IGCSE COMPUTER SCIENCE • EXERCISE SHEET

2.2 Methods of error detection

Name: _____ Class: _____ Date: _____ **Total: 27 marks**

KEY WORDS parity check 奇偶校验 • echo check 回送校验 • checksum 校验和 • parity bit 奇偶校验位 • check digit 校验码

Objective

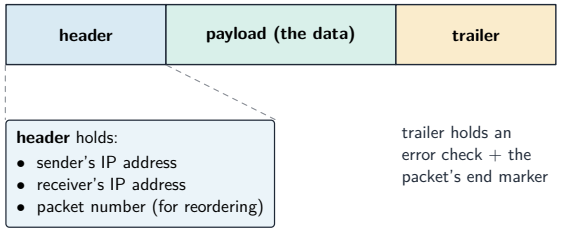
Build the skills to answer exam questions on **error detection** 错误检测 — **parity check** 奇偶校验, **checksum** 校验和, **ARQ** 自动重传请求, and **check digit** 校验码.

You must be able to:

- work out a parity bit and detect a parity error
- describe checksum, echo check and ARQ
- describe a check digit and the errors it catches

1 Worked examples

■ Parity and ARQ



The trailer carries an error check; the receiver checks the data arrived correctly

- **even parity:** total number of 1s must be even; add a parity bit to make it so.
- **ARQ:** receiver sends an acknowledgement; no positive one before the timeout → resend.

■ Networks: name it, then say what it does

LAN or WAN? A **local area network (LAN)** 局域网 covers a small area such as one building and its cabling belongs to the owner. A **wide area network (WAN)** 广域网 covers a large geographical area and uses third-party communication links; the internet is the largest WAN.

The hardware, and what each does:

Device	What it does
network interface card (NIC) 网卡	gives the device its MAC address and lets it connect
switch 交换机	joins devices on one LAN and sends a frame only to the port of the device it is addressed to, using a look-up table of MAC addresses
router 路由器	joins different networks, reads IP addresses and forwards packets towards the right network
wireless access point 无线接入点	lets Wi-Fi devices join the wired network
modem 调制解调器	converts between the computer's digital signal and the analogue signal a telephone line carries

MAC address or IP address? The **MAC address** 物理地址 is fixed in the hardware and identifies the device itself on the local network; it is written as six pairs of hexadecimal digits, such as `00-1C-B3-4F-25-FE`. The **IP address** 网际协议地址 identifies the device's position on a network and can change when the device moves to another network. A switch works with MAC addresses; a router works with IP addresses.

Wired or wireless? Wired is faster, more reliable and more secure, because the signal cannot be picked up outside the building; wireless allows movement, needs no cabling and is cheaper to install, but is slower, can be blocked by walls and must be encrypted with a network key.

Worked example. A school connects 30 computers in one room and links them to the internet. Which devices does it need, and why? A NIC in each computer to connect it; a switch to join the computers in the room, because it sends each frame only to the addressed device and so wastes no bandwidth; a router to connect the room's network to the internet, because it forwards packets between different networks using IP addresses; and a wireless access point if tablets must also join.

2 Practice

2.1 State what a parity bit is used for. [1]

2.2 State one error a check digit can detect. [1]

2.3 Give two differences between a LAN and a WAN. [2]

2.4 Identify the device that uses MAC addresses to send data only to the correct port, and the device that connects two different networks. [2]

2.5 Give two advantages of a wired connection over a wireless one. [2]

3 Exam-style questions

3.1 Using **even** parity, the parity bit for the data `1101001` is: [1]

- **A** 0
- **B** 1
- **C** either
- **D** none

3.2 Data is checked using a checksum.

(a) Describe how a checksum detects an error. [2]

(b) Explain why a parity check might fail to detect an error. [2]

3.3 Describe how Automatic Repeat reQuest (ARQ) ensures data arrives correctly. [2]

3.4 A small office has eight computers, a printer and an internet connection.

(a) Identify the type of network the eight computers form, and justify your answer. [2]

(b) Complete the table by naming the device that performs each task. [3]

Task	Device
gives each computer a MAC address and connects it to the network	
sends data only to the port of the computer it is addressed to	
connects the office network to the internet	

(c) Explain the difference between a MAC address and an IP address. [3]

(d) The office adds Wi-Fi for visitors' laptops. Give one benefit and one drawback compared with wired connections. [2]

(e) Explain why the Wi-Fi should use a network key. [2]

Solutions

2.1 to detect an error in a byte after transmission.

2.2 any of: an incorrect digit; a transposition error; a missing/extra digit.

2.3 Any two of: a LAN covers a small area such as one building while a WAN covers a large geographical area; a LAN's cabling belongs to the owner while a WAN uses third-party links; a LAN is usually faster.

2.4 A switch; a router.

2.5 Any two of: it is faster; it is more reliable, with fewer dropouts; it is more secure, because the signal cannot be picked up outside the building.

3.1 A. `1101001` already has four 1s (even), so the even-parity bit is `0`.

3.2 (a) the checksum is calculated from the data before sending and re-calculated at the receiver; if the two values differ, an error has occurred.
(b) if two bits flip, the number of 1s may still be correct, so the parity check passes despite the error.

3.3 the receiver sends a positive or negative acknowledgement; if the sender gets no positive acknowledgement before a timeout, it resends the packet.

3.4 (a) A LAN, because the computers are in one building over a small area and the office owns the cabling.
(b) Network interface card (NIC); switch; router.
(c) A MAC address is fixed in the hardware by the manufacturer and identifies the device itself; an IP address identifies where the device is on a network and can change when it joins a different network; a switch uses MAC addresses within the LAN while a router uses IP addresses between networks.
(d) Benefit: visitors can move around and no cabling is needed for them. Drawback: it is slower or less secure, and walls can weaken the signal.
(e) Without a key anyone within range could join the network and could intercept the data being transmitted, so the key encrypts the traffic and keeps outsiders out.