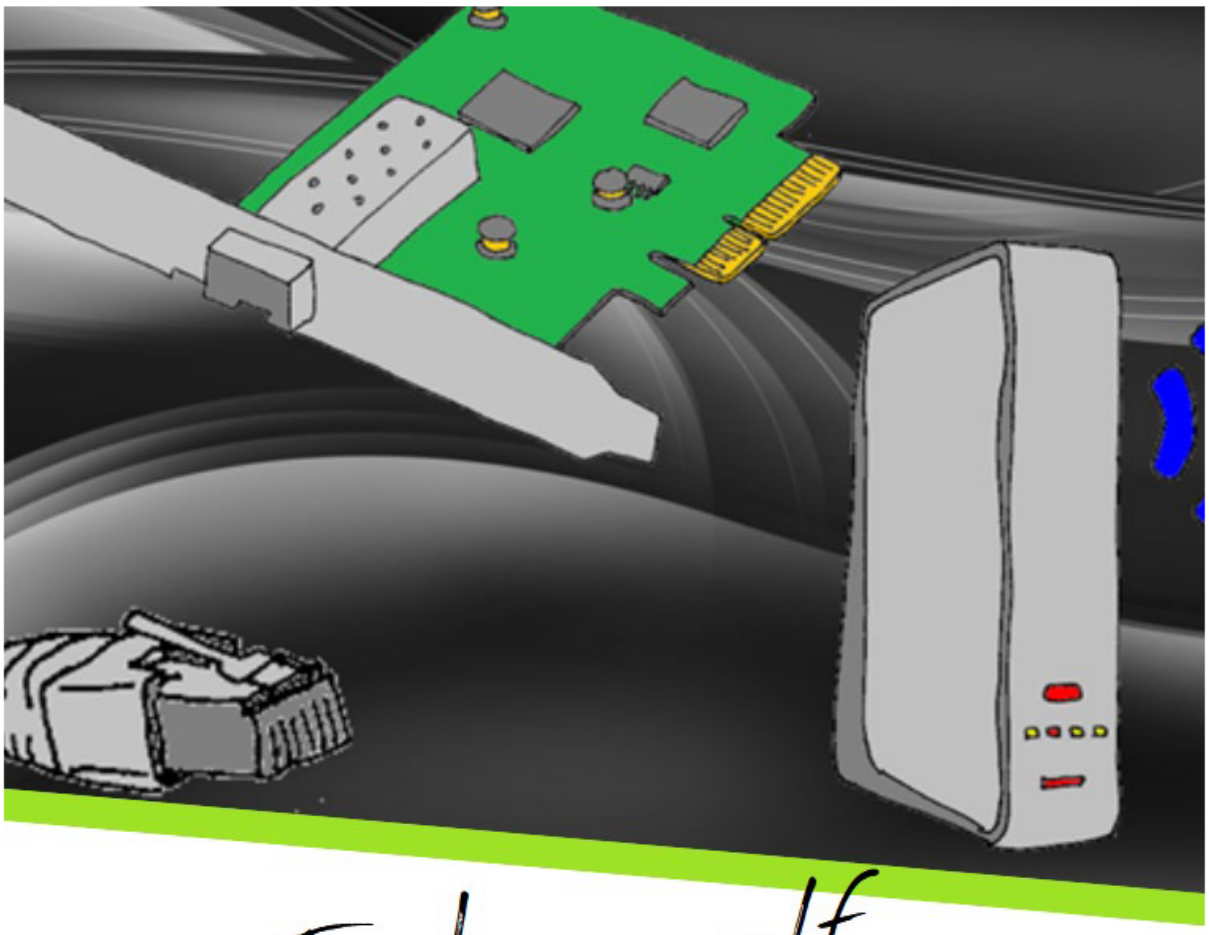
Student Workbook



Teach yourself all about the

FUNDAMENTALS OF COMPUTER NETWORKS

AQA GCSE (9-1) In Computer Science 8525

for first assessment 2022

Your Name:		Class:	

Nichola Wilkin Ltd

Knowledge Checklist

Before you start, please tick the areas you are already confident in. Once you have worked through ALL of this workbook (including those areas you are already familiar with) go through the checklist again and tick the areas you now feel confident in and which areas you still need to work on.

	I am confident before I start this workbook	I am confident now I have completed this workbook	I still need to work on this area
Define what a computer network is			
Discuss the advantages and disadvantages of computer networks			
Describe the main types of network (PAN, LAN and WAN)			
Discuss the advantages and disadvantages of wireless networks as opposed to wired networks			
Describe LAN topologies (Star and bus)			
Define the term network protocol			
Explain the purpose and use of the following network protocols (Ethernet, Wi-Fi, TCP, UDP, IP, HTTP, HTTPS, FTP, SMTP and IMAP)			
Understand the need to network security			
Explain the following methods of network security: authentication, encryption, firewall and MAC address filtering)			
Describe the 4-layer TCP/IP model (application layer, transport layer, internet layer and link layer)			

Table of Contents

Please note this is a preview sample of the full workbook to enable you to get a feel of the language and tasks used in the product.

Therefore, some pages are missing from this preview and the interactive features have been deactivated.

Network topologies

A network topology is the pattern in which computers, printers, routers or other devices are connected to a local area network (LAN) with cables. There are two network topologies you should be aware of:

- Star
- Bus

Network "topology" = the shape of the connections on a physical network

First lets look at some of the technology that may be found on a network.

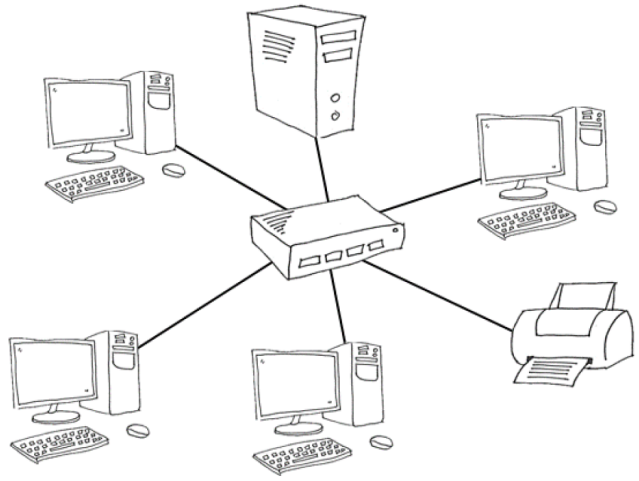
Computer – This may take the form of a desktop computer (as shown in the image) or it could be any type of computer such as a laptop. It is also sometimes referred to as a workstation.

Printer – This is usually shared between the computers on the network.

There may be other hardware such as a scanner, plotter, speaker system etc that may be attached to the network and shared by the users on that network.

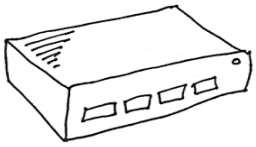
Server – This can be large dedicated computer in an air-conditioned server room which is extremely powerful and can only be used by specialist technicians or it can be a small computer that looks like any other computer on the network. It allows the files to be stored centrally and manages the network.

Star network topology



Star topology = all the devices connect to a central hub or switch

With a star topology every device on the network has its own dedicated line to the hub or switch at the centre of the network.



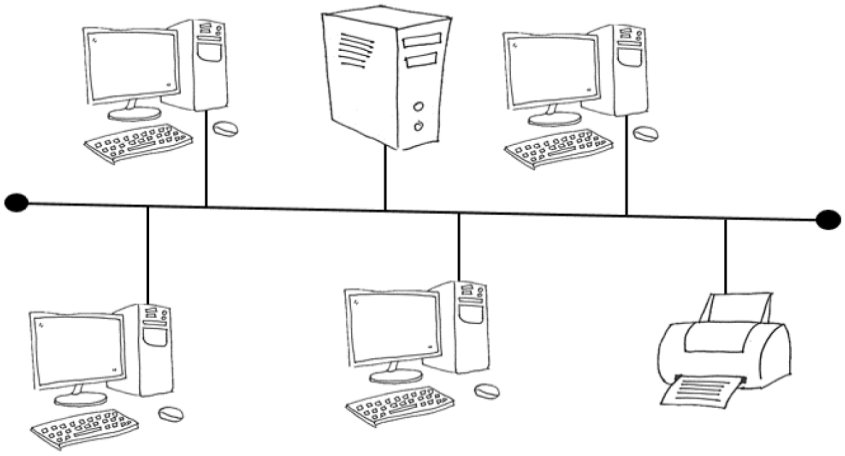
Hub or Switch – This is a specific piece of hardware that is used in star networks. All the data that travels around the network must pass through this piece of hardware. The difference between a hub and a switch is how they pass that data onto the recipient computer.

A **hub** will send the message it receives to ALL the devices on that network and trust that the correct recipient will accept the message and all the other devices will ignore the message.

A **switch** will pass the message ONLY to the correct recipient and will not send it anywhere else.

Advantages	Disadvantages
• It is very reliable. If a connection between one computer and the hub/switch is broken the rest of the network will continue to work • It is easy to connect or remove devices without affecting rest of the network. • There are no collisions of data as it is all controlled through the hub/switch which speeds up the data transfer around the network	• If the central hub/switch stops working the whole network will stop working • Purchasing the hub/switch is an additional cost and this type of network uses the most cable and so is the most expensive • The speed of the network depends on the capacity of the hub/switch • With a hub, all the devices are sent all the data on the network which can be a security concern. This does not happen with a switch

Bus network topology



Bus topology = all the devices connect to a central cable

With a bus network, all the devices are connected to one central main cable called the "bus". At each end of the cable a terminator "●", which is fitted to stop signals reflecting down the bus. Each computer is responsible for sending message and listening to see if any messages on the network are meant for them.

When a computer sends a message using the bus topology, they transmit it in both directions along the bus and the device it is addressed to will pick it up. All the other devices ignore the message and the terminators absorb the messages that get to the ends of the bus stopping them bouncing the data back along the cable.

Advantages	Disadvantages
• It is easy to install a bus network • It is cheaper than a star network as it requires less cabling and does not need a hub or a switch	• If the main bus is broken the whole network stops working • As more devices are added the network will become slower as there will be more data collisions • All the devices are sent all the data on the network which can be a security concern.

Task 4: Read the scenarios and decide which network topology would be most suitable to use

Scenario	Star	Bus
A school wants to set up a LAN which will connect three computing classrooms and some computers in the library along with a teacher's computer in each classroom. They do not have much money to spend.		
A large company wants a reliable network for their staff and wants to minimise possible breakdowns and data clashes. Money is no object.		
A hospital needs a high-speed reliable network that will connect a computer and printer in each area of the LAN. If the system breaks down, lives can be put at risk. There are lots of devices on the network.		
A factory needs to link one computer and printer in the warehouse to a few computers and a printer in the accounts department and one computer and printer in the manager's office.		

Task 5: Match the fisherman to their fish. Type the correct letter to label each fish using the descriptions below.

A = A type of network that does not use cables to transmit data. The data can be transmitted using Bluetooth or Wi-Fi signals

B = A copper cable that is used in a wired network that transmits data using electronic pulses that can lose its signal if used over large distances

C = A network topology that uses cables to connect all the devices directly to a central switch or hub

D = A very small network, usually using Bluetooth technology, which links people personal devices such as mobile phone and headphones

E = A large network over a large geographical area. The internet is one of these

F = A wireless frequency that is used with a WAP to transmit and receive the signals

G = A small network which is contained over a small geographical area such as a single building

H = A network topology that uses a central cable that all the devices connect to and which has terminators at either end to absorb the messages to stop them reflecting along the cable

I = A radio frequency that is usually used in a wireless PAN

J = A type of network that uses physical wires to connect the device to the network. These can be either Ethernet or Fibre Optic cables

K = A connection that is made over a wired network that transmits data using light pulses and can be used over great distances

Network Protocols

Protocol is another name for rules. They are necessary when connecting computers on a network to make sure all the devices follow the same communication methods so they can work together. Network protocols are incredibly important as they lay out the standards for how the network works.

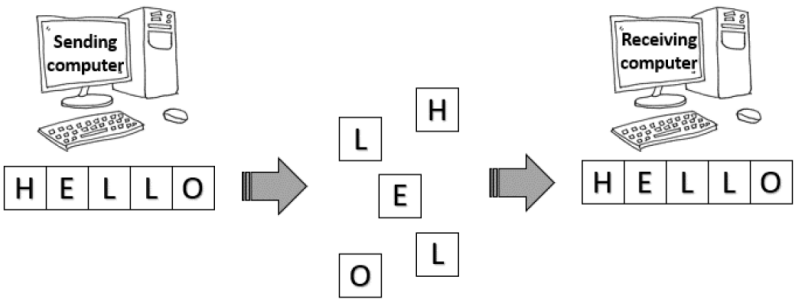
Network protocol = the standard policies, rules, procedures and formats that allow communication between devices on a network.

Task 6: Use the space below to write a list of the things that you think a protocol would identify

How is data transmitted over a network?

Data is sent through networks in packets

When data is sent through a network it is split into small sections called "packets". Each packet contains the address of the destination it needs and a message to tell the receiving computer how to put the pieces of the message back together in their original order.



Once the message has been received successfully a message is sent back from the recipient computer to the sending computer to tell them to stop trying to send the message. If no message is sent telling the sending

computer that the message has been received correctly, it will keep trying either indefinitely or, more commonly, for a set number of attempts. If the recipient computer did not send the "message received" message, it would add additional and unnecessary traffic to the network that could slow the time it takes for other messages to get to their destinations.

Bandwidth

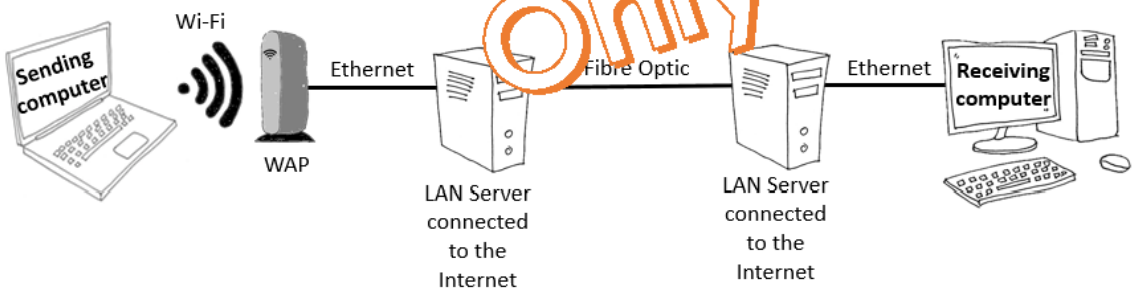
Bandwidth is the amount of data that can be transmitted in a fixed amount of time measured in bits per second (bps).

The average bandwidth of different communication methods are as follows:

Method	Bandwidth
Bluetooth	24 Mbps
Wi-Fi	54 Mbps
Ethernet cable	100 Mbps
Fibre Optic	20 Ghz

Bandwidth = the bits per second that can be sent through a network connection

Often a message may have to travel ov[illegible] s[illegible]rent media when traveling over a WAN. It may start on a [illegible] using Wi-fi and then connect to a LAN using ethernet [illegible] travel to another network using Fibre Optic and finally conne[illegible] al LAN using ethernet before finding its destination computer.



This means that the bandwidth can change as the message progresses and this can often make the data appear in a jumbled order so it is vitally important that a message is sent telling the receiving computer how to unjumble the message it receives.

Common network protocols

Protocol	Purpose and Use
Ethernet	This is a group of protocols that deal transferring data over the ethernet sections of a LAN. It describes how the packets are formatted and how to upload data.
Wi-Fi	Wi-Fi is a brand name which defines groups of protocols that describe how data is sent across a WLAN.
TCP	TCP (Transmission Control Protocol) defines how to establish and maintain a network conversation through which applications can communicate and data can be sent (usually over the internet).
UDP	UDP (User Datagram Protocol) is an alternative communication protocol to the TCP.
IP	IP (Internet Protocol) defines how data is sent from one computer to another on the Internet and includes a standard way for how devices are addressed.
HTTP	HTTP (Hypertext Transfer Protocol) defines how web pages are formatted and transmitted and how webservers should cope with commands for web pages.
HTTPS	HTTPS (Hypertext Transfer Protocol Secure) is a secure version of HTTP which encrypts all data sent between the browser and the webpage. These are often used for payment pages on websites.
FTP	FTP (File Transfer Protocol) this is a standard network protocol that is used to transfer files. It can be used on LANs and WANs such as the internet.
Email protocols	There are two email protocols you need to be aware of: SMTP (Simple Mail Transfer Protocol) and IMAP (Internet Message Access Protocol). SMTP defines how e-mail messages are sent between servers and IMAP defines how email messages are stored on a mail server but allows the end user to view and manipulate the messages as though they were stored locally on the end user's computer.

Task 7: Group the protocols we have looked at into the following categories. Some protocols may occur in more than one column.

Local data transfer	Internet data transfer	Email

Task 8: Answer these questions

Question	Your Answer
1. What is meant by the term "network protocol"?	
2. When data is sent across a network it is split into smaller sections. What are the sections called and name three things that they would contain?	
3. What is the difference between HTTP and HTTPS? When would HTTPS be used?	
4. Describe two protocols used for email.	
5. Describe what the Ethernet protocol is.	
6. Which protocol defines how devices are addressed on the internet?	

TCP/IP model

The TCP/IP model is split into two parts:

- TCP (Transmission Control Protocol)
- IP (Internet Protocol)

TCP (Transmission Control Protocol)

TCP prepares a message for transmission and defines how a receiving computer reassembles the message

This part of the TCP/IP model is concerned with how messages are prepared before they are sent across a LAN and how the receiving computer reassembles them.

To send a message the sending computer will:

- split the message into packets
- add the address of the receiving computer
- add a sequence number to each packet so the receiving computer knows the order they should be reassembled in
- add check digits so errors can be found and corrected

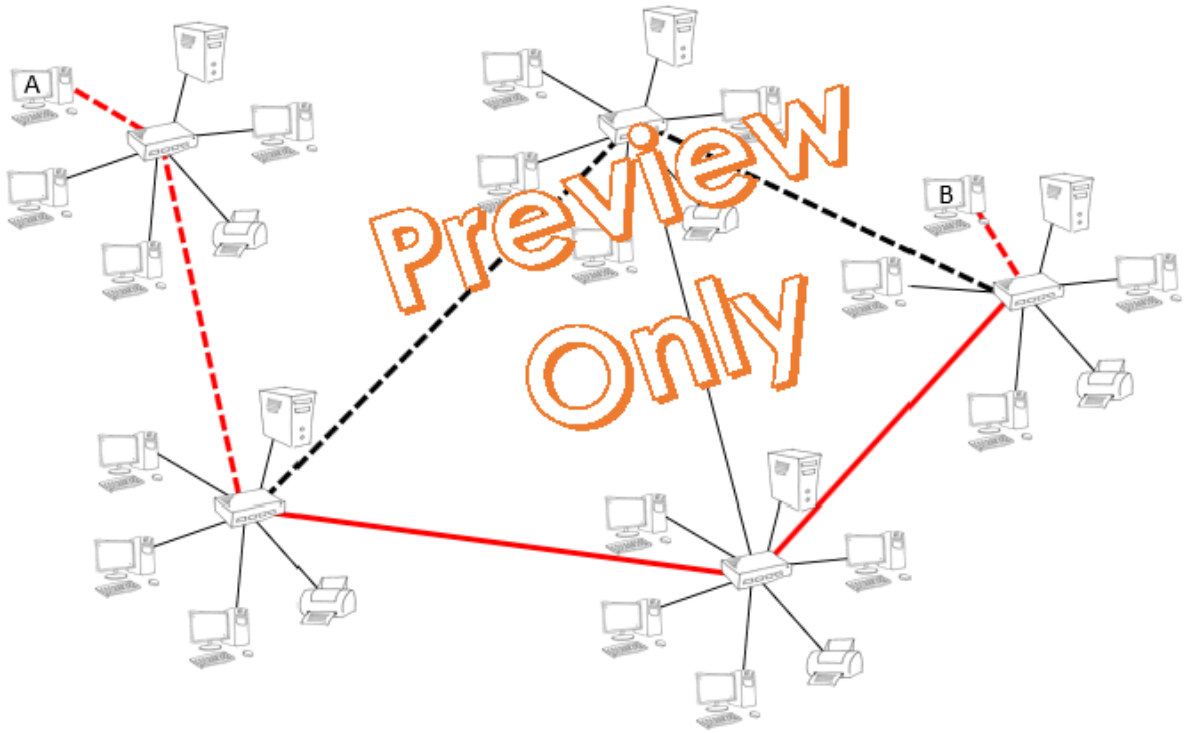
When a message is received the receiving computer will:

- check each packet has been received correctly by using the check digits
- fix any errors that may have occurred
- find any missing packets in the sequence and request that they are resent
- if there are no errors or missing packets, use the sequence to reassemble the message
- send a message to the sending computer that the data has been successfully received

IP (Internet Protocol)

The IP dictates the route the message will use when it is sent over the internet using the IP address to find the correct computer. The internet is really a large collection of networks and to get a message from one computer to another over the internet it will usually pass through lots of possible networks and there may be more than one route that the message could travel along to get to the same destination.

IP works out the best route for the message to take for the IP address of the destination device

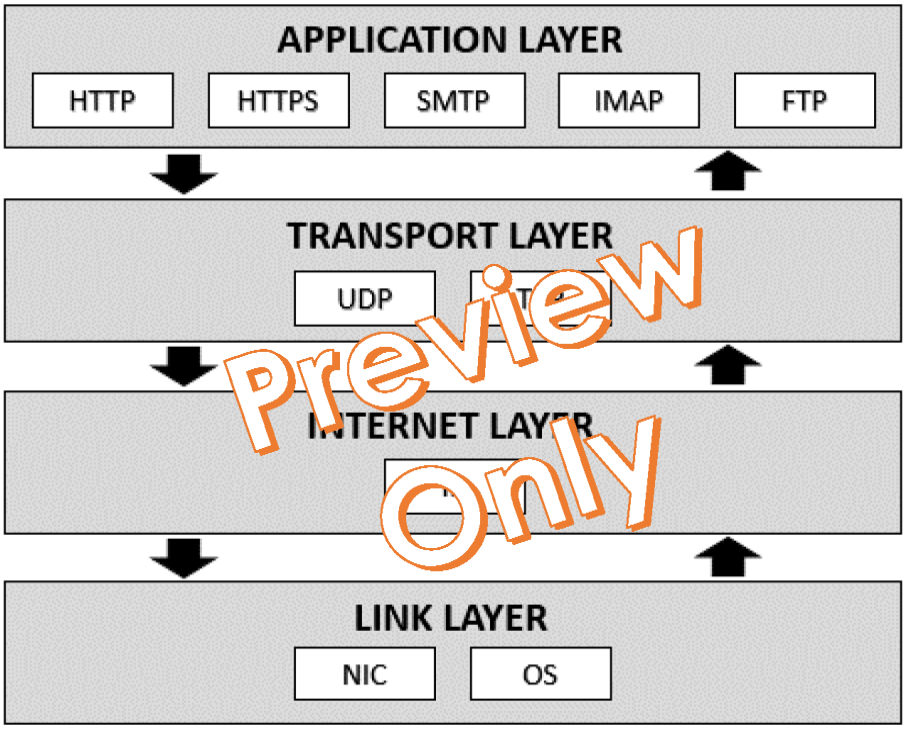


Take the example above. If computer A wants to send an email to computer B it could follow the red route or the dotted route. The IP will find the best possible route for the message to take.

The 4 layers of the TCP/IP model

The TCP/IP model has 4 layers of protocols:

- Application
- Transport
- Internet
- Link (this is sometimes also known as the network access layer or the network interface layer)



Each layer contains protocols (see page 17) and can only communicate with the layer directly above or below it so, for example, the internet layer can communicate with the transport and link layers but it cannot communicate with the application layer.

Application layer

The application layer is the top layer and can only communicate with the transport layer. The protocols in the application layer are concerned with how data moves in and out of applications such as web browsers, email programs and file managers. These applications allow users to accomplish various tasks over the network.

Application layer = how data moves in an out of applications the user uses to perform tasks over a network

Task 14: From what you know about protocols (see page 17) tick the protocols which would govern transferring data across networks using the following applications. Each protocol can only be selected once in a column.

Application	Protocols				
	IMAP	HTTP	SMTP	FTP	HTTPS
Web browsers					
Email programs					
File manager					

Transport layer

This layer sets up the communication between two devices and includes the protocols to define, establish and maintain how applications can communicate and data can be sent. It includes rules about the "language" that is used, the size of the packets and how the packets are structured etc. There are two protocols you need to be aware of in the transport layer:

Transport layer = how the data is sent over the network

- UDP (User Datagram Protocol)
- TCP (Transmission Control Protocol)

Only one of these protocols would be used in a network as they both do the same thing, just in slightly different ways. The most common protocol for the transport layer is TCP.

Internet layer

There is only one protocol in the internet layer you need to be aware of and that is the IP. The IP dictates the route the message will use when it is sent over the internet using the IP address to find the correct computer.

Internet layer = finds the best route for the message to get to its destination

Link layer

This contains the hardware to connect to the network and instead of protocols, it defines how the NIC (Network Interface Card) and the OS (Operating system) work to enable connection to a network.

Link layer = how the hardware (NIC) works with operating system (OS) drivers

Task 15: Without looking at the previous pages, name the 4 separate layers and write in your own words what each of these layers do in a TCP/IP 4-layer model and identify what each layer includes (i.e. list the protocols etc. that are used in that layer).

Layer	What it does	What is in this layer?