Core Topic  Communication Systems

Outcomes - a student -
• H1.1 applies an understanding of the nature and function of information technologies to a specific practical situation
• H1.2 explains and justifies the way in which information systems relate to information processes in a specific context
• H2.1 analyses and describes a system in terms of the information processes involved
• H2.2 develops solutions for an identified need which addresses all of the information processes
• H3.1 evaluates the effect of information systems on the individual, society and the environment
• H3.2 demonstrates ethical practice in the use of information systems, technologies and processes
• H4.1 proposes ways in which information systems will meet emerging needs
• H5.2 assesses the ethical implications of selecting and using specific resources and tools

Characteristics of Communication Systems
When participants from within the information system need to receive or transmit data or information, then a communication system is required. These systems support people need to work together, by enabling them to electronically exchange the data and information.

A communication systems model can be viewed as -

The source - a person, computer or other communication device  
The message - may be a document, picture, sound or numeric data  
Encoding is done to a format which can be transmitted or broadcast  
Encoded message travels via a communication channel or link  
Message is decoded at the other end - errors from noise found and corrected  
The receiver is the destination, and can be a person, or other communication device.

Obviously once the hardware is set up, for accurate communication to take place the protocols for communication must be set and adhered to. These protocols are rules concerning both the parameters (settings) and the standards for data flow, including - transmission timing, speed, error checking techniques, number of bits used, number of start and stop bits, etc. If protocols are not maintained then either the data will not be transmitted correctly or at all.

Protocols serve a range of functions -
• telling a computer that a message is coming to it
• identifying all computers involved in the transfer of data
• controlling the format, timing and sequencing of network signals
• detecting and correcting errors

**Handshaking**
This is the process of initiating communication between two modems before the actual transfer of the data. This involves the sending of pre-arranged signals to try and define and establish the necessary protocols, such as X-modem or Z-modem on personal computers. If the handshake is not successful, then communication will not successfully take place between the two devices.

**Speed in Communication Links**
The rate at which data is or can be transmitted between devices can be measured in several ways -

• **bits per second** - this is literally the number of bits being transmitted past a fixed point per second. Thus the bps is a measure of the *speed of the data transfer*, and depends on the modem and the type of data line in use, from 57,600 (56k) for normal modems to much higher speeds for cable modems and say ISDN lines. This is sometimes termed the *bit rate*.

• **baud rate** - this is a measure of the number of signal switches per second (or frequency) and is not an accurate measure for data transfer rate - as shown below -

![Signal Changes Diagram](image)

- in the example above, the bps is 8 in the second, while the baud rate would be 5 for the number of signal changes or switches (0 to 1 or 1 to 0).

A formula for calculating the approximate time of transmission is -

\[
\text{Time in seconds} = \frac{\text{number of bits to transmit (bytes x 8)}}{\text{speed of data link in bps}}
\]

**Error Checking**
Some errors will always occur in electronic data transmissions (old telephone lines, electrical interference, storms, power fluctuations, etc.) and these errors need to be firstly detected and then corrected. Noise (unwanted electrical interference) on the phone line is the major source of errors. As the speed of transmission has increased over recent years so the error rate has also increased - from about 1 bit in 100 000 in copper phone lines, to somewhat higher rates. For fibre optic lines the expected error rate is around 1 in 100 million bits transmitted.

The main *error correction methods* include -
1. Parity bit check
2. Check sum
3. Cyclic redundancy check

**Parity bit check** - uses the 8th bit (of the 8 required in ASCII code) as a check bit for the previous
7 bits, and this is known as the parity bit. This parity bit can be set to either 1 or 0. Parity can be none, even or odd - and so long as both sender and receiver have the same setting, will allow checking to take place for the accuracy of the transmission. This is achieved in this method by adding the number of 1’s in the 7 bits and adjusting the total using the parity bit - as seen below -

<table>
<thead>
<tr>
<th>Parity type</th>
<th>Data bits</th>
<th>Parity bit</th>
</tr>
</thead>
<tbody>
<tr>
<td>For even parity</td>
<td>1 0 0 1 0 1 1</td>
<td>0</td>
</tr>
<tr>
<td>For odd parity</td>
<td>1 1 0 1 1 0 0</td>
<td>1</td>
</tr>
</tbody>
</table>

Thus the parity bit is set to 0 or 1 depending on the need for odd or even parity in the setup, such as the odd example above, where the total of the 7 data bits is 4 (even) but since it is to be sent as odd parity, the parity bit must be set to 1 to give a total of 5 (now it is odd).

In this method, each character is checked for the same parity at the receiving end as the sending end, and so long as it is the same then it is assumed that no transmission error has occurred. However, if say two errors occur (or 4 or even 6) then the parity will remain the same and the errors will not be detected, as pairs will cancel each other out. This makes parity checks less reliable and they are not widely used.

**Check sum** - is a method similar to parity checking, but in this method the number of bits in a whole block of data has the 1’s added to give a number termed the **checksum** which is tallied and transmitted along with the data, so that at both ends of the transmission this figure is compared to see any differences. If the two checksums do not match then an error is indicated - though not the location of the error or the presence of multiple errors cancelling each other out.

**Cyclic redundancy check** - in this method the transmitted data has extra digits attached to each block (the BCC or block check character) and the whole of the data is treated as a long binary number. This number is divided by a predetermined constant at the sending end and the remainder of the division (the BCC) is sent with the data. Later at the receiving end the same division process occurs and the two remainders are compared. If the two numbers are equal it is assumed that no errors have occurred, but as in the previous methods, it is still possible that a number of errors may cancel each other out. Because of the calculation process, this method is more accurate than the previous two.
- when the BCC’s match, a signal acknowledging this - termed an ACK, is sent back to the sender (so that the next block will be sent)
- when the BCC’s don’t match, a negative acknowledgement signal is sent - termed a NAK, is sent to the sender (so the sender will resend the block with errors).

NOTE - more sophisticated error checking techniques have been created, but these require more bits to do the checking and end up sometimes doubling the size and thus transmission time for each file. For example, the Hamming code uses 3 bits for checking each 4 bits of data. Since errors rates of less than 1% generally occur in data transfers, such sophisticated error detection techniques are not generally used.

The most common **error correction method** is to retransmit the data.
Exercise 1 - complete each of the following -

(a) What are the X and Z-modem protocols? What are XON and XOFF? Why are each of these important?
(b) Which is a better measure of the rate of data transmission, baud rate or bits per second? Why?
(c) Why do errors occur in electronic communication? Which method would you use to detect these errors? Why?
(d) Would you be totally sure all messages were 100% correct having used the method you chose above? Why?
(e) What is ASCII code and what is it used for?
(f) Describe how you would establish the communication link between two people -
   (i) who do not speak the same language
   (ii) one of whom is deaf

To be completed by - .................................................................

Settings
Once the protocols are set up at handshaking, the settings (which are generally parameters) are made so that both ends of the communication link are set the same.
Some common parameters are -
• bits per second - speed of transmission e.g. 56000
• data bits - number in a byte e.g. 7-bit ASCII
• parity - whether data contains a parity bit for error correction, or odd or even parity
• stop/start bits - the number of bits used in asynchronous transmission (0, 1 or 2 normally)
• flow control - the software handshaking protocol e.g. XON/XOFF

Examples of Communication Systems
We are seeing a constantly growing list of examples of uses for communication systems for individual and business purposes, including -
• teleconferencing
• messaging systems
• electronic commerce

Teleconferencing is the use of video, audio and other data transfer methods (including graphs, animations, etc.) to allow people to communicate in real-time over large distances, rather than all of the individuals having to travel to the same meeting room to conduct business.

Audio data can be transmitted and received by using an audio conference which is a telephone call linking three or more people participating from at least two locations. This may include the use of a speaker phone if several of the participants are in the same office.
Audiographic conferencing is an extension which allows the participants to view pictures or graphical material (charts, spreadsheets, etc.) at the same time - see the picture above.

Video data is transmitted and received by utilising a video conference, which is an interactive meeting between at least two groups of people who can see and hear each other via a TV screen. This image can vary from full sized television screens to small monitor-top cameras and views seen in sections of computer screens, depending on the purpose and cost to the users. Most important business situations use television screens.

Advantages of teleconferencing include -
• lower costs - since travel and accommodation expenses for trips are eliminated
• time saving - since only the meeting time is needed and not all the travelling time, etc. however the differences in time zones may mean that a lunchtime meeting for one person may be a midnight meeting time for another, so convenience may be a concession.

Disadvantages of teleconferencing include -
• lack of physical contact at meetings means that unless a prior face-to-face social bond has been created, the effectiveness of video conferencing is decreased, as we are still used to sizing people up and establishing relationships (personal or business) in person and not to a TV character.

Uses of Teleconferencing
Since the technology has improved in quality and cost, a wide range of ‘one-off’ through to regular uses have been made of teleconferencing including -
• branch meetings for state or nationwide businesses - rather than have managers travelling to conferences every few months, teleconferencing allows meetings to take place either on a regular basis or even for emergency purposes if needed.
• specialist city doctors can consult with country colleagues, patients or preferably both whenever necessary or on a regular clinic schedule.
• distance education for school students in remote areas can now include teleconferencing if the equipment is available on the farm or cattle station (this is an extension of the School of the Air service).
• any conference which would be difficult or too expensive to organise can be completed as a teleconference at a few days notice and at a much more reasonable cost.

Messaging Systems
The traditional messaging methods over time have extended from letters and books to telephone and fax, but over recent years these have been supplemented by other methods, including - voice mail and electronic mail.
• **Telephone** - is a system for transmitting sounds and speech along phone lines between distant locations. A telephone answering system is a messaging system which stores messages and allows the owner to hear the message at a later time.

• **Fax** or facsimile - is the transmission of the picture of a page to produce a copy of the original at another location. The page is scanned then the image is digitised and finally transmitted and printed (or stored) at the destination. E-mail should replace fax as improvements in compatibility between systems allows attachments of word processed documents to be an easy and straightforward process.

• **Electronic mail (e-mail)** - is the use of computers and networks to send and retrieve messages or documents addressed to individuals or locations. Each e-mail address allows messages to be sent and received in real-time or stored and retrieved later, or a distribution list may be used to send the same message to a group of people. E-mails can be stored, forwarded to others, have parts extracted to be printed, etc. and so are more adaptable than a phone or fax message (since phone messages can be garbled or written incorrectly and faxes need to be retyped to make a reply). Image and audio files can also be attached to text messages in e-mails, though file size and format problems are still of concern.

_How e-mail works_ -
One computer in the network acts as the main host and users of the system have mailboxes on this computer each with the user’s address. When the sender posts the e-mail it travels to the host computer and to the mailbox to which it is addressed. Here it is stored until checked by the mailbox owner and is then downloaded to the user’s computer ready to be read and replied to if necessary.

**E-mail parts** -
1. **Title** - located at the top of the form and may contain -
   - address of the person the message is going to
   - address of the sender (done automatically)
   - subject - a brief description of the message
   - carbon copy - if multiple people are to be sent the message
   - attachment - used to send other files

2. **Body** - the message

3. **Signature** - the sender’s details, which are automatically pasted to the end of each e-mail e.g. phone and fax numbers, address, etc.

<table>
<thead>
<tr>
<th>Subject - Homework</th>
</tr>
</thead>
<tbody>
<tr>
<td>To: <a href="mailto:bdaly@bigpond.com.au">bdaly@bigpond.com.au</a></td>
</tr>
<tr>
<td>Return to: <a href="mailto:jsmith@wshs.edu.au">jsmith@wshs.edu.au</a></td>
</tr>
</tbody>
</table>

Dear BJ
More homework for Year 12 IPT classes, they are hopeless.

Bye
JS

E-mail: jsmith@wshs.edu.au
Date: 01-02-01
Time: 10.23.38
Voice mail - is the storing of messages in the person's voice, thus combining the recording ability of an answer machine with the editing and forwarding concepts of e-mail. For many people this method is more personal and conveys more meaning to the listener. This method is more flexible than e-mail in that any telephone can be used for voice mail - both for sending and receiving brief messages anywhere and any time. As with e-mail, voice mail messages can be sent to an individual or to a distribution list.

Exercise 2 - complete each of the following -
(a) Do you have an e-mail address? Why? How do you get one? If you have one, what is it?
(b) How does voice-mail actually work?
(c) What is a mailing list? What is one used for?
(d) Having used a chat program, including a meeting room, then answer the following -
   (i) how is this communication method different to meeting in person?
   (ii) what are the benefits of chat room type communication?
   (iii) what are the potential problems (not technical) or hazards in such communicating?
(e) For a selected messaging system, complete a storyboard to show the communication of a particular message to a friend.
(f) For the list of terms on the back page of this booklet, find a definition for each and print it out -fitting it into 2 pages please. You can share this job over several people.

To be completed by - ...................................................

Electronic Commerce
People are tending to use electronic forms of funds transfers and goods purchasing much more in recent times, and this has extended to other online areas such as share trading for example. Several of these areas include -
- **EFTPOS** - where goods are paid for and cash accessed if required at the cash register (electronic funds transfer at point of sale is what EFTPOS stands for). Therefore a single use of a credit card allows the user to pay for goods and collect cash in the one transaction.

- **Electronic banking** - is another area where people are able to - check balances, transfer funds between accounts, bill paying, etc. without having to go to a teller and ask for the details. This started with ATM's and has extended to the use of home or business computer through the Internet banking facility offered by their bank.

- **Electronic retailing** - is a growing area and will become an important area as people become more used to it, and the convenience it offers to busy people - particularly around Xmas time for example. Amazon.com, E-Bay, etc. all have growing numbers of regular users through the Internet, and many people are now booking airline flights directly for themselves (Virgin and Impulse in particular).
• **Electronic stock trading** - a number of companies allow users to perform online share and stock trading via the Internet (such as Schwab and Co, the Commonwealth bank, etc.) to purchase, track and sell on the stock market.

• **Electronic publishing** - publishers of traditional books or magazines as well as first time authors, etc. are able to use the Internet to publish documents with not just text and some pictures, but to include a wide range of media forms. Such multimedia documents can have movies included as options, animations, personalised sections, links to others documents, web sites, etc. as well as be updated hourly for example.

- A number of newspapers have an electronic version of the daily news, which is sometimes more up-to-date than the traditional published version - see the Sydney Morning Herald site and compare the two.
- Online magazines or e-zines are continually updated rather than published daily or weekly, and may be either WWW documents or as e-mail and sent to subscribers e.g. PCWeek.

### Transmitting and Receiving in Communication Systems

1. **Communication Concepts** - these concepts cover the protocols, handshaking and error detection techniques and correction methods already covered, as well as network topologies and their differences.

#### Transmission of Data

Data is transferred between devices in one of two ways -

(i) **Parallel** transmission - where data is transmitted simultaneously using separate channels, i.e. each bit has its own wire along which it travels. This is often used to send data to printers.

(ii) **Serial** transmission - where the data bits travel one after the other down the one wire. This method is used to transmit data to peripheral devices such as modems, printers and is used on networks.

Serial transmission can be of two types -
- **asynchronous** transmission - characters are sent one at a time with special start and stop bits indicating the start and finish of each character. This method is commonly used in personal computers, being controlled by the start and stop bits. It is inexpensive, slow, inefficient and limited in error checking (slow and inefficient due to all the start and stop bits).
Asynchronous transmission of the letters ‘S’ and ‘E’

This method may be compared to putting people into cars and sending them one at a time along a highway to reach their destination - all going in the same direction at similar speeds, but with different distances between them, each car on its own.

- **synchronous** transmission - data characters and bits are transferred at a fixed rate, with the transmitter and receiver synchronised. The same number of bytes are sent per second, being synchronised by the each device using the clocks in each. This method is faster and more efficient since their are no extra bits required and is used on larger computer systems.

Synchronous transmission of the letters ‘S’ and ‘E’

This method may be compared to putting people onto a train and sending them all together along a rail line to reach their destination - all at the same speed exactly synchronised.

The direction of data flow for transmission may be one of 3 possibilities -

1. **Simplex mode** - allows transmission in one direction only, from the sender to the receiver. e.g. radio, television, keyboard to CPU.

2. **Half-duplex mode** - allows transmission in either direction, but only one way at a time, so that sender and receiver have to take turns e.g. old radios (user said ‘over’ when finished), walkie-talkie, one lane bridge for cars.

3. **Full-duplex mode** - allows transmission in both directions at once e.g. telephone, e-mail, two lane highway.

**Networks**

These are made up of a number of computers connected together to work in some way. Each device
(including terminals, workstations, printers, storage devices, etc.) connected to the network is termed a **node**.

The number of computers and other devices in a network can vary from several to thousands, but the two main network classifications are -

- **Local area networks (LANS)** - this is a connection for computers within a building or several building on the one site. Thus these have a limited geographical area and nodes are linked by coaxial or fibre-optic cabling. Advantages of LANS include -
  - shared resources of printers, modems, etc.
  - shared application software such as word processors, databases, etc.
  - communications improved with electronic messaging

- **Wide area networks (WANS)** - this is a connection of computers over wide areas such as a state, country or the world. Many WANS include a mainframe computer termed the host and many terminals, such as for the Visa network, with thousands of ATMs, etc. connected worldwide. Some use normal telephone lines, others private leased lines or a combination of the two and data is generally sent as packets over such large distances. Other methods include microwave and satellite transmissions. A technique termed **packet switching** is used to divide messages into conveniently small packets for transmission.

**Network Topologies** - these are the different shapes and configurations for the layout of local area networks or LAN’s, and they include as the main types - Star, Bus and Ring.

Using a Gateway or Bridge, the different topologies (or architectures) may be joined to form a hybrid or mixed arrangement.

Such network topologies use techniques to allow multiple users to access the network at the same time - but without confusing the messages or crashing the network.

1. **Star network**

   ![Star Network Diagram]

   In this arrangement, all of the messages go through the central node or hub that serves as a switch, receiving and forwarding them to the destination node. These normally use circuit switching and can integrate voice and data traffic, providing good control with all messages going through the same node.

   This topology supports all nodes transmitting together, since all nodes have a dedicated connection, but bottlenecks can occur since all messages have to go through the central hub, (and the switching technique to prevent collisions) takes time as the traffic increases.

   Reliability problems can occur because the entire network is down if the hub is down and the cost of linking every node to the hub becomes excessive as the number of nodes grows and the nodes are further from the hub. Expansion is limited by the processing power of the hub.

2. **Bus network**

   ![Bus Network Diagram]

   This arrangement has each node attached to a central channel called a bus. Each device connected to the bus can access any other device by using its address. While all device ‘hear’ the message only the addressed device responds to the message. Control is distributed among the nodes and it is easy to expand. As traffic on this type increases,
so the performance degrades - as each node is in contact, and it is a shared communications pathway. Only one node can transmit data onto the network at any one time, and so nodes must be ‘intelligent’ enough to handle situations when the cable is in use or two nodes send at the same instant and collisions occur (CSMA/CD helps with this). If any node is disabled the others continue to work, but a communication failure can make the network hang.

3. Ring network

In this topology the nodes are linked directly without a central server, so that all messages between nodes must be retransmitted by all nodes between the source and the destination. Network control and processing are distributed to each node and if any nodes are disabled the messages must be routed around that node to keep the network operating.

Traffic can be one-way (slower) or two-way which is faster. Token passing is a technique often used with ring networks to prevent signal collisions.

Network Access

There are several methods for multiple users to be able to access the network at the same time, with the most common being -

1. **Ethernet** - was the first industry standard LAN access method based on bus topology. All nodes on the network can transmit data simultaneously in both directions, with addressing allowing all data packets to arrive at the correct node. Collisions and the resultant errors are overcome by the use of a method called Carrier Sense Multiple Access and Collision Detection CSMA/CD. This method allows all nodes to sense signals on the network and to wait until no signals on the bus for them to transmit, which generally works error free - otherwise the nodes stop and try again at another time.

2. **Token ring** - is based on ring topology, and works by continually passing around special data packets called tokens between nodes on the network. When a workstation wants to send data, it has to capture a free token, then attaches data and addressing information to it. When the token arrives at the destination, the data is taken and replaced with an acknowledgement which is sent back to the original node.

2. Network Hardware

To enable a network to function, a number of hardware devices are available, including -

- **cables, servers, routers, switches, hubs and transmission media.** The two main concerns for the performance of the network are -
  - bandwidth - the amount of information that can be transmitted in a given amount of time (measured in megabits or millions of bits per second - Mbps)
  - the maximum operating distance for the medium used (measured in metres or feet)

**Cables** - current cable standards can be somewhat confusing, but include -

- twisted pair wire (as used in telephone cables) comes as either shielded or unshielded and is classified in various grades - Categories 1 to 5 - where the data grade Cat 3 allows 16 Mbps, Cat 4 allows 20 Mbps and Cat 5 allows 100 Mbps.
• coaxial cable - consists of a copper wire conductor, then an insulator, a foil shield, a woven metal outer shielding, and a plastic outer coating - and these can be seen as television aerial cables. This is sometimes termed Category 6 cable as it carries more than 100 Mbps, and come in two types thin (home TV aerial wire) and thick (cable TV wiring on light poles).

• fibre optic cable - consists of a bundle of extremely thin glass tubes each wrapped in a strong support wire, coated with a layer of insulating plastic and then a tough outer coating. Unlike the previous media, light is transmitted instead of electrical signals and thus lasers are needed to convert the electrical signals to pulses of light for transmission and then electronics are needed to convert the signals back to electrical signals at the receiving end. This media is sometimes termed Category 7 cable and again several types are available - single-mode (narrow core) and multi-mode (wider core).

### Interface Cards

Each computer connected to the network must have a **network interface card** fitted into an expansion slot so that the connection can be made to the network. A network cable connection is normally connected to the card and accessed at the rear of the computer. These cards are made to operate at certain speeds e.g. 10 Mbs, 100 Mbs, etc.

### Servers

Servers are computers (with particular specifications) used for a range of purposes, including - file servers, print servers and mail or web servers.

(i) **File server** - this a dedicated computer (not in normal use), used for file management, with a large hard disk to store files and software programs accessed by the users on the other nodes on the network. Both programs for users as well as their files may be stored here or just the files (as at Westfields SHS). The networking software provides security and centralised backups can be done at low use times, and large companies may have a number of file servers.

(ii) **Print server** - this is a computer with large hard disk storage (termed a low end server) and one or more printers connected, to be shared between users of the network. When a large number of print jobs are sent to the printer(s), the disk storage area is used to store print jobs in a queue until they can be printed.

(iii) **Mail or Web server** - these are low end servers which control e-mail and/or Internet/intranet use for the network. For example Westfields has a server for Internet and Intranet access for all of the computers within the school. This server is normally connected to a fast, high bandwidth connection (such as ISDN or T1) and Web access is via this computer.

### Hubs

A hub (really a repeater) has a group of ports (8, 12, 16 or 24) and these take the signal sent from each computer and repeat or regenerate that signal out each port on the hub. So if a computer is sending a document to a printer, all of the other computers on that hub hear the message and ignore it, while the printer accepts the data and prints the document. Only one computer can transmit data at once, and even though one transmission is very quick, it is obvious that as the network becomes more active, the overall speed slows down.
Bridges
A bridge generally has 2 parts and is used to either -
(i) link two networks together by converting the addressing data from one into the addressing data in
the appropriate protocol for the other, or
(ii) divide a network in half, reducing the overall traffic, achieving this by looking at where the data is
heading and making a decision whether to allow the data to cross the bridge or not. These can also be
used to join and convert LocalTalk to Ethernet (on Mac networks).

Gateways - these permit communication between computers on incompatible networks.

Switches
These are basically multi-port bridges, which can support multiple conversations between devices
which do not effect each other ( unlike hubs ). This occurs by creating a momentary ‘virtual circuit’
between two ports, transferring data full speed without interruption . e.g. a 16 port switch can have a
separate conversations - allowing an aggregate bandwidth of 80 Mb/sec ( compared to a hub with an
aggregate of only 10 Mb/sec bandwidth ).

Routers
These are used to provide filtering or security between two networks, or when joining a network to a
WAN. It is an intelligent bridge, able to make decisions or change the format of data before it is passed
on. These are mostly used for connecting a LAN to the Internet, where the Internet traffic is routed into
and out of the LAN.

Exercise 3 - complete each of the following -

The network at Westfields has been installed for several years and runs throughout the various
buildings to computer rooms, classrooms, staffrooms, etc.
(a) What topology has been installed? Why?
(b) Draw a sketch of the network, in red, on the map photocopied from your diary.
(c) At what speed is the network running? What determines this? Why?
(d) What servers, cabling type(s) have been used? Why?
(e) What devices have been used to connect the parts of the network? Why?
(f) What are the differences between how a hub and a router work?

Questions -
(i) What are the differences between terminals and workstations?
(ii) Why are different cable types used in most networks?

To be completed by - ...................................................

Transmission Media
The media for the transmission of communication signals is divided into either -

- wire transmission
- wireless transmission
Wire transmission - includes twisted pair, coaxial cable and fibre optic cable -

(i) Twisted pair - is made up of insulated copper wire twisted together to form a spiral about 1 mm thick (the twisting helps reduce the interference from other cabling). They are commonly used by telephone systems, carrying information for several kilometres but may need repeaters. Two types are used - unshielded (UTP) most commonly, and shielded (STP). This is the slowest medium of the 3, with a bandwidth up to 60 Kbps.

(ii) Coaxial cable - consists of stiff copper wire surrounded insulating material encased by a cylindrical conductor like a mesh, then an outer insulator (plastic coating). The insulating cuts down on the distortion and this medium is generally used up to several kilometres, being seen in television aerial cabling. The bandwidth for coax is 10 Mbps.

(iii) Fibre-optic cable - uses pulses of laser light to transmit the data in tiny glass fibres, and is therefore free from electromagnetic and radio interference. It is a secure and high speed method with few errors occurring, and are replacing copper telephone wires for new areas. The bandwidth for fibre-optic cables is 400 Mbps.

Wireless transmission - moves the data through air and space, not needing a physical connection between the source and the destination, and includes microwave, satellite, wireless networks and mobile phones.

(i) Microwave - when cable media is not convenient microwave transmission may be used. This operates by sending radio waves at very high frequency from antennae on towers approximately 50 kilometres apart. These towers are generally placed on tall buildings or mountains - since this method operates only in line-of-sight, so the aerials must be visible to one another. This method is faster than telephone lines or coaxial cables, and is error free except for changing weather conditions and objects (e.g. trees) which obstruct the line-of-sight.
(ii) **Satellite** - this method also uses very high frequency radio waves to send the data, but utilises both land-based dishes and orbiting stations. Signals are sent from a ground station to a satellite and back down to another ground station, transmitting large amounts of data over long distances. Transponders, or small specialised radios on the satellite, receive amplify and retransmit signals. They are generally used for television and radio broadcasts and Internet communications.

(iii) **Wireless LANs** - these use radio waves to link users to the network, but have problems with maintaining signal quality and electromagnetic radiation is still a problem.

(iv) **Mobile phones** - these use radio waves to transmit data to a grid of cellular stations which are linked to the wire-transmission telephone network (at the nearest exchange).

### 3. Network Software

Network operating software is specifically designed to support computers on a LAN, and examples include Novell Netware and Windows NT. Part of the system resides in each node as well as in the server, performing a range of tasks including -

- administration - organises users, installs software applications and hardware devices, carries out maintenance tasks including backups.
- file management - allows users to use remote hard disk(s) on the server and manages the network directory
- resource management - allows network devices to be shared, assigns printers and orders print jobs
- applications - handles user requests to share data and applications
- security - monitors and restricts access to the network resources

#### Logon and logoff Procedures

On connecting or logging on to a network, each user is given a certain level of access. **Logon** is how the user is identified using their ID and a password (generally with up to 8 characters in the ID and at least 1 digit in the password). The **password** is the main security measure for most networks and should not be an easily guessable word or number. The password file on the network is normally encrypted and protected from unauthorised access. Passwords may need to be frequently changed as an added security measure.

The logon procedure normally allows up to 3 attempts to enter the correct ID and password, since typing errors can occur as well as problems with the communications link. Depending on the level of access the user will be able to use arrange of features, as assigned by the network administrator.

The logoff procedure should always be done correctly, as otherwise another user will be able to access the first users files and features. As well, the logoff clears the communication line for another user to utilise.

### Network Based Applications

*Westfields Sports High  IPT - HSC  J. Smith  2004*
Some programs have been designed to operate on a network. Sometimes these are simply different versions of the software, to allow multiple users to the same application, while others are specially made for network use.

**Internet and Intranet**

As you would all know, the Internet is the enormous world-wide network of computers which began with the military, then was used by universities and finally became the popular and multi-million user resource it is today. It is a combination of millions of smaller networks, with easy to use programs like Explorer and Netscape allowing inexperienced users to access the many sites available, and anyone with the technology and an account with an ISP can make use of the Internet.

An Intranet is a private network, or LAN (like Westfields one) that is used to share data within a company or other organisation about things of interest to that organisation - policies, manuals, programs, etc. Most intranets also have access to the Internet as well, allowing employees to get out to the Internet for other purposes beyond the intranet. A firewall is needed to allow access out to the Internet - to maintain the security of the intranet (this makes it a one-way access). Intranets can only be accessed by those within the company - either at work or sometimes by remote access, through a login and password.

---

**Exercise 4 - complete each of the following -**

(a) Construct a table to compare the cable types and such features as - bandwidth, range, strengths and weaknesses, etc. to be researched and completed.

(b) Why are wired and wireless methods both used for data transmission?

(c) Why does a place like Westfields Sports HS need access to both an intranet and to the Internet?

(d) Why are privacy and confidentiality a concern with all messaging systems?

To be completed by - ............................................................

---

**Other Information Processes**

In all communication systems, a number of processes play an important part, including - collecting, processing and displaying.

- **Collecting**

Collecting data for any communication system involves generating the data to be transmitted e.g. a person has to enter details and insert a card for an ATM to send data to the bank’s computer. The data collection process may include the use of a range of collection devices to gather the different types of data, with each device being dependent on the application used and the data type to be transmitted. Some data collection devices include -

- telephone for voice mail
- ATM’s for electronic banking
- EFTPOS for a retail store
- keyboard for e-mail
• Processing
The processing of data is the manipulation of that data so that it is in the correct form for transmitting, that it, it is encoded for sending and decode at reception.

Encoding is the conversion of the data from its original form into the form required for transmission e.g. from sound when you speak into the telephone into electrical pulses to be transmitted along the telephone lines. The receiver in the telephone at the other end of the line then decodes the electrical pulses back into the original sound of the voice. The type of encoding and decoding will depend on whether the original data is in analog or digital form.

Analog data - is how most natural events in the world occur, such as temperature, light, pressure, etc. with continuous measurement done in pulses (usually electrical or optical) giving smooth continuous wave forms.

Digital data - is given in digits or numbers, changing in a series of jumps and is how information technology operates (zero’s and one’s).

From these it is seen that there are 4 possibilities for encoding and decoding for transmission
1. analog data to analog signal - where the wave shape of the data is encoded into the signal e.g. telephone
2. digital data to analog signal - where the 0’s and 1’s are encoded into a continuous wave e.g. modem
3. digital data to digital signal - where the 0’s and 1’s are sent through a channel as a series of on and off pulses e.g. LAN message
4. digital data to analog signal - where the wave shape of the data is encoded into a series of 0’s and 1’s e.g. digitising in a scanner

Attachments with E-mail
These are computer files such as pictures, videos and sounds which are sent with an e-mail message. Since the receiver of the e-mail needs to know an attachment is included, and what type it is, it is usual to refer to it in the text of the message, giving the filename and its format.

All e-mail programs have to encode file attachments into characters since the TCP/IP protocol does not allow the transmission of binary code. Some use the Multipurpose Internet Mail Extension (MIME) protocol to achieve this, as it can negotiate many different operating systems and types of software - thus improving the ability to exchange files other than just text.

Client-server Architecture
This term is used to describe the software relationship between the client (user) and the server. A client sends a request to a server according to an agreed protocol and the server responds - similar to a customer (the client) sending an order (the request) on an order form (the protocol) to a supplier (the server) for certain goods (the data).

Such architecture provides a convenient method to interconnect programs which may be distributed across different nodes of the network. The Internet also uses client-server architecture, the Web browser being a client program that requests services from a Web server to complete the request.
The server should give a user friendly interface so that clients are not aware of the information technology actually providing the service.

Displaying
This is the presentation of the information, often in a variety of forms from text to images, video, etc. A range of hardware and software combinations can be used to display the variety of formats e.g. telephone or EFTPOS

**Telephone** - audio information is displayed using a telephone, using a transmitter to convert sound into an electrical signal suitable for transmission down the copper wires, and a receiver that converts the signal back into sound. The telephone is also the display device used for retrieving voice mail.

**EFTPOS** - transaction information is displayed by the EFTPOS terminal, which contains a screen to display the name and price of the product to be purchased. On contacting the purchaser’s bank, the EFTPOS terminal displays the approval if funds are available. A receipt is then produced for the customer for the transaction(s).

---

**Exercise 5** - complete each of the following -
(a) Why do e-mails sometimes need attachments?
(b) Why are encoding and decoding so important for transmitted data?
(c) Compare and contrast the data collection techniques used by an ATM and a video camera - in some detail of how this is actually achieved.

To be completed by - ...................................................

---

**Issues Related to Communication Systems**
A range of positive and negative issues have resulted from the impact of the greater and wider range of communication systems. In principle all people should benefit from the improved access to data and the greater knowledge it should lead to for everyone. In these days knowledge is power and opens the door to wealth and prosperity.

**Messaging Systems**
While messaging systems have improved communication between people, they have raised a number of issues -

- **Social effects** - the ideas delivered by this means somehow appear less forceful and caring than those ideas delivered personally. The systems have difficulty when people want to express feelings, and many messages seem ‘wishy-washy’ compared to face-to-face communication.

- **Danger of misinterpretation** - since a certain amount of communication between people depends on the context, the inflection used by the speaker, as well as gestures and body language, problems do occur with messaging systems. For example, the statement “This is just great” could be very positive or quite negative when said out loud, but as a fax or e-mail could easily be confusing to the reader. Even phone messages or voice mail lose some meaning when the speaker’s hands and other body language are not on view.

- **Power relationships** - the accepted ‘pecking order’ in an organisation can be drastically altered by
the use of messaging systems e.g. the lowest paid employee can e-mail the manager directly. The normal communication through supervisors and middle management can be disrupted.

- **Privacy and confidentiality** - the storage of most messages by messaging systems means that other people may have access to someone’s private communication. For example, e-mails voice mail are stored on servers which generally have multiple user access, as well as the risk of hackers breaking in to the server and reading, copying, altering, etc. messages they find there. Telephone conversations can be scanned and listed to or taped, as well as overheard by nearby people, and faxes can be read by anyone passing the fax machine. Obviously messaging systems do not guarantee privacy or confidentiality.

- **Electronic junk mail** - this is another hazard of messaging systems, where for example one person can e-mail hundreds or thousands of others (termed spamming) easily. This may be some form of advertising through to hate mail or even chain type letters, and would be difficult to prohibit in our free society.

- **Information overload** - with the improvements in access to communication, the volume of information that people are bombarded with - at work, home and everywhere else. Messaging systems add to the other forms of information, with e-mails and voice mails adding to the normal workload and pushing some people to the limit. There is a perception that people will reply more quickly to e-mails and voice mails (since most of these are quite brief) than to telephone and written messages. However, quickly composed messages are more likely to create the problems listed above than well thought out ones, and so make the problem issues worse, potentially adding more stress to the situation.

### Implications of Internet Trading

Internet trading or e-commerce is growing at a great rate, with turnover of around $200 billion. The ease of producing Web sites for almost any business has meant that goods and services can be promoted to a large audience quite economically. Information about services or products can be sourced, as well as the opportunity of shopping globally. Some implications of e-commerce include -

- **Taxation** - so far governments have been unable to apply taxes to transactions over the Internet, since many purchasers are overseas, only identified by their credit card number, etc. As the volume of transactions increases, so the losses of such tax dollars will become quite significant.

- **Employment** - As Internet trading increases, so the number of people employed in shops will gradually decrease, while the number needed in the information technology industry will increase.

- **Nature of business** - traditional businesses which have opportunities for human interaction are being challenged as people elect to buy products over the Internet rather than from the store in person. People can also complete some of their business at home (banking, travel bookings, etc.) with the hassles of driving, parking, walking, etc.

- **Trade implications** - where countries used to have trade barriers in place, the use of communication technology has made these restrictions irrelevant. People are buying and selling goods on the Internet with no thought to national boundaries trade barriers or other considerations.
Censorship
This is one of the most controversial aspects of the Internet, in that a large amount of offensive and even depraved material can be found - from pornography to racism, violence and how to make bombs. Any Internet user from young children upwards can knowingly or accidentally access such material, and many people think that such offensive material should be banned. Others disagree, stating that banning any material restricts our free society (though we already have restrictions for books, videos, etc.). A number of governments and their law enforcement agencies have attempted to censor material on Web sites but with no success so far.

The Internet Industry Association (IIA) represents Australian ISP’s and this group has a code of conduct section on censorship of online material. In part this directs ISP’s to check and remove offensive content from their servers and to block access to classified material on overseas sites. How all of the thousands of existing Web sites and thousands of new ones are to checked daily has not been worked out. No country has yet devised methods to effectively deal with their own producers of material for Web sites, let alone working out multinational agreements about even the definitions for offensive material. At the moment parents and teachers have the responsibility for preventing children from accessing offensive material.

Internet Banking
Now that Internet banking is available to view account balances and transaction records, transfer funds between accounts and pay bills using Bpay, people are using the convenience of performing such functions from home, 24 hours a day. Obviously cash or cheque deposits and cash withdrawals still have to be completed at the bank or ATM.

Issues arising from Internet banking include -
• security - data encryption is used to ensure that data is secured for transfer from the customer’s computer to the bank’s computer. If the transfers were not secure people would not risk their details and possibly their money.
• changing nature of work - as more people utilise Internet banking so the tasks required of bank workers will alter and they will need to employ less tellers and more people with information technology skills.
• branch closures and job loss - already the use of ATM’s and EFTPOS has had an effect on employment levels in banks (as well as more part-time rather than full-time workers) and the increased use of Internet banking will lead to further reductions in staff levels and branch closures.

Removal of Physical Boundaries
Something that electronic communication has done to alter the lives of most users, is that it has removed a number of physical boundaries, including -
• people having to always travel to work at least 5 days per week
• only professionals being able to produce radio and television broadcasts
• international borders acting as boundaries for sales of goods

Working from Home

*Telecommuting* is the term used to describe people who work from home and electronically communicating with their company. Some choose to work mainly or partly from home (maybe going into the office once every week or two), while others are employed to work this way.

**Advantages**
- flexibility in work hours
- no wasted travel to and from work
- able to save money on transport and food costs
- allows physically impaired to work normally
- employer saves on office space and furniture
- able to work collaboratively over large distances

**Disadvantages**
- problems with bandwidth
- people miss social and professional contact with others
- isolation can cause loneliness for some
- work and home life cannot be separated and each can interrupt the other
- the cost of home technology setup and its maintenance
- concerns over employee loyalty to a company they rarely visit
- security of files in a home office

Virtual Organisations

Clubs and groups of people with mutual interests (such as computer user groups) used to physically meet once or twice a month, to discuss, demonstrate, etc. their area of interest. The venue for the meeting often had some rental cost, people would be busy on such nights, etc. and so for a lot of cases, the meeting is now more likely to be on the Internet. This can be via e-mail, a chat room, etc. as required.

So virtual organisations have come into being, with little or no costs and a lot of freedom for all involved.

This has meant that for Participants, support is provided for -
- individuals - by providing a means of communication, person to person in all the formats (phone, fax, e-mail, etc.).
- groups or teams - by enabling them to exchanges both ideas and data when working on projects (fax, e-mail, etc.).

Radio and Video

Radio and video are now able to be accessed through the Internet, with radio stations broadcasting a range of music styles as well as sporting events, etc. Video on the Internet allows organisations to create unlimited numbers of video channels to use for sales, training, performances, etc. - all of which may be viewed world wide. These have reduced costs and shorter production times, but the quality of such videos is lower than for normal TV broadcasts. The quality is expected to improve with progress in technology, such as bandwidth.
Assignment - complete the following -

Collect a folio of current information on trends and advances in communication technology, using -
(a) newspaper articles
(b) the Internet

Be sure to reference all material used for your portfolio fully and correctly.

To be handed in by - ........................................................

Exercise 6 - complete each of the following -

(a) Locate the IIA site on the Web and make a summary of the section on online censorship. Are these directions workable for ISP’s? Why?

(b) If you were put in charge of censoring the Internet for Australia, what could you do to ensure that children were kept away from offensive material - both at home and at school?

(c) Information overload is a real problem for managers in many businesses. What is the problem, and suggest some possible solutions.

(d) If Internet (e-commerce) continues to grow rapidly, what concerns will there be for the Australian worker?

(e) Complete a practical investigation of Internet banking to find out how many Australian institutions (banks, building societies, credit unions, etc.) have Internet banking.
Then -
(i) What are the benefits of Internet banking?
(ii) What are the risks involved in Internet banking (to the user)?

(f) Using Powerpoint, create a simulated Internet banking simulation program, following class discussion of what is required.
Examining the Commonwealth Bank Netbank may help you with this - see - www.commbank.com.au

(g) An insurance salesman has been told that his company has decided to change his group over to telecommuting, and close down most of the office. He would still visit clients each week day and would now update his files at home, and connect to the office when he decided to do so. On Fridays, electronic communication would be used to update the office, and the salesmen could all meet electronically if required.
Describe the changes to the working life of this person, as well as the advantages and disadvantages as you see them.

To be completed by - ........................................................
**Terms to know** - you should know the meanings of all of the following for this topic -

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>asynchronous</td>
<td></td>
</tr>
<tr>
<td>bits per second</td>
<td></td>
</tr>
<tr>
<td>bus</td>
<td></td>
</tr>
<tr>
<td>coaxial cable</td>
<td></td>
</tr>
<tr>
<td>cyclic redundancy</td>
<td></td>
</tr>
<tr>
<td>fibre optic cable</td>
<td></td>
</tr>
<tr>
<td>full-duplex</td>
<td></td>
</tr>
<tr>
<td>half-duplex</td>
<td></td>
</tr>
<tr>
<td>ISDN</td>
<td></td>
</tr>
<tr>
<td>microwave transmission</td>
<td></td>
</tr>
<tr>
<td>packet switching</td>
<td></td>
</tr>
<tr>
<td>parity</td>
<td></td>
</tr>
<tr>
<td>protocol</td>
<td></td>
</tr>
<tr>
<td>ring topology</td>
<td></td>
</tr>
<tr>
<td>serial transmission</td>
<td></td>
</tr>
<tr>
<td>simplex</td>
<td></td>
</tr>
<tr>
<td>star topology</td>
<td></td>
</tr>
<tr>
<td>stop bit</td>
<td></td>
</tr>
<tr>
<td>token passing</td>
<td></td>
</tr>
<tr>
<td>WAN</td>
<td></td>
</tr>
<tr>
<td>ZModem</td>
<td></td>
</tr>
<tr>
<td>baud rate</td>
<td></td>
</tr>
<tr>
<td>bridge</td>
<td></td>
</tr>
<tr>
<td>client server</td>
<td></td>
</tr>
<tr>
<td>CSMA</td>
<td></td>
</tr>
<tr>
<td>data compression</td>
<td></td>
</tr>
<tr>
<td>file server</td>
<td></td>
</tr>
<tr>
<td>gateway</td>
<td></td>
</tr>
<tr>
<td>hub</td>
<td></td>
</tr>
<tr>
<td>LAN</td>
<td></td>
</tr>
<tr>
<td>modem</td>
<td></td>
</tr>
<tr>
<td>parallel transmission</td>
<td></td>
</tr>
<tr>
<td>printer server</td>
<td></td>
</tr>
<tr>
<td>repeater</td>
<td></td>
</tr>
<tr>
<td>satellite transmission</td>
<td></td>
</tr>
<tr>
<td>server</td>
<td></td>
</tr>
<tr>
<td>smart terminal</td>
<td></td>
</tr>
<tr>
<td>start bit</td>
<td></td>
</tr>
<tr>
<td>synchronous transmission</td>
<td></td>
</tr>
<tr>
<td>twisted pair cable</td>
<td></td>
</tr>
<tr>
<td>XModem</td>
<td></td>
</tr>
</tbody>
</table>