

Exercise walk-through

2.1.2

Cloud computing, transmission media, Ethernet and CSMA/CD, and internet hardware

A-Level Computer Science

You must be able to

- show understanding of cloud computing, including the use of **public** and **private** clouds, and its benefits and drawbacks
- show understanding of the differences between, and the implications of using, **wireless** and **wired** networks
- describe the characteristics of **copper cable**, **fibre-optic cable** 光纤, **radio waves** (including WiFi), **microwaves** and **satellites**
- show understanding of Ethernet and how collisions are **detected and avoided**, including **CSMA/CD**
- describe the hardware that supports the internet: **modems** 调制解调器, the **PSTN**, **dedicated lines** 专线 and the **cell phone network** 蜂窝网络

1

The method

Method — Cloud computing, and the two kinds of cloud

The one-mark definition the scheme wants, learnt as a sentence: cloud computing is **on-demand computing services – storage, processing, software – provided over the internet by a third party.**

- A **public cloud** is owned by a provider and shared by many customers over the public internet.
- A **private cloud** is dedicated to **one** organisation, on its own hardware or hosted for it alone.

The difference is **who may use it**, not where the hardware sits. That is the distinction the mark scheme tests.

Benefits	Drawbacks
reachable from any device with an internet connection	nothing is reachable without an internet connection
storage and processing scale up and down, and you pay only for what you use	the data sits on a third party's hardware, so security and privacy depend on them
the provider handles the hardware, the backups and the security updates	an ongoing subscription cost rather than a one-off purchase
no local server to buy, house or maintain	the provider could fail or be attacked; large files may be slow to transfer

Method — Cloud computing, and the two kinds of cloud

- A “**justify**” answer must join a property of the cloud to **this** organisation’s situation. “It is cheaper” earns little; “they need no server of their own and pay only for the storage they use, and their staff reach the files from any site” earns the marks.

Method — The five transmission media

The exam asks for **characteristics**, so give a property, not a verdict.

Medium	Characteristics
copper cable (twisted pair, coaxial)	cheap and easy to install; carries an electrical signal; affected by electromagnetic interference ; the signal weakens over distance, so repeaters are needed; lower bandwidth than fibre
fibre-optic cable	light pulses in a glass core; very high bandwidth; long distances without repeaters; immune to interference; hard to tap, so secure; expensive, and needs skilled installation
radio waves (WiFi)	no cable, so devices can move; a range of tens of metres, weakened by walls; a shared frequency, so interference and lower speed; can be intercepted, so needs encryption
microwaves	higher-frequency radio for point-to-point links; needs a line of sight ; affected by rain and buildings; high bandwidth
satellites	reach remote areas and the whole globe; a long delay (latency), because the signal travels to orbit and back; affected by weather; expensive

Method — The five transmission media

And the comparison, which is asked in both directions:

- **wired beats wireless** on speed, reliability (no interference), security (a cable has to be physically tapped) and consistency.
- **wireless beats wired** on mobility, on installation cost, and on adding a device without running new cable.

Method — Ethernet and CSMA/CD

Ethernet is the standard for wired LANs: devices are joined by twisted-pair or fibre cable, and data travels in **frames** carrying the source and destination **MAC addresses**. On a shared medium two devices can send at once, and the result is a **collision** 冲突. **CSMA/CD** is Carrier Sense Multiple Access with Collision Detection, and its name is its method:

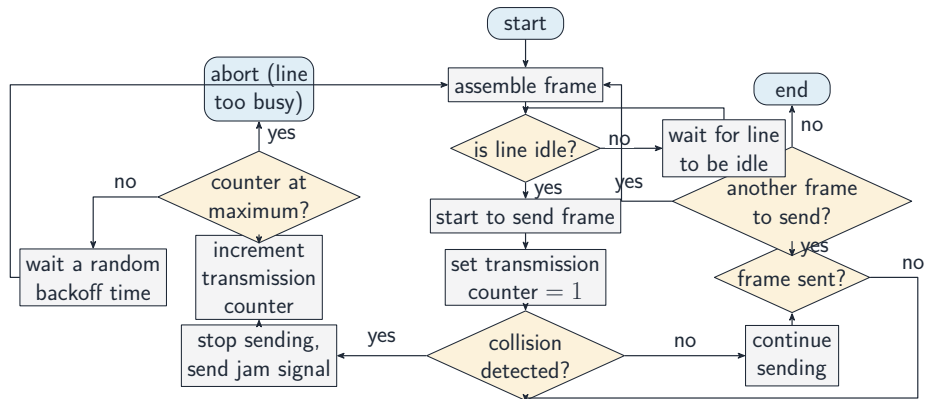
- 1 **carrier sense** – listen to the cable before sending, and wait if it is busy.
 - 2 **multiple access** – many devices share the one medium.
 - 3 **collision detection** – keep listening **while** transmitting; a clash is a collision.
 - 4 on a collision, both devices stop, send a brief **jam signal** so every device knows, then wait a **random backoff** time before retrying.
- The random wait is the part most often left out, and it is a mark. If both waited the **same** time they would collide again immediately.

Method — Ethernet and CSMA/CD

- Modern **switched** Ethernet gives each device a full-duplex point-to-point link, so collisions no longer occur at all.

Method — Ethernet and CSMA/CD

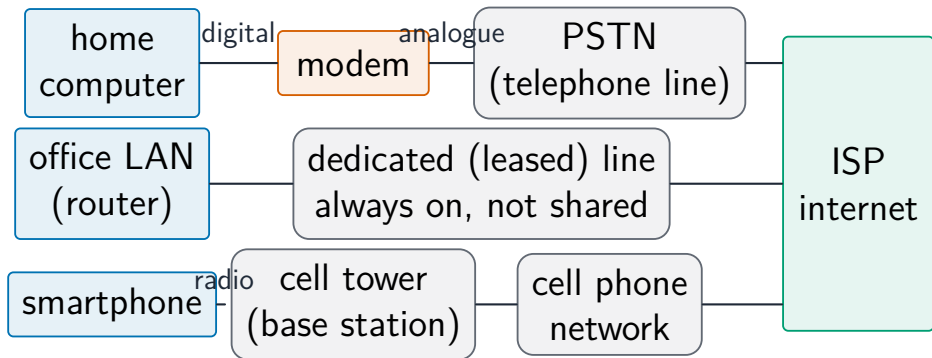
Ethernet is the standard for wired LANs: devices are joined by twisted-pair or fibre cable, and data travels...



Method — The hardware that supports the internet

- **modem** – converts the computer's **digital** signal into an **analogue** signal for a telephone line, and back again at the other end. The name is **modulator-demodulator**.
- **PSTN** – the public switched telephone network of exchanges and lines; a dial-up or DSL connection carries internet data over it.
- **dedicated line** – a leased line between an organisation and its ISP: always on, with a fixed bandwidth that is **not shared**, so faster and more reliable, but expensive.
- **cell phone network** – the phone sends data by radio to the nearest cell tower (base station); the towers link to the phone company's network, which routes the data on to the internet. As the phone moves it is **handed over** from one cell to the next.

Method — The hardware that supports the internet



2

Practice

Practice 2.1 ■ 1 mark

State what is meant by **cloud computing**.

Solution 2.1

Method: Cloud computing, and the two kinds of cloud — p.4

Worked steps

- on-demand computing services – storage, processing or software – provided **over the internet** by a **third party** B1

Practice 2.2 ■ 2 marks

State **one** difference between a **public cloud** and a **private cloud**.

Solution 2.2

Method: Cloud computing, and the two kinds of cloud — p.4

Worked steps

- a **public** cloud is owned by a provider and shared by many customers over the public internet **B1**
- a **private** cloud is dedicated to **one** organisation, on its own hardware or hosted for it alone **B1**
- the difference is **who may use it**, not where the hardware is kept

Practice 2.3 ■ 2 marks

Give **two** characteristics of fibre-optic cable that copper cable does not have.

Solution 2.3

Method: The five transmission media — p.6

Worked steps

- any two: a much higher bandwidth; it carries light, so it is immune to electromagnetic interference; it runs far longer distances without a repeater; it is hard to tap, so it is more secure **B1** **B1**

Practice 2.4 ■ 2 marks

State what the letters **CSMA/CD** stand for, and state what a device does during the **carrier sense** stage.

Solution 2.4

Method: Ethernet and CSMA/CD — p.8

Worked steps

- **Carrier Sense Multiple Access with Collision Detection** (B1)
- carrier sense: the device **listens to the medium before transmitting**, and waits if another device is already sending (B1)

Practice 2.5 ■ 2 marks

Describe the function of a **modem**.

Solution 2.5

Method: The hardware that supports the internet — p.11

Worked steps

- it converts the computer's **digital** signal into an **analogue** signal that a telephone line can carry **B1**
- and converts the analogue signal back to digital at the receiving end (modulation and demodulation) **B1**

3

Exam-style

Exam-style 3.1 ■ 4 marks

A small company currently keeps its files on a server in its own office. It is considering moving them to a **public cloud**. Give **two** benefits and **two** drawbacks of making this change.

Solution 3.1

Method: Cloud computing, and the two kinds of cloud — p.4

Worked steps

- benefits, any two: the files are reachable from any site or device with an internet connection; the storage scales up or down and they pay only for what they use; the provider handles the hardware, the backups and the security updates; there is no server to buy, house or maintain **B1** **B1**
- drawbacks, any two: nothing is reachable without an internet connection; the data sits on a third party's hardware, so its security and privacy depend on the provider; there is an ongoing subscription cost instead of a one-off purchase; the provider could fail or be attacked; large files may be slow to transfer **B1** **B1**

Exam-style 3.2 ■ 6 marks

For each situation, name the most suitable transmission medium and give **one** reason for your choice.

Exam-style 3.2 (a)

a link between two office buildings on opposite sides of a valley,
with a clear view between them

Solution 3.2 (a)

Method: The hardware that supports the internet — p.11

Worked steps

microwave B1

- a microwave link is point-to-point and needs a **line of sight**, which the clear view across the valley provides, and it avoids laying cable across the valley

B1

Exam-style 3.2 (b)

the backbone cable carrying all the traffic of a university campus

Solution 3.2 (b)

Worked steps

fibre-optic cable B1

- it has the bandwidth to carry the whole campus's traffic, runs the distance without repeaters and is immune to interference B1

Exam-style 3.2 (c)

an internet connection for a research station in a desert, hundreds of kilometres from the nearest cable

Solution 3.2 (c)

Worked steps

satellite B1

- it reaches a place no cable does; the delay and the cost are accepted because there is no alternative B1

Exam-style 3.3 ■ 4 marks

Two computers on a shared Ethernet cable begin to transmit at the same moment.

Describe what each computer does from the moment the collision occurs until the data is successfully sent.

Solution 3.3

Method: Ethernet and CSMA/CD — p.8

Worked steps

- both computers **detect the collision** while they are still transmitting, because each keeps listening to the medium as it sends (B1)
- both **stop transmitting** immediately and send a short **jam signal**, so that every device on the medium knows a collision has occurred (B1)
- each then waits a **random** length of time – the backoff (B1)
- when its wait ends, a computer listens again to check the medium is idle and retransmits; the waits are random so the two are very unlikely to clash a second time (B1)

Exam-style 3.4 ■ 4 marks

A school is wiring a new building. The desktop computers in the labs will use wired connections, and there will also be wireless access points for laptops and phones.

Explain why the school uses **both**, rather than only one.

Solution 3.4

Method: The five transmission media — p.6

Worked steps

- the wired connections give the lab computers higher speed, lower latency and fewer errors, and they are more secure because a cable has to be physically tapped **B1**
- the lab computers never move, so they lose nothing by being cabled **B1**
- the wireless access points let laptops and phones **move** around the building and join without new cable being run to each seat **B1**
- adding a device costs nothing in cabling, and a device with no network port can still connect; the school accepts the lower speed and the interference for those devices **B1**

Exam-style 3.5 ■ 5 marks

A remote research station needs an internet connection. Three options are suggested: a **modem over the PSTN**, a **dedicated line**, and a **satellite** link.

Exam-style 3.5 (a) ■ 2 marks

State **one** advantage and **one** disadvantage of the dedicated line.

Solution 3.5 (a)

Method: The hardware that supports the internet — p.11

Worked steps

advantage: it is **always on**, with a fixed bandwidth that is **not shared** with other customers, so it is faster and more reliable **B1**

- disadvantage: it is **expensive**, and a physical line must be installed all the way to the ISP **B1**

Exam-style 3.5 (b) ■ 3 marks

The station is 400 km from the nearest telephone exchange. State which option must be used, and give **two** consequences of that choice.

Solution 3.5 (b)

Worked steps

satellite B1

- any two consequences: there is a noticeable **delay**, because every signal travels to orbit and back, which makes real-time use such as video calling awkward; the link is affected by **weather**; it is expensive, both the equipment and the service

B1 B1

- neither of the others can be used: a modem needs a telephone line and a dedicated line needs cable laid the whole 400 km