Exercise walk-through

2.1.1

Network types, client-server and peer-to-peer models, and topologies

A-Level Computer Science

You must be able to

- show understanding of the characteristics of a LAN and a WAN, and justify which one a situation needs
- explain the **client-server** 客户端-服务器 and **peer-to-peer** 对等网络 models, their benefits and drawbacks, and justify the use of a model for a given situation
- show understanding of **thin-client** 瘦客户端 and **thick-client** 胖客户端 and the differences between them
- show understanding of the **bus**, **star**, **mesh** and **hybrid** topologies, how packets are transmitted between two hosts in each, and justify a topology for a given situation
- describe the hardware used to support a LAN, and the role and function of a **router** 路由器

1 The method

Method — Justifying LAN or WAN

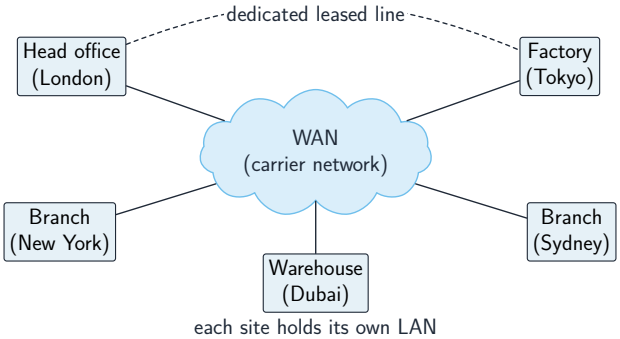
A "state whether this is a LAN or a WAN, and justify your answer" question is marked on the **justification**, not the name. Two things decide it:

- **the area covered** – one site or building is a LAN; separate towns, countries or continents need a WAN.
- **who owns the links** – a LAN's switches and cabling belong to the organisation; a WAN uses a third party's infrastructure (leased lines, the **PSTN**, the internet).

Worked example. *A school connects the computers in one building. A company connects its offices in two cities.* The school has a **LAN**: one site, and the school owns the cabling. The company needs a **WAN**: the sites are far apart, so the link must be leased from a telecommunications company. A WAN also has lower data rates and higher **latency** 延迟 than a LAN, because the signal travels much further through equipment the organisation does not control.

Method — Justifying LAN or WAN

A "state whether this is a LAN or a WAN, and justify your answer" question is marked on the justification ,...



A wide-area network links many systems across a large area

Method — Choosing between the two models

	client-server	**peer-to-peer**
roles	servers provide, clients request	every node is both
files	stored and backed up centrally	spread across the peers
security	managed once, on the server	each machine secured separately
weakness	the server is a single point of failure	a file is unavailable when its owner's machine is off

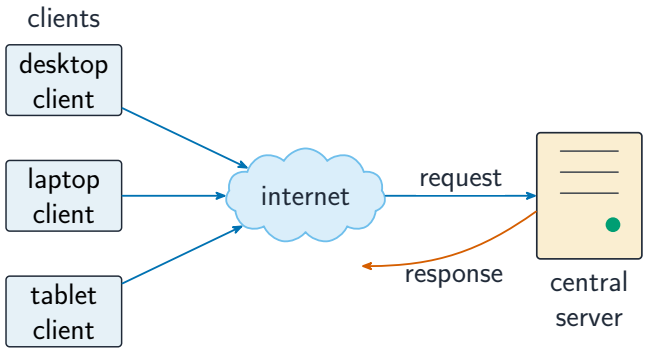
Method — Choosing between the two models

Justifying a model. A school or business wants **client-server**: one login works on any machine, files are backed up in one place, and software and security are managed once – at the cost of the server itself, a technician, and that single point of failure. A few friends sharing files want **peer-to-peer**: nothing to buy, quick to set up, each user keeps control of their own machine.

- An online game played in a browser against other people is **client-server**: the browser is the client, and the shared world runs on the company's server, which is what keeps every player's view consistent.

Method — Choosing between the two models

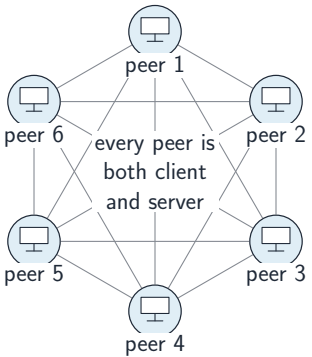
center Justifying a model.



In a client-server network, clients request services from a central server

Method — Choosing between the two models

center Justifying a model.



In a peer-to-peer network, every node is both client and server

Method — Thin and thick clients

	thin client	**thick client**
processing	almost all on the server	on the client itself
storage	almost all on the server	on the client itself
needs the network	always	only to reach shared resources
cost of the client	low	high

Method — Thin and thick clients

- In a **thin-client** model the server processes the data and stores it; the client only sends input and displays output. Cheap terminals, one place to back up and update – but nothing works if the network or server fails.
- In a **thick-client** model the client runs the software and stores its own files, so it still works offline and loads the server less – but every client must be bought, updated and secured.
- A school computer room suits thin clients; a video editor needs a thick client.

Method — How a packet travels in each topology

This is the part most often lost. Say what happens to the **packet**, not just what the diagram looks like.

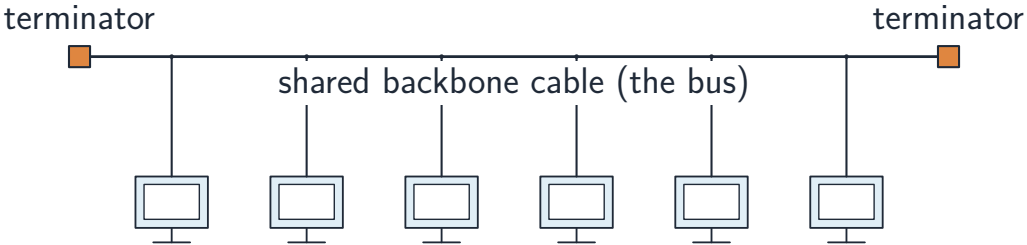
- **Bus** – the sender puts the packet on the one shared cable; **every** device sees it, and only the device whose address matches accepts it. Only one device may transmit at a time, so collisions are possible.
- **Star** – the sender passes the packet to the central **switch** 交换机, which reads the destination address and forwards it **only** down that device's cable. Two other devices can talk at the same moment.
- **Mesh** – the packet is passed from node to node along one of **several possible routes**; if a link fails, another route is used.
- **Hybrid** – a mix, for example a star in each office with mesh links between the offices.

Method — How a packet travels in each topology

Justifying a topology. A classroom or office wants a **star**: one failed cable affects one device, adding a device is easy, and a switch means no collisions. Where reliability matters most – a hospital, an internet backbone – use a **mesh**, because traffic reroutes around a failure. A **bus** only where cost matters and few devices share the cable.

Method — How a packet travels in each topology

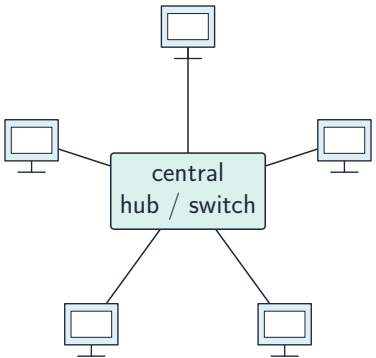
Justifying a topology.



Bus topology: all devices share one cable with a terminator at each end

Method — How a packet travels in each topology

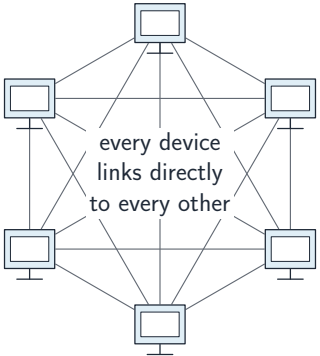
Justifying a topology.



Star topology: every device connects to a central hub or switch

Method — How a packet travels in each topology

Justifying a topology.



Mesh topology: every device links directly to the others

Method — The hardware a LAN is built from

- **NIC** – lets a device send and receive on the network, and carries its unique **MAC address** MAC 地址. A wireless device has a **WNIC**, which converts data to radio signals and back, follows the wireless protocol, and connects the device to an access point.
- **switch** – forwards each frame only to the port for the destination MAC address (a **hub** copies it to every port, which is why hubs are obsolete).
- **wireless access point (WAP)** – lets wireless clients join the wired LAN.
- **server**, **cabling**, **bridge** (joins two LAN segments), **repeater** (retransmits a weakened signal to extend a cable's reach).

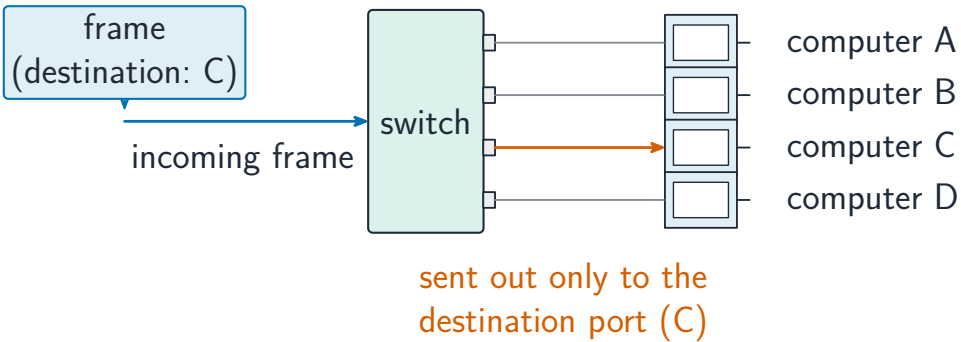
A **router** joins **different** networks. It reads each packet's destination **IP address** and forwards it using a **routing table**, hands out private addresses by DHCP, and performs network address translation so many private addresses share one public one.

Method — The hardware a LAN is built from

- The distinction the scheme wants: a **switch** sends data to a device **within** one LAN using its MAC address; a **router** sends data **between networks** using its IP address. A router does **not** find the IP address for a URL – that is DNS – and it does not store web pages.

Method — The hardware a LAN is built from

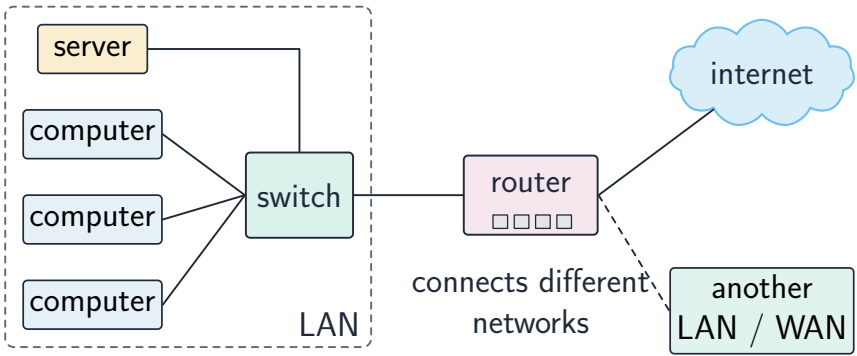
A router joins different networks.



A switch sends each frame only to the port for its destination

Method — The hardware a LAN is built from

A router joins different networks.



A router connects a LAN to the internet or another network

2 Practice

Practice 2.1 ▪ 3 marks

A company has one office building. It is deciding between a client-server and a peer-to-peer network. State which model it should choose, and give **two** reasons.

Solution 2.1

Method: Choosing between the two models — p.6

Worked steps

- **client-server** B1
- any two: files are stored and backed up centrally; one user account works on any machine; software and security are managed once, on the server; the server can be a powerful machine B1 B1

Practice 2.2 ▪ 2 marks

State **two** differences between a **thin client** and a **thick client**.

Solution 2.2

Method: Thin and thick clients — p.10

Worked steps

- any two: a thin client does little or no processing locally, a thick client does its own; a thin client stores almost nothing locally, a thick client stores its own files; a thin client depends on the network at all times, a thick client can work without it; a thin client is cheaper than a thick client B1 B1

Practice 2.3 ▪ 2 marks

Describe how a packet reaches its destination in a **star** topology.

Solution 2.3

Method: How a packet travels in each topology — p.12

Worked steps

- the sending device passes the packet to the central switch B1
- the switch reads the destination address and forwards it **only** down the cable to that device B1

Practice 2.4 ▪ 2 marks

State the role of a **bridge** and the role of a **repeater** in a LAN.

Solution 2.4

Method: The hardware a LAN is built from — p.17

Worked steps

- a **bridge** joins two LAN segments into one network and passes traffic between them B1
- a **repeater** receives a weakened signal and retransmits it at full strength, extending the reach of a cable B1

Practice 2.5 ▪ 2 marks

State **one** difference between a switch and a router.

Solution 2.5

Method: The hardware a LAN is built from — p.17

Worked steps

- a switch sends data to a device **within** one LAN, using its MAC address B1
- a router sends data **between different networks**, using the IP address B1

3 Exam-style

Exam-style 3.1 ▪ 5 marks

A university has two campuses, five kilometres apart. Each campus has several computer rooms.

Exam-style 3.1 (a) ▪ 2 marks

State the type of network used **within** one campus, and the type used **between** the two campuses.

Solution 3.1 (a)

Method: Justifying LAN or WAN — p.4

Worked steps

within one campus: a **LAN**; between the two campuses: a **WAN** B1 B1

Exam-style 3.1 (b) ▪ 3 marks

Justify your answer to part (a), referring to the area covered **and** to who owns the links.

Solution 3.1 (b)

Worked steps

a LAN covers a small area – one site or building – and the university owns its own switches and cabling B1

- the campuses are five kilometres apart, which is a large geographical area B1
- the link between them must be leased from a telecommunications company rather than owned, which is what makes it a WAN B1

Exam-style 3.2 ▪ 5 marks

A hospital is choosing a topology for the network that links its critical servers.

Exam-style 3.2 (a) ▪ 1 mark

State which topology it should choose.

Solution 3.2 (a)

Method: How a packet travels in each topology — p.12

Worked steps

a **mesh** topology B1

Exam-style 3.2 (b) ▪ 3 marks

Explain, by describing how a packet travels, why this topology suits the hospital.

Solution 3.2 (b)

Worked steps

every device is linked directly to others, so there are several possible routes between any two B1

- a packet is passed from node to node along one of those routes B1
- if a link or device fails, the packet is rerouted along another path, so the network keeps working – which is what a hospital needs B1

Exam-style 3.2 (c) ▪ 1 mark

State **one** drawback of this topology.

Solution 3.2 (c)

Worked steps

it needs a great deal of cabling, so it is expensive to install and to extend B1

Exam-style 3.3 ▪ 4 marks

A design company replaces its desktop computers with thin clients.

Exam-style 3.3 (a) ▪ 2 marks

Describe how the processing and storage are shared between the client and the server after the change.

Solution 3.3 (a)

Method: Thin and thick clients — p.10

Worked steps

the **server** does the processing and stores the data B1

- the client only sends the user's input and displays the output it receives B1

Exam-style 3.3 (b) ▪ 2 marks

Give **one** benefit and **one** drawback of the change for the company.

Solution 3.3 (b)

Worked steps

benefit, any one: the client machines are cheap; everything is backed up, updated and secured in one place B1

- drawback, any one: nothing works if the network or the server fails; the server must be powerful enough for every client at once B1

Exam-style 3.4 ▪ 9 marks

A small office LAN has six computers, a printer and a connection to the internet.

Exam-style 3.4 (a) ▪ 6 marks

Name **three** items of hardware the LAN needs, and state the function of each.

Solution 3.4 (a)

Method: Justifying LAN or WAN — p.4

Worked steps

any three, one mark for the name and one for the function B1 *x 6*:

- **switch** – connects the devices in the LAN and forwards each frame only to the port for its destination
- **NIC** – lets a device send and receive on the network, and carries its unique MAC address
- **router** – connects the LAN to the internet and forwards packets between the two networks
- **cabling** – carries the signals between the devices and the switch

Solution 3.4 (a)

- **WAP** – lets wireless devices join the wired LAN
- **server** – provides a service to the other devices, such as files or printing

Exam-style 3.4 (b) ▪ 3 marks

Describe the role and function of the **router**.

Solution 3.4 (b)

Worked steps

it joins the LAN to a **different** network, here the internet B1

- it reads each packet's destination **IP address** and forwards it using its routing table B1
- any one further function: it hands out private IP addresses by DHCP; it performs network address translation so the LAN shares one public address; it acts as a firewall B1