Data Communication & Networking

Contents

- Introduction to Data Communication
- Introduction to Computer Networks

Communication Systems

A Communication system is the combination of hardware, software and data transfer links that make up a communication facility for transferring data in a cost effective and efficient manner

Data Communication Network

Communication means relaying of information or Data from one point to another.

Data is information presented in whatever form. E.g. images, documents, sound, figures. Etc.

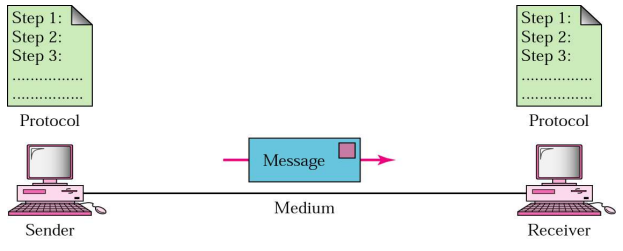
Data communications is the exchange of data between two or more devices via some form of transmission medium such as a wire cable

Elements of Data communication

The components that make up Data communication include:

- **The sender of the message.**
- **The message being sent.**
- **The medium through which the message is sent.**
- **The protocol. The rules that governs the process of sending the message. over the medium**
- **The receiver of the message, which is the destination of the message**

Components of Data Communication



1. Message
2. Sender
3. Receiver
4. Medium
5. Protocol

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Message- Is the actual information or data to be communicated or passed onto the other party

Sender- Is the message initiator/ the gadget intending to pass on information

Medium -Is the pathway for the message to be communicated or passed onto the other party

Protocol - protocols define format, order of messages sent and received among network entities, and actions taken on message transmission, receipt

Receiver - Is the party to whom the message is intended to be delivered.

Common Communication Tasks

Data encoding: the process of transforming input data or signals into signals that can be transmitted over a medium

Signal generation: generating appropriate electro-magnetic signals to be transmitted over a transmission medium

Synchronization: timing of signals between the transmitter and receiver from when a signal begins and when it ends (duration of each signal)

Error detection and correction: ensuring that transmission errors are detected and corrected

Flow control: ensuring that the source does not overwhelm the destination by sending data faster than the receiver can handle

Multiplexing: (sometimes contracted to muxing) is a method by which multiple analog or digital signals are combined into one signal over a shared medium.

This technique used to make more efficient use of a transmission facility and is used at different levels of communication

Addressing: indicating the identity of the intended destination

Routing: selecting appropriate paths for data being transmitted

Message formatting: conforming to the appropriate format of the message to be exchanged

Security: ensuring secure message transmission

Systems management: configuring the system, monitoring its status, reacting to failures and overloads, and planning for future growth

Ancient/Manual Methods and tools of Data Communication

- **They were manual in nature**
- **Used messengers.**
- **Sounding of Drums, bells or Horns.**
- **Smoke and fire**

Shortcomings the olden/Manual day data communication

- **Distortion of message by the messenger**
- **Small coverage**
- **Delay**
- **Misinterpretation of message by the recipient**
- **Message fails to reach intended destination**
- **Message cannot be kept future reference**

The modern electronic data processing tools

- Computers
- Mobile phones
- Social media such as Face book and tweeter
- E-mail
- Instant messaging
- Internet relay chat rooms

- Skype
- News groups
- Video conferencing
- Wikis and Blogs
- Podcasts

E-mail

- E-mail or electronic mail is primarily text-based electronic message that is sent from one computer or other ICT devices to others. In order to send or receive an e-mail, one must have a computer connected to the Internet, E-mail software, and an e-mail account.
- When mail is received on a computer system, it is usually stored in an electronic mailbox for the recipient to read later.
- Messages can be replied to or forwarded with speed and ease.

E-mail software (e-mail client)

- E-mail software is an application software which allows individuals to create an e-mail accounts and be able create, send and receive, store, and forward e-mail using SMTP (Simple Mail Transfer Protocol) and POP (Post Office Protocol).
- Examples Microsoft outlook, Yahoo, Roundcube, Thunderbird, Opera mail, etc.

Benefits/advantages of using email

- Its quick; e mail takes seconds to send compared to snail mail.
- It's cheap. Compared to posting or faxing messages
- The same message can easily be sent to many recipients at once by use of a mailing list.
- Messages can be replied to or forwarded with speed and ease because the software automatically inputs the address of the sender.
- Other files can be sent as attachments which has increased the popularity of email in business.

- it is convenient because a message can be sent anywhere in the world without having to leave one's desk.
- E-mail can be used by businessmen to send advertisements to potential customers.
- It is possible to send multimedia content as e-mail.
- The sender is informed in case the email is not sent so that is able to find other ways of delivering the message.
- A copy of the message is kept

Disadvantages of e-mail

- The sender and receiver both need internet access and e-mail accounts-most people in Uganda do not have access to e-mail.
- The hardware needed is expensive
- Email will not be delivered if there is a small error in the address.
- Some people are not keen on checking their mail boxes. So an urgent message may not be read in time.

- There is a large volume of unsolicited e-mail known as 'spam' that tends to fill up mailboxes.
- E-mail tends to take peoples valuable time at the expense of work or study.
- Parcels cannot be delivered via e-mail which limits its usability.
- Most viruses are spread via email.
- The privacy of an email message cannot be guaranteed. So confidential messages ought not sent via e-mail.

Mailing lists

- This is an e-mailing facility which distributes the same messages to the electronic mailboxes of all subscribers to the mailing list. The automated list manager assembles all the messages and sends them to the subscribers which enables email discussion among the subscribers of a particular mailing list. One can subscribe to or unsubscribe from a mailing list.
- An example of a mailing list are listservs.

Internet Relay Chat (IRC)

- IRC is a text based communication system that allows you to enter 'virtual chat rooms'. Within these rooms one sends and receives instant messages to and from anyone else in the same chat room. Each room has a different name which usually indicates the nature of the chat room.
- IRC is provided by commercial businesses that have their own servers. All one needs is an appropriate software to access the a chat room.

Instant messaging(IM service)

- This is a one-to-one chat service as opposed to group chat offered by IRC. An instant messaging software which must be installed on the computer allows the user to build a list of ones Net-connected friends from which one selects who to chat with at a particular time in case they are on-line.

Video Conferencing

- Videoconferencing is the conduct of a session/discussion using a set of telecommunication technologies which allow two or more locations to communicate by simultaneous two-way real time video and audio transmissions.
- videoconferencing is mostly used in business, education, medicine and media.
- It reduces the need to travel to bring people together.

USE OF WIKIS

- A Wiki is a website that allows people to add, modify, or delete content in a collaboration with others. the easy creation and editing of any number of interlinked web pages via a web browser using a simplified markup language or a WYSIWYG text editor.
- Wikis are typically powered by wiki software and are often used to create collaborative websites, to power community websites, for personal note taking, in corporate intranets, and in knowledge management systems.

Use of Blogs

A blog is a web site, where the user can write content or commentary on an ongoing basis. Usually maintained by an individual with regular entries of commentary, descriptions of events, or other material such as graphics or video. Entries are commonly displayed in reverse-chronological order. The new content shows up at the top, so your visitors can read what's new. Then they comment on it or link to it or email you. or not.

PODCASTS(Netcasts)

- Podcasts are digital media files consisting of an episodic series of audio, video, PDF, or ePub files subscribed to and downloaded or streamed online onto a computer or mobile device.
- Podcasting means making digital audio or video files available on the internet in such a way that others can set their computers to automatically download new episodes in a series as you post them.

Webcasts

- A Webcast is the delivery of live or delayed sound or video broadcasts over the internet using streaming media technology. The sound or video is captured by the conventional video or audio systems, then digitized and streamed . Eg News broadcast, Radio and TV programs

Webinars(Web conferencing)

- **A Webinars is short for web based seminar. It refers to conducting a seminar or lecture via the internet using graphics, text and live sound, unlike web casting, the audience is able to interact with the presenter such as asking questions by sending an instant message.**

Communication Network

A communication network is a collection of devices connected together by some communications media to exchange information or share resources

- Example devices are:
  - mainframes, minicomputers, supercomputers
  - workstations, personal computers
  - printers, disk servers, robots
  - Gateways, switches, routers, bridges
  - Cellular phone, Pager,
  - Refrigerator, Television, Video Tape Recorder

Data communication media

- They include both Physical transmission media and Wireless Transmission media.
- Physical media are data pathways that are made up of wires that connect from one device to another. E.g.
- Twisted pair cables
- Coaxial cables
- Fibre optic cables

Transmission media

Common transmission media include the following:

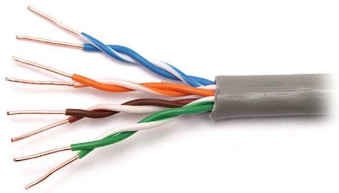
- Twisted pair cables
- Coaxial cables
- Fiber optic cables
- Terrestrial Microwave
- Radio
- Satellite

Twisted pair cables

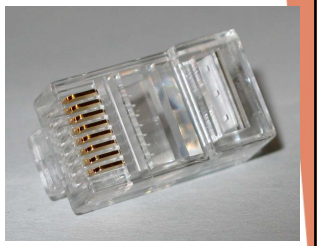
A twisted pair cable consists of eight insulated copper wires twisted in pairs and arranged in a regular spiral pattern to minimize the electromagnetic interference between adjacent pairs

There are two types of twisted pair cables; shielded twisted pair(STP) and Unshielded Twisted Pair(UTP)

UTP cable

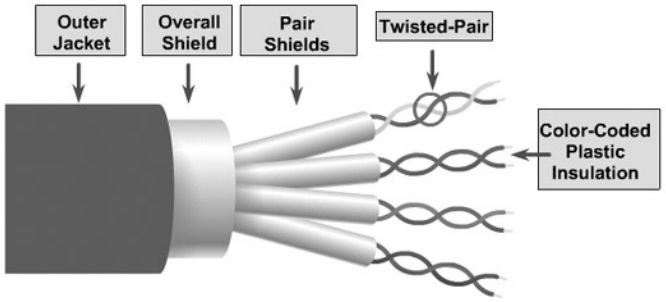


UTP connector (RJ 45)
RJ stands for “registered jack”



Twisted pair terminated with RJ 45 connector

Shielded twisted pair(STP)



Each pair is twisted to decrease interference.

Advantages of twisted pair cables

- They are relatively cheap to use because its cost per unit length is low.
- They are convenient to use because they are small in size.
- they are easy to install because of their flexibility it is easily strung around the room or wall.
- Shielded twisted pair has a foil shielding to help provide a more reliable data communication.
- Because UTP is small, it does not quickly fill up wiring ducts

The Disadvantages of twisted pair cables

- Used over a short distance, usually less than 100 meters
- Twisted pair's susceptibility (prone) to the electromagnetic interference which leads to signal loss.
- They are easily damaged. Especial the UTP.
- They are low frequency cables. So they are not suitable for transmission of very high frequency signals like cable TV, TV antenna and radio antenna signals

Coaxial cables

- A coaxial cable is one that consists of two conductors that share a common axis hence the name "co-axial". The inner conductor is a straight wire, and the outer conductor is a shield that might be braided or a foil. The two conductors are separated by a nonconductive element.

BNC connector

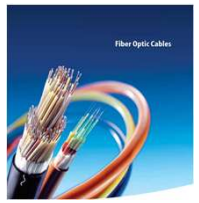
Features of coaxial cable

- both conductors share a common center axial, hence the term "co-axial"
- It has a high bandwidth
- It is highly resistant to signal interference
- It is used for long distance (300-600 meters)
- It is quite bulky and sometimes difficult to install
- the most common type of connector used with coaxial cables is the BNC connector

- It has higher installation costs
- Coaxial is prone to lightning strikes which damage the cables or equipment on which it is connected .
- It is more expensive than twisted pair cables
- It is not flexible

The Fiber Optic cables

- Fiber Optic Cable is a transmission medium, which is made up of hundreds to thousands of fine, light-conducting filaments made up of glass or plastic.
- Data is changed into pulses of light, which are sent down these glass or plastic fibers at very high speed over long distances.



- Fiber optic cable consists of a center glass core surrounded by several layers of protective materials
- It has protection against environmental interference
- It has high data carrying capacity (bandwidth of up to 2 Gbps)
- It Can be used over greater distances due to the low loss, high bandwidth properties.
  It can be used for 2km without the use of a repeater
- Fiber optic networks operate at high speeds - up into the gigabits

- Greater resistance to electromagnetic noise such as radios, motors or other nearby cables.
- Fiber optic cables cost much less to maintain.
- They are light weight and small in size, which makes them ideal for applications where running copper wires would be impractical .
- It is difficult to tap data over a fiber optic without being noticed due to difficulty of connecting new nodes when others are switched on.
- They are poor conductors of electricity which eliminates the possibility of electrical shocks.

- Fiber optics are expensive compared to the other types of cables.
  - They are difficult to install and modify, therefore require skilled installers
  - It is difficult to add additional nodes on the network.
  - It is much more costly than other cables to install

Wireless media

Wireless communication technology, is one where the transfer of information over a distance is done without the use of cables(wires) as a medium.

Wireless technology is applied in Local area networks (WLANs), extended local area network, and connecting a network to another network.

Advantages of Wireless Media

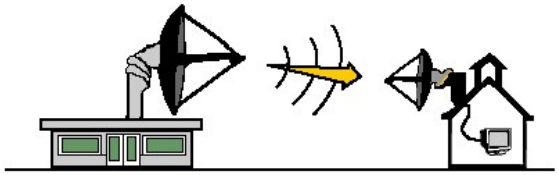
- Wireless technology overcomes the inconvenience of using too many wires for communication.
- Wireless is appropriate to use in places where cabling is practically impossible.
- Wireless increases flexibility and mobility at the work place because workers can sit anywhere with their computers without being limited by the extent of cable connections.

Types of wireless media

- Radio
- Microwave
- Infrared
- Blue tooth

Microwave transmission

- Microwave transmission refers to the technology of conveying information or energy by the use of radio waves whose wavelengths between one metre and one millimeter.



- Microwave transmission requires line of sight in order to work properly because it is a point-to-point connection.
- This means microwave must be transmitted in a straight line (with no obstacles such as buildings or hills in the line of sight between the microwave stations).
- The distance covered by microwave signals is based upon the height of the antenna.

- Microwave communication can take two forms: terrestrial (ground) links and satellite links.
- Terrestrial microwaves use Earth-based transmitters and receivers, sending data from one microwave station to another.

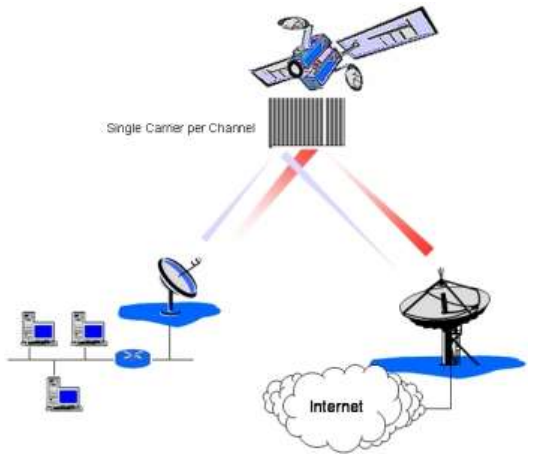
- Microwave antennas are usually placed on top of buildings, towers, hills, and mountain peaks to avoid obstructions.
- Microwave transmissions use parabolic antenna and dishes that produce a narrow, highly directional signal.

Limitations of Microwave

- microwave signals are highly subjected to atmospheric interference.
- microwave can be exposed to electronic eavesdropping.

Communications Satellites

- Satellites are communication devices stationed in space and use microwave radio as their telecommunications medium to communicate with the earth based communication facilities.
- Satellites are capable of receiving and relaying voice, data, and TV signals to and from earth based communication facilities (earth stations) that use parabolic antennas (satellite dishes) to communicate with the satellites.



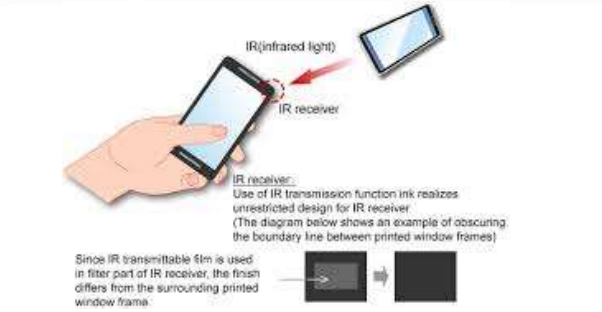
- Satellite microwave communication is flexible and possible with most remote sites and with mobile devices, because no cables are required, which enables transmission with ships at sea and motor vehicles.

Radio transmission

- Radio is the transmission of signals, by converting them into electromagnetic waves.
- The electromagnetic waves are transmitted in space towards the destination.
- Electromagnetic waves are intercepted by the receiving Antenna. The signal power is collected at the receiving antenna.
- Radio waves are not a line of sight transmission, therefore not affected by presence of objects between the transmitter and receiver.

Infrared transmission

- Infrared (IR) light is electromagnetic radiation with longer wavelengths than those of visible light.
- Infrared signal is usually transmitted across relatively short distances to transmit data between personal devices for example, between a computer and a cell phone.
- Infrared can be either beamed between two points or broadcast from one point to many receivers.



Bluetooth

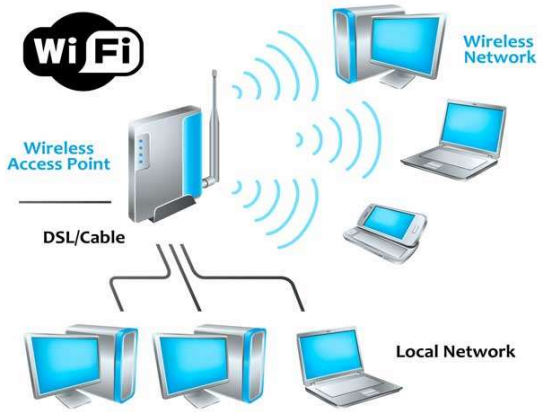
- Bluetooth is a short range wireless technology which Operates at approximately 1Mbps with range from 10 to 100 meters. Bluetooth is an open wireless protocol for data exchange over short distances.

Wireless local area network (WLAN)

- A WLAN is a network that provides wireless network communication in a small geographical area using high frequency radio signals or infrared light beams or microwave or Bluetooth to communicate between the workstations and other devices.
- Clients communicate with the access point using a wireless network adapter similar in function to a traditional Ethernet adapter.

- A wireless local area network (WLAN) links two or more devices using a wireless distribution method (spread-spectrum).
- Most modern WLANs are based on IEEE 802.11 standards, marketed under the Wi-Fi brand name.

- The WAP usually connects to a wired network, and can relay data between wireless devices and wired devices.
- Wireless LANs use spread spectrum technology to enable communication between multiple devices in a limited area. An example of open-standards wireless radio-wave technology is IEEE 802.11b.



- The wireless LAN network devices include; Wireless network adaptors, wireless access points, wireless bridges, wireless routers, and antennae.

Wireless access point

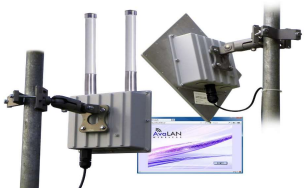
- A wireless access point (WAP or AP) is a device that connects wireless communication devices together to form a wireless network.
- To be able to communicate with a wireless device, the computer must have a wireless network adaptor.

WLAN adaptor/card

- This is a device that provides an interface between the network operating system and an antenna to create a wireless connection to the network

Access point (AP)

- AP is the wireless equivalent of a LAN hub. It receives buffers, and transmits data by means of a wireless antenna between WLAN and a wired network



Outdoor LAN Bridges

- An outdoor LAN bridge is a device used to connect LANS in different buildings.

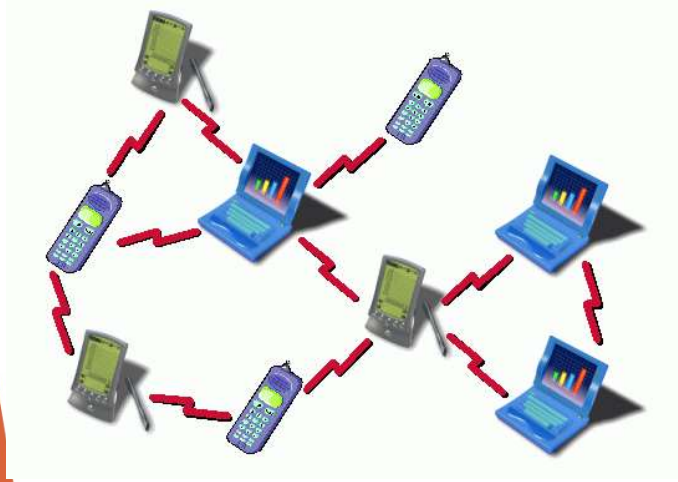
Wireless Local Area Network(WLAN) topologies

WLAN can be built with either of the following topologies:

- Peer- to – Peer (Ad hoc) topology
- Access Point – based topology
- Point –to- Multipoint bridge topology

Peer –to- Peer (ad hoc) topology

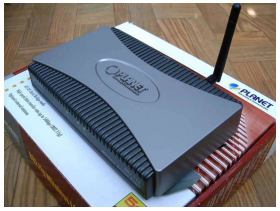
- In the ad hoc topology devices are configured to communicate directly to each other.



Access point – based topology

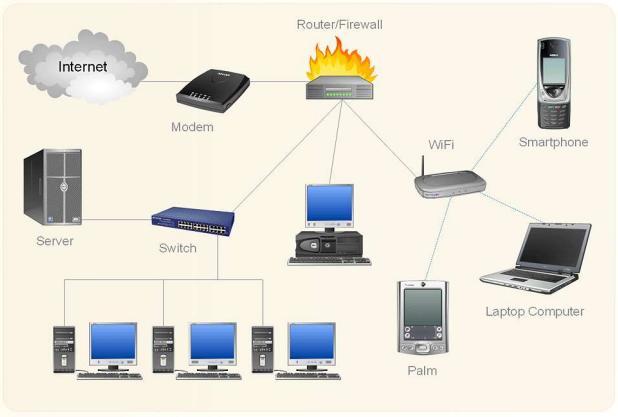
- This is where access point(s) are used to enable a wireless device to communicate with any other wired or wireless device on the network.
- Access points are used to bridge traffic onto a wired or wireless backbone, or where network devices are interconnected using access points.

Access points

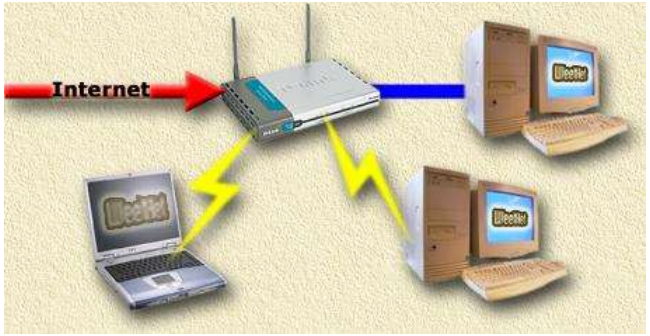


Planet WAP-4000 Wireless Access Point

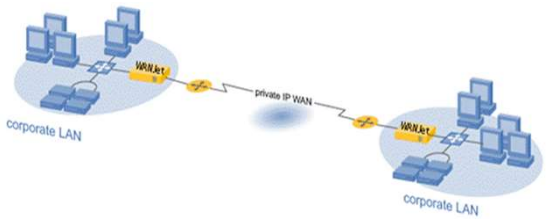
Network Diagram



- This is where a wireless bridge is configured to connect a LAN in one building to a LAN in another building even if the buildings are not close together but within a clear line of sight.



This is a wireless network over a wide area in which separate areas of coverage are connected wirelessly.



Wireless Wide Area Networks equipment

Long distance wireless equipment include:

- Satellite
- Microwave dishes
- Microwave antennae

The Wireless Web

The wireless web refers to the use of the World Wide Web through equipment like cellular phones, Pagers, PDAs, and other portable communications devices that offers anytime/anywhere connection.

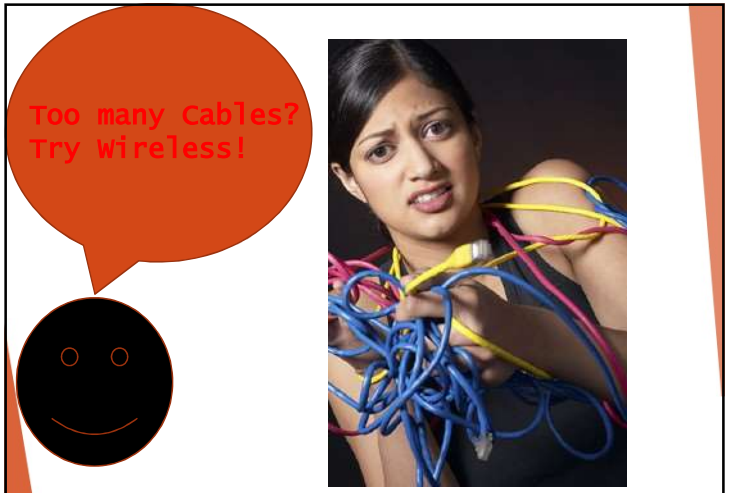
Wireless application Protocol (WAP)

The Wireless Application Protocol (WAP) refers to a group of related technologies and protocols widely used as a standard protocol in providing Internet access to mobile phones or other small mobile devices.

WAP protocol involves a website transmitting scaled-down versions of normal web pages specifically optimized for use by wireless telecommunications devices such as smartphones.

Advantages of a wireless network

- Cost reduces because There is no need to buy and lay cables.
- Work is reduced for setting up the network because there are no cables involved.
- It enables usage of a variety of devices on network such as personal digital assistants (PDA), blackberry devices, and other cell phones.
- It enhances mobility and flexibility of a network due to ability to move devices without the restriction of cables for example, mobile phones and laptops.



- Fast data transfer rates are possible where there are no environmental obstacles.
- It also allows an organisation to offer visitors wireless internet access or hot-desk or hotspot facilities.
- Wireless technology makes it easy to set up temporary network installations. These situations include any temporary department set up for a specific purpose that soon will be torn down or relocated.
- Wireless technology is becoming cheaper and affordable over time

Disadvantages of a wireless network

- Poor security of data on a wireless net work, outsiders can easily log on an unsecured wireless network.
- They are slower than LANs using cabling
- They are prone to electrical interference from lights and radios
- They are Subject to obstructions such as walls.
- Wireless access points and WI-FI technology in general have a limited spectrum/range. signal strength decreases as the range increases.