



ALIGNED WITH THE 2023-2025 SYLLABUS

**CAIE IGCSE**

# COMPUTER SCIENCE (0478)

**THEORY**

# 1. Data Transmission

## 1.1. Types and Methods of Data Transmission

### Data Packets

- Packet Structure -
  - Header
    - Contains the IP address of the sender and the receiver
    - The sequence number of the packet
    - Size of the packet
  - Payload
    - Contains the actual data
  - Trailer
    - Includes a method of identifying the end of the packet
    - Error-Checking methods
- Packet Switching - Method of data transmission where the data is broken into multiple packets. Packets are then sent independently from start to end and reassembled at the receiver's computer.

Advantages	Disadvantages
There is no need to create a single line of communication	Packets may be lost
Possible to overcome failed or busy nodes	More prone to errors in real-time streaming
High data transmission speed	Delay at the receiver while the packets are being re-ordered
Easy to expand package usage	

### Data Transmission

- Simplex data transmission* is in one direction only (e.g. computer to printer)
- Half-duplex data transmission is in both directions but not at the same time (e.g., walkie-talkie)
- Full-duplex data transmission* is in both directions simultaneously (e.g. broadband connection on the phone line)
- Serial data transmission* is when data is sent one bit at a time over a single wire
- Parallel data transmission* is when data of several bits (1 byte) are sent down several wires at the same time.

### Comparison of Serial and Parallel Data Transmission

Serial	Parallel
Better for longer distances (Telephone Lines)	Better for short distances (Internal circuits)
Cheaper Option	Expensive (More hardware required)
Used when the size of data transmitted is small	Used when speed is necessary
Slower Option	Faster than Serial
Easier to synchronise as there's only one data stream.	Difficult to synchronise due to skew between bits.

## 1.2. Universal Serial Bus (USB)

- USB is an asynchronous serial data transmission method
- USB consists of:
  - Four-wire shielded cable
  - Two wires are used for power and earth
  - Two wires are used in data transmission

Advantages	Disadvantages
Automatically detected	Transmission rate is less than 120 MB/sec
Only fit one way, prevents incorrect connections	Maximum cable length is about 5 metres
Different data transmission rates	
Backwards compatible	
Industry-standard	

## 1.3. Methods of Error Detection

### Parity Checks

- It uses the number of 1-bits in a byte
- Two Types -
  - Even - Even number of 1-bits
  - Odd - Odd numbers of 1-bits
- Example (Even Parity) -

0	1	0	1	1	0	1	0
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- The **LMB (Left-Most Bit)** is the parity bit. As the number of 1s is even, the parity bit would be set to even.

#### Limitations with Parity Checks

- Two bits may change during transmission; therefore error is not found
- Even though the parity checks would reveal the errors, the bit(s) changed wouldn't be identified

### Parity Blocks

- To overcome the limitations of parity bits, Parity blocks would be used.

	1	2	3	4	5	6	7	
A	1	0	1	1	1	1	1	0
B	1	1	0	1	0	0	0	1
C	1	0	1	1	0	1	1	1
D	1	1	0	1	0	0	1	1
E	1	1	1	0	0	1	0	0
	1	1	1	0	0	1	1	1

- Any changes in bits would be identified through the rows and columns

### Checksum

- Whenever a block of data needs to be sent, the sender would calculate the checksum value using a specific algorithm.
- Once the data has been sent, The receiver would calculate the checksum again with the same set of data and the same algorithm used before.
- The receiver would then compare the value received and the newly calculated value. If they aren't matched, A request is made to re-send the data.

### Echo Check

- Once the data has been sent, The receiver will send the data back to the sender for verification.
- The sender would compare the received and original data for errors.
- The only downside is that we wouldn't know if the error occurred when sending the data or sending the data back for verification.

### Check Digits

- Check digits are calculated from all the other digits in the data (ex-codes). The check digit would be the last digit of the code.
- These are used to identify mistyping errors such as -
  - 6372 typed as 6379
  - 8432 typed as 842

### Automatic Repeat Requests (ARQs)

- Uses acknowledgements and timeouts to make sure the user received the data
- The receiver would check the data for any errors; if none are found, a positive acknowledgement is sent to the sender. However, if errors are found, a negative acknowledgement will be sent, and the data will be sent again.
- The sender uses timeouts to wait for a pre-determined amount for the acknowledgement.
- If no acknowledgements are received after the timeout, the data will be sent again to the receiver.

## 1.4. Encryption

- Encryption is a process of turning the data into an unreadable form so it doesn't make sense to hackers and other attackers.

### Plaintext and Ciphertext

- Plaintext is the original data that is being sent
- Ciphertext is the text produced after encryption

### Symmetric and Asymmetric Encryption

- Symmetric Encryption:
  - It uses an encryption key for the encryption process; the same key is used for encrypting and decrypting the data.
- Asymmetric Encryption:
  - Uses a public key and a private key. The public key is available to everyone, whereas the private key is only available to the user.
  - The receiver would have the private key, and they would send the public key to the sender. The sender can encrypt the message with the public key, and the data can be decrypted using the private key.

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