OCR Computer Science A Level

1.3.3 Networks

Concise 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)
- Network Security and Threats
- Firewalls
- Proxies
- Encryption

1.3.3 d)
- Network Hardware

1.3.3 e)
- Client-server
- Peer-to-peer

Networks and Protocols

Characteristics of a network
- Two or more computers connected together that can transmit data
- Physical topology is the physical layout of the network
- Logical topology is the way in which data flows around a network

Topologies
- Bus topology: network topology where all terminals (devices) are connected to a backbone cable

Advantages of Bus Topology	Disadvantages of Bus Topology
Cheaper to set up, doesn't require any additional hardware	If backbone cable fails, the entire network gets disconnected As traffic increases, performance decreases All computers can see the data transmission

- Star Topology: uses a central node (switch/computer) to direct the flow of data, MAC (Media Access Control) addresses identify each device.

Advantages of Star Topology	Disadvantages of Star Topology
Performance is consistent even if network is being heavily used If one cable fails, only that station is affected Transmits data faster, so it gives better performance than bus topology It's easy to add new stations No data collisions	Expensive due to switch and cabling If the central switch fails, the rest of the network fails

- Mesh Topology: every node is connected to every other node
- Most commonly found with wireless technology like Wi-Fi

Advantages of Mesh Topology	Disadvantages of Mesh Topology
No cabling cost As nodes increase, the reliability and speed of network becomes better Nodes automatically get incorporated It's faster since nodes don't go through a central switch	You have to purchase devices with wireless capabilities Maintaining the network is difficult

Protocols
- Sets of rules defining how two devices communicate with each other
- Need to be standard so all devices can communicate, regardless of manufacturer

The Internet Structure

- A network of networks
- Allows computers on opposite sides of the globe to communicate with each other

The TCP/IP Stack
- Transmission Control Protocol / Internet Protocol
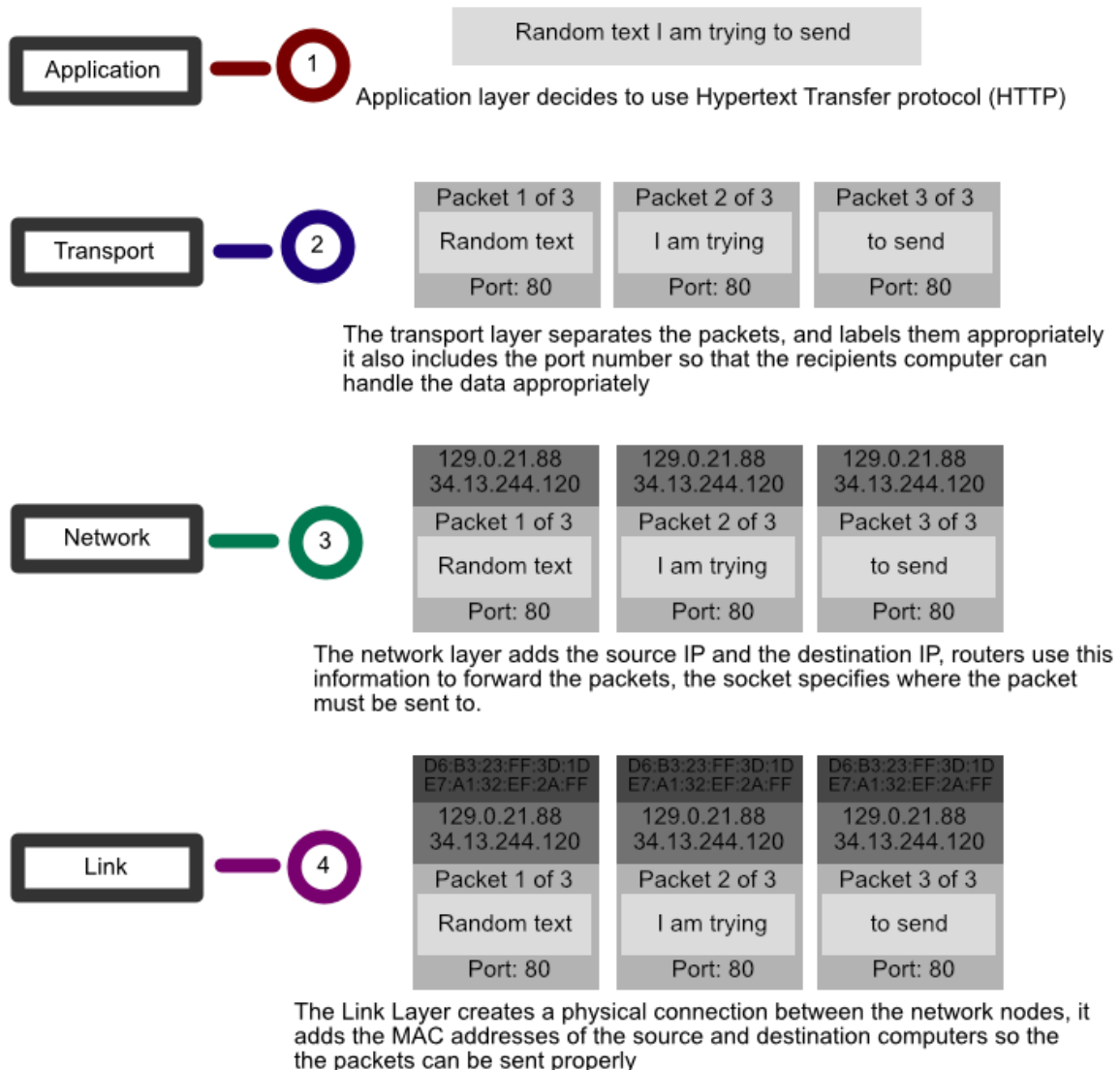- A stack of networking protocols that work together passing packets during communication

Protocol Layering
- Application Layer
  - Based at the top of the stack
  - Specifies what protocol needs to be used in order to relate the application that's being sent
- Transport Layer
  - Uses the TCP to establish an end-to-end connection between the source and recipient computer
  - Splits up data into packets
  - Labels packets with their packet number
  - Requests retransmission of any lost packets
- Network Layer
  - Adds source and destination IP addresses
  - Routers operate on the network layer and the router is what uses the IP addresses to forward the packets

- Link Layer
  - The connection between the network devices
  - Adds the MAC address identifying the Network Interface Cards of the source and destination computers

- On the recipient's computer the layers occur again in reverse:
  - Link Layer
    - Removes the MAC addresses
  - Network Layer
    - Removes the IP addresses
  - Transport Layer
    - Removes the port number and reassembles the packets
  - Application layer
    - Presents the data to the recipient in the form it was sent

This is a diagram of the TCP/IP Stack

Application — 1	Random text I am trying to send

Application layer decides to use Hypertext Transfer protocol (HTTP)

Transport — 2	Packet 1 of 3	Packet 2 of 3	Packet 3 of 3
	Random text	I am trying	to send
	Port: 80	Port: 80	Port: 80

The transport layer separates the packets, and labels them appropriately it also includes the port number so that the recipients computer can handle the data appropriately

Network — 3	129.0.21.88 34.13.244.120	129.0.21.88 34.13.244.120	129.0.21.88 34.13.244.120
	Packet 1 of 3	Packet 2 of 3	Packet 3 of 3
	Random text	I am trying	to send
	Port: 80	Port: 80	Port: 80

The network layer adds the source IP and the destination IP, routers use this information to forward the packets, the socket specifies where the packet must be sent to.

Link — 4	D6:B3:23:FF:3D:1D E7:A1:32:EF:2A:FF	D6:B3:23:FF:3D:1D E7:A1:32:EF:2A:FF	D6:B3:23:FF:3D:1D E7:A1:32:EF:2A:FF
	129.0.21.88 34.13.244.120	129.0.21.88 34.13.244.120	129.0.21.88 34.13.244.120
	Packet 1 of 3	Packet 2 of 3	Packet 3 of 3
	Random text	I am trying	to send
	Port: 80	Port: 80	Port: 80

The Link Layer creates a physical connection between the network nodes, it adds the MAC addresses of the source and destination computers so the the packets can be sent properly

LANs and WANs
- Local Area Network (LAN) is a network spread over a small geographical area
- Wide Area Network (WAN) is a network spread over a large geographical area, that typically requires extra hardware

DNS
- Domain Name System
- The system given to the method of naming internet resources
- A hierarchy where each smaller domain is separated from the larger domain by a full stop
- DNS server translates domain names into IP addresses when we access a website.

Packet and Circuit Switching
- Circuit Switching
  - A method of communication where a direct link is created between two devices
  - Link maintained for the entire conversation
  - The two devices must transfer and receive data at the same rate
- Packet Switching
  - A method of communicating packets of data across a network
  - A packet is just a section of the data
  - Packets aren't limited to a single route

Circuit Switching		Packet Switching	
Advantages	Disadvantages	Advantages	Disadvantages
The data arrives in a logical order which results in a quicker reconstruction of the data.	Bandwidth is wasted during periods of time where no data is sent.	There are multiple methods to ensure data arrives (check Checksum and Cyclic Redundancy Check)	Time is spent deconstructing and reconstructing the data packets.
This enables two uses to hold a call without delay in speech.	The devices must transfer and receive data at the same rate.	There is more than one method of getting to the other devices, so if one path breaks you can use another.	
	Since switches are used, electrical interference is produced which can corrupt or lose data.	You can transfer packets over very large networks to allow communication globally.	

Data Packets
- Segments of data
- Contain various pieces of information
    - Header
        - Sender and the recipient's IP addresses
        - Protocol being used
        - Order of the packets
        - Time To Live / Hop Limit
    - Payload
        - The raw data
    - Trailer
        - Checksum, or cyclic redundancy check

Network Security and Threats

Firewalls
- Devices designed to prevent unauthorised access to a network
- Consist of two network interface cards (NICs), in-between the user and their internet connection.
- Pass packets between these two NICs and compares them against a set of rules (packet filters) set by the firewall software
- Perform packet filtering / static filtering
    - Limit network access in accordance with administrator rules and policies

Proxy Servers
- Act as an intermediary, collecting and sending the data on behalf of the user
- Protect the privacy of the user who remains anonymous
- Cache frequently used website data making it faster to load
- Reduce the web traffic
- Can be used by administrators to prevent access to sensitive or irrelevant information at work or at school

Encryption
- A way of keeping data secure when transmitting over the Internet

Network Hardware

Network Interface Cards (NICs)
- Required to connect to a network
- Assign a unique Media Access Control (MAC) address to each device

Switches
- Used to direct the flow of data across the network
- Most commonly used in a star topology

Wireless Access Points (WAPs)
- Allow devices to connect to a network wirelessly
- More commonly used to connect devices to a router which can allow internet access
- Used in mesh networks

Routers
- Used to connect two or more networks together
- One network will often belong to the ISP's network (internet service providers' network) allowing the network to connect to the internet

Gateways
- Used when protocols aren't the same between networks
- Translate protocols so that both networks have the same protocols
- Remove the header from packets before the remaining data is added with the new protocol of the new network in mind

Client-Server and Peer-to-Peer

Client-Server
- Client-Server networks have terminals known as clients connected to a server
- The server is just a powerful central computer
- The server holds all of the important information and has extra processing power and the clients can request to use it

Advantages of Client-Server	Disadvantages of Client-Server
- More secure - Central backups eliminate the need for client backups - Sharing data and resources between clients	- Expensive to set up - Staff with training are required to maintain the server

Peer-to-Peer networks
- Computers are connected to each other so that they can share files
- Inexpensive to set up
- Allow users to share resources
- Easy to maintain