Chapter 2 Communication

1. Purpose and benefits of networking devices
   1.1 Benefit:
   - Devices, such as printers, can be shared
   - licences to run software on networks are often far cheaper than buying licences for an equivalent number of stand-alone computers
   - Users can share files
   - Access to reliable data that comes from a central source, such as a file server
   - Data and files can be backed up centrally at the end of each day
   - users can communicate using email and instant messaging.
   - A network manager can oversee the network and, for example, apply access rights to certain files, or restrict access to external networks, such as the internet
2. Characteristics of a LAN and a WAN
   2.1 LAN:
   A network within a building/site/small geographical area
   Network connected by hubs and switches
   2.2 WAN:
   This network spans a large geographical area
   2.3 Why LAN? (9618 w21p11/13 Q8a)
   - Small geographical area
   - Does not use internet to transmit data within the building
3. Client-server
   3.1 Definition
   at least one computer used to "serve" …
   …her computers are referred to as "clients"
   server provides services / applications etc. …
   …which may be requested by clients
   3.2 Benefit
   - files and resources are centralised
   - creation of security / manage security
   - user needs user name and password to access network
   - centralised back-up
   - intranet capability
   - Internet monitoring
   - clients can be less powerful machines, therefore less expensive to buy
   - saving resources on server reduces the burden on the client

   3.3 Drawback
   - Initial set-up costs for the server and the client workstations will be high
   - A server-based network requires the use of a specialist network operating system
   - If the server fails then the work of all users is affected
4. Peer-to-peer
   4.1 key features of a peer-to-peer network:
   • All computers are of equal status

- Each computer provides access to resources and data // data is distributed
- Computers can communicate and share resources
- Each computer is responsible for its own security

4.2 Benefit

- No dedicate additional computers
- additional computer can join the P2P network easily
- server is not required
- can act as both a provider and receiver of resources

4.3 Drawback:

- Reduced security // no central management of security
  - ··· only as secure as the weakest computer on the network
  - ··· each computer is at risk from viruses from other computers
- No central management of backup
  - ... if the data from one computer is not backed up it is lost to all of them
- No central management of files/software
  - ··· consistency may be difficult to maintain
  - ··· each computer may have different software from the others
- Individual computers may respond slower
  - ··· because they are being accessed by other computers
- In order to share files etc. all the computers involved need to be switched on
  - ... so the files etc. may not be always available

5. Thin Client and Thick Client

5.1 Thin Client

the device that needs access to the internet for it to work and depends on a more powerful computer for processing

5.2 Thick Client

Device which can work both off line and on line and is able to do some processing even if not connected to a network/internet

6. Network Topology

6.1 Bus

Definition:

network using single central cable in which all devices are connected to this cable so data can only travel in one direction and only one device is allowed to transmit at a time.

Benefits

- Easier to set-up/extend
- Less cable required

Drawbacks

- If the main cable breaks, network performance badly degraded
- Difficult to detect and troubleshoot fault at an individual station
- Efficiency reduces as the number of devices connected to it increases
- Collisions - not suitable for networks with heavy traffic
- Security is lower

6.2 Star

Definition: A network that uses a central hub/switch with all devices connected to this central hub/switch so all data packets are directed through this central hub/switch

Benefits

- Signals only go to destination -secure
- Easy to connect/remove nodes or devices/trouble shoot
- centralised management helps on monitoring the network
- Failure of one node or link doesn't affect the rest of network
- Performance does not degenerate under load
- Connections may use different protocols
- Fewer collisions

Drawbacks

- If central device fails then whole network goes down
- Performance is dependent on capacity of central device

6.3 Mesh: Direct links between devices

6.4 Hybrid: network made up of a combination of other network topologies

7. Wired and Wireless Network

7.1 Copper cable: Carries data as electrical signals and can consist of a twisted pair

7.2 Benefits of copper cable:

– copper cabling is less expensive to install
– copper cable is easier to install because it is more flexible
– it is easier to make terminations using copper cabling
– the expertise in use of copper cabling is more extensive
– has been around for years … so very little is "unknown" about installations using this type of cabling

7.3 Fibre-optic cable: Transmits data as light // Uses (a bundle of) glass/plastic threads to transmit data

7.4 Radio waves: Carries data wirelessly, often known as Wi-Fi // Carries data in the form of electromagnetic waves

7.5 Microwaves

7.6 Satellite: A communication device in Earth's orbit that receives and transmits data

7.7 Differences between fibre-optic cables and Copper cables:

- Fibre optic data is transmitted using light, copper cable through electrical signals
- Fibre optic has higher bandwidth than copper cable // Fibre optic has higher transmission rates than copper cable
- Fibre optic has smaller risk of (noise) interference than copper cable
- Fibre optic can be used over longer distances than copper cable before repeaters are needed
- Fibre optic is much more difficult to hack into than copper cable
- Fibre optic is more prone to damage than copper cable

7.8 Benefits of fibre-optic cables

- (Consistently) faster data transmission
- More stable connection
- Less interference in the signal
- The signal does not degrade as quickly // Needs less signal boosting

- More secure // more difficult to hack
- Greater bandwidth // Faster transmission speeds possible

7.9 Drawbacks of fibre-optic cables

- High initial cost as new hardware will be needed
- Expertise required to complete connections
- Specialists / trained personnel are needed to install / maintain
- Difficult to terminate // The electronics at both ends are more complex
- Fibres can break when bent
- Only transmits data in one direction // Cannot transmit power, only data

7.10 Wired network

- Faster connection // higher bandwidth
- … less time waiting / less latency / fewer delays
- More reliable / stable connection
- … is less susceptible to issues with distance/walls/interference
- More secure

7.11 Wireless network

- Freedom of movement
- … can move between different rooms with a mobile device and still receive/transmit data
- … no need of a physical connection
- Easily expanded if friends want to access the same network
- Less cabling / expertise is needed
- … making the initial setup less expensive

8. Cloud computing

8.1 Definition: Accessing a service/files/software on a remote server

8.2 Public cloud:

Computing services offered by 3rd party provider over the public Internet

Public is open/available to anyone with the appropriate equipment/software/credentials

8.3 Private cloud:

Computing services offered either over the Internet or a private internal network

Only available to select users not the general public

Private is a dedicated/bespoke system only accessible for/from the organization

8.4 Benefits and Drawback of using cloud computing:

1. Benefits:

   Can be accessed anywhere with Internet access

   Do not need to install security // security might be better

   Do not need to perform backups

   Do not need to buy specific software/hardware

   Can easily share documents

   Can have multiple people working on the same document

2. Drawbacks:

   You cannot access it if no internet access

   Reliant on someone else to backup

   Reliant on someone else for security // can have poorer security

   Cannot access if server goes down

It can take a long time to upload/download the data
It can be more expensive in the long term
There could be a limit to the amount of storage unless paid for
There could be compatibility/access issues
There could be issues with the company offering cloud services

8.5 Benefits of storing data using cloud computing (cloud storage)

- Cloud storage can be free (for small quantities)
- No need for separate (high capacity) storage devices // saves storage on existing devices
- Can access data from any computer with internet access
- Most cloud data services will have in-built backup/disaster recovery
- Security could be better
- Can easily increase capacity
- Data can be easily shared

9. Hardware used to support a LAN

9.1 Switch

9.2 Server: Manages access to a centralized resource

9.3 Types of server:

- File server
- Print server
- Proxy server
- Web server
- Application server

9.4 NIC: To enable the servers to connect to the (company) network

9.5 WNIC

Definition: Hardware component that allows a device to connect to a wireless network // Provides a MAC address to the device to identify it on the wireless network

Functions of a WNIC:

- Provide interface to wireless network
- … as an antenna
- Receives analogue radio waves
- … convert them to digital / binary
- Checks incoming transmissions for correct MAC / IP address
- … ignore transmissions not intended for it
- Encrypts / encodes the data
- Decrypts / decodes the data
- Takes digital/binary input and converts to analogue waves
- … sends the radio waves via the antenna

9.6 WAP

Definition: Hardware component that provides radio communication from the central device to nodes on the network (and vice versa)

9.7 Cables: copper and fibre-optic

9.8 Bridge:

Used to connect two networks that have the same protocol

E.g. connecting two LANs

9.9 Modem: To connect (the servers) to the Internet over a telephone line

9.10 Gateway: Joins networks that use different sets of rules to transmit data

Role of gateway:

- Connect two (or more) networks
- Can connect a network to a WAN // acts as the single access point for…
- Receives packets and send packets towards the destination
- …using the IP address of the destination
- Assigns private IP addresses
- Connects two dissimilar networks // networks that use different protocols

9.11 Repeater

Definition: Restores the digital signal so it can be transmitted over greater distances

10. Role and function of a router

10.1 Definitioin: Receives and sends data between two networks operating on the same protocol

10.2 Functions of routers:

- To receive packets from devices or the Internet
- To forward / route packets to the destination
- To find the destination of the packet
- To assign / allocate private IP addresses to devices on LAN
- To store / update / maintain a routing table
- To find the most efficient path to the destination
- To maintain a table of MAC and IP addresses

10.3 Similarities between a router and a gateway:

- Both devices regulate network traffic between two networks // connect two networks
- Both receive packets from a network and both forward packets onto a network

10.4 Difference between a router and a gateway:

- A Router connects two networks using the same protocol, a Gateway can connect two networks using different protocols

11. Collision detected and avoided

A workstation / node (wishing to transmit) listens to the communication channel

…data is only sent when the channel is free //

… if channel is free data is sent

Because there is more than one computer connected to the same transmission medium

… two workstations can start to transmit at the same time, causing a collision

If a collision happens, the workstations send a (jamming) signal / abort transmission

…and each waits a random amount of time before attempting to resend

12. Bit streaming

12.1 Bit Streaming definition:

- sequence of digital signals / bits
- over a communication path / Internet
- transfer of data at high speed
- requires fast broadband connection
- requires some form of buffering
- bits arrive in the same order as sent

12.2 Benefits of using bit streaming

– no need to wait for a whole file to be downloaded
– no need to store large files on user' s computer
– allows on demand playback
– no specialist software is required for playback in browser

12.3 Potential problems of using bit streaming

– video stops / hangs if very slow Internet / broadband speed low
– video stops / hangs if inadequate buffering capacity
– loss of Internet means can' t access films / files
– may require specific software to run the files / films
– viruses can be downloaded from the websites

12.4 On demand

– digital video tape, analogue video tape, or digital files are converted to bit streaming format for broadcasting on the net; this is known as encoding these encoded streaming video files are then uploaded to a dedicated server
– a link for the encoded video is placed on a web site
– a user clicks on the link to download the encoded streaming video; the streamed video is
– then broadcast to the user as and when they require it
– can be paused / can go back and re-watch / fast-forward, etc.

12.5 Real time

• It is being watched live
• It is not being downloaded to watch later // not already stored online
– an event is captured live with a video camera
– the video camera is connected to a computer
– the video signal is converted to streaming media files (encoded) on the computer
– the encoded feed is then uploaded from the computer to a dedicated streaming server via cable, DSL, or a high-speed internet connection
– the server then sends the live images it to all users requesting it as real-time video streaming
– cannot be paused etc.

12.6 Why video constantly stops and starts again?

• Insufficient bandwidth // slow internet connection
• … experiencing problems with buffering
• Video is too high quality to stream in real-time
• Congestion on the home network
• Too much demand for the video from the supplier
• Too many applications running on computer
• Trying to watch the video in High Definition

12.7 Difference between real-time and on-demand bit streaming

• Real-time - a live stream of an event that is currently taking place
• On-demand - streaming of an event/programme that has taken place in the past
• Real time – the event is captured live with a video camera connected to a computer
• On-demand – Existing media are encoded to bit streaming format and uploaded to a server
• Real-time – cannot be paused / rewound etc
• On-demand – can be paused / re-wound / fast forwarded etc

13. WWW and internet

13.1 Internet

- Internet is the infrastructure / global collection of networks
- Internet uses IP protocol

13.2 WWW

- World Wide Web is the (multimedia web) pages / content
- The World Wide Web is accessed over the Internet
- Webpages are written in HTML
- HTTP protocol used to transfer web pages

13.3 Why both Internet and WWW are both used? (9618 s21p11/13 Q4d)

- using internet because sending data on the infrastructure
- using WWW because accessing a website (that is stored on a web server operated by the webmail) that is part of the WWW

13.4 Difference between the World Wide Web (WWW) and the internet

- WWW is a collection of interlinked, hypertext documents/webpages/multimedia resources (accessed via the Internet) //WWW is content from web servers organised as web pages
- Internet is the global connection of interconnected computer networks
- The Internet uses TCP/IP protocol / WWW uses http protocols to transmit data

14. Hardware used to support the internet

14.1 PSTN

- Dedicated channel used between two points for the duration of the call
- Connection maintained throughout the telephone call
- Lines remain active even during a power outage
- The PSTN consists of many different types of communication lines
- Data is transmitted in both directions at the same time // (full) duplex data transmission
- The communication passes through different switching centres

14.2 Internet-based system

- Connection only in use whilst sound is being transmitted
- Encoding schemes and compression technology used

14.3 Dedicated lines

Definition: Connection that is only used for that business/organisation // permanent connection

Benefits:

- (Probably) faster connection / communication / transmission of data
- (Usually) more consistent transmission speed
- Improved security

Drawbacks:

- Expensive to set-up / maintain
- Disruption to the dedicated line would leave no alternative

14.4 Cellphone network

Send data to cell towers over mobile connection

14.5 Sateliite system

Send data to satellites in orbit

15. IP (Internet Protocol)

15.1 Purpose of an IP address

- Gives each device on a network an identifier // IP address used to locate a device on a network
- Each address is unique within the network
- Allows a device/gateway/node to send data to the correct destination / a specific device/gateway/node

15.2 Differences between the format of an IPv4 and IPv6

- IPv4 has 4 groups of digits, IPv6 has 8 groups of digits
- In IPv4 each group is from 0-255, in IPv6 each group is from 0-65535
- IPv4 uses a full-stop between each group, IPv6 uses a colon between each group
- IPv4 is 32-bit, IPv6 is 128-bit // IPv4 uses 4 bytes, IPv6 uses 16 bytes

15.3 Public IP: It is visible to any device on the internet

15.4 Private IP: It is only visible to devices within the Local Area Network (LAN)

15.5 Why the device in a LAN does not have a public IP address?

- The router has the public IP address for the LAN
- All data comes through the router
- The device is not accessible / visible to the outside world
- … to ensure security // to protect the laptop from external threats

15.6 Differences between a public IP and a private IP:

- Private IP is only known within the LAN // Public IP is known outside of the LAN/ on Internet
- Public is allocated by ISP // Private is allocated by the router
- Public addresses are unique throughout the Internet, private addresses are unique only within the LAN
- Private IP addresses are more secure than public IP addresses
- Public address can be reached across the Internet.
- Private address can only be reached internally/through the LAN/Intranet // private address cannot be reached across the Internet.
- NAT (Network Address Translation) is necessary for a private IP address to access the Internet directly.
- 10.0.0.1 to 10.255.255.254 and 172.16.0.1 to 172.31.255.254 and 192.168.0.1.to 192.168.255.254 form the private address space // IP addresses from the private address space are never assigned as public.

15.7 Benefits of private IP address:

- Improved security because the IP address is not visible outside the network
- An internet presence is not required for each employee computer
- Only the router needs a public IP address, as only the router needs to be externally visible
- Reduces number of (public) IP addresses needed

15.8 Static IP: It does not change each time a device connects to the internet

15.9 Dynamic IP: A new one is reallocated each time a device connects to the internet

15.10 Why server use a static IP:

- Static IP does not change whereas a dynamic IP address does change
- … the DNS does not need updating
- … which might be delayed causing ‘address not found’ errors
- The webserver may be accessed directly using just the IP address // the IP address is still held in cache memory

16. URL

- Definition (9608 w15p12 Q9b)
    - Reference website address on the internet
    - Includes protocol and domain name
- Protocol
    - E.g. https, http
- Domain name
    - Definition (9608 s21p13 Q6b)
        - Domain name is a memorable form of IP address
        - Each domain name is linked to an IP address
    - Domain host*
        - E.g. www
    - Website name*
        - e.g. Cambridge
    - Domain type*
        - E.g. .com, .org, .co, .net, .gov
    - Country code*
        - E.g. .uk, .cn
- File name*
    - E.g. page1.html
- E.g. Protocol://domain name/path/file name
  E.g. https://www.Cambridgeinternational.org/6908.html

17. DNS
    Definition: Used to translate domain name into corresponding IP address
    How a URL is converted into its matching IP address:
    - URL is parsed to obtain the Domain name
    - Domain name is sent to the nearest Domain Name Server (DNS)
    - DNS holds a list of Domain names and matching IP addresses
    - DNS name resolver searches its database for the Domain name
    - If DNS does not find the Domain name, the request is forwarded to a higher level DNS
    - If the Domain name is found, the IP address is returned
    - If the Domain name is not found, the request is passed to a higher level server
    - If the Domain name is finally not found, an error message is generated

18. Firewall: Monitors and controls incoming and outgoing network traffic based on set criteria