

Exercise walk-through

Types and methods of data transmission ■ 2.1

eXercise

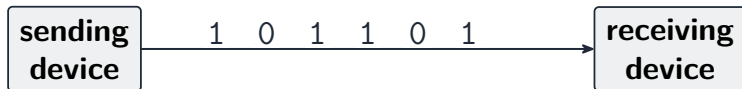
You must be able to

- describe a packet (header, payload, trailer) and packet switching
- compare serial and parallel transmission
- compare simplex, half-duplex and full-duplex

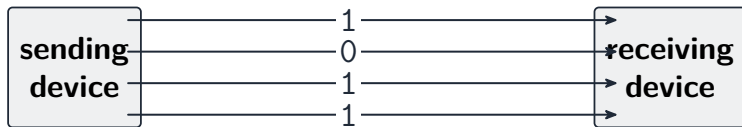
Method — Transmission methods

- a **packet** has a header (addresses, packet number), payload (data) and trailer (error check).

Method — Transmission methods



serial: one bit at a time, one wire



parallel: several bits at once, several wires

Serial (one wire) vs parallel (several wires)

Method — Transmission methods

simplex  one way only (computer → printer)

half-duplex  both ways, one at a time (walkie-talkie)

full-duplex  both ways at the same time (phone call)

Simplex, half-duplex, full-duplex

Method — Serial or parallel, simplex or duplex, and the checks

Data transmission 数据传输 is described by two independent choices.

Choice	Options	What it means
how many wires	serial 串行	one bit at a time down a single wire
	parallel 并行	several bits at once, one per wire
which directions	simplex 单工	one direction only
	half-duplex 半双工	both directions, but only one at a time
	full-duplex 全双工	both directions at the same time

Method — Serial or parallel, simplex or duplex, and the checks

Serial is used over long distances because it is reliable and cheap: with parallel, bits sent together can arrive at slightly different times (**skew**), and the wires interfere with each other, so parallel is only used over short distances such as inside a computer.

Universal serial bus (USB) is serial and half-duplex. It is widely used because the connector only fits one way, the device is detected automatically and the right driver loaded, it carries power as well as data, and it is an industry standard.

Method — Serial or parallel, simplex or duplex, and the checks

Error checking after transmission. A **parity check** 奇偶校验 adds one parity bit to each byte so that the number of 1s is even (even parity) or odd (odd parity); the receiver counts the 1s and rejects a byte whose count is wrong. It cannot detect two errors that cancel, and cannot say which bit is wrong. A **checksum** 校验和 adds up the bytes in a block and sends the total with it; the receiver recalculates and compares. An **echo check** sends the data back to the sender to be compared with the original, which is thorough but doubles the traffic and cannot say where the error happened. An **automatic repeat request (ARQ)** uses acknowledgements and a timeout to ask for a resend.

Method — Serial or parallel, simplex or duplex, and the checks

Worked example (parity). The byte 0110101 is to be sent with even parity in the eighth bit. It contains four 1s, which is already even, so the parity bit is 0 and the byte sent is 01101010. If the byte arrived as 01101011, the receiver would count five 1s, an odd number, and reject it.

Practice 2.1 ■ 3 marks

Name the three parts of a packet.

Solution 2.1

Worked steps

header; payload; trailer **B1** **B1** **B1**.

Practice 2.2 ■ 2 marks

State the difference between serial and parallel transmission.

Solution 2.2

Worked steps

serial sends one bit at a time down one wire **M1**; parallel sends several bits at once down several wires **A1**.

Practice 2.3 ■ 2 marks

Identify the type of transmission used by USB, in both senses (serial or parallel, and which directions).

Solution 2.3

Method: Serial or parallel, simplex or duplex, and the checks

Worked steps

Serial **B1** and half-duplex **B1**.

Practice 2.4 ■ 2 marks

Complete the parity bit for the byte 1011011 using odd parity, and state the value you chose.

Solution 2.4

Method: Serial or parallel, simplex or duplex, and the checks

Worked steps

1011011 has five 1s, which is already odd, so the parity bit is 0 **B1**; the byte sent is 10110110 **B1**.

Practice 2.5 ■ 2 marks

Give two reasons why USB is widely used.

Solution 2.5

Method: Serial or parallel, simplex or duplex, and the checks

Worked steps

Any two of: the connector only fits one way; the device is detected automatically and the driver is loaded; it carries power as well as data; it is an industry standard used by almost all devices **B2**.

Exam-style 3.1 ■ 1 mark

A walkie-talkie, where only one person speaks at a time, uses:

- A** simplex
- B** half-duplex
- C** full-duplex
- D** parallel

Solution 3.1

Method: Serial or parallel, simplex or duplex, and the checks

- A simplex
- B half-duplex
- C full-duplex
- D parallel



Worked steps

- B. One at a time both ways is half-duplex.

Exam-style 3.2 ■ 2 marks

Data is sent across a network as packets.

- (a) State two benefits of sending data as packets.
- (b) Explain why packets may need to be reordered at the receiver.

Solution 3.2

Method: Serial or parallel, simplex or duplex, and the checks

Worked steps

- (a) any two of: only a lost packet is resent (not the whole file); packets can take different routes; many users share the connection **B1** **B1**.
- (b) packets can take different routes and arrive out of order **M1**; the packet numbers are used to put them back in the right order **A1**.

Exam-style 3.3 ■ 3 marks

A weather station sends readings to a computer 200 metres away.

- (a) Identify the method of transmission that should be used over this distance, and explain why.
- (b) The station only ever sends data and never receives it. Give the name of this type of transmission.
- (c) Each reading is sent as a byte with even parity. Complete the table by giving the parity bit for each byte.

Data bits	Parity bit
0110110	
1111011	
0000001	

Exam-style 3.3 ■ 3 marks

- (d) Explain why a parity check would not detect the error if two bits were changed during transmission.
- (e) Describe how an echo check works, and give one disadvantage of using it.
- (f) The computer is connected to a printer with a USB cable. Give two benefits of using USB.

Solution 3.3

Method: Serial or parallel, simplex or duplex, and the checks

Worked steps

- (a) Serial transmission **B1**; over 200 metres parallel wires would suffer skew, with bits arriving at different times **B1**, and the wires would interfere with each other, so serial is more reliable and needs less cable **B1**.
- (b) Simplex **B1**.
- (c) 0110110 has four 1s, so the parity bit is 0 **B1**; 1111011 has six 1s, so the parity bit is 0 **B1**; 0000001 has one 1, so the parity bit is 1 **B1**.
- (d) A parity check only counts the number of 1s **B1**; if one bit changes from 0 to 1 and another from 1 to 0, the count is unchanged and the byte passes the check even

Solution 3.3

though it is wrong **B1**.

(e) The data is sent to the receiver, which sends a copy straight back to the sender **B1**; the sender compares the returned copy with what it sent, and if they differ the data is sent again **B1**. Disadvantage: it doubles the traffic, or it cannot tell whether the error happened on the way out or on the way back **B1**.

(f) Any two of: the connector fits only one way; the device and driver are detected automatically; it carries power; it is a universal standard **B2**.