Supporting Technical Education Teaching:

**Curriculum Resources**

Teaching Guide

Topic: Digital environments

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| --- | --- |
| Route | Digital |
| Qualification | T-Level Technical Qualification in Digital Production, Design and Development<https://qualifications.pearson.com/en/qualifications/t-levels/digital-production-design-and-development.html> |
| Topic | Digital environments |
| Specification coverage | Route Core Element 7- Digital environments |

This resource is part of a series of materials to support technical education teaching. The approach to developing the materials draws from research led by Professor Kevin Orr that sets out a model for understanding of technical education pedagogy, alongside the Raspberry Pi Foundation’s twelve pedagogy principles for teaching computing.

The curriculum development begins with the knowledge that students are working to learn and apply. Teachers draw from their subject and industry expertise, and their knowledge of their students, to make decisions about the core concepts the curriculum will focus on, how they will sequence these concepts, and the activities that are selected to support students’ learning. The decisions behind the resources suggested in this topic are the result of choices made by the curriculum development team, which will be reviewed and improved by teachers’ decision-making and ongoing reflection in their own circumstances.

The materials also seek to support teachers in bringing classroom and industry closer together, by providing assets that draw from authentic industry materials, and using opportunities to capture workplace practice that can be shared with students.

HEALTH AND SAFETY

It is assumed that activities outlined in this Teaching Guide will be undertaken in suitable facilities or work areas and that good practices, appropriate use policies and procedures will be observed. Teachers should consult their employers’ risk assessments before use and consider whether any modification is necessary for the particular circumstances of their own class/institution.

Acknowledgements

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Materials for other topics are available at: [www.technicaleducationnetworks.org.uk](http://www.technicaleducationnetworks.org.uk)

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Introduction

This document for teachers outlines both the topic area covered, and approach to using the suite of resources and assets for each lesson.

# Topic purpose

This topic is an introduction to digital environments and explores the characteristics of computer systems and hardware used in physical environments. The different categories and purposes of software and its use in organisations will be investigated. Physical storage and backup systems including how these allow organisations to build resilience will be covered, together with how digital environments can be connected using networks and how communication takes place. The benefits and limitations of virtual and cloud environments will also be explored.

There are ten lessons in this teaching sequence and each lesson is assumed to be 1.5 hours. You may want to adapt the suggested sequencing of concepts and activities as appropriate for your students and circumstances. The lessons are broken down to provide teacher flexibility on the depth covered in the activities; lessons can also be split over multiple shorter lessons if required. Alternatively, lessons 1-2, 3, 4-6, 7-9 and 10 could be taught as standalone sessions through the course with summative assessments available at the end of each of these sections.

Each lesson has been designed to give students the opportunity to cover the core concepts and then opportunities to apply their understanding with an industry specific “Apply it” activity.There are also opportunities to build several essential skills that are developed during the course and general competencies for maths, English and digital.

# Industry importance

Software developers and engineers design, create, and maintain the software applications and systems that operate within digital environments. Digital environments can be physical, virtual, or cloud-based, and how these technologies are deployed has an impact on the organisation and its stakeholders. The theory underpinning these environments, such as how communication takes place over a network or the features offered by different operating systems, allows students to fully appreciate these digital environments and the opportunities they offer.

Depending on the specific field or role, professionals working in the digital sector should have a solid foundation in relevant technical skills and stay updated with emerging technologies, such as the Internet of Things (IoT) and artificial intelligence (AI), and the benefits and limitations of these technologies.

It is important that students have the opportunity to explore how different digital environments can meet the needs of organisations and their stakeholders. Students should be able to apply their knowledge of digital environments to a wide range of industry contexts. Although the roles within the digital sector are very varied, having a sound understanding of digital environments and being able to adapt to the opportunities and challenges presented by these environments is critical.

“A firm understanding of the role, function and operation of devices within a digital environment is essential knowledge for many digital careers. Through this T-level component students will develop and apply this essential knowledge."

**James Robinson, Senior Learning Manager, Raspberry Pi Foundation**

## Industry links

* The Royal Society has lots of publications and information on continuing professional development ([royalsociety.org](https://royalsociety.org/))
* Many professionals working within the digital sector are members of a professional body such as:
	+ BCS, The Chartered Institute for IT ([www.bcs.org](https://www.bcs.org/))
	+ IEEE ([www.ieee.org](https://www.ieee.org/))
	+ The Institution of Engineering and Technology ([www.theiet.org](https://www.theiet.org/))
	+ The Institution of Analysts and Programmers ([www.iap.org.uk](https://www.iap.org.uk/))
	+ Business Application Software Developers Association ([www.basda.org](https://www.basda.org/))
	+ Royal Academy of Engineering ([raeng.org.uk](https://raeng.org.uk/))
	+ Computer & Communications Industry Association ([ccianet.org](https://ccianet.org/))
* The UK government’s National Careers Service for England has a section focused on careers in the digital sector: [nationalcareers.service.gov.uk/job-categories/computing-technology-and-digital](https://nationalcareers.service.gov.uk/job-categories/computing-technology-and-digital)

# Prior learning

Students do not require any specific prior knowledge before studying the topic. Some students may have covered the core concepts at GCSE, those who have studied technical programmes prior to beginning their course may have been introduced to some content relating to digital environments.

# Accessibility

The teaching materials have been designed to provide teachers with a flexible framework, including different approaches to activities, suggested consolidation activities to further embed knowledge, and adaptable study questions to assess learning. As with all resources, teachers will wish to consider the specific needs of their students when using the materials, including Special Educational Needs and Disabilities (SEND).

Learning outcomes and specification coverage

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Lesson | Learning outcomes | Specification coverage | Skills and General competencies | Links to other specification content |
| 1 Computer systems | Students will be able to:* **Recognise** key features of a computer system
* **Compare** a range of digital devices, considering purpose and features
* **Identify** the role of key hardware components and peripherals
* **Apply** knowledge of computer systems and hardware to real-world scenarios
 | **7.1.1** Understand the features and characteristics of different types of physical computer system:* Personal computers
* Mobile devices
* Servers
* Smart/internet-enabled devices

**7.1.2** Understand the features and characteristics of hardware and peripherals used in physical computer systems:* Input devices
* Output devices
* Processors
* Memory
* Secondary storage devices
* Motherboard/mainboard
* Cooling
* Sensors
 | English:**E1** Convey technical information to different audiences**E2** Present information and ideas**E3** Create texts for different purposes and audiences**E4** Summarise information/ideas**E6** Take part in/leading discussionsDigital:**D1** Use digital technology and media effectively**D3** Communicate and collaborate | **5.1.3** Understand how digital supports the business needs of an organisation |
| 2 Software in computer systems | Students will be able to:* **Identify** the purpose of software used in computer systems
* **Compare** different types of software, considering purpose and features
* **Explore** the role of the operating system
* **Apply** your knowledge of computer systems and software to real-world scenarios
 | **7.1.3** Understand the purpose and functions of software used in computer systems:* Operating systems
	+ Batch operating system
	+ Multitasking/time-sharing operating system
	+ Real-time operating system
	+ Network operating system
	+ Mobile operating system
* Utility software
* Application software
* Code development tools (IDEs, debuggers)

**7.1.4** Understand the benefits and drawbacks of software, hardware, and peripherals in different contexts | English:**E1** Convey technical information to different audiences**E2** Present information and ideas**E3** Create texts for different purposes and audiences**E4** Summarise information/ideas**E5** Synthesise information**E6** Take part in/leading discussionsMaths:**M5** Process data Digital:**D1** Use digital technology and media effectively**D3** Communicate and collaborate | **5.1.3** Understand how digital supports the business needs of an organisation**5.1.5** Understand how digital is used to meet user needs and ensure the quality of product/service |
| 3 Memory and storage | Students will be able to:* **Identify** the features of physical storage systems
* **Describe** the role of main memory and its key characteristics
* **Recognise** the need for secondary storage
* **Compare** the different types of physical storage and recovery systems
 | **7.1.5** Understand how physical data storage and recovery systems work, their features, benefits, and drawbacks:* Redundant array of independent disks (RAID)
	+ RAID 1
	+ RAID 5
	+ RAID 10
* Network attached storage (NAS)
* Storage area network (SAN)
 | English:**E1** Convey technical information to different audiences**E2** Present information and ideas**E4** Summarise information/ideas**E6** Take part in/leading discussionsMaths:**M6** Understand data and riskDigital:**D2** Design, create and edit documents and digital media**D3** Communicate and collaborate | **4.1.2** Data security and protection |
| 4 Networks | Students will be able to:* **Explain** why devices are connected to networks
* **Describe** what a network is
* **Compare** common network types
* **Recognise** the characteristics of different network topologies
 | **7.2.1** Understand the benefits and drawbacks of connecting devices to form networks**7.2.2** Understand the features, characteristics, benefits, and drawbacks of wireless connection methods**7.2.3** Understand the features, characteristics, benefits, and drawbacks of wired connection methods**7.2.4** Understand different types of network:* LAN
* WAN
* PAN

**7.2.5** Understand the concepts of bandwidth and latency, and their effect on the performance of networks and connected systems**7.2.6** Understand the concept of different network models:* Client-server
* Thin client
* Peer-to-peer

**7.2.7** Understand the characteristics of network topologies:* Logical vs physical
* Star
* Mesh
* Tree
* VLAN
 | English:**E1** Convey technical information to different audiences**E2** Present information and ideas**E3** Create texts for different purposes and audiences**E4** Summarise information/ideas**E5** Synthesise information**E6** Take part in/leading discussionsDigital:**D2** Design, create and edit documents and digital media**D3** Communicate and collaborate | **5.1.4** Understand the factors that determine the feasibility of a digital project**5.1.5** Understand how digital is used to meet user needs and ensure the quality of product/service**5.2.1** Understand the importance of digital within organisations, and the ways in which digital is used to add value to a company |
| 5 Communication over networks | Students will be able to:* **Discover** how communication takes place over a network
* **Recognise** some common components of a network and their purpose
* **Describe** the role of protocols in network communication
* **Identify** the contents and purpose of a packet in transmitting data across a network
 | **7.2.8** Understand the role and characteristics of common components of a network:* server
* internet connection/internet backbone
* router
* network switch
* client

**7.2.11** Understand the role of data packets in transmitting over a network, including:* contents and structure of a data packet
* role of the components of a data packet
* packet switching
* error handling – Cyclic Redundancy Check (CRC)

**7.2.12** Understand the role of common network protocols including:* DHCP
* DNS
* FTP
* HTTP / HTTPS
* NTP
* POP3 / IMAP4 / SMTP
* TCP/IP
 | English:**E2** Present information and ideas**E4** Summarise information/ideas**E5** Synthesise information**E6** Take part in/leading discussionsDigital:**D1** Use digital technology and media effectively**D2** Design, create and edit documents and digital media**D3** Communicate and collaborate**D6** Code and program | None |
| 6 Communication over networks | Students will be able to:* **Describe** how applications communicate over a network
* **Compare** the layers of the OSI and TCP/IP models
* **Distinguish** between network layers and protocols that operate on each layer
 | **7.2.9** Understand the seven-layer OSI model to describe how applications communicate over a network, including the function and related protocols of each layer:* application layer
* presentation layer
* session layer
* transport layer
* network layer
* data link layer
* physical layer.

**7.2.10** Understand the four-layer TCP/IP model to describe how applications communicate over a network, including the function and related protocols of each layer:* application layer
* transport layer
* internet layer
* network access layer.

**7.2.12** Understand the role of common network protocols including:* DHCP
* DNS
* FTP
* HTTP / HTTPS
* NTP
* POP3 / IMAP4 / SMTP
* TCP/IP

**7.2.13** Understand how physical, virtual and cloud environments, along with networks, are used in combination, including the Internet of Things (IoT), to solve problems and meet the needs of organisations and their stakeholders | English:**E1** Convey technical information to different audiences**E2** Present information and ideas**E4** Summarise information/ideas**E5** Synthesise information**E6** Take part in/leading discussionsDigital:**D2** Design, create and edit documents and digital media**D3** Communicate and collaborate  | **5.1.5** Understand how digital is used to meet user needs and ensure the quality of product/service |
| 7 Virtual environments | Students will be able to:* **Examine** the key features of virtual environments:
	+ Increased security
	+ Sharing
	+ Aggregation
	+ Emulation
	+ Isolation
	+ Portability
* **Analyse** the benefits and drawbacks of the use of virtual environments in a range of contexts
 | **7.3.1** Understand the key features of virtual environments: * increased security
* managed execution
* sharing
* aggregation
* emulation
* isolation
* portability.

**7.3.2** Understand benefits and drawbacks of the use of virtual environments in a range of contexts | English:**E1** Convey technical information to different audiences**E2** Present information and ideas**E3** Create texts for different purposes and audiences**E4** Summarise information/ideas**E5** Synthesise informationDigital:**D1** Use digital technology and media effectively**D6** Code and program | **5.1.3** Understand how digital supports the business needs of an organisation**5.1.5** Understand how digital is used to meet user needs and ensure the quality of product/service**5.2.1** Understand the importance of digital within organisations, and the ways in which digital is used to add value to the business |
| 8 Cloud environments | Students will be able to:* **Define** what cloud storage is
* **Describe** how organisations use cloud environments
* **Examine** the different models of cloud deployment
* **Explore** how the responsibility of ownership is distributed between subscriber and service provider
* **Distinguish** between cloud service models
 | **7.4.1** Understand the concepts of cloud computing deployment in terms of: * applications
* data
* runtime
* middleware
* operating system
* virtualisation
* servers
* storage
* networking

**7.4.2** Understand common cloud delivery models and the way in which responsibility and ownership of resources are distributed between the subscriber and service provider: * IaaS (Infrastructure as a Service)
* PaaS (Platform as a Service)
* SaaS (Software as a Service)
 | English:**E2** Present information and ideas**E4** Summarise information/ideas**E5** Synthesise information**E6** Take part in/leading discussionsDigital:**D3** Communicate and collaborate | **5.1.3** Understand how digital supports the business needs of an organisation**5.1.5** Understand how digital is used to meet user needs and ensure the quality of product/service**5.2.1** Understand the importance of digital within organisations, and the ways in which digital is used to add value to the business |
| 9 Cloud delivery methods | Students will be able to:* **Recognise** the concept of DaaS (Data as a Service)
* **Discover** how DaaS is used and the benefits and drawbacks it provides for organisations
* **Identify** what is meant by cloud sourcing and cloud portability
* **Explore** the ways in which organisations use cloud environments to provide access to digital tools, services, and storage
 | **7.4.3** Understand the concept of DaaS (Data as a Service) in terms of: * data science platforms
* dashboards
* business information tools
* data lakes
* databases
* file systems

**7.4.4** Understand how DaaS (Data as a Service) is used by organisations, and the benefits and drawbacks it provides for organisations and their stakeholders. **7.4.5** Understand the concept of cloud sourcing and cloud portability, and the implications for service providers and organisations (subscribers). | English:**E2** Present information and ideas**E4** Summarise information/ideas**E5** Synthesise information**E6** Take part in/leading discussionsMaths:**M5** Process data Digital:**D2** Design, create and edit documents and digital media**D3** Communicate and collaborate | **5.1.3** Understand how digital supports the business needs of an organisation |
| 10 Resilience of environment | Students will be able to:* **Recognise** the need to ensure digital environments are resilient
* **Compare** a range of methods used to improve the resilience of digital environments
* **Identify** the impact on organisations and stakeholders if resilience is not achieved
* **Apply** your knowledge of the benefits and drawbacks of methods used to improve the resilience of digital environments in a real-world scenario
 | **7.5.1** Understand the need to ensure digital environments are resilient, and the impact on organisations and stakeholders if this is not achieved. **7.5.2** Understand methods used to improve the resilience of digital environments: * data and system redundancy
* back-up systems
* hot, cold and warm sites
* data back-up and recovery procedures
* device hardening

**7.5.3** Understand the benefits and drawbacks of methods used to improve the resilience of digital environments. | English:**E1** Convey technical information to different audiences**E2** Present information and ideas**E4** Summarise information/ideas**E5** Synthesise information**E6** Take part in/leading discussionsMaths:**M6** Understand data and risk Digital:**D1** Use digital technology and media effectively**D2** Design, create and edit documents and digital media**D3** Communicate and collaborate | **5.4.1** Understand the potential risks to an organisation of use of digital systems and technologies**8.1.1** Understand the importance of maintaining privacy and confidentiality of an organisation’s information, as well as that of stakeholders**8.1.3** Understand potential technical threats and vulnerabilities to systems data and information**8.1.4** Understand potential physical threats and vulnerabilities to systems data and information**8.1.5** Understand potential human threats and vulnerabilities to systems data and information |

Lesson guidance

# Lesson 1: Computer systems

This lesson introduces computer systems including common hardware that is found in most systems. The lesson then progresses onto a range of different devices that can be classified as computer systems that share common characteristics and the key components that make up a computer system.

## Preparation

|  |  |
| --- | --- |
| Resources provided | Slides Activity sheets:* + A2 Activity sheet – Hardware peripherals
	+ A2 Answer sheet – Hardware peripherals
	+ A3 Activity sheet – Processor components
	+ A3 Answer sheet – Processor components
 |
| Equipment needed | Students may require access to computers for some activities in the lesson. |
| Safety factors | Teachers and students are required to carry out their own risk assessments for the activities in each lesson.You may consider internet access for students in line with appropriate use policies and procedures of the organisation. |
| Prior learning | Students should have an understanding of input and output devices and experience of using peripheral devices. Students may have prior knowledge of what a processor is and the role it plays in a computer system. |
| Common misconceptions | The different roles of computer systems, particularly the client and server. The terms CPU and processor are often used interchangeably. Students should be aware that a CPU can contain one or more processors. |
| Accessibility | Seek to ensure wide representation for any visiting speakers and case studies used.Consider students’ potential lack of confidence in participating in a debate at this early stage of their learning. It is worth establishing the core principles of working in a collaborative manner, in a ‘safe space’, at this point in the course. |

## Activity guide

|  |  |
| --- | --- |
| Starter activity: What is a computer system?SUGGESTED TIME: 5 minutesRESOURCES: Slides 2–5general competencies: E6 | Before the lesson, study the slide deck as a guide to summarise what will be covered in the lesson to introduce the topic.Begin the lesson by showing students the introduction video. This introduces the topic of digital environments to students and explores how digital environments are used at the Raspberry Pi Foundation.Then ask the question, **“What devices have you used in the past three days?”** The students should discuss their answer with a partner and then consider the question, “**What components does a device need to be considered a computer?”** It would be helpful to introduce the term ‘characteristics’ at this point.Once discussed, ask the students to consider the list of devices on slide 4. For each one, they should question whether or not it is a computer by applying the characteristics they discussed with their partner. Use slide 5 to introduce the lesson objectives. |
| Activity 1: What is a computer?Suggested time: 20 minutesResources: Slides 6–14general competencies: E2, E4, E6, D1, D3 | Slide 6 shows the students the Input, Process, Output and Storage (IPOS) model. Use this to highlight the process stage and its importance to a device being classified as a computer system. Slide 7 introduces the concept that computers can be grouped into different categories. Students could reflect on the devices they listed for the starter activity and think about what categories the devices fit into.Pose the question to students, “**What would an organisation have to consider when buying new computers?”**You may want to get students to discuss this in small groups or pairs and feedback their discussions to the rest of the group. A note is provided on the slide to highlight the issue around availability that many organisations may have had to consider during the COVID-19 pandemic. Introduce the term ‘personal computer’ (PC) and the characteristics of a PC. Ask students to think about what should be considered when buying a laptop or desktop computer system. It may be useful to highlight the idea of purpose/intended use here, as this may alter some of the decisions made.* + **Physical size** — people who travel a lot may require a smaller, lighter laptop device
	+ **Processor speed** — people who work with a lot of images and multimedia content will require more processing power for creating, editing, and converting content
	+ **Cost** — what are the budget implications for the organisation?

Introduce the term ‘mobile device’ and the characteristics of a mobile device. Ask students to think about the considerations when buying a mobile device: * + **Size and resolution of the display** — this may depend on the user and accessibility requirements
	+ **Battery duration** — people who spend large proportions of their time away from power sources would require larger battery capacity, for example, if a delivery driver uses a smartphone to log the delivery of items throughout the day, they need a device that will have enough battery capacity to last the day

Slide 10 introduces the term **server** to students and the main point to highlight here is that a **client** is a device or service that makes a request and the **server** is a computer system that provides services to any authorised client. More specific servers will be covered later on in the topic.Describe the term ‘internet of things’ (IoT) and explain that these devices are often referred to as smart or internet-enabled devices. Discuss some of the examples provided on the slide deck with students. Students may be more familiar with smart home devices and wearable technology, so it may be good to explore some of the other areas in more detail:* + **Industrial IoT devices - inventory trackers** — Industry can now monitor inventory in real time, i.e. stock coming in and out and deliveries made to customers. You could use the example of a smart shop like Amazon Fresh where technology can automatically detect what shoppers have put in their baskets.

Students should select one of the smart/internet-enabled categories from slides 12 and 13 and conduct some guided discovery about how these devices are used in different industries. Full information for this activity is outlined on slide 14. They should then prepare a debate where they will explore the benefits and drawbacks of the use of smart/internet-enabled devices in the industry they researched. |
| Activity 2: Von Neumann architectureSuggested time: 15 minutesResources: Slides 15–24A2 Activity sheetA2 Answersgeneral competencies: E4 | Show students the video on slide 15.Introduce the concept of the stored program computer and use slide 16 to explore a brief history of the development of computers. Share the features of von Neumann architecture and discuss with students whether this matches the characteristics they discussed in the starter activity.Use slides 17 to 21 to go through the role of the main components starting with input and output devices. Slides 22 and 23 are ‘industry spotlights’ which introduces a software engineer and software developer. Ask students to consider what peripheral devices these individuals may use as part of their job role. Group students into pairs or small groups and instruct students to open their version of the ‘**A2 Activity sheet** – Hardware peripherals’ (full information for this activity presented on Slide 24). In their groups students should discuss and list peripheral devices that they think may be useful for a software engineer or developer. They can use the activity sheet to record their responses. Encourage students to focus on the characteristics and features using the example provided to guide them. As a further activity students could attempt the Explorer task to explain what peripheral devices another organisation may use (this may be the students' industry placement or another small or large organisation). Give them 10 minutes to do this. Share and display some sample answers from ‘**A2 Answers** – Hardware peripherals’ with students. You may also get groups to share their responses to the rest of the class. |
| Activity 3: Processor componentsSuggested time: 10 minutesResources: Slides 25–33A3 Activity sheetgeneral competencies: E4 | Return to the diagram on slide 25 to explain the role of the processor and use slide 26 to introduce the names of the main components of the processor.Display slide 27 and instruct students to open their version of the ‘**A3 Activity sheet** – Processor components’. Students should research and make notes on the knowledge organiser. * + **Arithmetic and logic unit (ALU):** Performs arithmetic and logic operations. Where calculations and logical processing are done.
	+ **Control Unit:** Performs the FDE (fetch-decode-execute) cycle. Moves data around the CPU and issues signals that control hardware.
	+ **Clock:** Sends pulses to regulate the number of cycles per second.
	+ **Buses:** High-speed internal connections used to send signals and data between the processor and other components. For example, the address bus carries memory addresses.
	+ **Registers:** Small, fast access memory locations. Used by the processor to store small amounts of data that are needed during processing. For example, the result of a calculation.

This activity also includes a task for students to explore why a device may not be performing as well as it used to within an industry context. Share the answers for the activity by displaying slide 28 to the students and sharing the sample answers provided on the answer sheet.Use slide 29 to discuss some of the factors that can affect the performance of processors. Share slide 30 with students and explain the different types of processor cooling. Discuss whether students know what cooling system their devices use (some who are into gaming may be able to explain in detail).Use slides 31 to 33 to explain the role of main memory and the motherboard.* + **Main memory:** Memory that can be accessed directly by the processor.
	+ **Motherboard:** The main circuit board within a computer, motherboards contain the buses and components, such as the CPU and RAM. Motherboards differ in size and shape depending on the physical characteristics of the device.
 |
| Retrieval activitySuggested time: 5 minutesResources: Slide 34 | Use the retrieval questions on slide 34 to check understanding with students. The retrieval activity is also a discussion point to explore any misconceptions and ensure that every student has identified the correct answers. |
| Apply It activitySuggested time: 25 minutesResources: Slide 35general competencies: E1, E2, E3, E6, D3 | This is the point of the lesson where students can apply their understanding of the concepts covered in the first part of the lesson. Students are provided with a scenario of a fitness centre which has received some additional funding to improve hardware used within the business.Students should develop a **proposal** that recommends hardware that will:* + Monitor entry/exit to the fitness centre without staff having to open the door or buzz people through every time a customer arrives
	+ Provide entertainment for customers whilst they are using the gym facilities
 |
| PlenarySuggested time: 10 minutesResources: Slides 36–37general competencies: E6, D3 | Provide opportunities for students to share their **Apply it** activity recommendation to the class and allow students to discuss the feasibility of each proposal. You may be able to draw similarities between students' solutions. Share slide 36 to provide students with some sample answers and to perhaps consider some devices that they did not include in their solution.Share slide 37 to summarise the learning that has taken place during the lesson and present the outline for the next lesson. |

# Lesson 2: Software in computer systems

This lesson introduces the subject of software in computer systems including the features and functions of different types of software with examples. The lesson then progresses onto an Apply it activity that will give students the opportunity to demonstrate their knowledge of communication systems, hardware, peripherals, and software that would be required in real-world scenarios.

## Preparation

|  |  |
| --- | --- |
| Resources provided | Slides Activity sheets:* + A1 Activity sheet – Operating systems in industry
	+ A1 Answer sheet – Operating systems in industry
	+ A2 Activity sheet – Types of software
	+ A2 Answer sheet – Types of software

Computer systems summative assessment questions and answers |
| Equipment needed | Students will require access to computers and the internet for some activities in the lesson. |
| Safety factors | Teachers and students are required to carry out their own risk assessments for the activities in each lesson. You may consider internet access for students in line with appropriate use policies and procedures of the organisation.  |
| Prior learning | Students should have prior experience of using software and may be aware that software falls into different categories.Students may be aware of the role of an operating system and some of the functions it provides. |
| Common misconceptions | A Key Performance Indicator (KPI) may be confused with a general requirement. |
| Accessibility | Seek to ensure wide representation for any visiting speakers and case studies used.Consider students’ potential lack of confidence in participating in the "hot seat" activity. It is worth establishing the core principles of working in a collaborative manner, in a ‘safe space’, at this point in the course. |

## Activity guide

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| Starter activity: Key components of the processor — retrieval practiceSUGGESTED TIME: 5 minutesRESOURCES: Slides 2–4general competencies: E6 | Before the lesson, study the slide deck as a guide to summarise what will be covered in the lesson. Begin the lesson by showing the students descriptions of different processor components on slide 2. Then, ask the question, “**What part of the processor matches each description?**” Students should discuss their answers with a partner. As time progresses, it may be helpful to remind the students of the names of the parts — buses, clock, ALU, registers, and control unit.Then use the animation to reveal the answers and compare these with the answers on the slide.Move on to slide 3 and play the introduction video. Allow a few minutes to discuss the video and the question on the slide. Use slide 4 to introduce the lesson objectives. |
| Activity 1: Operating systemsSuggested time: 20 minutesResources: Slides 5–13A1 Activity sheetA1 Answer sheetgeneral competencies: E4, E5, D1 | Show the students slide 5 and ask the class if they regularly use Microsoft Windows, macOS, Linux, or Android operating systems. You can follow this up with the question, “**What do operating systems do?**” Then, move on to slide 6 to reveal some roles of the operating system. Display slide 7 to show and explain the five main types of operating systems providing an example of each.Use slides 8 to 12 to describe the types of operating systems and give examples. On slide 8, introduce the concept of a payroll system as a computer program that assists companies in paying their employees. You could ask the students if they receive a payslip from part-time work and mention that some payroll systems in the 1960s were processed using a batch operating system, which involved processing data in large batches without user interaction.Progress on to slide 13 and instruct students to open their version of the ‘**A1 Activity sheet** – Operating systems in industry’. This is an opportunity for students to apply their understanding of operating systems to some real-world applications. This activity ends with a study style question, it is important to model here that the answer should relate back to the scenario in the question. If it helps you could share the answer provided on the answer sheet to demonstrate this. |
| Activity 2: Types of softwareSuggested time: 20 minutesResources: Slides 14–19A2 Activity sheetA2 Answer sheetgeneral competencies: E2, E4, D3 | Show slide 14 and play the video. Allow a few minutes to discuss the video and the question on the slide. Using slide 15, introduce the concept that you can categorise software into the following types: utility software, application software, and integrated development environments (IDEs).Use slides 16 to 18 to go into more detail about each type of software. On slide 17, you could ask the students to match the generic names of the examples of application software to the icons shown in the image, for example, “word processor” to “Microsoft Word”.Slide 18 introduces IDEs. Ask the students what IDE they use, and if useful, you could ask the students to look at other IDEs that are available but that they may not use, for example:* + Mu
	+ PyScripter
	+ Thonny
	+ Microsoft Visual Studio
	+ Eclipse
	+ PyCharm

If useful for your students, you could discuss the following: * + **Source code editor:** Allows developers to write and edit code in various programming languages with syntax highlighting and autocomplete to make coding easier.
	+ **Debugger:** Helps developers find and fix errors in their code by providing a step-by-step execution of the code, allowing them to track variables and values, and providing other tools to debug the code.
	+ **Compiler:** Translates the code written in a high-level programming language into machine code that can be executed by a computer.
	+ **Assembler:** Translates the assembly language code into machine code that can be executed by the computer’s CPU.

Move on to slide 19 and instruct students to open their version of the ‘**A2 Activity sheet** – Types of software’. You could ask students to work in pairs for this activity and use the answer sheet to provide some examples. |
| Retrieval activity: Hot seatSuggested time: 20 minutesResources: Slide 20general competencies: E6, D3 | Introduce the activity on slide 20.1. Instruct the students to create two questions that are based on this lesson
2. Ask for one volunteer to sit in the ‘hot seat’ at the front of the class
3. Randomly choose a student to ask their question to the person in the hot seat
4. If the person in the hot seat cannot answer the question, they can ask someone else in the class
5. The person who asked the question becomes the person in the hot seat
6. Repeat as many times as you feel is appropriate

To facilitate this activity, you may want to create additional questions. If you feel the question that the student asks are too hard or too easy, you may want to adapt the student’s question before the person in the hot seat answers it. |
| Apply It activitySuggested time: 25 minutesResources: Slide 21general competencies: E1, E3, E4, E6, M5, D3 | This activity has been created to assess the students’ knowledge of Lesson 1 and 2. Students are provided with a scenario of a grocery delivery company and a fast food delivery company. Students should work in groups and choose/be allocated one of the businesses to focus on. Students should identify the hardware and software requirements that the business would need to meet in order to provide an effective service. **Note**: You may want to discuss that a list of requirements is often referred to as KPIs which are covered in more detail in the occupational specialism. You may also want to give students an example from the sample answers to help them generate their own lists. |
| PlenarySuggested time: 10 minutesResources: Slides 22–23Computer systems summative assessment questions and answersgeneral competencies: E6, D3 | Provide opportunities for students to share their lists of requirements with the class. You may be able to draw similarities between students’ solutions.Share slide 22 to provide students with some sample answers and to perhaps consider some requirements that they did not include in their lists.Share slide 23 to summarise the learning that has taken place during the lesson and share the outline for the next lesson. Students could now be assigned the summative assessment questions on computer systems to check progress. |

# Lesson 3: Memory and storage

This lesson focuses on the need for persistent storage of data. In Lessons 1 and 2, students have developed their knowledge of physical computer systems and have explored the typical hardware and software that make up these systems. In Lesson 1, students were introduced to the concept of memory in the wider context of the general model of a computer system. In this lesson, students will deepen their understanding of the different types of memory, their uses, and the requirement for backup and data recovery.

## Preparation

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| Resources provided | Slides Activity sheets:* + A1 Activity sheet – RAM or ROM
	+ A1 Answer sheet – RAM or ROM
	+ A3 Activity sheet – RAID
	+ A3 Answer sheet – RAID

Memory and storage summative assessment questions and answers |
| Equipment needed | Students may require access to computers for some activities in the lesson. |
| Safety factors | Teachers and students are required to carry out their own risk assessments for the activities in each lesson.  |
| Prior learning | Students should have prior experience of saving and retrieving work on a computer system. Students may know the uses of main memory and secondary storage and may be able to recall some of the characteristics of storage devices.Students should have an understanding of how storage fits into the IPOS model from Lesson 1. |
| Common misconceptions | Students may not be aware that most Network Attached Storage (NAS) typically use RAID to backup data so the two are interlinked. |
| Accessibility | Seek to ensure wide representation for any visiting speakers and case studies used.Consider students' potential lack of experience in approaching and answering study style questions. It is worth discussing exam key terminology and command words at this point of the course. |

## Activity guide

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| Starter activity: What do we do with data?SUGGESTED TIME: 5 minutesRESOURCES: Slides 2–5general competencies: E6 | Before the lesson, study the slide deck as a guide to summarise what will be covered in the lesson.Display slide 2 and give students enough time to attempt the study question.This is a retrieval activity based on the content covered in Lesson 2. Use the animation to share sample answers and discuss these with students.Use slide 3 to introduce the lesson objectives.Show students the introduction video on slide 4. Then ask the question, “**Why do we need to store data?**”Display slide 5 and ask students to consider the questions on the slide relating to the data their college or school keeps. You may wish to get students to discuss these questions in small groups or pairs and then share their ideas with the rest of the group. It is important to address the issues relating to the collection of data and storage here, such as relevant legislation and confidentiality. |
| Activity 1: Main memorySuggested time: 10 minutesResources: Slides 6–9A1 Activity sheetA1 Answer sheetgeneral competencies: E2, E4, D2 | Slide 6 introduces the two main types of main memory. It is important to highlight to students here that main memory is directly accessed by the processor. Slide 7 explores the uses of RAM and ROM. It is important to emphasise the point that, for any program to be executed, it must first be loaded into RAM. Instruct students to open their version of the ‘**A1 Activity sheet** – RAM or ROM’. Students should put the statements provided into the correct side of the table. You could get students to do this in pairs. There is then a study question for students to attempt. Share the answers from ‘**A1 Answer sheet** – RAM or ROM’ with students and get them to make any necessary corrections.Slide 9 introduces the term ‘**cache**’ to students. Illustrate the fact that cache is used to access frequently used data. |
| Activity 2: Main memory isn’t enoughSuggested time: 15 minutesResources: Slides 10–17general competencies: E6 | Slide 10 introduces the concept that main memory is not designed to be a permanent storage option, and secondary storage is required if data is to be stored persistently.Slide 11 discusses secondary storage as a term that applies to a wide range of devices that provide persistent storage for data files and applications. Secondary storage is non-volatile, meaning that data is not lost when power is removed. Secondary storage can be categorised as:* + Solid state
	+ Optical
	+ Magnetic

Slides 12–14 explain each of these categories in more detail. You may want to introduce some examples here:* + **Solid state:** SSDs, USB/flash memory sticks, SD cards
	+ **Optical:** CDs, DVDs
	+ **Magnetic:** HDDs, magnetic tape

Display slide 15 to students and give them a few moments to decide which device fits into which category. Use the animation to reveal the answers.You may want to ask students if any of them have a device that has an optical disk drive and discuss the fact that this technology is becoming largely redundant.Slide 16 is an ‘industry spotlight’ which focuses on the data used and required by an impact analyst. Students are asked to consider the same questions they considered in the starter activity. Slide 17 introduces the term ‘**cloud storage**’. It is important to highlight to the students the shift in using cloud storage as secondary storage. You could ask them when was the last time they purchased some music or a film on a CD or DVD to illustrate this point. Students will explore cloud storage further in Lessons 8 and 9. |
| Activity 3: Physical storage and recovery systems Suggested time: 20 minutesResources: Slides 18–24A3 Activity sheetA3 Answer sheetgeneral competencies: E2, E4, M6 | Share slide 18 to introduce Network Attached Storage (NAS):* + **NAS** is a data storage device that connects to and is accessed through a network, instead of connecting directly to a computer like an external hard drive. The NAS can be configured so that it can also be accessed remotely by authorised users via a web client. NAS is typically used for home or small- to medium-sized businesses. NAS has a single point of failure, meaning if the device fails or access to the device fails, then no other devices will be able to access the data. NAS is often used in conjunction with RAID, so it may be useful to discuss this link with students.

Share slide 19 to introduce Storage Area Networks (SAN):* + **SAN** is a network of interconnected storage devices — meaning it is a dedicated network for storage. As data is usually mirrored across devices if one device fails, then data can still be accessed. SAN is a high-speed network because all devices are interconnected using fibre channel (using fibre optics). SANs are not affected by regular network traffic, as they are partitioned off from the rest of the LAN. SANs are expensive and complex to maintain and are typically used by large businesses or organisations.

Slide 20 introduces the fact that storage devices can degrade over time and can fail. It is important for organisations to protect data by using data backup and recovery systems.Instruct students to upload their version of the ‘**A3 Activity sheet** – RAID’. They will need to use the activity sheet to make notes as you share slides 21–24 with them. As an alternative you may want to print out slides 22–24 and students could make notes as a guided discovery activity. Introduce the term ‘Redundant Array of Independent Disks (RAID)’ and explain how these systems work by having multiple hard drives grouped together. It is important to introduce some key terminology here:* + **Redundancy** – having duplicate copies of data means that if one drive fails the data still exists somewhere else
	+ **Read performance** – the time taken to read data from storage
	+ **Write performance** – the time take to write data to storage

Share slides 22–24 to explain the differences between RAID 1, RAID 5, and RAID 10:* + **RAID 1** – a minimum of two disks with a direct copy on each one - this is known as **mirroring**
	+ **RAID 5** – a minimum of three disks required. You will need to introduce the terms:
		- **Parity** – extra data that is calculated and stored alongside the data the user wants to write. This extra data is then used to check if data has been lost or corrupted when it is moved from one location to another.
		- **Striping** – the process of breaking data down into smaller segments and then writing the data across all of the drives available. This speeds up access time as multiple disks work together to read and write data.
	+ **RAID 10** – a minimum of 4 disks required, basically two RAID 1 systems striped across 4 disks

You may want to give students some additional time here to finish making notes on the RAID systems or to extend their notes by conducting some independent research. |
| Retrieval activitySuggested time: 5 minutesResources: Slide 25 | Use the retrieval questions on slide 25 to check understanding with students and use this as a discussion point to explore any misconceptions and ensure that every student has identified the correct answers. |
| Apply it activitySuggested time: 25 minutesResources: Slide 26general competencies: E1, E2, E6, D3 | This is the point of the lesson where students can apply their understanding of the concepts covered in the first part of the lesson. Students are provided with a scenario of a GP surgery that holds lots of sensitive, personal data that needs to be stored correctly. Students could consider:* + Which backup/recovery system would be most appropriate for the scenario?
	+ What would the cost implications be?
	+ Would the proposed solution need any specialised skills or hardware?
	+ What would be the benefits and drawbacks of the proposed solution?

Students should be prepared to share their recommendations verbally to the rest of the group and could add justification for their recommendations if appropriate. |
| PlenarySuggested time: 10 minutesResources: Slides 27–28Memory and storage summative assessment questions and answersgeneral competencies: E6, D3 | Allow students the opportunity to explain their choices for the Apply it activity to the rest of class and provide a discussion point for altering opinions or to draw similarities between students' solutions.Share slide 27 to provide students with some sample responses to the Apply it activity and to perhaps consider some devices that they did not include in their solution.Share slide 28 to summarise the learning that has taken place during the lesson and share the outline for the next lesson.Students could now be set the Memory and storage summative assessment questions to check their learning and progress made. |

# Lesson 4: Networks

This lesson introduces students to what a network is and why networks are used. Prior to this lesson, students have discovered what a computer system is and common hardware components and types of software used within these systems in earlier lessons in this teaching sequence. In this lesson, students will develop their understanding of how computer systems can be connected together, by exploring different network types. They will also learn about the different types of transmission media and network topologies that can be used to implement a network.

## Preparation

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| Resources provided | SlidesActivity sheets:* + A1 Activity sheet – Advantages and limitations of transmission media
	+ A1 Answer sheet – Advantages and limitations of transmission media
	+ A2 Activity sheet – Network types and models
	+ A2 Answer sheet – Network types and models
	+ A3 Activity sheet – Topologies
	+ A3 Answer sheet – Topologies
 |
| Equipment needed | Students may require access to computers for some activities in the lesson. |
| Safety factors | Teachers and students are required to carry out their own risk assessments for the activities in each lesson. |
| Prior learning | Students should have experience of using networks. For example, logging into school or college-based networks and using WiFi networks at home or elsewhere.Students may have an understanding that networks can be set up in different ways. |
| Common misconceptions | Students may confuse a physical and logical topology. Use slide 19 to explain the difference. |
| Accessibility | Seek to ensure wide representation for any visiting speakers and case studies used.Consider students' potential lack of experience in drawing network diagrams for the "Apply it" activity. It may be worth modelling what these diagrams look like at this point of the course depending on the needs of your students. |

## Activity guide

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| Starter activity: Secondary storage — retrieval activitySUGGESTED TIME: 10 minutesRESOURCES: Slides 2–8general competencies: E6, D3 | Before the lesson, study the slide deck as a guide to summarise what will be covered in the lesson. Display slide 2 and ask students to complete the retrieval activity. This is linked to the research activity on secondary storage completed in Lesson 3. To reveal the answers, click through the animations on the slide.Use slide 3 to introduce the lesson objectives.Play the video on slide 4 to introduce the topic of the lesson, networks. Allow a few minutes to discuss the video and the question on the slide.**What is a network?**Display slide 5 and ask students to discuss the question “**What is a network?**” with a partner. Students may think of some suggestions, such as:* + A group of people who come together to communicate or share information
	+ Social networks or social media platforms
	+ Connected computers that share resources

Use the animation to share the definition of a network with students.Slide 6 introduces some different types of communication systems to students. The important thing to stress here is that all of the systems require a network. Networks make communication and sharing information possible.Slides 7 and 8 are optional slides which introduce students to a networking case study. If these are used, you may need to allocate more time for this part of the lesson. Students are presented with the fact that networks and the infrastructure required for networks are not available in all locations. Students should be given the opportunity to discuss the scenario and some possible solutions. Slide 8 shares the real-world solution that was implemented in this scenario. |
| Activity 1: Why use a network?Suggested time: 15 minutesResources: Slides 9–15A1 Activity sheetA1 Answer sheetgeneral competencies: E5, E6, D2 | Use slides 9 and 10 to list some advantages and disadvantages of networks and introduce the concept of comparing the costs and benefits.Use slides 11 to 12 to introduce the term ‘transmission media’ to students.* + Wired transmission media are physical cables that connect devices (Ethernet, fibre-optic)
	+ Wireless transmission media send signals through the air using electromagnetic waves (Wi-Fi, Bluetooth)

Show slide 13 and ask students to reflect on examples of **wired** and **wireless** networks that they have seen or used in their day-to-day lives. Use the animation to share some examples with students once they have had some time to consider.Move on to slide 14 to introduce the concept that lots of networks include a combination of wired and wireless transmission media.Show slide 15 and instruct students to open their version of the ‘**A1 Activity sheet** – Advantages and limitations of transmission media’. Students should read through the description, advantages, and limitations of each transmission medium and then use this information to recommend the type of transmission medium that is the most suitable for each scenario. This activity includes an explorer task where students can explore a justification for each of the different scenarios. Give them 5 minutes to do this with suggestions provided below: * + **The chef goes live:** Bluetooth, as the chef needs to move freely with the headset
	+ **A local coffee shop:** Wi-Fi, to allow customers to have free access to the internet using their mobile devices
	+ **The online gamer:** Bluetooth, as the gamer wants to change positions frequently
	+ **Print on demand:** Wi-Fi, as the house owner does not want to install any new wiring in the building
	+ **The TV studio:** Fibre-optic cable, as they need to be able to send large files at high speeds
	+ **The bakery:** Copper cable, as they have a minimal budget and need a stable connection
 |
| Activity 2: Types of networkSuggested time: 15 minutesResources: Slides 16–17A2 Activity sheetA2 Answer sheetgeneral competencies: E1, E2, E4, E5 | Use slide 16 to introduce that networks can be created in different ways. Common network types include:* + Local area network (LAN/WLAN)
	+ Wide area network (WAN/WWAN)
	+ Personal area network (PAN/WPAN)

A network model describes the architecture of the network. Common models include:* + **Client–server model** — Dedicated servers fulfil the requests of one or more clients. It might be worth mentioning here that you may have specific servers for specific purposes; for example, a web server would take requests for webpages and then return those webpages. Lesson 5 goes into more detail about specific servers.
	+ **Peer-to-peer model** — Each device can be configured to share its resources such as processing power or internet bandwidth.
	+ **Thin client model** — Each device has limited main memory and processing capability. Application servers attached to the network perform most of the data processing.

Show slide 17. Students should use the ‘**A2 Activity sheet** – Network types and models’ and conduct some guided study to discover more about the different network types and models. They are then introduced to a scenario where they research the effects of **latency** and **bandwidth** on a network. Students should show an understanding that: * + **Latency** is the delay between the time a signal is transmitted and the time a signal is received
	+ **Bandwidth** is the theoretical maximum amount of data that a communication channel can carry at one time
 |
| Activity 3: Network topologiesSuggested time: 10 minutesResources: Slides 18–28A3 Activity sheetA3 Answer sheetgeneral competencies: E5, E6, D2 | Use slides 18 to 20 to introduce the term ‘topologies’ to students and explain that graphs are sometimes used to represent the arrangement of network components. Some key terminology is introduced over the first few slides in this activity:* + **Node** — a component on the network.
	+ **Edges** — these show how components are connected together.
	+ **Hub or switch** — a central device on a network that transfers data between nodes. A hub will broadcast data to all nodes, whereas a switch will only transfer data to the required location.

Slides 21 to 26 illustrate how the star, mesh, and tree topologies are arranged and how data is transmitted across these networks. **Note:** Several slides include animated GIFs. These animations may only play in presentation mode.Move on to slide 27 to introduce the concept of a **virtual local area network (VLAN**). Students should understand that this is a logical implementation of a network rather than a physical implementation like the topologies they have just seen. A VLAN is a logical overlay of a network that is used to split a large LAN into smaller LANs or segments.Show slide 28 and instruct students to open their version of the ‘**A3 Activity sheet** – Topologies’. Students should research the advantages and limitations of each topology and then use this information to recommend the type of topology that is the most suitable for each scenario. |
| Retrieval activitySuggested time: 5 minutesResources: Slide 29 | Use the retrieval question on slide 29 to check understanding with students. The retrieval activity is also a discussion point to explore any misconceptions and ensure that every student has identified the correct answers.  |
| Apply it activitySuggested time: 25 minutesResources: Slide 30general competencies: E1, E2, E3, E4, E6 | This is the point of the lesson where students could apply their understanding of the concepts covered in the first part of the lesson. Students are provided with a scenario of an independent coffee retailer which has four branches. Students should: * + Carry out **research** into computerised tills and produce a summary of the features and benefits of suitable devices.
	+ Produce a simple network diagram for either a single coffee shop or the whole business.
 |
| PlenarySuggested time: 10 minutesResources: Slides 31–34general competencies: D3 | Provide opportunities for students to share their recommendation for the Apply it activity to the class and allow students to discuss the feasibility of each proposal. You may be able to draw similarities between students’ solutions.Share slides 31 to 33 to provide students with some sample responses to the Apply it activity and to perhaps consider some network solutions they did not consider for their answer. Share slide 34 to summarise the learning that has taken place during the lesson and share the outline for the next lesson.  |

# Lesson 5: Communication over networks

In Lesson 4, students were introduced to why networks are used and some common network topologies. This lesson explores how communication takes place over a network. Students will be introduced to common network components and apply this knowledge by specifying network components for given scenarios. They will explore the role of different servers and be introduced to the term ‘protocol’ researching some common protocols used in networking. They will also learn about IP addresses and how packet switching is used to send data across a network such as the internet.

## Preparation

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| Resources provided | Slides Activity sheets:* + A1 Activity sheet – Selecting hardware for a network
	+ A1 Answer sheet – Selecting hardware for a network
	+ A2 Activity sheet – Types of servers and their purpose
	+ A2 Answer sheet – Types of servers and their purpose
	+ A3 Activity sheet – Protocols
	+ A3 Answer sheet – Protocols
	+ A4 Activity sheet – Traceroute
 |
| Equipment needed | Students will require access to computers and the internet for some activities in the lesson. It would be beneficial if students also had access to command prompt for the Traceroute activity. |
| Safety factors | Teachers and students are required to carry out their own risk assessments for the activities in each lesson. You may consider internet access for students in line with appropriate use policies and procedures of the organisation. |
| Prior learning | Students should have prior understanding of the structure of networks from Lesson 4.Students may have prior knowledge of network devices, for example they may connect to the internet at home using a home hub or router.Students may understand that data is split into packets before being transmitted across a network. |
| Common misconceptions | Students may assume that all packets are the same. It is important to explain to them that the structure of a packet and its contents will change depending on the protocol being used. |
| Accessibility | Seek to ensure wide representation for any visiting speakers and case studies used.Consider students' potential lack of confidence in naming and knowing the uses of network hardware when approaching Activity 1. Students could be split into groups for this activity and activities could be allocated to students based on previous experience and knowledge. |

## Activity guide

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| Starter activity: Network models – retrieval activitySUGGESTED TIME: 5 minutesRESOURCES: Slides 2–4 | Before the lesson, study the slide deck as a guide to summarise what will be covered in the lesson.Display slide 2 and ask students to correctly name the network models that the diagrams represent. Use the animation to reveal the correct answers.Display slide 3 and pose the question to students, “**What do we need to consider when networking devices together?**” Give students time to discuss and share responses. Use the animation to reveal some answers. **Note:** The answers in bold will be covered in this lesson.Use slide 4 to introduce the lesson objectives. |
| Activity 1: Common network componentsSuggested time: 15 minutesResources: Slides 5–6A1 Activity sheetA1 Answer sheetgeneral competencies: D2, D3 | Use slide 5 to introduce some common network components to students. Take time to explain the role and purpose of each device. It is worth highlighting:* + The difference between a **hub** and a **switch**
	+ The fact that a network could have more than one server

Display slide 6 and instruct students to open their version of the ‘**A1 Activity sheet** – Selecting hardware for a network’. Students need to read through the scenarios for each network and then select the most appropriate components to complete the diagrams. You may want to divide up the scenarios amongst students in the class or allow students to complete this activity in pairs. Allow students 10 minutes for this task and then share the answers using the ‘**A1 Answer sheet** – Selecting hardware for a network’. Students should make any corrections required on their activity sheet. |
| Activity 2: ServersSuggested time: 20 minutesResources: Slides 7–9A2 Activity sheetA2 Answer sheetgeneral competencies: E2, E4 | Show students the video on slide 7, which introduces what a server is and some common types of servers. Ensure students have understood:* + A **server** is a computer on a network that provides a resource that can be used by any authorised client station. In the client–server model, servers are responsible for authorisation, and can grant or deny any request they get. Whilst they should not reject every request, it is important to understand that requests must be authorised.
	+ A **client** is a computer or computer-controlled device that is typically used by an end user. Clients are user-facing computers that run software to make requests to servers and interpret or display the responses. A client cannot force a server to respond to a request.

Display slide 8 and instruct students to open their version of the ‘**A2 Activity sheet** – Types of servers and their purpose’. Students should match the servers to the descriptions provided on the activity sheet. This could be an activity that students complete in pairs or small groups if you feel this is appropriate. This activity includes an explorer task where students can explore the use of servers in organisations. Give them 10 minutes to do this and then use slide 9 to share the correct answers.  |
| Activity 3: ProtocolsSuggested time: 20 minutesResources: Slides 10–16A3 Activity sheetA3 Answer sheetgeneral competencies: E2, E4, E5 | Display slide 10 and ask students, “**Can you think of any rules for communication that we use in our daily lives?**” Give them time to consider different types of communication and rules that may be in place for that type of communication. You could also explore what would happen if we did not have rules for communication. Use slides 11 and 12 to share some example responses.Use slide 13 to introduce the term ‘protocol’ to students and link this to the fact that computers also need to have rules for communication. Move on to slide 14 to introduce some commonly used protocols, which students will look at in more detail over the next few slides. Play the video on slide 15, which goes into more detail about what a protocol is and explains some features of protocols. Layers are introduced here but will be explored in more depth in Lesson 6.Display slide 16 and instruct students to open their version of the ‘**A3 Activity sheet** – Protocols’. Students should conduct some guided study to discover the role and purpose of each common protocol. You may wish to get students to work in pairs for this activity or ask students to each focus on one particular protocol and then share their research with the rest of the group to disseminate the information. Students could use <https://adacomputerscience.org/concepts/network_protocols> as a source of information for their research as an example. * + **DHCP** — used to assign IP addresses to devices on a network
	+ **DNS** — used to look up domain names and return corresponding IP addresses
	+ **HTTP** — used to transfer webpages across the internet
	+ **HTTPS** — a secure version of HTTP that uses encryption to protect the data that is transmitted
	+ **FTP** — used to move files between two devices
	+ **NTP** — used to synchronise clock time sources in a network
	+ **POP/IMAP/SMTP** — email protocols
	+ **TCP/IP** — a suite of communication protocols that allows computers to communicate over a network

The activity sheet also contains an explorer task which can be used to further develop students’ understanding. Students are given an industry-based scenario and have to recommend the most appropriate protocol for the needs of the user.  |
| Retrieval activitySuggested time: 5 minutesResources: Slide 17general competencies: E6 | Use the retrieval activity to check understanding of protocols with students. This takes a specific example of a webpage request and the protocols that are used at each stage. Students could provide their responses verbally for this activity.  |
| Activity 4: Packets and IP addressesSuggested time: 15 minutesResources: Slides 18–23A4 Activity sheetgeneral competencies: D1, D6 | Use slide 18 to explain the purpose and structure of an IP address. Examples of both an IPv4 address and an IPv6 address are provided on the slide. Move on to slide 19 to define the term ‘packet’ for students and explain that data is broken down into smaller sections. Show slide 20 to illustrate the typical contents of a packet. Some concepts to highlight include:* + **Packet number/sequence number** — allows the packets to be reconstructed at the destination
	+ **Checksum** — used to check the packet for errors during transmission
	+ **Payload** — the actual data that is being sent
	+ **Trailer/footer**— marks the end of the packet
	+ **CRC** (cyclic redundancy check) — a mathematical algorithm used to generate a unique checksum that is used to verify the integrity and accuracy of the data sent

It is worth discussing here that not all packets contain the same information; it depends on the type of packet.Use slides 21 and 22 to show how a packet is split and sent across a network. **Note:** Slide 22 contains an animated GIF, which may only play in presentation mode. Display slide 23 and instruct students to open their version of the ‘A4 Activity sheet – Traceroute’. This is a practical activity where students use Traceroute to investigate the number of ‘hops’ taken to reach a particular domain. **Note:** students will require access to the terminal for this activity.  |
| Retrieval activitySuggested time: 5 minutesResources: Slide 24general competencies: E6 | Use the retrieval questions on slide 24 to check understanding with students. The retrieval activity is also a discussion point to explore any misconceptions and ensure that every student has identified the correct answers. |
| PlenarySuggested time: 5 minutesResources: Slide 25 | Share slide 25 to summarise the learning that has taken place during the lesson and present the outline for the next lesson.  |

# Lesson 6: Communication over networks

In Lesson 5, students were introduced to hardware components, the role of a protocol, and some common protocols used in networking. In this lesson, students will explore the OSI and TCP/IP network models and learn what happens at each layer. They will link back to their understanding of common protocols by identifying which layer each of these protocols operates at. Students will then have the opportunity to demonstrate their understanding through the Apply it activity.

## Preparation

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| Resources provided | Slides Activity sheets* + A1 Information sheet – A HTTP request
	+ A1 Activity sheet – Networking models
	+ A1 Answer sheet – Networking models

Networks summative assessment questions and answers |
| Equipment needed | Students may require access to computers for some activities in the lesson. |
| Safety factors | Teachers and students are required to carry out their own risk assessments for the activities in each lesson. |
| Prior learning | Students should have prior understanding of protocols and know some common networking protocols from Lesson 5.Students should understand how data is split into packets from Lesson 5. |
| Common misconceptions | Students need to be aware that each different type of application uses one or more different protocols. Students may assume an unreliable protocol does not work; however, it means that the protocol does not guarantee that it will work. |
| Accessibility | Seek to ensure wide representation for any visiting speakers and case studies used.Consider students' potential lack of experience in approaching and answering study style questions. It is worth re visiting exam key terminology and command words at this point of the course if mentioned earlier in the programme.Activity 1 can be delivered in two different ways depending on which method would be most suitable for students (please see activity guide for details). |

## Activity guide

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| Starter activity: Network hardware components – retrieval activitySUGGESTED TIME: 5 minutesRESOURCES: Slides 2–3 | Before the lesson, study the slide deck as a guide to summarise what will be covered in the lesson. Display slide 2 and ask students to consider the study question. You may want students to work in pairs or small groups to discuss their answer before sharing back with the group.Use the animation to share a sample answer. It is important here to highlight the difference between a switch and a hub to check students’ understanding from Lesson 5. Use slide 3 to introduce the lesson objectives. |
| Activity 1: The OSI network modelSuggested time: 30 minutesResources: Slides 4–24 (slide 10–20 are optional, see notes)A1 Information sheetA1 Activity sheetA1 Answer sheetgeneral competencies: E2, E4 | Show the video on slide 4 to introduce the concept of how communication takes place over the internet. Slide 5 recaps the term ‘**protocol**’, which students were introduced to in the previous lesson. Slide 6 introduces that these protocols are organised into a **protocol stack**.Use slide 7 to introduce the OSI seven-layer network model. It is important to illustrate the arrows on the diagram to explain that communication can travel up and down the protocol stack.Slide 8 introduces the TCP/IP network model. Use this slide to illustrate how some of the layers of the OSI model have been condensed. Slide 9 explains that as communication happens, the data moves down the model with additional data added at each layer (**encapsulation**). At the receiving end, data is removed (**decapsulation**) as it moves up the stack. **Note: There are two potential options to deliver content for the next part of this activity:*** + 1. You may choose to deliver the content on slides 10-20 as a presentation which shows a step-by-step process of a HTTP request going through each layer and discussing some common protocols that take place at each layer.
	+ 2.You may choose the information on slides 10-20 to be presented in a worksheet. If this is the case please use the ‘**A1 Information sheet** – A HTTP request’, which you could ask students to read through independently for guided study.

Instruct students to open their version of the ‘**A1 Activity sheet** – Networking models’ which requires students to identify the layer from the description provided and then provides an explorer activity for students to further their understanding of the role of specific layers within the TCP/IP model. Slides 22 and 23 can be used to share sample answers with students. Slide 24 is an ‘industry spotlight’ and asks students to consider what types of networks a remote worker would use, and which protocols this would involve. Give students time to discuss and share their responses to these questions. |
| Retrieval activitySuggested time: 5 minutesResources: Slide 25 | Use slide 25 as a retrieval activity to check students are familiar with common protocols and the layers at which they operate.* + **Application:** HTTP, FTP, DHCP
	+ **Transport:** TCP, UDP
	+ **Network:** IP, ARP
	+ **Data link:** Wi-Fi, Ethernet

Use the animation to reveal and share the answers with students.  |
| Activity 2: Comparing network modelsSuggested time: 15 minutesResources: Slides 26–28general competencies: E5, E6, D3 | Show the video on slide 26 that introduces the concept of reliable and unreliable protocols to students. Display slide 27 and ask students to pair up or work in small groups. Pose the questions on the slide:* + **Describe** the layers of each model and the protocols that operate at each layer.
	+ Discuss the **similarities** and **differences** between the two models.

Students should work together to ensure they can recall the layers of each model and some protocols that operate at each layer. Students should then be able to explain the similarities and differences between the two models. Give them 10 minutes to do this.Encourage students to share their answers and then use slide 28 to share a sample answer. Discuss if this matches the answers they provided. |
| Retrieval activitySuggested time: 5 minutesResources: Slide 29 | Use slide 29 as a retrieval activity to check students are familiar with the order of layers within the OSI model. You may wish to do this as a mini-whiteboard activity where students all write down the name of the layer they think is missing. Use the animation on the slide to reveal the answers. |
| Apply it activitySuggested time: 20 minutesResources: Slide 30general competencies: E1, E2, D2, D3 | This is the point in the lesson where students can apply their understanding of the concepts covered in the first part of the lesson. Students are introduced to the scenario of a web-based business that wants to move their online sales from third party retail sites to their own retail website. Students should explore and research which protocols would be most suitable for the online store. Students should include a rationale for their choices and explain the benefits to the organisation of each. You could extend this activity by asking students to consider a larger organisation and whether or not they would use similar protocols to the web-based business. |
| PlenarySuggested time: 10 minutesResources: Slides 30–31Networks summative assessment questions and answers | Ask students to share some responses/work they have developed for the Apply it activity and then use slide 31 to support any gaps in responses.Share slide 32 to summarise the learning that has taken place during the lesson and present the outline for the next lesson. Students could now be set the Networks summative assessment questions to check learning and progress made. |

# Lesson 7: Virtual environments

In Lesson 6, students were introduced to the OSI and TCP/IP network models and what happens at each layer of the protocol stacks. In this lesson, students will discover how virtual machines and virtual environments can be created, and the advantages and disadvantages of this approach. Students will then have the opportunity to demonstrate their understanding through the Apply it activity.

## Preparation

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| Resources provided | Slides Activity sheets:* + A1 Activity sheet – Virtual machines
	+ A2 Activity sheet – Server virtualisation
	+ A3 Activity sheet – Virtual development environments
 |
| Equipment needed | Students will require access to computers and the internet for some activities in the lesson. If possible, access to standalone machines may be beneficial for students to set up their own virtual environment on as supplementary learning. There are instructions and further details provided in the activity guide for how to do this in Activities 1 and 3. |
| Safety factors | Teachers and students are required to carry out their own risk assessments for the activities in each lesson. You may consider internet access for students in line with appropriate use policies and procedures of the organisation.If students are going to set up a virtual environment it should be on a standalone computer which is not connected to the provider’s network. |
| Prior learning | Students should have prior understanding of physical networks from Lessons 5 and 6.Students should have prior knowledge of how communication happens over networks and what happens at each layer of the TCP/IP model.Students may have prior experience of using virtual networks to connect to provider’s intranets. |
| Common misconceptions | Students may not have been introduced to the concepts of virtualisation, emulation and aggregation and may need guidance to articulate the difference between these. |
| Accessibility | Seek to ensure wide representation for any visiting speakers and case studies used.Consider students' potential lack of experience with setting up virtual machines in the practical activity. It is recommended students work in pairs for these practical tasks and may initially need more support with this. |

## Activity guide

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| Starter activity: Communication over networks – retrieval activitySUGGESTED TIME: 5 minutesRESOURCES: Slides 2–4 | Before the lesson, study the slide deck as a guide to summarise what will be covered in the lesson.Show slide 2 and ask students to match the protocols with the layers that were covered in Lesson 6. Use slide 3 to reveal the correct answers and correct any misconceptions or gaps in learning.Use slide 4 to introduce the lesson objectives. |
| Activity 1: Virtual machinesSuggested time: 25 minutesResources: Slides 5–10A1 Activity sheetgeneral competencies: E4, E5, D1 | Show slide 5 to remind students that they will generally use a physical machine and that will typically have an operating system, main memory, and secondary storage (all covered in previous lessons in this teaching sequence).Show slide 6 and instruct students to open their version of ‘**A1 Activity sheet** – Virtual machines’ and fill in **Part A** which requires them to investigate and record the attributes of the system they are currently using. In Windows, this can be found by using **Windows>System Information**. Ask the students for their responses to the last two bullet points: * + What other operating systems are you aware of?
	+ Why might you want to use a different operating system?

Show slide 7 to introduce the concept of virtual machines. This explores the concept that you do not need a physical machine to install more than one operating system. VirtualBox is a free, open-source virtualisation software developed by Oracle Corporation. It allows you to create and run virtual machines (VMs) on your computer. A Type 2 hypervisor runs on top of a host operating system. It enables the creation and management of virtual machines (VMs) on a host machine that already has an operating system installed.Show slide 8 and instruct students to open their version of ‘**A1 Activity sheet** – Virtual machines’ and fill in **Part B**. This activity asks them to look at the documentation for VirtualBox. You will need to make sure students can access information about this product on the web and you could pick an alternative product if you wish. Students could also work in pairs to configure a real virtual machine if they have the appropriate equipment such as a standalone device.Show slide 9 to introduce emulators. Make sure students understand that an emulator is emulating a different hardware platform in order to run software that will only run on that platform and is not the same as a virtual machine. Show slide 10 and instruct students to open their version of ‘**A1 Activity sheet** – Virtual machines’ and fill in **Part C**. Ask students to share their research and findings with the rest of the class. Some of them may have had experience of using emulators for gaming as an example. |
| Activity 2: Server virtualisationSuggested time: 15 minutesResources: Slides 11–14A2 Activity sheetgeneral competencies: E4, E5 | Show slide 11 and introduce an alternative ‘type-1’ hypervisor that is used to create a set of virtual servers. Show slide 12 to explain that the virtual server is created as a “VM image” which includes the operating system, configuration settings, and files. Such images are considered to be a single file by the operating system, so they can be readily backed up or redeployed to a different physical machine. Encourage students to think of the benefits of having multiple servers on one large computer system. Drawbacks could include the server being a single point of failure.Show slide 13 to introduce Activity 2. Instruct students to open their version of ‘**A2 Activity sheet** – Server virtualisation’. Students should use the website suggested for some guided study to explore situations in which real businesses have benefited from using virtual servers. When they have completed their own research, allow enough time for them to share their findings with the rest of the class. You could ask students to contribute to a shared slide deck to capture their research or to make a poster that could be displayed. Slide 14 concludes this section with an overview of server **aggregation** and their use in processing Big Data. You could use this as an opportunity to discuss Big Data and encourage students to think of the many different varieties of data, and the volume and velocity at which it is produced. Students will explore more about the use of data in organisations in Lesson 9. |
| Activity 3: Virtual development environmentsSuggested time: 20 minutesResources: Slides 15–18A3 Activity sheetgeneral competencies: D6 | Show slide 15. This is another part of the lesson that may benefit from some practical work where students could set up an environment on a standalone computer system. This site provides a clear guide that can be followed by students: <https://realpython.com/python-virtual-environments-a-primer/>. If there are issues with permissions on the provider’s network the exercise could be carried out on a standalone machine if one is available. Slide 16 is an optional slide that you could share with students. It is a video story of Cian, a Software Engineer who found a love for coding by attending a CoderDojo club. Pose the question, “**What encouraged Cian to become a software engineer?** **What skills do you think he has had to develop?**” to students.Show slide 17 to introduce the Java VM. If the students are not yet familiar with compilers and interpreters, you should give them an overview first before talking about the benefits of the Java approach. This page from Ada Computer Science provides an overview: [the-cc.io/tl-translators](https://the-cc.io/tl-translators)Instruct students to open their version of ‘**A3 Activity sheet** – Virtual development environments’. Show slide 18 and ask students to complete the activity. If students do not use Python, you may wish to focus on a programming language that they are familiar with. Again, you could make this more interactive by getting them to work in pairs and asking them to share their thoughts with the rest of the class. |
| Apply it activitySuggested time: 20 minutesResources: Slide 19general competencies: E1, E2, E3 | Show slide 19. This is the point of the lesson where students can apply their understanding of the concepts covered in this lesson, specifically the second activity. Students are introduced to the scenario of a grocery delivery company that has been advised to virtualise their servers. Students are required to create a short presentation for the company covering the following points: * + **What is meant by server virtualisation?**
	+ **The benefits of server virtualisation to the business**
 |
| PlenarySuggested time: 5 minutesResources: Slides 20–22 | Ask students to share some responses/work they have developed for the Apply it activity and then use slides 20–21 to support any gaps in responses. Share slide 22 to summarise the learning that has taken place during the lesson and present the outline for the next lesson. |

# Lesson 8: Cloud environments

In Lesson 3, students discussed the need for secondary storage. In this lesson, they will explore in more detail how cloud storage and cloud technologies can be utilised by organisations to provide storage and services via the internet. Students will compare the benefits and drawbacks of an organisation using cloud environments and investigate the main cloud deployment and service models including how the responsibilities of the cloud service provider differ in these models. Students will then have the opportunity to demonstrate their understanding through the Apply it activity.

## Preparation

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| Resources provided | Slides Activity sheets:* + A2 Activity sheet – Cloud service models
	+ A2 Answer sheet – Cloud service models
	+ A3 Activity sheet – Cloud deployment
	+ A3 Answer sheet – Cloud deployment
 |
| Equipment needed | Students may require access to computers for some activities in the lesson. |
| Safety factors | Teachers and students are required to carry out their own risk assessments for the activities in each lesson.  |
| Prior learning | Students should have prior knowledge of secondary storage from Lesson 3.Students will likely have used cloud-based technologies to either store data or to access cloud-based services such as email.Students may have some experience of cloud service providers and may pay for cloud storage. |
| Common misconceptions | Students may assume that the cloud is one storage location, they should be made aware that "the cloud" is terminology used to describe storage and software solutions online as it is managed by multiple different cloud service providers. |
| Accessibility | Seek to ensure wide representation for any visiting speakers and case studies used.Consider students' potential lack of experience in approaching and answering study style questions. It is worth discussing exam key terminology and command words at this point of the course. |

## Activity guide

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| Starter activity: types of virtualisation – retrieval activitySUGGESTED TIME: 10 minutesRESOURCES: Slides 2–5 | Before the lesson, study the slide deck as a guide to summarise what will be covered in the lesson.Display slide 2 and explain to students that they will be attempting a study question. You could break down the question with students and highlight the exam command word “**explain**” and what is required for this type of question. Give them 5 minutes to record their response to the question.Show slide 3 to share a sample answer. You could ask students to share their responses with the rest of the class at this point and add to the sample answer provided. It is important here to highlight that the answer should link back to the case study introduced in the question. Show the video on slide 4, whilst students are watching the video ask them to make notes on “**how does this organisation use the cloud to meet their business needs?”**. Following the video, ask students to think of another organisation (this may be the students' industry placement or another organisation) and ask **“how does this organisation use the cloud to meet their business needs.”**Use slide 5 to introduce the lesson objectives. |
| Activity 1: What is the cloud?Suggested time: 20 minutesResources: Slides 6–13general competencies: E4, E6 | Display slide 6 and pose the question to students: **“What is the cloud?”** Take and discuss responses with students.Use slides 7–10 to introduce and explore the concept of cloud computing and cloud storage:* + Cloud computing is a model for providing on-demand network access to a shared pool of computing resources via the internet
	+ A cloud storage business model most commonly used is to provide a certain amount of storage for free and then charge per GB
	+ Cloud storage can be configured so that it automatically synchronises with local drives

Use slide 11 to introduce the industry case study of a photographer working for a news agency. Students should discuss in pairs the benefits and limitations of the photographer and news agency using cloud storage. Give students 10 minutes for this task.Ask pairs to share their responses to the activity. Use slides 12–13 to share some common benefits and limitations of cloud storage. |
| Activity 2: Cloud deployment modelsSuggested time: 25 minutesResources: Slides 14–17A2 Activity sheetA2 Answer sheetgeneral competencies: E2, E4, E5 | Use slide 14 to introduce the four models of cloud deployment:* + Private cloud
	+ Public cloud
	+ Hybrid cloud
	+ Community cloud

Use slide 15 to explain to students what each of these deployment models means and provide some typical examples. As an additional activity you may ask students to research some of these examples such as Amazon Web Services (AWS) to compare what services they offer to clients. Use slide 16 to introduce the three cloud service models:* + **SaaS** - Software as a Service
	+ **PaaS** - Platform as a Service
	+ **IaaS** - Infrastructure as a Service

These are displayed in a pyramid to illustrate that the role of the cloud service provider becomes more significant as you move down.Use slide 17 to instruct students to open their version of the ‘**A2 Activity sheet** – Cloud service models’. Students should read through the information about each service model and conduct some research to explore the advantages and disadvantages of each model. Students are then provided with some industry-based scenarios for which they have to recommend the most suitable cloud service model. |
| Activity 3: Responsibility of ownershipSuggested time: 10 minutesResources: Slides 18–19A3 Activity sheetA3 Answer sheetgeneral competencies: E4, E6 | Show slide 18 which illustrates the responsibilities of the client and the cloud service provider for each cloud service model. Discuss with students the benefits and limitations of giving more responsibility to the cloud service provider for an organisation or client.Show slide 19 and instruct students to open their version of the ‘**A3 Activity sheet** – Cloud deployment’. Students should conduct some research into the key characteristics of cloud deployment (runtime, middleware, etc). Students are then asked to explore the different levels of responsibility for each cloud service model. They could draw upon the group discussion at the start of this activity for their answer.  |
| Retrieval activitySuggested time: 5 minutesResources: Slide 20 | Use slide 20 as a retrieval activity to check students are familiar with the characteristics of cloud storage and cloud deployment models. Students could feed back their thoughts either verbally or by written responses with any gaps in learning addressed.  |
| Apply it activitySuggested time: 20 minutesResources: Slide 21general competencies: E2, D3 | This is the point of the lesson where students can apply their understanding of the concepts covered in the first part of the lesson. Students are introduced to the scenario of a web-based business that wants to improve the opportunities for collaboration between staff. Students are asked to produce a presentation for the business owner on the most suitable cloud deployment and service model for the organisation.  |
| PlenarySuggested time: 5 minutesResources: Slides 22–23 | Ask students to share some responses/work they have developed for the Apply it activity and then use slide 22 to support any gaps in responses.Share slide 23 to summarise the learning that has taken place during the lesson and present the outline for the next lesson.  |

# Lesson 9: Cloud delivery environments

In Lesson 8, students explored what cloud environments are and how organisations use cloud storage including the different models for cloud deployment and cloud service. In this lesson, students will explore Data as a Service (DaaS) and the benefits and limitations this can provide for organisations. Students will investigate the issues of cloud portability and interoperability and have the opportunity to demonstrate their understanding through the Apply it activity.

## Preparation

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| Resources provided | Slides Activity sheets:* + A2 Activity sheet - Cloud portability and interoperability

Virtual and cloud environments summative assessment questions and answers |
| Equipment needed | Students will require access to computers and the internet for some activities in the lesson. |
| Safety factors | Teachers and students are required to carry out their own risk assessments for the activities in each lesson. You may consider internet access for students in line with appropriate use policies and procedures of the organisation. |
| Prior learning | Students should have knowledge of cloud services and cloud service providers from Lesson 8. |
| Common misconceptions | DaaS sometimes refers to Device as a service but in this lesson content DaaS refers to Data as a Service. |
| Accessibility | Seek to ensure wide representation for any visiting speakers and case studies used.Consider a student's potential limited experience at this point of the programme in reading and interrogating articles and technical literature. It may be worthwhile reading the article provided as a class and then having a group-based discussion on whether students agree or disagree with the article. |

## Activity guide

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| Starter activity: Cloud services models – retrieval activitySUGGESTED TIME: 5 minutesRESOURCES: Slides 2–4 | Before the lesson, study the slide deck as a guide to summarise what will be covered in the lesson.Display slide 2 and ask students to correctly match the description to the type of cloud service model. Share the answers with the students using the animation on the slide.Show the video on slide 3 to introduce how organisations like the Raspberry Pi Foundation use data. While students are watching the video, ask them to make notes on **“how this organisation uses data effectively to meet their business needs.”** Following the video, ask students to think of another organisation (this may be the students' industry placement or another organisation) and ask how this organisation uses data effectively to meet their business needs.Use slide 4 to introduce the lesson objectives. |
| Activity 1: Data as a Service (DaaS)Suggested time: 30 minutesResources: Slides 5–10general competencies: E2, E6, D2, D3 | Display slide 5 to share the quote from Eric Schmidt about data. Pose the question to students: **What implication does this have on organisations?**Use the animation on the slide to highlight the fact that dealing with large amounts of data can be complex. Discuss with students why data is important to organisations (financial planning, consumer trends, machine learning).Display slide 6 to introduce the term Data as a Service (DaaS). Then use slides 7 and 8 to share some of the features a DaaS can provide. Show the video on slide 9 to introduce the term ‘machine learning’ to students and to demonstrate how machine learning is used within an organisation for specific projects.Display slide 10 to explore another use of DaaS. Can students think of any other examples?In small groups ask students to explore the **uses, benefits,** and **limitations** of DaaS. Students could produce a short presentation which they can share with the rest of the group for this activity.  |
| Activity 2: Cloud sourcing and portabilitySuggested time: 25 minutesResources: Slides 11–14A2 Activity sheetgeneral competencies: E4, E5, M5 | Display slide 11 and discuss the following terms with students:* + **Cloud sourcing** – The process by which cloud services are provided by a third party
	+ **Cloud service provider** – The third party who provides the cloud service
	+ **Subscriber/client** – The user of the cloud service who will typically pay a fee for the service
	+ **Scalability** – The option to increase and decrease cloud provision as the needs of the subscriber changes

It may be useful to discuss with students what cloud services they use and whether they pay for any cloud provision.Display slide 12 and discuss the following terms with students:* + **Cloud portability** – The ability to move a cloud system or resource from one location or service provider to another. This may be the case if a subscriber wants to change service provider.
	+ **Cloud interoperability** – The ability of two or more cloud service providers to interact to share or exchange information, for example, can a document easily be transferred from one cloud storage to another.

Slide 13 shares an extract from Ofcom’s publication: *Public cloud infrastructure services*:**“Our provisional view is that there are features of the market that act as barriers to switching and multi-cloud use, that we have reasonable grounds to suspect that these features prevent, restrict, or distort competition in the UK.”**Using slide 14 instruct students to read the article in full and then open their version of the ‘**A2 Activity sheet** - Cloud portability and interoperability’ to summarise their findings from the report. |
| Retrieval activitySuggested time: 5 minutesResources: Slide 15 | Use slide 15 as a retrieval activity to check students are familiar with the terms cloud portability and Data as a Service (DaaS). Students could feed back their thoughts either verbally or by written responses with any gaps in learning addressed. |
| Apply it activitySuggested time: 20 minutesResources: Slide 16general competencies: E6 | This is the point of the lesson where students can apply their understanding of the concepts covered in the first part of the lesson. Students revisit the scenario of the independent coffee retailer. The coffee retailer has several branches and wants the opportunity for branches to share sales and performance information. Students should discuss how DaaS could be used by the coffee retailer to improve the analysis of their sales data.You could ask students to make some notes and to share their thoughts with the rest of the group verbally. |
| PlenarySuggested time: 5 minutesResources: Slides 17–18Virtual and cloud environments summative assessment questions and answers | Ask students to share some responses/work they have developed for the Apply it activity and then use slide 17 to support any gaps in responses.Share slide 18 to summarise the learning that has taken place during the lesson and share the outline for the next lesson. Students could now be set the Virtual and cloud environments summative assessment questions to check progress. |

# Lesson 10: Resilience of environment

This lesson introduces the subject of the resilience of a computer system’s environment. Students will discover what is meant by a resilient environment and the measures taken to achieve resilient environments. Students will explore the different options for mirroring and backing up. This lesson ends with an Apply it activity that will give students the opportunity to demonstrate their knowledge of resilient environments that would be required in real-world scenarios.

## Preparation

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| Resources provided | Slides Activity sheets:* + A1 Activity sheet – Threats to computer systems
	+ A1 Answer sheet – Threats to computer systems
	+ A2 Activity sheet – Types of backup
	+ A2 Answer sheet – Types of backup

Apply it task scenariosSummative assessment questions and answers |
| Equipment needed | Students may require access to computers for some activities in the lesson. |
| Safety factors | Teachers and students are required to carry out their own risk assessments for the activities in each lesson. |
| Prior learning | Students should have an understanding of the term “backup” and know why it is important to have saved copies of data.Students may have experienced losing files and data and the impact that this has had on them as individuals. |
| Common misconceptions | Students may need some additional support determining the differences between the concepts of recovery and backup. |
| Accessibility | Seek to ensure wide representation for any visiting speakers and case studies used.Consider students' potential lack of experience in approaching and answering study style questions. It is worth discussing exam key terminology and command words at this point of the course.For the Apply it activity students can choose the format of the output of their work. Please see activity guide for more detail on how this task can be approached.  |

## Activity guide

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| Starter activity: DaaS – retrieval practiceSUGGESTED TIME: 10 minutesRESOURCES: Slides 2–4 | Before the lesson, study the slide deck as a guide to summarise what will be covered in the lesson.Display slide 2 and explain to students that they will be attempting a study question. You could break down the question with students and highlight the exam command word “**discuss**” and what is required for this type of question. Give them 5 minutes to attempt and record their response to the question.Show slide 3 to share a sample answer. It is important to highlight here the fact that the sample answer links back to the scenario in the question. This is a key exam skill that students should adopt. You could ask students to share their responses with the rest of the class at this point and add to the sample answer provided.Use slide 4 to introduce the lesson objectives. |
| Activity 1: Threats to computer systemsSuggested time: 20 minutesResources: Slides 5–8A1 Activity sheetA1 Answer sheetgeneral competencies: E6, M6, D3 | Show the students slide 5 and ask students to provide a response if they regularly backup their own devices. Explain to the students that this lesson is about resilience of computer systems that can be large and across different locations.Show slide 6 to explain some of the steps that can be taken to achieve digital resilience. This then leads into slide 7 which explains the reasons why organisations need to be digitally resilient.Move on to slide 8 and instruct students to open their version of the ‘**A1 Activity sheet** – Threats to computer systems’. This activity requires students to work in groups to identify some common risks to computer systems. It would be worth prompting students to think about threats that would fit into one of the three categories:* + **External threats**
	+ **Internal threats**
	+ **Natural threats**

Include time for groups to share their responses with the rest of the class and depending on the size of your group may need more time for this activity.  |
| Activity 2: Method for improving resilienceSuggested time: 15 minutesResources: Slides 9–12A2 Activity sheetA2 Answer sheetgeneral competencies: D3, E4 | Show slide 9 and introduce the concept of disaster recovery sites. Students may be unfamiliar with this idea, so it’s important to explain that disaster recovery sites are specifically designed for larger computer systems that require a similar-sized infrastructure for recovery purposes if their own buildings or facilities are out of action.The following article could prompt an interesting conversation about the need and requirement for disaster recovery: <https://www.computerworld.com/article/2510996/9-11--top-lessons-learned-for-disaster-recovery.html> Using slide 10, introduce the terms hot, cold, and warm recovery sites. Pick out the key differences between the three. Show slide 11 which introduces the different types of backups:* + **Full backups**: A complete replica of data where every file and folder is backed up
	+ **Incremental backups**: Only data that has changed since the last backup was created is backed up
	+ **Differential backups:** Will continually back up any data that has changed since the last backup (this is often confused with incremental backups)
	+ **Mirror backups:** Not only a backup of data but the whole system is copied (often referred to as a mirror image)

Show slide 12 and instruct students to open their version of the ‘**A2 Activity sheet** – Types of backups’. You may want to ask the students to form groups of three or four and ask each group to focus on one scenario to then share back their recommendation with the rest of the class.Emphasise that these scenarios are vocational contexts that the student may find themselves in during their industry placements/when employed.  |
| Activity 3: Redundancy in computer systemsSuggested time: 10 minutesResources: Slides 13–17general competencies: E4, E5, E6 | Slide 13 and 14 introduce the concepts of hardware and software redundancy. It would be helpful to introduce the term ‘**mirroring**’ here and ensure that students understand this term.Show slide 15 to students to introduce the activity. This activity requires the students to put themselves into a vocational situation of being a network administrator. Their network manager has asked them to give feedback back about the **benefits** and **drawbacks** of software and hardware redundancy. Allow students time to conduct some research before they generate their lists. Allow them 10 minutes to do this.Show slide 16 to reveal some sample benefits and drawbacks and ask groups to share any additional benefits or drawbacks that are not included on the list. Slide 17 shows examples of device hardening techniques. You may want to explain that by employing specific techniques, vulnerabilities can be reduced and the defence of devices can be strengthened. **Auto logout:** This helps mitigate the risk of unauthorised access when a device is left unattended or forgotten* + **Port disabling:** By limiting the available entry points, we reduce the potential attack
	+ **User access restriction:** This ensures that users have access only to the resources necessary for their tasks, minimising the impact of potential attacks
	+ **Two-Factor Authentication (2FA):** Users are required to verify their identity through an additional method, such as receiving a text message or using an authentication app
	+ **Removing unnecessary applications:** By reducing the number of installed applications, we decrease the potential attack and improve overall security
 |
| Retrieval activitySuggested time: 5 minutesResources: Slide 18 | Use slide 18 as a retrieval activity to check students are familiar with backup sites and the reasons for building resilience into digital systems.Students could feed back their thoughts either verbally or by written responses with any gaps in learning addressed. |
| Apply it activitySuggested time: 30 minutesResources: Slide 19general competencies: E1, E2, D1, D2 | This is the point of the lesson where students can apply their understanding of the concepts covered in the first part of the lesson. Students can pick any of the Apply it case studies they have been introduced to through Lessons 1 to 9 for this activity. A booklet with the case studies (**Apply it task scenarios**) is available if students need to remind themselves of these scenarios. This activity can be completed in a variety of ways. Students can complete this in groups or individually. The students can produce one output from the following that answers the tasks on the slide:* + A voice note for each point
	+ A video short that answers each point
	+ A podcast
	+ A short written report
	+ A presentation that could be shared with the business owner of the given organisation

You may want to choose any other suitable outputs for your students depending on their individual needs. |
| PlenarySuggested time: 5 minutesResources: Slide 20 | Discuss with students the Apply it activity they chose for the task and ask them to share some of their recommendations to build resilience. Share slide 20 to summarise the learning that has taken place during the lesson. There is a summative assessment based on the topics and concepts covered in the topic You may wish to set this for students as part of this lesson or as a follow-up activity in a subsequent lesson.  |

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| Lesson 1 Slide 7 | <https://arstechnica.com/gadgets/2023/08/some-shops-will-let-you-buy-more-than-one-raspberry-pi-at-a-time-again/> | ARS Technica | June 2024 |
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| Lesson 8 slide 8 | <https://cloudindustryforum.org/wp-content/uploads/2023/04/Breaking-new-ground-with-cloud.pdf> | Cloud Industry Forum | June 2024 |
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| Lesson 10 Lesson plan page 3 | <https://www.computerworld.com/article/2510996/9-11--top-lessons-learned-for-disaster-recovery.html> | Computer World | June 2024 |

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