution is in the Middle East with 61%. For more about the ethical dilemmas of globalisation visit www.ethicalfocus.org.

What examples can you identify of inequality due to globalisation? How would you judge whether this inequality is immoral and unethical? Discuss with a peer.

Research

Take a look at the Ethics and Data Protection document issued by the European Commission in November 2018. Make notes on how the EU aims to protect data being transferred to and collected outside non-EU countries.

Hint: you could try locating this document via www.ec.europa.eu.

Reflect

Have you, or do you know someone who has, shared another's personal details without their permission?

Link

For more about AUPs, visit http://whatis.techtarget.com.

Research

Research the current legislation protecting users and their data in your region.

Hint: you could try exploring Europe's GDPR implementation and enforcement of policy in the Asia-Pacific region (www.fortinet.com). Try searching Deloitte for data and privacy protection in ASEAN or the Cybercrimes Law and penalties in the UAE (www.pinsentmasons.com).

Freedom of speech and censorship

There appears to be conflict between the ability to exercise freedom of speech and the suppression of speech through censorship. Morally and ethically, freedom of speech should follow protocols such as those explored earlier: that is, netiquette.

Acceptable use

Many businesses implement acceptable use (of IT) policies (AUP), which state protocols for what are deemed morally and ethically acceptable, including:

- constraints (websites, activities, time)
- devices (types and their use, including whether personal devices can be used for business activities and vice versa)
- security (complying with legislation, keeping data secure).

Ethical hacking (white hat and grey hat)

Ethical hacking refers to a specialist who undertakes testing to ensure the security of an organisation's IT system. There are actually three different labels for ethical hackers. The black hat hacker has no permission to hack into the system and intends malice. The white hat hacker is someone who has permission and intends no malice, whereas the grey hat hacker intends no malice either, but has no permission.

Protection of data

Morally and ethically the protection of data is about the value and respect we place on someone else's data. The chances are you or someone you know will have been contacted by a third party without prior warning. When organisations collect our data we should be able to trust them *not* to share that data unless we first give permission to do so. For example, if we share information about someone, even to another friend or colleague, without their permission first, we are in breach of the law. This action could have occurred without malice or consideration about the consequences. Even sharing information where we could be inadvertently overheard or leaving an imprint on a writing pad is putting that data at risk.

Legal issues

Chief Information Security Officer of Honeycomb Connect Banking Information Technology explained, in a webcast to his members in 2006, that everyone could be a potential threat, intentionally or unintentionally. Legislation is necessary to provide legal remedies for breaches; it acts as a deterrent and it sets clear acceptable limits that describe what unauthorised access actually is (see Table 1.2 for information about current legislation).

Therefore, legislation such as the Computer Misuse Act of 1990, which legislates against computer crime, is necessary to protect data and IT systems from attack by:

- hackers
- fraud and theft
- copyright infringement
- abuse, for example:
  - cyber bullying
  - trolling (deliberately trying to cause arguments or offence)
  - child pornography
  - harassment.

There are many examples of an individual's personal data being violated, such as hacking into bank accounts or stealing personal identities. Developers are working tirelessly to produce methods for protecting data. We will now explore some of the legal issues relating to the use of IT systems and the implications for individuals, organisations and their stakeholders.

The role of current legislation (and subsequent additions and amendments) in protecting users and their data from attack and misuse

We all have opinions about legal, moral and ethical issues, particularly if it affects someone close to us. However, as you may have been discovering, we do not all share the same views, nor can we do much about what we consider to be an injustice without the support of greater forces, such as those provided by government legislation and enforcement.

As technology and its uses continue to evolve and expand, legislation is reviewed for its currency and updated to combat risk. Ensuring legislation is fit for purpose in accordance with current expectations and behaviours is really complicated, as laws must work together in harmony and not contradict other laws. Hence working parties devote considerable time and effort to producing legislation based on many sources of data that are gathered, analysed and evaluated.

Organisations are responsible for ensuring that they are aware of current legislation and any changes. You will note from the following examples that amendments, additions and convergences exist to address the changes, such as the legislation that exists in the UK and is aimed to protect on a global basis.

Link

Full legislation and amendments can be found at http://www.legislation.gov.uk/.

Computer Misuse Act 1990

The Computer Misuse Act 1990 is a generic set of rules prohibiting unauthorised access to data and unlawful treatment of data where access is permitted. The act links to other legislation by identifying the scope of the legislation and the territory covered by the act. Changes are currently being made to keep up with technological developments over the last 25 years. The Computer Misuse Act lists three basic offences. These are:

- **unauthorised access to a computer system** – punishable by up to two years in prison and a hefty fine
- **unauthorised access with intent to commit a criminal act** – punishable by up to five years in prison and a hefty fine
- **unauthorised access and modification of a computer system** – punishable by up to ten years in prison and a hefty fine.

The act covers all offences, ranging from minor intrusions into a company database by an employee to an incident that may impact on national security.

Copyright and intellectual property

Copyright laws and plagiarism rules are the same whether content is copied from a printed book or from digital material, and whether it is text, image, sound or any other media that you have not created. It is all too easy in the digital age to accidentally breach copyright legislation. Simply using an image from Google Images, for example, on a website could result in a lawsuit for unauthorised use of images. If you are using images found on the internet, it is essential that you obtain permission to use them. There are many sources that are licensed under the Creative Commons licence, which allows easy reuse with a clear conscience and free of the risk of potential legal action.

The Copyright (Computer Programs) Regulations 1992

The Copyright (Computer Programs) Regulations 1992 expand upon the CDPA in terms of:

- jurisdiction (Northern Ireland is included)
- literary work (preparatory design material for a computer program is included)
- restrictions to issuing copies of, adapting or converting computer programs
- permission to back up copies of programs when for lawful use.

Health and safety

Health and safety regulations will vary by country but should set out rules for using devices that have either alphanumeric or graphic display screens. Regulations should be designed to protect users' health, in particular in connection with RSI. Regulations are likely to advise taking regular breaks, and engaging in other activities to reduce the risk of RSI. Businesses should be required to consider the moral and ethical issues of employees expected to spend extended lengths of time in front of computer screens. Regulations may also include the requirement for risk-assessing workstations to try to ensure that employees' individual needs are considered in relation to their workstation and IT use.

Data Protection

Copying someone else's data without their permission or acknowledgement is against the law and both morally and ethically inappropriate.

The DPA of 1998 was superseded by the DPA of 2018 to incorporate the EU General Data Protection Regulation (GDPR), which was introduced to cope with the digital age (source based on https://eur-lex.europa.eu). It states that 'subjects have a right not to be subject to automated decision making or profiling' regardless of the legitimacy of the intentions. Organisations that do not comply can incur fines of up to 20 million euros.

The concern of most users is cyber security and how their data are protected from attack and misuse. There is no single legislation to protect users internationally. However, countries are striving to form common bonds – for example, the United Nations received a request from Russia, China, Uzbekistan and Tajikistan calling for an International Code of Conduct for information security. In 2013, the European Union adopted the cyber security strategy, which aims to protect freedom of expression and privacy in core cyber security.

By 2019, data privacy laws existed in over 80 countries, although the level of data protection varies when compared to that of the EU, the General Data Protection Regulation implemented in 2018. It comprises seven principles:

- lawfulness, fairness and transparency
- purpose limitation
- data minimisation
- accuracy
- storage limitation
- integrity and confidentiality (security)
- accountability.

Advances are being made, however, and in 2020 the United Nations reported that 107 countries had in place, or were developing, legislation for data protection and privacy legislation worldwide.

Research

Research laws relating to your own country. Make notes about their key principles and the impact of any breaches in data misuse. Identify what additions and amendments have been made or are in hand. Sign up for alerts or RSS feeds to ensure your knowledge and compliance is current.

Hint: did you know there are interactive websites, such as the world map at cnil.fr, which enable you to locate data privacy by country and the level of cover when compared with that of the EU.

Consumer rights

In the UK, consumer rights are protected by the Consumer Rights Act (2018). This Act defines how the law protects the use of digital data, such as downloading music, games or videos. The Act makes it clear to consumers and organisations about their refund and return policies.

For example, consumers are entitled to a full refund if they advise the retailer within 14 days they wish to cancel, even when goods have been received and are not faulty or on sale. The Act also applies to goods purchased online, mail and phone order sales.

The Act also protects retailers by not having to give a refund if the customer knew an item was faulty when they purchased it, or they damaged it when trying to repair it, or they simply decided they no longer wanted the item (unless was bought without seeing it first).

With regard to digital data, the law states the consumer has a right to a refund for unwrapped CDs, DVDs and computer software if they are faulty.

The same Act also made it illegal for organisations to impose additional charges for using a credit card to make purchases.

Accessibility

The Open Accessibility Framework is concerned with accessibility. This framework defines all aspects of development from the high-level architecture of IT systems to that which is experienced by the end user. The framework aims to ensure that what is delivered is accessible to all. The six framework steps are:

1 define accessible
2 stock elements
3 development/authoring tools
4 platform support
5 the app itself
6 assistive technology.

Link

For more about the Open Accessibility Framework, visit http://www.oaeg.org.

Professional guidelines and codes of practice

Earlier you were learning about the purpose and use of policy in organisations. You learned that government rules and legislation influence policy, as do internal operational matters such as flexible working time.

Let us consider now how organisations implement and make use of professional guidelines and **codes of practice**. We will also consider the implications of these on the organisation and their stakeholders.

Key term

Codes of practice – sets of rules that are agreed by a professional body on how people within certain professions must behave. Some examples are the code of ethics known as the Hippocratic Oath for those in the medical profession; the Accountable Journalism code in Pakistan; the code of ethics and professional conduct in the UAE; Thai Union Business Labour; and the EU code of conduct for lawyers in Turkey.

The purpose and role of codes of practice produced by professional bodies for the use of IT systems

Codes of practice are intended to regulate the development, design, implementation and use of these systems. Their purpose is to protect users and customers and to provide assurance regarding data protection as well as clear guidance about their values. Values are based around moral and ethical considerations.

The impact of codes of practice on individuals and organisations

Codes of practice are also self-regulated, which means that any individual can report a breach as a cause for concern for investigation to the organisation itself, rather than to

an independent body. Each of the promises identified in the code of practice will also be formally monitored and regulated. Therefore anyone in breach of any aspect of the code of practice will be dealt with in accordance to the organisation's policies and legislation.

The benefits of having a code of practice include having a consistency of use of an IT system and the provision of a set of common ground rules to avoid misunderstandings or misinterpretations. Individuals are responsible for making themselves aware of the requirements of such codes.

Guidelines and current legislation (and subsequent additions and amendments) designed to ensure the accessibility of IT systems

Legislation is there to protect everyone and ignorance is not excusable in the eyes of the law. Businesses often monitor compliance by appointing someone to remain up to date with changes to legislation and to implement procedures for employees to follow.

Link

For more about the Equality Act 2010, visit www.equalityhumanrights.com.

Equality Act 2010

The Equality Act of 2010 has replaced the DDA to promote equality regardless of characteristics. For example, it legislates against unlawful behaviour such as that described in the previous section and makes explicit the characteristics of vulnerable groups, known as those with protected characteristics.

International Organization for Standardization (ISO)

The ISO standards (also known as IEC27000) are designed to help organisations keep information secure. These standards include a collection (known as a family) to provide requirements for information security management of IT systems (ISMS). The standards provide a systematic approach to managing data.

Organisations undergo rigorous assessments to verify their systems comply to these standards in order to be awarded the ISO label. You may have seen this promoted by organisations such as Microsoft and IBM. Some organisations publish their ISO action plans outlining their monitoring systems and targets.

In 2016 Changi airport gained ISO accreditation for security of information; and the global travel business, Travelport, was the first organisation of its kind to gain recognition.

Link

For more on the WCAG and mobile accessibility, visit http://www.w3.org.

Web Content Accessibility Guidelines (WCAG) 1.0 and 2.0 and World Wide Web Consortium (W3C®)

In 1994, Tim Berners-Lee founded the W3C to initiate universal accessibility codes of practice for accessibility of the internet. The WCAG defines guidance for creating web content that avoids discrimination, by providing three basic tips on:

- user interface and visual design
- writing and presenting content
- mark-up and coding.

As the use of the internet continues to grow and develop, W3C continues to strive to eradicate inaccessibility – for example by, defining terminology and user needs, providing guidelines and resources for use, and designing for inclusion, such as mobile accessibility and content.

Managing information technology within organisations

In this final section you will gain a greater understanding about the concepts and challenges of managing infrastructure, data, information and users.

The role and implications of acceptable use policies within an organisation

While organisations must have policies and procedures, if they are too complicated or lengthy to implement, then it is likely they won't work, or they will be ignored. Each policy requires monitoring to assess compliance – for example, restrictions to access of files containing sensitive data, or process and responsibility for checking data accuracy.

You may have experienced having your personal details repeated to you by an employee where others can overhear. Perhaps the employee is not aware of the implications, or a policy and procedure has overlooked the need to provide guidance.

ISO member organisations are audited for policy compliance.In order to assess the organisation's commitment to delivering a professional service (ww.bpca.org.uk; www.iso.org). However, until a policy and its procedure are tested it is unlikely to be known whether it will work effectively. Therefore users should be prepared to make recommendations for changes where appropriate.

On a large scale, some countries hold a referendum to invite recommendations. In an organisation, an internal policy that is not directly related to government policy and law might be easily refined so it works more effectively.

Contents of policies to manage IT infrastructure, data, information and users

- **User management**, e.g. security, such as the example about sharing sensitive information even subconsciously and how to keep the data secure using encryption methods and back-ups. A back-up process that remains on the premises is a risk to data, particularly if the premises are damaged or destroyed. The acceptable use of data is determined by government legislation and laws on a wider scale, such as the GDPR of 2018.
- **Customer management and support** – as consumers we are probably familiar with organisations providing information by means of self-help sources such as FAQs (Frequently Asked Questions) in the first instance. FAQs rely on the analysis of common customer queries and complaints and providing them saves both time and cost of human support.

Incident resolution flow charts illustrate a procedure as a series of stages or steps, often easier to follow than a series of bullet processes. The example shown in Figure 1.5 is a generic flowchart for managing an incident.

Making flowcharts available for customers to follow also aids accessibility and understanding.

The use of social media and other communications has a valuable part to play but must also be regulated. An organisation will rely on a policy or protocol to prevent inappropriate sharing or disclosing of information, standardising marketing messages and launching new products or good news quickly to the masses. Service industries use text messaging as reminders of appointments and time slots for deliveries.

Key term

Intellectual property – a term associated with intangible assets. That is something of value that you cannot physically touch. Examples include company logos, illustrations and written material.

- **Asset management** is the process of logging every item (asset) that the organisation is responsible for, such as buildings and equipment, financial and **intellectual property**.

Once assets are logged, the organisation will require systems for managing them. These include issue reporting procedures, maintenance schedules, issue logs, and the remote and local deployment of software.

- **Incident management** – earlier we considered the need for a policy for back-up procedures and this would also include recovery procedures. Standard approaches are needed for both processes to ensure everyone carries out the procedure in the same way. How information is managed and communicated with public and authorities requires set guidance and controls – for example, the methods used, the information shared and not shared, and the implications of doing so incorrectly. Imagine the potential risks of sending an organisation's accounts or customer database by email. Rules are needed not only for the methods of communication but also for the standardisation of written information, often referred to as house style. Not only does this give an image of professionalism but is especially important when ensuring the information is in an accessible and secure format.
- **Performance metrics** are the figures and data that show an organisation's actions, abilities and overall quality. Large amounts of data can be managed more easily and readily using IT. Systems are designed to integrate the collection of data and to assist analysis. While the data collected will be stored in a database, once manipulated the information is best presented in visual format of some kind. Figure 1.6 is an example of a metric of system developer performance:

Figure 1.5 Incident management flow chart

Figure 1.6 Key developer performance metrics

Considerations for organisations using in-house and external systems

Points that organisations using in-house and external systems for the provision of IT systems should consider include the following:

- **Service-level agreements (SLAs)** – These are detailed contracts and procedures used to ensure compliance. SLAs are used both internally, particularly between departments (for example, as technical department setting out standards and rules for users in other departments) and externally. External SLAs might include every aspect from how a supplier works within the policies and procedures of the customer organisation to how the supplier will be monitored for compliance.
- **Hardware and software requirements** – Consistency and standardisation should be ensured, for example the capabilities of systems and the versions of software used.
- **Costs** – Control over any leasing charges, external technical support and budget allowances for investment, maintenance and repairs should be controlled.
- **Availability** – Arrangements for the downtime of systems should be made, ensuring that interruption to organisational practices is minimal. External support in case of unexpected system downtime, methods for notifying customers of potential loss of systems, etc. should also be in place.
- **Scalability** – As an organisation grows and systems become more sophisticated, the organisation will need to consider the scalability of its existing systems. For example, whether current systems have the ability to cope with increases to information and digital traffic. Imagine how Amazon has to ensure their IT systems have the capacity and processing power to deal with increased volumes of orders at times of religious festivals and Black Friday, for example. Amazon's system needs to capture, process and despatch orders within the timescale the customer is expecting. Suppliers require advance warning and delivery schedules need managing. Facebook also faced challenges due to increased traffic and its ability to be scalable.

- **Legal ownership of data and jurisdiction** – As you have learned, there are many rules and regulations about the legal ownership of data, and these rules may vary globally. Organisations and their employees need to be aware of the jurisdiction of the ownership laws. For example, in 2010 it was determined that the data jurisdiction is where the server is located. However, in October 2019 the Court of Justice ruled that in the case of Google v CNIL there is no obligation under EU law for Google to apply the European right to be forgotten globally. The European Union has influenced broadcasting law since 1989 with a fourth version being considered in 2020. However, as more data are being held in virtual servers the law continues to be challenged, and organisations are recognising the importance of storing digital data within a cloud in their local jurisdiction. For example:
  - Problems may arise from having data and processing residing in multiple jurisdictions and include the sharing of information with a country outside the GDPR agreement. Security breaches can arise due to conflicting rules, or delays in accessing data for court hearings.
  - Issues can also arise from data and processing residing in regions that may not have appropriate laws to cover the protection and use of data implementation. While more than 100 countries now have data protection laws, there are still a large number that do not. This can cause unimaginable problems and breaches to security. Iraq, Pakistan, Jordan and Thailand have drafted their legislation recently (2019), and Asia Pacific has developed a uniform standard known as APEC (Asia-Pacific Economic Corporation). However, consider a scenario where the rules differ or are non-existent. An organisation's or individual's data might be sold to third parties and used for fraudulent activities. Trade secrets could be infiltrated and impact on a country's economic situation. Even military information could be accessed and lead to unimaginable harm. Terrorists could gain information enabling them to target major events or key individuals.

Assessment practice 1.3 C.P6, C.P7, C.M3, BC.D3

A small business owner, Serena, has asked for your advice about protecting the data on her system. She runs an engineering business that produces steel products to customer specifications, some of which are uniquely designed sculptures. She is concerned about her customer records, especially the unique designs and their copyright. She has heard that there is legislation about protecting such information but does not know what it entails or how to implement it.

The business currently operates on a single computer used by the administrator/receptionist but, as the business grows, she wants to be prepared for taking on at least two new members of staff, one for technical drawing and another for managing all customer information and accounting procedures. Serena is interested in what systems and software she should budget for and how to secure the data. She needs you to:

- describe internal and external threats to data and information that her organisation might be at risk of
- analyse how these threats, and mitigation of those threats, will impact on her organisation and its stakeholders
- describe the procedures that would need to be implemented in her organisation to allow her to protect data and information
- analyse how your suggested procedures will impact on her organisation and its stakeholders
- justify your decisions
- discuss the options available to her that best suit the short-term business plan
- demonstrate how they will provide her with peace of mind and fulfil any legislative requirements
- calculate software and hardware costs
- analyse at least two different options for suitability
- write an evaluation of your findings and make recommendations for her to consider.

Assessment practice 1.3 *continued*

Plan

- Prioritise the tasks and prepare a checklist of things to do.
- Identify a range of resources to help me.
- Keep a detailed list of all my sources that anyone can locate.
- Allow for some buffer time as a contingency.

Do

- Structure my schedule to ensure that I cover all the criteria.
- Double check my calculations and find alternative costings.
- Put the customer needs first beyond my own preferences.
- Provide alternatives for the technical language and terminology.

Review

- I am pleased with the outcome and I do not think I could improve it at this stage.
- I know what I need to learn to expand my current knowledge.
- I can recognise what progress I have made from undertaking this activity.

Pause point How could you have presented the outcomes differently if the customer was from a different sector or had more technical knowledge?

Hint Try putting yourself in the position of a business owner and viewing the outcomes through 'different eyes'.

Extend Find yourself a local business mentor who can give you constructive feedback about your suggestions.

Theory into practice

What strategies for safe online working have you learned that you could recommend to your workplace or where you study?

Assessment practice 1.4 C.P7, C.P8, C.M4, BC.D3

The Canadian Health Commission (CHC) is looking to improve the data collection system across the health care system in Canada by introducing a standardised approach. The problem they have identified is that of overcoming the challenges faced when trying to collect data on patients' race, ethnicity, language and communication needs.

The organisation is striving to create a comprehensive system that combines data collected from multiple agencies. Those agencies need to include:

- hospitals
- community health centres
- physician practices
- health plans
- government or federal agencies.

Assessment practice 1.4 *continued*

The organisation recognises that each agency faces opportunities and challenges in how to collect the data sensitively and consistently.

To identify the next steps towards improving data collection they have recognised that, in some instances, the opportunities and challenges are unique to each type of organisation while, in others, they are common to all, including how to:

- ask existing and potential patients questions about race, ethnicity, and language and communication needs
- train staff to elicit this information in a respectful and efficient manner
- address the discomfort of registration/admission staff about requesting this information.

You have been asked to:

1. Write a report that describes procedures to be implemented to allow them to protect the data and information collected.
2. Include advice about how these procedures should be implemented to ensure the organisation operates in legal, moral and ethical ways, and the way that this would impact on the organisation and its stakeholders.
3. Provide recommendations for CHC justified by your findings.

Plan

- What do I need to find out?
- What is my timeframe?
- What will the structure of the report look like?
- How can I demonstrate that this meets the required standard for distinction?

Do

- I know how to locate where my weaker areas are and how to improve.
- I understand what is being asked of me.
- I can check that all the criteria are met.
- I can make improvements to my analytical and evaluating skills.

Review

- I can describe how to improve further.
- I can recognise my strengths.
- I can explain how I tackled each part of this activity.
- I can explain how this knowledge and experience will be useful to me elsewhere.

Further reading and resources

Websites

Useful websites for further information relating to Unit 1:

- http://www.cisco.com
- http://computer.howstuffworks.com
- http://www.dummies.com

Pause point What ethical and moral factors feature in this assessment activity and on whom do they have an impact?

Hint Try exploring other case studies or talking to a mentor or business colleague.

Extend How would you develop an outline for logging the data electronically?

THINK FUTURE

Ahmed Khan

Student

I was part way through my BTEC when I started to realise 'I can do this!' I joined the course mainly because I didn't know what else to do and I like computers. I was worried I wouldn't make the grade, but I enjoyed studying.

So after getting some careers advice from my teacher and student services I found a university course I fancied and applied. It meant filling in an application and I wasn't very confident, but I had help to write about what I am good at and why I wanted to go into higher education. I can't wait to go on to do a degree as I shall be the first person in my family to go to university. I have done some research about possible jobs in the future and it seems they're crying out for software developers.

It wasn't until I talked to my parents about my plans and they asked me to explain what software developers do, that I realised I needed to be more focused. When I looked through the courses again, I realised I needed to be specific in what I wanted and identify what my strengths were. I also realised then that I wanted to make a success of the course and not struggle with something that might not interest me. I especially enjoyed learning about design philosophy and knew that my creative skills would be useful when designing software.

I would be preparing for a job where I would work in a team on projects that might also involve me researching clients' needs to inform the design.I thought about the research I had done on this course and how much I had developed from when I first started. I must admit that at first I didn't think very hard about the information I found and now I know about ways to check it is accurate before relying on it. However, I have a lot more to learn.

My parents are proud of my achievements so far and they are especially pleased that I have a mission to follow! Most of all, I am proud of myself and can't wait to continue my journey. I'm not saying it's going to be easy though!

Focusing your skills

Skills health check and preparing to apply to higher education

It is important to promote the skills you have gained as they can be used in the future in lots of different situations. Here are some ideas for you.

1. Make a list of the skills you have and how they will help you in higher education.
2. Divide your list into four skills sections: employment, creative, study, social.
3. Rate each one to identify what you are really good at and what you need to improve on.
4. Ask someone who knows your skills well to check your list in case you have missed anything.
5. Research the variety of higher education courses on offer and read through the syllabuses of those that interest you.
6. Arrange to visit some universities that offer courses that interest you in order to assess which ones might suit you and where you might fit in best.
7. You should also consider preparing for any visits and possible interviews by producing:
   - an updated CV, with examples of where you have applied your skills as a student or employee
   - a list of sensible and interesting questions
   - a bibliography of your sources used for research and your application.

Glossary of key terms

AIO – an all-in-one (AIO) device is one that is multifunctional. They are also known as MFDs.

Alt text – alternative text for an image or other media, for example on a web page or in an e-book. The alternative text is read by screen readers to tell the user what the image or other media depicts. Alternative text therefore needs to be descriptive and concise.

Amortise – gradually write off the initial cost of an asset over a period of time, because regular payments are made.

Bandwidth – the available amount of data transmission capability.

Bespoke – means built specifically to a customer's requirements.

Bit – short for binary digit. Bit is the smallest component of data represented as a zero (0) or a one (1).

Broadband – a high-speed transmission technique, whereby a wide band of frequencies is used to transmit messages. It commonly refers to internet access via a range of networks including DSL, Wi-Fi, 3G, 4G and 5G. Today, broadband is a very familiar term in the UK and all of our digital devices, such as smartphones, games consoles and internet-enabled televisions, use broadband to connect to the internet and share data all the time.

Cash flow – the movement of funds in and out of the organisation.

Codec – a device or program that compresses data for faster transmission.

Codes of practice – sets of rules that are agreed by a professional body on how people within certain professions must behave. Some examples are the code of ethics known as the Hippocratic Oath for those in the medical profession; the Accountable Journalism code in Pakistan; the code of ethics and professional conduct in the UAE; Thai Union Business Labour; and the EU code of conduct for lawyers in Turkey.

Containerisation – a virtualisation method used to separate several applications. The application bundles do not contain a copy of the operating system. Instead they use the host's operating system.

Covert – hidden or secret.

CPU – central processing unit, which acts as the computer's brain to process instructions.

CSV (comma-separated values) – is a file type that stores records in a line and presents data in plain text as individual fields, where each field is separated by a comma.

Database – a collection of data, which can be in digital or paper form, such as a telephone directory.

Data cleansing – ongoing checking of data for accuracy, currency and completeness.

Data engineer – someone who designs and produces database programs known as information systems.

Digital SLR camera – known as DSLR cameras. They have a much larger, better-quality sensor, capturing a better image than traditional cameras which capture the image onto film.

Driver – a routine program used to operate peripheral devices, such as monitors and keyboards.

Early adopter – an individual who feels compelled to obtain the latest products and technology as soon as they become available. For example, robotic vacuum cleaners, smart TVs and watches.

Email host – an internet provider that offers an email service to its users.

Encrypting – converting data into a code to avoid it being accessed easily by unauthorised users. Specialist software is used to encrypt data.

Ethical – relating to the knowledge of moral principles: that is, how we behave.

Extranet – an intranet system that can be accessed by authorised external users to retain data security.

Fibre-optics – a collection of very fine strands of silica glass, which use light to transmit data at high speeds.

Firmware – means the low-level controls built into a device that enable the device to carry out instructions given by the user. For example a remote control requires firmware to instruct it on what is required, such as turning on or dimming a light

GPS – the global positioning system (GPS) is an accurate worldwide navigational and surveying facility. It uses the signals from orbiting satellites to work out the position of the device.

GUIs – graphical user interfaces are those that allow users to interact with a digital device using graphical icons.

Hardware – computer equipment that you can physically touch. It includes computers and other digital devices themselves and also peripheral devices such as the keyboard, monitor and mouse.

Hardwired – a permanent connection between components of an IT system with dedicated wired cabling. Modern buildings are often purpose-built with the cables integrated into the fabric of the building and internet connections are provided for direct connection of non-mobile digital devices such as PCs, servers and machinery.

HTML – stands for hypertext mark-up language and is used to create web pages.

IEEE 802.11 – refers to a set of rules, or protocols, relating to the LAN (local area network).

Infrared (IR) – is a short-range wireless mobile technology. It is limited because it requires 'line-of-sight' and also cannot penetrate walls.

Input mask – a database instruction that restricts or controls the type, format or amount of data entered.

Intellectual property – a term associated with intangible assets. That is something of value that you cannot physically touch. Examples include company logos, illustrations and written material.

Interface – a point where two (or more) systems meet and interact. In computing, an interface is a device or program enabling a user to communicate with a computer.

Intranet – a local network website where access is restricted to internal users, such as within an organisation.

Latency – the 'delay' experienced – for example, when playing online games. High latency results in you seeing the movements you made to a character a longer period of time after you made them.

Malware – short for malicious software, is software created to steal data by gaining access to an IT system without the user's consent.

Mbps – megabits per second, the speed for downloads and uploads. MBps refers to megabytes per second, used in reference to file size.

MFD – a multifunctional device, such as a smartphone, includes a camera that connects to the internet or a printer that also scans and photocopies. They are also known as AIOs.

Moral – principles about what is right and wrong behaviour.

Netiquette – a word derived by combining internet (net) with correct behaviour (etiquette); it is especially related to online discussions and forums but also emails.

NFC – short for 'near-field communication' is a method offering a low-speed connection between two electronic devices.

Outsource – when a function is undertaken by specialists, such as accountants, deliveries, managing IT systems, etc.

Overheads – the costs incurred by organisations for staffing, premises, equipment, etc.

Ping – a test of end-to-end connectivity that times the return of an ICMP packet between two hosts.

Platform – the operating system that enables applications or programs to operate on a digital device.

Policies – rules by which individuals and organisations must abide. For example, restrictions for passing on sensitive information.

Procedures – step-by-step processes used to ensure actions are consistent and standardised. For example, accessing files within a computer system.

Query – a way of interrogating data by applying a set of criteria.

RFID – radio-frequency identification.

Router – an electronic device that enables data to be transmitted between networks.

RSI – pain inn muscles and nerves caused by repetitive movements and overuse.

RTP – real-time transport protocol.

SD card – the name given to the memory card used in digital cameras and some other portable devices. SD stands for secure digital.

SLR camera – a single lens reflex camera provides exactly the same photograph as seen in the viewfinder.

Software – applications or programs that are installed onto a digital device. They enable us to carry out certain functions such as word processing or creating spreadsheets, using media, accessing websites or playing computer games.

Software developer – someone who contributes to producing computer programs (software applications) or computer games.

Stakeholder – there are two types of stakeholders: internal (those within the business, such as its employees) and external (those outside the business, such as customers and anyone with an interest in the business). Stakeholders may have a financial or even an emotional interest in the business.

Standalone computer – a computer not reliant on any other computers or digital devices to function; therefore, it can be used independently.

Sync – is short for 'synchronise' or 'synchronisation', which means to match up and pull together, for example, to make sure that multiple devices have the same copy of the relevant files in many places.

Terminal window – also referred to as a terminal emulator, this is a window (or graphical user interface) devised by Microsoft for accessing command lines.

URL – stands for uniform resource locator and is the term given to the address of a website.

Virtualisation – to create a virtual version of a device or resource.

VOIP – voice over internet protocol.