OCR Computer Science AS Level

1.3.3 Networks

Intermediate Notes

Specification

1.3.3 a)

- Characteristics of a Network
- Importance of Protocols and Standards

1.3.3 b)

- The internet Structure:
  - The TCP/IP stack
  - Protocol Layering
  - LANs and WANs
  - DNS
  - Packet and Circuit Switching

1.3.3 c)

- Client-server
- Peer-to-peer

Networks and Protocols

Characteristics of a network

A network is the name given to two or more computers connected together with the ability to transmit data between each other. There are two main types of networks: Local Area Networks and Wide area networks.

Local area network (or LAN) is the name given to a network which is spread over a small geographical area or a single site, for example: a school. A wide area network (or WAN) is the name given to a network which is spread over a large geographical area.

Protocols

A protocol is a set of rules defining how two computers communicate with each other. Protocols are standard so that all devices have a designated method of communicating with each other, regardless of manufacturer.

Examples of commonly used protocols are:

- HTTP – Used for web page rendering
- TCP/IP – A networking protocol used in the routing of packets through networks
- POP3 and IMAP – Mailing protocols, used for email access.
- FTP – Used for the transmission of files over networks.

The Internet Structure

The Internet is a network of networks which allows computers on opposite sides of the globe to communicate with each other. Continents are connected to each other using large international backbone cables.

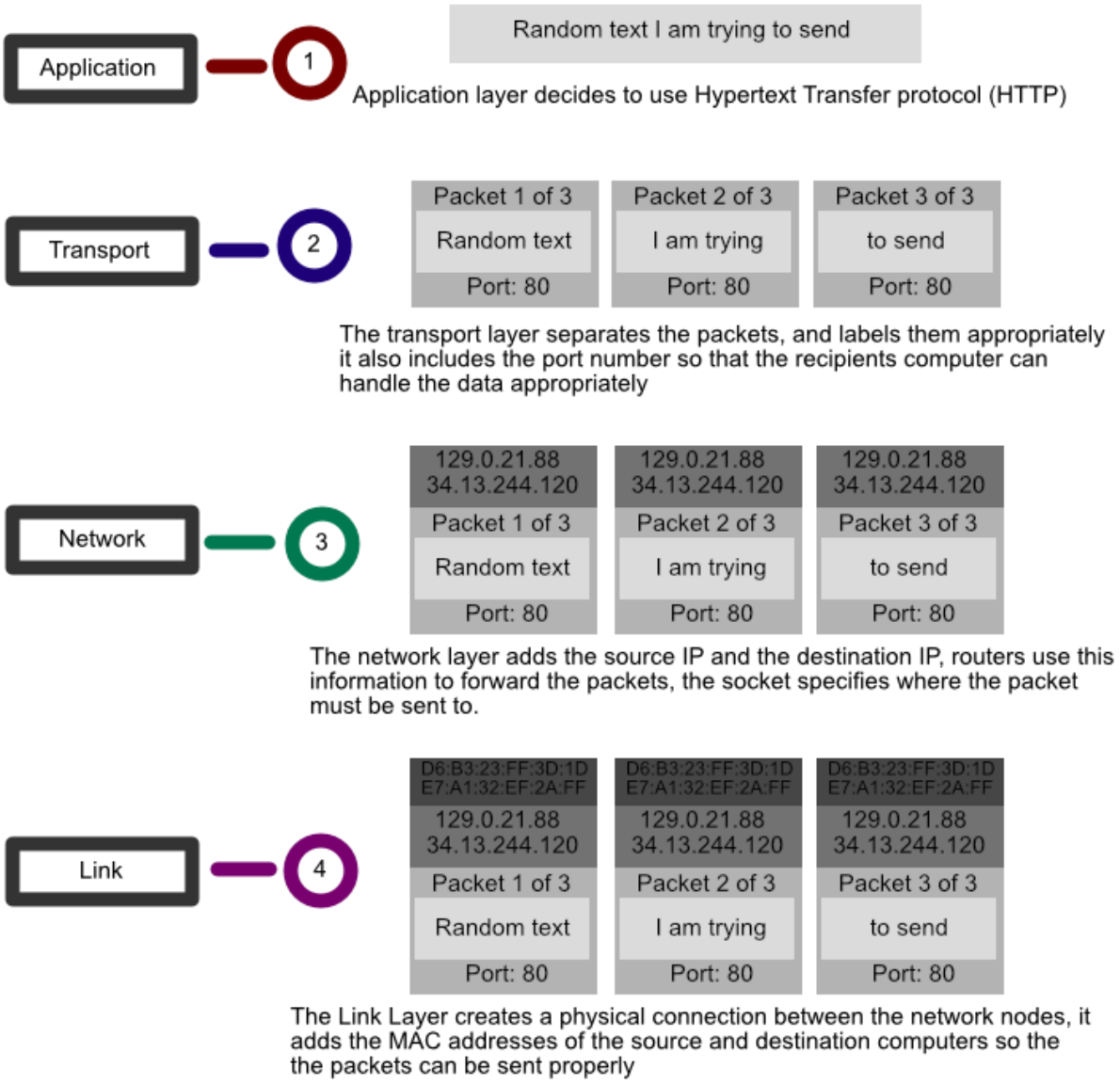
The TCP/IP Stack and protocol layering

TCP/IP is a stack of networking protocols that work together passing packets during communication. They work as follows:

- Application Layer
  - Specifies the protocol that needs to be used in order to relate the application that's being sent.
  - For example, if the application is a web browser then it would select the appropriate protocol such as HTTP
- Transport Layer
  - Establishes end-to-end connection between the source and the recipient computer
  - Splits up data into packets and labels these packets with their packet number, the total number of packets original data was split up into and the port number being used for communication

- Network Layer
  - Adds the source and destination IP addresses.
  - Routers use IP addresses and sockets to forward the packets to the specified destination
- Link Layer
  - Adds the MAC address identifying the Network Interface Cards of the source and destination computers

Below is a diagram showing exactly what happens in the process of sending a file.



LANs and WANs

As specified earlier, a LAN is a local area network and a WAN is a wide area network. A LAN is a network spread over a small geographical area while a WAN is typically spread over a large geographical area. Infrastructure used in WANs is owned by third-parties. The largest WAN is the Internet, and is made up of a series of smaller networks.

DNS

The domain name system (DNS) is the system used to name and organise internet resources. It is a hierarchy, in which each smaller domain is separated from the larger domain by a full stop. Domain names are much easier to remember than IP addresses, which is why they are used to link to servers across the world. The role of the domain name system server (DNS server) is to translate these domain names into IP addresses when we wish to access a website.

Network Communication

Data Packets

Packets are segments of data. They contain various information:

- Header:
  - Sender and recipient IP addresses
    Allow the packet to be delivered to the correct destination and enables the recipient device to trace where the packet came from.
  - Protocol being used
    Allows the recipient computer to interpret the packet.
  - Order of the packets
    Used to reconstruct data from packets
  - Time To Live / Hop Limit
    Tells the packet when to expire so that it does not travel forever.
- Payload
  - Raw data to be transmitted
- Trailer
  - Checksum, or cyclic redundancy check
    Code used to detect whether any errors have occurred during transmission.

Circuit Switching and Packet Switching

There are two techniques using which networks exchange data: circuit switching and packet switching.

Packet switching is a method of communication in which data is communicated using packets across a network. Packets are sent across the most efficient route, which can vary for each packet.

Advantages	Disadvantages
Multiple methods to ensure data arrives intact eg. checksums and cyclic redundancy checks	Time is spent deconstructing and reconstructing the data packets
Multiple routes can be used between devices, so if one path breaks, another can be used.	Must wait for all packets to arrive before data can be received.
Packets can be transferred over very large networks to allow communication globally.	

Circuit switching is a method of communication where a direct link is created between two devices. This direct link is maintained for the duration of the entire conversation between devices. This requires the two devices to transfer and receive data at the same rate.

Advantages	Disadvantages
Data arrives in a logical order which results in a quicker reconstruction of the data.	Bandwidth is wasted during periods of time in which no data is being sent.
Enables two users to hold a call without delay in speech.	Devices must transfer and receive data at the same rate.
	Using switches means electrical interference may be produced which can corrupt or destroy data.
	Ties up sections of the network which cannot be used by others data until transmission has been completed

Client-Server and Peer-to-Peer

Client-server

Client-server networks consist of terminals known as clients connected to a server. The server is a powerful, central computer. It holds all of the important information and resources and has greater processing power than the terminals.

Advantages of Client-server	Disadvantages of Client-server
• More secure as data is stored in one location • Central backups are carried out so there is no need for individual backups • Data and resources can be shared between clients	• Relatively expensive to set up • Functionality of terminals depends on the server; if this fails, performance falls • Trained staff are required to maintain the server

Peer-to-Peer

A network in which computers are connected to each other so that they can share files. Each device effectively acts as both a server and client, as it can both provide and request resources. Peer-to-peer networks are used in piracy, since it's almost impossible to trace the origin of files.

Advantages of Peer-to-peer	Disadvantages of Peer-to-peer
• Cheaper to set up • Allows users to share resources • Easy to maintain • Not dependent on a central server • Specialist staff are not required	• Impossible to trace the origin of files • Backups must be performed separately • Poorer security • May be difficult to locate resources