MODULE -IV

MOBILE RADIO COMMUNICATION
&
WIRELESS COMMUNICATION

Evolution of Mobile Communication

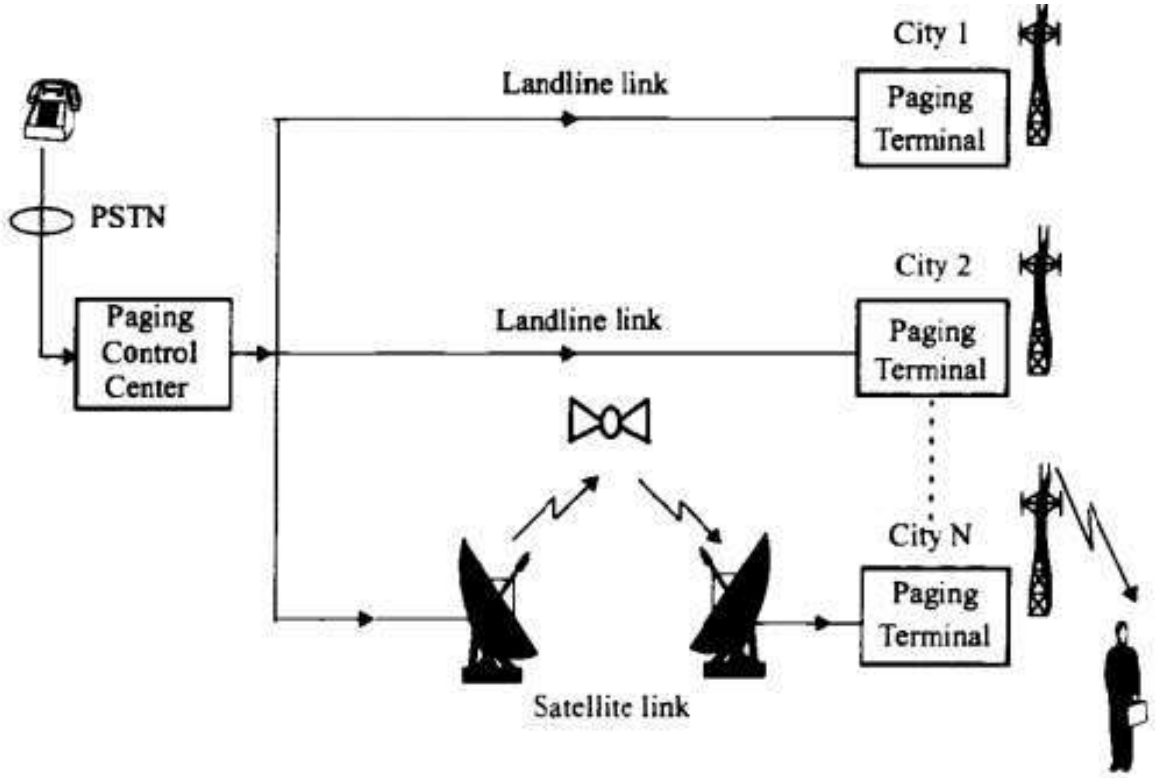
- ✓**Mobile radio** or **mobiles** refer to wireless communications systems and devices which are based on radio frequencies(using commonly UHF or VHF frequencies), and where the path of communications is movable on either end.
- ✓An obsolete(no longer in use) term is **radiophone**.
- ✓Early users of mobile radio equipment included transportation and government. These systems used one-way broadcasting instead of two-way conversations.
- ✓Early mobile radios used amplitude modulation (AM) to convey intelligence through the communications channel.
- ✓Problems with sources of electrical noise showed that frequency modulation (FM) was superior for its ability to cope with vehicle ignition and power line noise.
- ✓The frequency range used by most early radio systems, 25 to 50 MHz (vhf "low band") This plus the need for more channels led to the eventual expansion of two-way radio communications into the VHF "high band" (150 to 174 MHz) and UHF (450 to 470 MHz).
- ✓mobile radios use noise-canceling microphones or headsets
- ✓A mobile radio must have an associated antenna. The most common antennas are stainless steel wire or rod whips which protrude vertically from the vehicle

Paging Systems

- ✓Paging systems are communication systems that send brief messages to a subscriber.
- ✓Depending on the type of service, the message may be either a numeric message, an alphanumeric message, or a voice message.
- ✓Paging systems are typically used to notify a subscriber of the need to call a particular telephone number or travel to a known location to receive further instructions.
- ✓ In modern paging systems, news headlines, stock quotations, and faxes may be sent.
- ✓A message is sent to a paging subscriber via the paging system access number (usually a toll-free telephone number) with a telephone keypad or modem.
- ✓The issued message is called a page.
- ✓The paging system then transmits the page throughout the service area using base stations which broadcast the page on a radio carrier.

Types of paging

- ✓There are two different kinds of paging: **limited range** and **wide-area**.
- ✓ Limited-range paging:- sends messages over a relatively small area using a low-powered transmitter. It's perfect for sending emergency messages to all the doctors in a hospital ;for example. It covers a limited range of 2 km to 5 km
- ✓Wide-area paging:- is more like national radio broadcasting. Ie world wide coverage.
- ✓Though paging receivers are simple and inexpensive, the transmission system required is quite sophisticated.
- ✓Paging systems are designed to provide reliable communication to subscribers wherever they are.
- ✓ This necessitates large transmitter powers (on the order of kilowatts) and low data rates (a couple of thousand bits per second) for maximum coverage from each base station.
- ✓Wide area paging systems consist of a network of telephone lines, many base station transmitters, and large radio towers that simultaneously broadcast a page from each base station (this is called simulcasting). Simulcast transmitters may be located within the same service area or in different cities or countries.



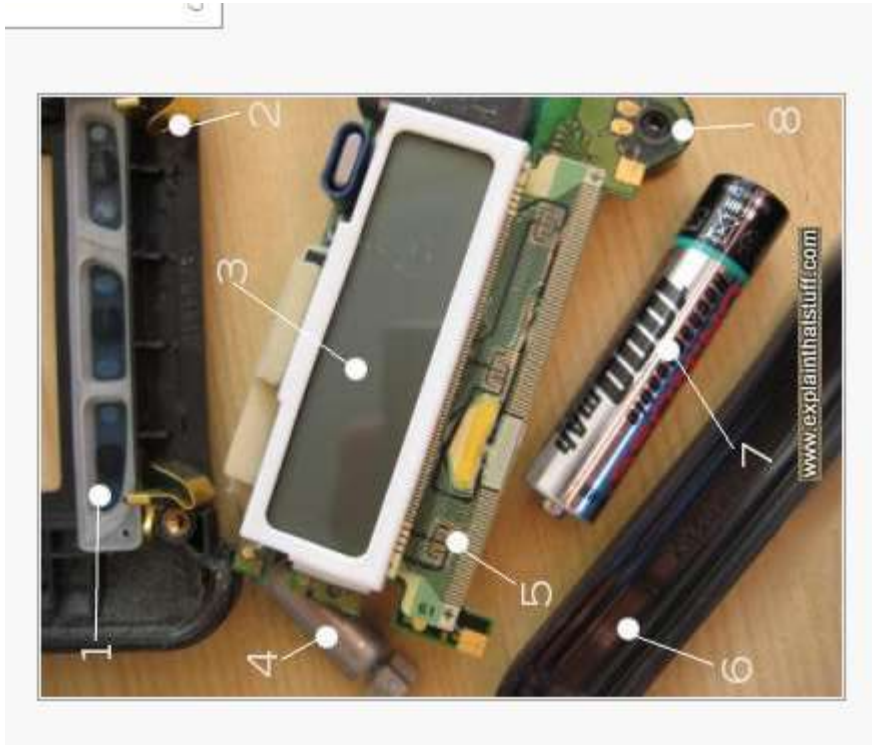
Wide area paging system

Disadvantages:

- ✓ It's a one-way form of communication. If you receive a pager message, you probably have to find a telephone to call back
- ✓ You don't receive a message if you're out of range or your pager is switched off, there's no way either you (or the sender) can find out about it.

1. Three rubber membrane buttons (work in a similar way to a cheap computer keyboard.
2. Battery connectors.
3. LCD display screen.
4. Vibrating alert: A small electric motor vibrates because it has an uneven piece of metal attached to its axle at the top. As the motor spins around that's what produces the vibrations you feel.
5. Main circuit board.
6. Removable battery flap.
7. 1.5 volt battery.
8. Small loudspeaker gives an audible alert

when a message is received.



Cordless Telephone Systems

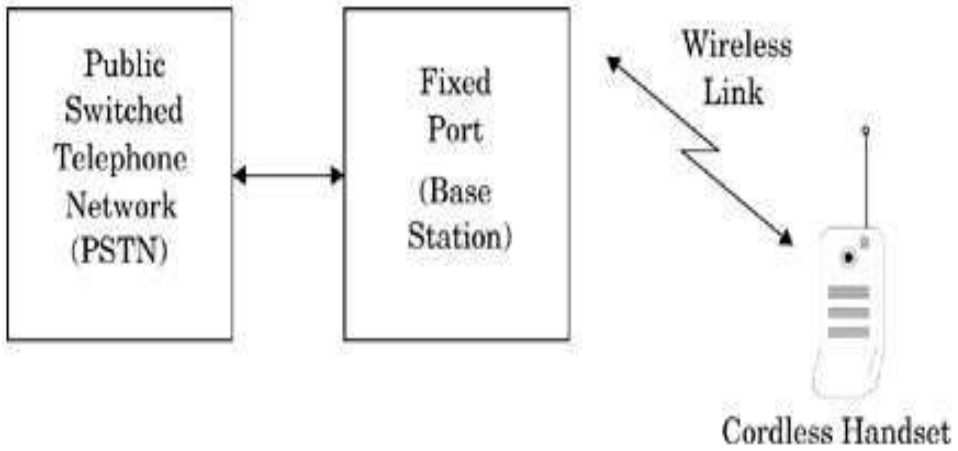
- ✓ A cordless telephone is basically a combination of telephone and radio transmitter /receiver.

WORKING

- ✓ **Base** is connected to the phone line through a wire.
- ✓ It acts as a normal telephone, receiving calls through the phone line as electrical signals.
- ✓ Then it converts the electrical signals to a radio signal and transmits that signal to the handset.

- ✓ **Hand set**-which can be used anywhere within a specified distance from the base
- ✓ The transmitted radio signal from the base is received by the handset.
- ✓ This signal is converted back to electrical signal and sent to the speaker.
- ✓ The speaker converts the electrical signal into the sound we hear.

- ✓When we talk via the handset, our voice is transmitted to the base as radio signal where it is converted to electrical signal and transmitted through the phone line.
- ✓The base and handset operate on a frequency pair that allows us to talk and listen at the same time, called duplux frequency.



Block Diagram of Base Unit

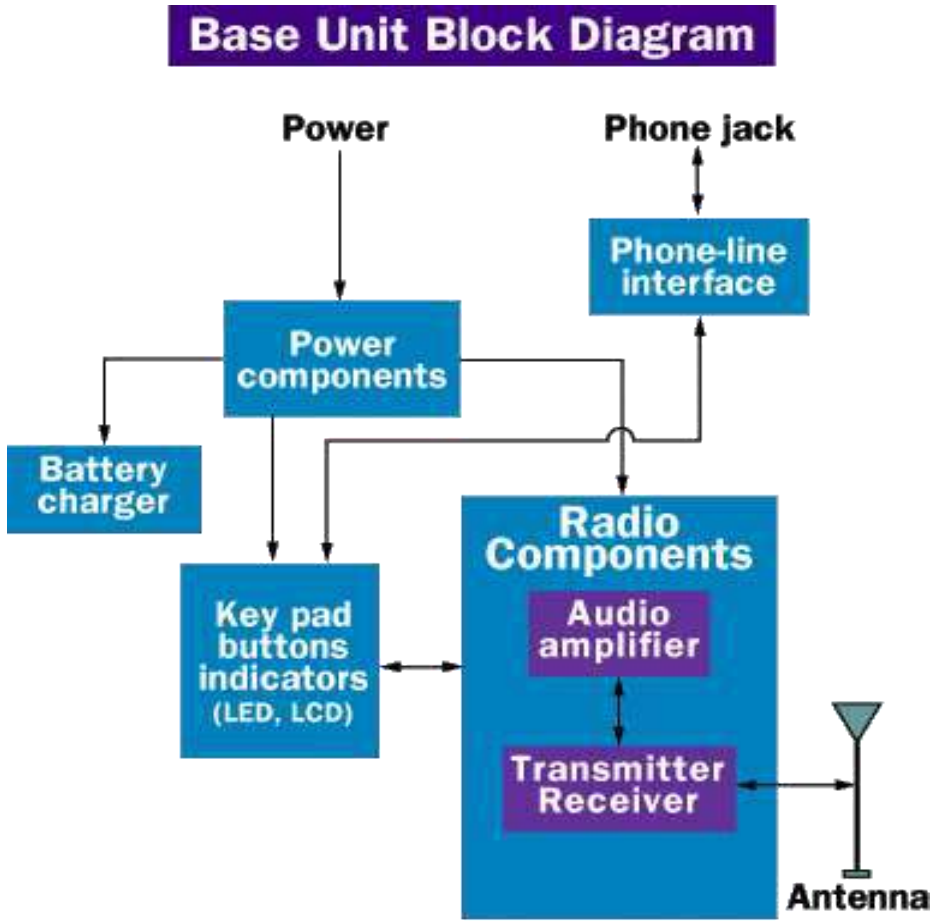
- ✓ A cordless phone has two major parts: base and handset .
- ✓ The frequency determines the signal clarity and the range over which the handset works.
- ✓ The base unit of the cordless phone is plugged into the telephone jack on your wall.

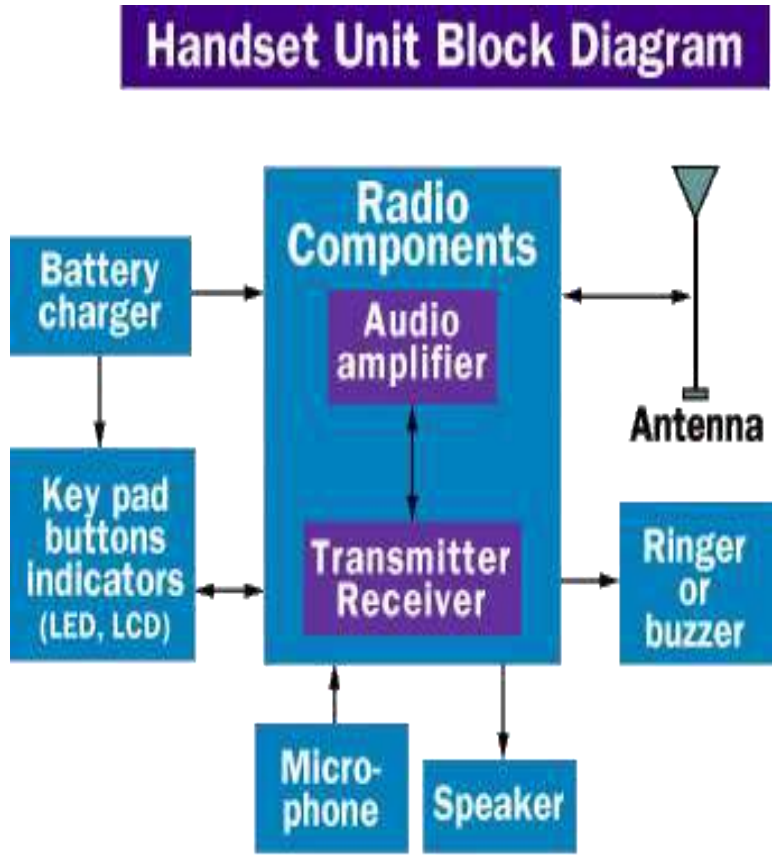
Phone line interface - receives and sends telephone signals through the phone line

Radio

- amplifies signals to and from phone-line interface, user controls and speaker phone (if present)
- broadcasts and receives radio signals to and from the handset

- ✓ **Power** - supplies low voltage power to the circuits and recharges the battery of the handset


Base Unit Block Diagram
Power
Phone jack
Phone-line interface
Power components
Battery charger
Key pad buttons indicators (LED, LCD)
Radio Components
Audio amplifier
Transmitter Receiver
Antenna


Handset Unit Block Diagram
Battery charger
Key pad buttons indicators (LED, LCD)
Radio Components
Audio amplifier
Transmitter Receiver
Antenna
Ringer or buzzer
Micro-phone
Speaker

Block Diagram of Base Unit

- ✓The handset has all of the equipment of a standard telephone (speaker, microphone, dialing keypad), plus the equipment of an FM radio transmitter/receiver.
  - ✓**Speaker** - converts electrical signals into the sound that you hear
  - ✓**Microphone** - picks up your voice and changes it to electrical signals
  - ✓**Keypad** - input for dialing
  - ✓**Buzzer** or **ringer** - intimate you that you have an incoming call
  - ✓**Radio components**
    - ✓amplify electrical signals to and from microphone and speakers
    - ✓send and receive FM radio frequencies
  - ✓**LCD or LED displays** - indicator lights
  - ✓**Re-chargeable battery** - supplies electrical power to handset

Table 1.5 Comparison of Mobile Communication Systems — Mobile Station

Service	Coverage Range	Required Infra-structure	Complexity	Hardware Cost	Carrier Frequency	Functionality
TV Remote Control	Low	Low	Low	Low	Infra-red	Transmitter
Garage Door Opener	Low	Low	Low	Low	< 100 MHz	Transmitter
Paging System	High	High	Low	Low	< 1 GHz	Receiver
Cordless Phone	Low	Low	Moderate	Low	< 100 MHz	Transceiver
Cellular Phone	High	High	High	Moderate	< 1 GHz	Transceiver

Table 1.6 Comparison of Mobile Communication Systems — Base Station

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0G

- ✓Wireless telephone started with 0G, which became available after World War-II.
- ✓In those pre-cell days, mobile operator sets up the calls and there were only a handful of channels available.
- ✓These mobiles does not support the handover feature i.e. Change of channel frequency.
- ✓0G refers to pre cellular mobile telephony technology in 1970’s. such as Radio telephones that some had in cars before the advent of cell phones.
- ✓Mobile radio telephonic system produced modern cellular mobile-telephony technology.
- ✓Since they were predecessors of first generation of cellular telephones, these systems, are called 0G (Zero Generation) Systems.

WIRELESS COMMUNICATION SYSTEMS

1G Technology- Analog signals(voice only)

- ✓1G refers to the first generation of wireless mobile communication where analog signals were used to transmit data.
- ✓It was introduced in the US in early 1980s and designed exclusively for voice communication
- ✓Some characteristics of 1G communication are −
  - ✓Speeds up to 2.4 kbps
  - ✓Poor voice quality
  - ✓Large phones with limited battery life
  - ✓No data security
  - ✓1G has low capacity unreliable handoff
  - ✓All the systems offered handover and roaming capability but the cellular networks were unable to interoperate between countries. This was the main drawback of First Generation mobile networks.

2G Technology- digital signal (GSM introduced- Narrowband TDMA and CDMA)

- ✓ 2G refers to the second generation of mobile telephony which used digital signals for the first time.
- ✓ It was launched in Finland in 1991
- ✓ used GSM technology.
- ✓ Some prominent characteristics of 2G communication are −
  - ✓ Data speeds up to 64 kbps
  - ✓ Text and multimedia messaging possible
  - ✓ Better quality than 1G
  - ✓ 2G has greater security for both sender and receiver.
  - ✓ data can be read by only intended receiver
  - ✓ 2G system uses digital mobile access technology such as TDMA and CDMA.
- ✓ When GPRS technology was introduced, it enabled web browsing, e-mail services and fast upload/download speeds.
- ✓ 2G with GPRS is also referred as 2.5G, a step short of next mobile generation.

3G Technology- (GPS introduced- Wideband TDMA and CDMA)

- ✓Third generation (3G) of mobile telephony began with the start of the new millennium and offered major advancement over previous generations.
- ✓ Some of the characteristics of this generation are −
  - ✓Data speeds of 144 kbps to 2 Mbps
  - ✓High speed web browsing
  - ✓Running web based applications like video conferencing, multimedia e-mails, etc.
  - ✓Fast and easy transfer of audio and video files
  - ✓Services include wide area.
  - ✓wireless voice telephony, video calls, and broadband wireless data, mobile television, GPS (global positioning system)
  - ✓3D gaming
- ✓**Downsides of 3G technology**
  - ✓Expensive mobile phones
  - ✓High infrastructure costs like licensing fees and mobile towers
  - ✓Trained personnel required for infrastructure set up
  - ✓The intermediate generation, 3.5G grouped together dissimilar mobile telephony and data technologies and paved way for the next generation of mobile communication.

4G Technology- OFDMA introduced- WIMAX

Fourth generation (4G) of mobile communication was introduced in 2011.
Its major characteristics are −

- ✓ Speeds of 100 Mbps to 1 Gbps
- ✓ Mobile web access
- ✓ High definition mobile TV
- ✓ Cloud computing
- ✓ IP telephony
- ✓ new technology OFDMA is introduced 4G.

APPLICATIONS

- ✓ VIRTUAL PRESENCE:
- ✓ VIRTUAL NAVIGATION:
- ✓ TELE-GEOPROCESSING APPLICATIONS: This is a combination of GIS(Geographical Information System) and GPS (Global Positioning System) in which a user can get the location by querying.
- ✓ TELE-MEDICINE AND EDUCATION:
- ✓ CRISIS MANAGEMENT:
- ✓ MULTIMEDIA – VIDEO SERVICES

DISADVANTAGES of 4G

- ✓ Higher data prices for consumers.
- ✓ It is very expensive and hard to implement.
- ✓ Complex hardware.
- ✓ Power usage is more

COMPARISON OF 2G,3G,4G,5G

Generation	Speed	Technology	Time period	Features
1G	14.4 Kbps	AMPS,NMT, TACS	1970 – 1980	During 1G Wireless phones are used for voice only.
2G	9.6/ 14.4 Kbps	TDMA,CDMA	1990 to 2000	2G capabilities are achieved by allowing multiple users on a single channel via multiplexing. During 2G Cellular phones are used for data also along with voice.
2.5G	171.2 Kbps 20-40 Kbps	GPRS	2001-2004	2.5G the internet becomes popular and data becomes more relevant.2.5G Multimedia services and streaming starts to show growth. Phones start supporting web browsing though limited and very few phones have that.
3G	3.1 Mbps 500-700 Kbps	CDMA 200 (1xRTT, EVDO) UMTS, EDGE	2004-2005	3G has Multimedia services support along with streaming are more popular. In 3G, Universal access and portability across different device types are made possible. (Telephones, PDA's, etc.)
3.5G	14.4 Mbps 1-3 Mbps	HSPA	2006 – 2010	3.5G supports higher throughput and speeds to support higher data needs of the consumers
4G	100-300 Mbps. 3-5 Mbps 100 Mbps (Wi-Fi)	WiMax LTE Wi-Fi	Now (Read more on Transitioning to 4G)	Speeds for 4G are further increased to keep up with data access demand used by various services. High definition streaming is now supported in 4G. New phones with HD capabilities surface. It gets pretty cool. In 4G, Portability is increased further. World-wide roaming is not a distant dream.
5G	Probably gigabits	Not Yet	Soon (probably 2020)	Currently there is no 5G technology deployed. When this becomes available it will provide very high speeds to the consumers. It would also provide efficient use of available bandwidth

COMPARISON OF 1G TO 5G TECHNOLOGIES

Technology	1G	2G/2.5G	3G	4G	5G
Deployment	1970/1984	1980/1999	1990/2002	2000/2010	2014/2015
Bandwidth	2kbps	14-64kbps	2mbps	200mbps	>1gbps
Technology	Analog cellular	Digital cellular	Broadbandwidth/ cdma/ip technology	Unified ip & seamless combo of LAN/WAN/WLAN/PAN	4G+WWWW
Service	Mobile telephony	Digital voice,short messaging	Integrated high quality audio, video & data	Dynamic information access, variable devices	Dynamic information access, variable devices with AI capabilities
Multiplexing	FDMA	TDMA/CDMA	CDMA	CDMA	CDMA
Switching	Circuit	Circuit/circuit for access network& air interface	Packet except for air interface	All packet	All packet
Core network	PSTN	PSTN	Packet network	Internet	Internet
Handoff	Horizontal	Horizontal	Horizontal	Horizontal&Vertical	Horizontal&Vertical

Include features too

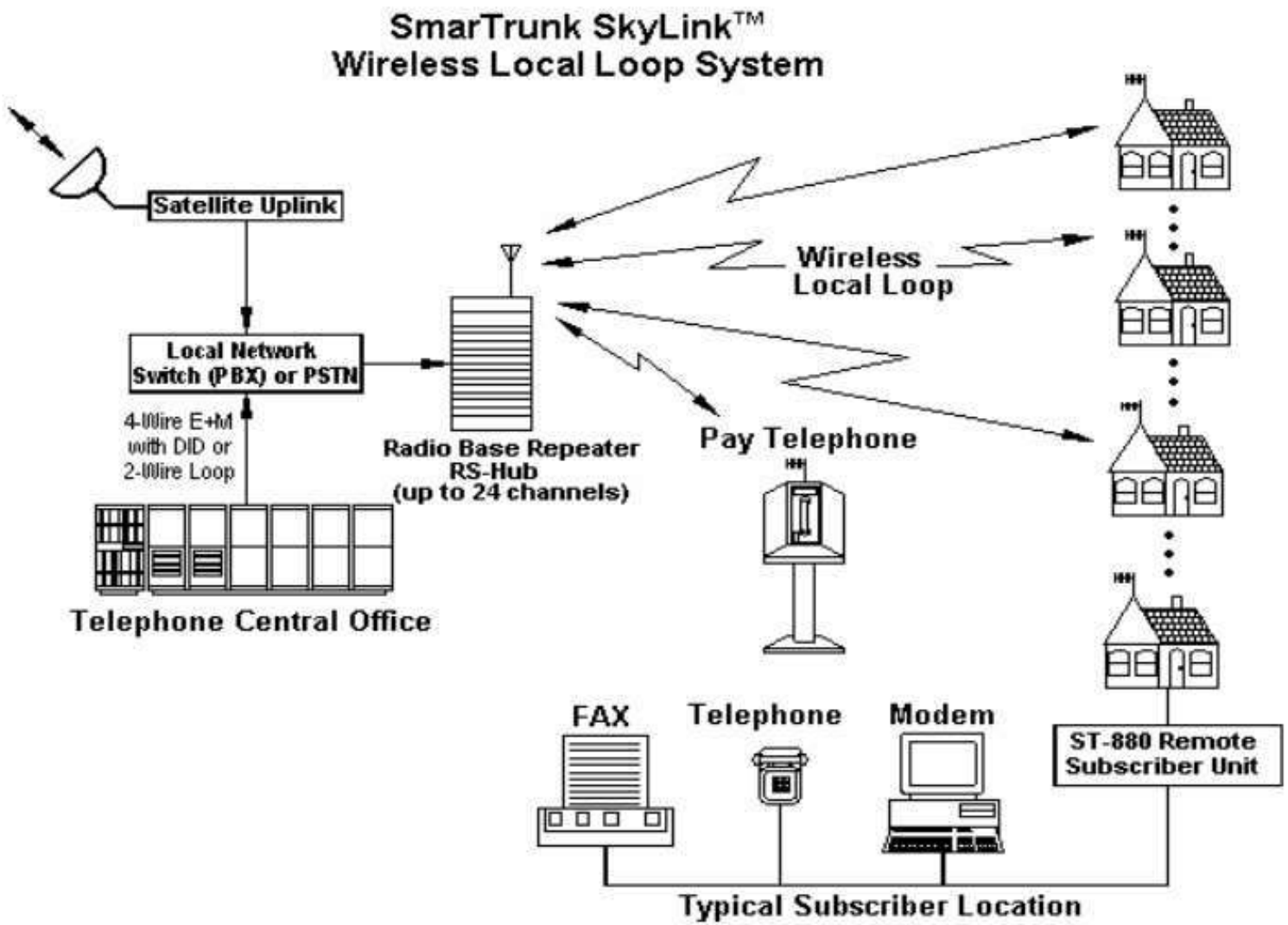
Wireless Communications Systems

- ✓Communication Systems can be Wired or Wireless and the medium used for communication can be Guided or Unguided.
- ✓In Wired Communication, the medium is a physical path like Co-axial Cables, Twisted Pair Cables and Optical Fiber Links etc. which guides the signal to propagate from one point to other. Such type of medium is called Guided Medium.
- ✓On the other hand, Wireless Communication doesn't require any physical medium but propagates the signal through space. Since, space only allows for signal transmission without any guidance, the medium used in Wireless Communication is called Unguided Medium.

Why Wireless Communication?

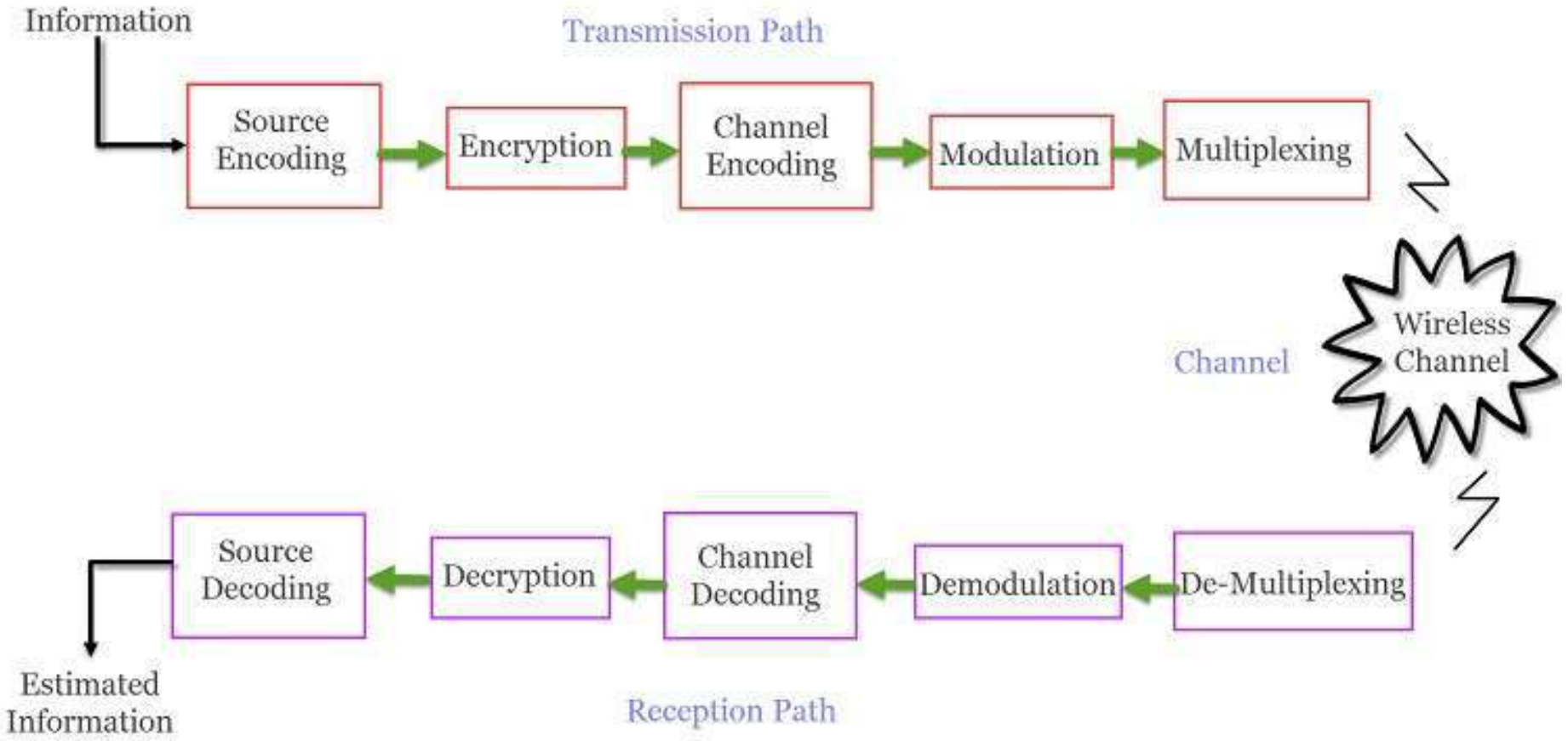
- ✓mobility.
- ✓flexibility and ease of use
- ✓ infrastructure

GENERAL WLL SET UP



Basic Elements of a Wireless Communication System

Wireless means transmitting signals using radio waves as the medium instead of wires



Transmission Path

- ✓The transmission path of a Wireless Communication System consists of Encoder, Encryption, Modulation and Multiplexing.
- ✓ Source Encoder:- The signal from the source is passed through a Source Encoder, which converts the signal in to a suitable form for applying signal processing techniques.
- ✓The redundant information from signal is removed in this process in order to maximise the utilization of resources.
- ✓ Encryption:-This signal is then encrypted using an Encryption Standard so that the signal and the information is secured and doesn't allow any unauthorized access.
- ✓Channel Encoding :- is a technique that is applied to the signal to reduce the impairments like noise, interference, etc. During this process, a small amount of redundancy is introduced to the signal so that it becomes robust against noise.
- ✓ Modulation:-Then the signal is modulated using a suitable Modulation Technique (like PSK, FSK and QPSK etc.) , so that the signal can be easily transmitted using antenna.
- ✓Multiplexing:-The modulated signal is then multiplexed with other signals using different Multiplexing Techniques like Time Division Multiplexing (TDM) or Frequency Division Multiplexing (FDM) to share the valuable bandwidth.

Channel

- ✓The channel in Wireless Communication indicates the medium of transmission of the signal i.e. open space.
- ✓A channel maybe subject to interference, distortion, noise, scattering etc. and the result is that the received signal may be filled with errors.

Reception Path

- ✓The Receiver is to collect the signal from the channel and reproduce it as the source signal.
- ✓The reception path of a Wireless Communication System comprises of Demultiplexing , Demodulation, Channel Decoding, Decryption and Source Decoding.
- ✓The task of the receiver is just the inverse to that of transmitter.

Characteristics of Wireless Communications Systems (Advantage)

- ✓Mobility − It allows users to access information beyond their desk and conduct business from anywhere without having a wire connectivity.
- ✓Reachability − It enables people to be stay connected and be reachable, regardless of the location they are operating from.
- ✓Simplicity − They are easy and fast
- ✓Maintainability − Need not to spend too much cost and time to maintain the network setup.
- ✓Roaming Services − It can provide service any where any time including train, buses, aeroplanes etc.
- ✓New Services − It provide various smart services like SMS and MMS.

Disadvantages of Wireless Communication

- ✓Interference
- ✓Security
- ✓Health Concerns

Wireless Network Topologies

- ✓There are basically three ways to set up a wireless network −
- ✓Point-to-point bridge:- interconnects two buildings having different networks.
- ✓Point-to-multipoint bridge :-used to connect three or more LANs that may be located on different floors in a building or across buildings
- ✓Mesh or **ad hoc network**:- is an independent local area network that is not connected to a wired infrastructure and in which all stations are connected directly to one another

Issues with Wireless Networks

- ✓**Quality of Service (QoS)**
- ✓**Security Risk**
- ✓**Reachable Range**

Wireless Technologies

- ✓Wireless Wide Area Network (WWAN)
- ✓Wireless Personal Area Network (WPAN)
- ✓Wireless Local Area Network (WLAN)
- ✓Wireless Metropolitan Area Network (WMAN)

Types of Wireless Communication Systems

- ✓Wireless Communication Systems also provide different services like video conferencing, cellular telephone, paging, TV, Radio etc.

Important Wireless Communication Systems available today are:

- ✓Television and Radio Broadcasting
- ✓Satellite Communication
- ✓Radar
- ✓Mobile Telephone System (Cellular Communication)
- ✓Global Positioning System (GPS)
- ✓Infrared Communication
- ✓WLAN (Wi-Fi)
- ✓Bluetooth
- ✓Paging
- ✓Cordless Phones
- ✓Radio Frequency Identification (RFID)
- ✓There are many other system with each being

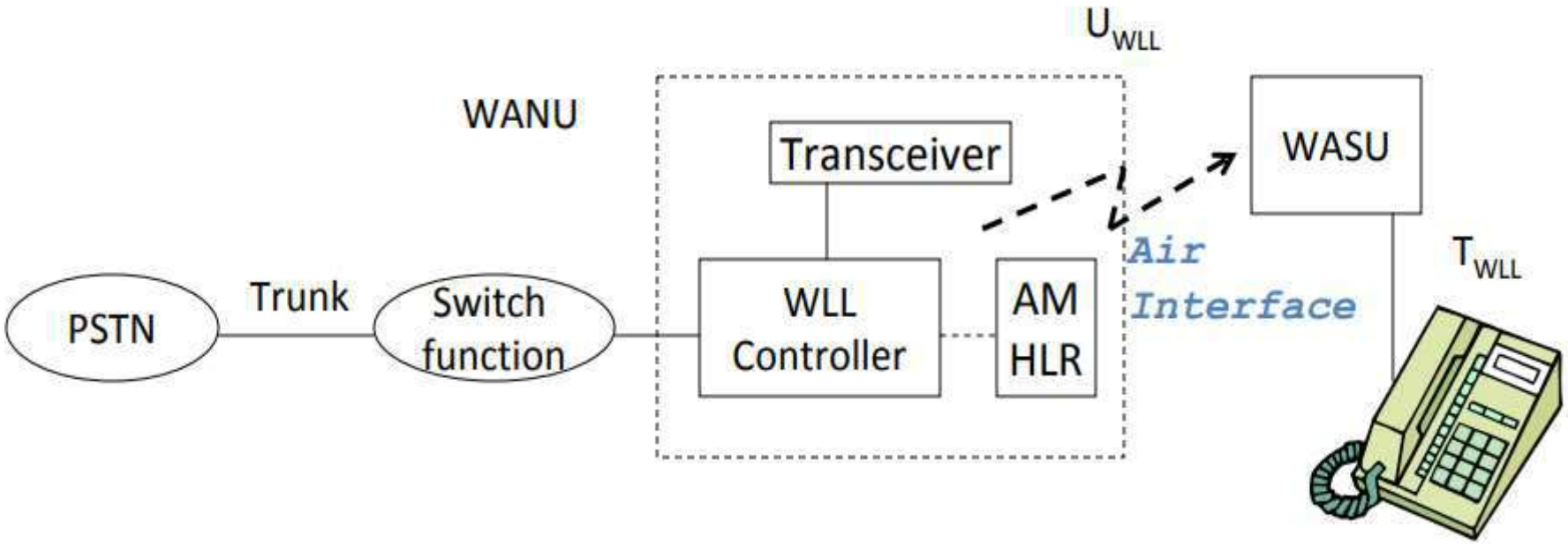
WIRELESS LOCAL LOOP-WLL

- ✓A wireless local loop (WLL) is a generic term for an access system that uses a wireless link to connect subscribers to their local exchange in place of conventional copper cable.
- ✓ Using a wireless link shortens the construction period and also reduces installation and operating costs.
- ✓In telephony, loop is defined as the circuit connecting a subscriber's station (e.g., telephone set) with the line terminating equipment in a central office (a switch in the telephone network).
- ✓Wireless local loop also known as the use of radio signals to make a connection from some local switching or distribution point in the fixed network to a number of houses.

WLL Frequency bands

Milimeter wave frequencies above 10 GHz and upto 300 GHz are used for WLL.

BLOCK DIAGRAM OF WIRELESS LOCAL LOOP SYSTEM



✓The given architecture consists of three major components i.e

- ✓WANU- Wireless Access Network Unit
- ✓WASU - Wireless Access Subscriber Unit
- ✓SF-Switching Function

WANU- Wireless Access Network Unit

✓Interface between underlying telephone network and wireless link

✓It consists of various components which include

- Several base stations transceivers or radio ports (RP)
- Radio port control unit (RPCU)
- Access manager (AM)
- Home Location Register(HLR)

✓It also provides various functionalities like:

- Authentication
- Air interface privacy
- Over-the-air registration of subscriber units.
- Operations and Maintenance
- Transcoding of voice and data
- Routing
- Billing
- Switching functions

Wireless Access Subscriber Unit (WASU)

- ✓It provides an air interface UWLL towards the network and a traditional interface TWLL towards the subscriber.
- ✓The interface includes
  - ➢ protocol conversion and transcoding
  - ➢ authentication functions
  - ➢ signaling functions

- ✓The power supply is provided locally.

- ✓The TWLL interface can be an RJ-11 or RJ-45 port.
- ✓The UWLL interface can be AMPS, GSM, DECT and so one.
  - ✓ located at the subscriber
  - ✓translates wireless link into a traditional telephone connection

Switching Function (SF)

- ✓It is associated with a switch that can be digital switch with or without Advanced Intelligent Network (AIN) capability, an ISDN switch or a Mobile Switching Centre (MSC).
- ✓The AWLL interface between the WANU and the SF can be ISDN-BRI or IS-634 or IS-653 or such variants.

WIRELESS LOCAL LOOP SYSTEM ARCHITECTURE

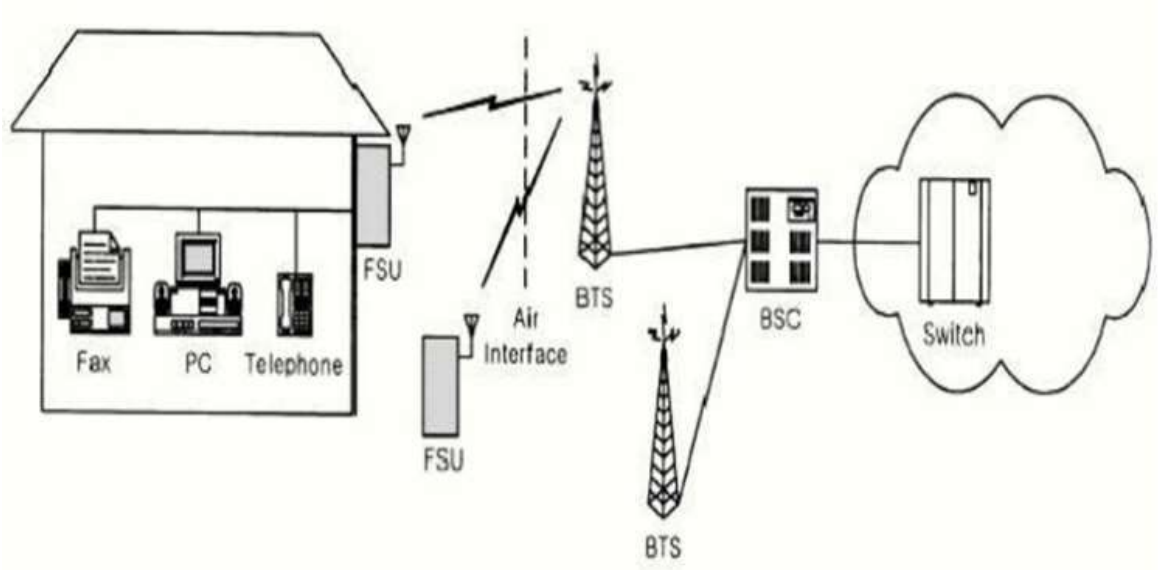


Figure 1. Typical architecture of WLL.

- ✓*The* fixed subscriber unit (FSU):- is an interface between subscriber's wired devices and wireless local loop network
- ✓The wired devices can be computers as well as telephones.
- ✓The fixed subscriber performs channel coding and decoding, modulation and demodulation, and transmission/reception of signal via radio.
- ✓The base transceiver system (BTS) performs channel coding/decoding, modulation and demodulation as well as transmission and reception of signal via radio.
- ✓The base transceiver system is also referred to as the radio port (RP).
- ✓A base station controller (BSC) :- controls one or more base transceiver systems (BTSs) and provides an interface to the local exchange (switch) in the central office

Benefits of WLL

- ✓Channel between transmitter and receiver is invariant and hence less complex algorithms are needed in WLL network.
- ✓Frequencies are 10 times higher than cellular mobile system, and hence higher bandwidth and high gain antennas can be employed. These antennas have spatial filter properties which helps reject non line of sight multipath signals.
- ✓Installation of cable in most of the countries takes time and also costly, this leads to WLL installation which is very cheap and can be done in few hours.
- ✓Users or subscribers need not have to pay monthly unlike cable service providers.

Drawbacks for WLL.

- ✓ Free Space loss is proportional to square of the frequency and hence it is higher at these frequencies.
- ✓ Above 10 GHz, attenuation effects due to rainfall and atmosphere will be higher in addition to multipath losses.
- ✓ Due to above drawbacks WLL systems will

Comparison

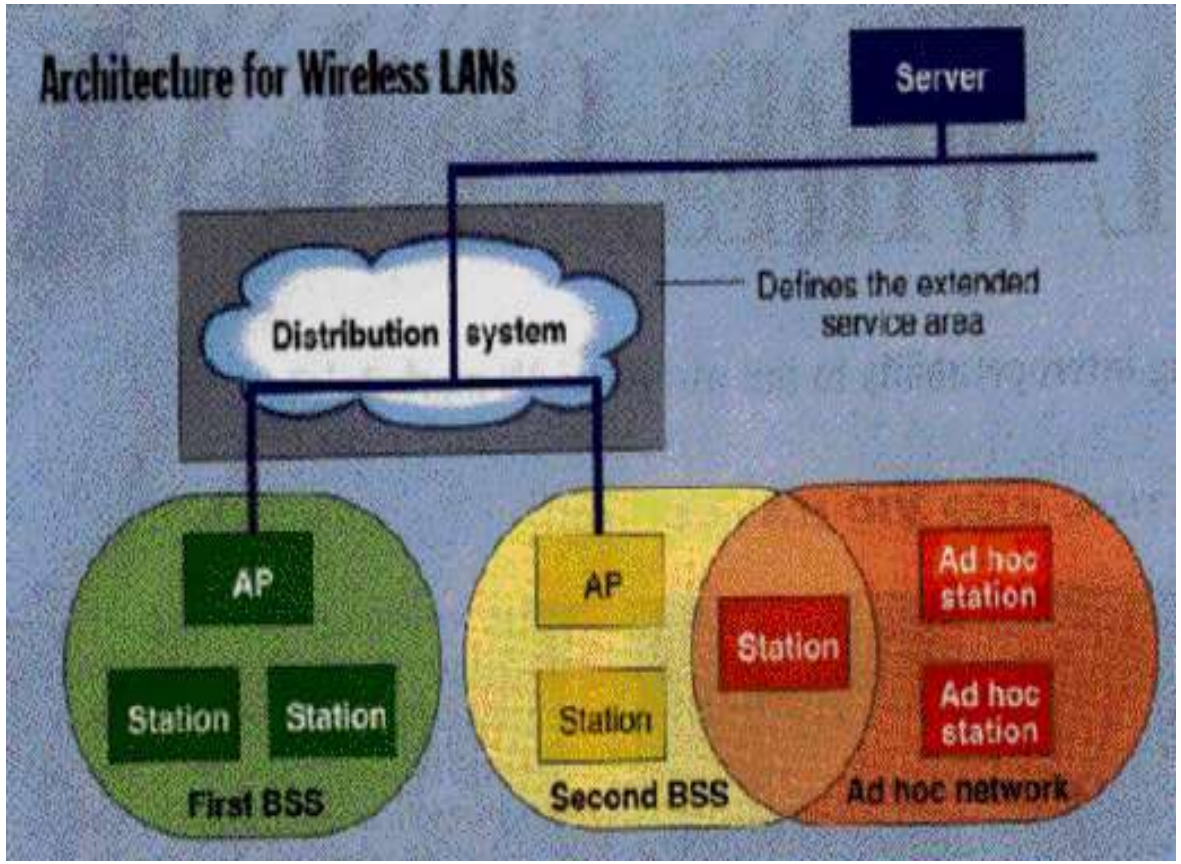
WLL	Mobile Wireless	Wireline
Good LOS component	Mainly diffuse components	No diffuse components
Rician fading	Rayleigh fading	No fading
Narrowbeam directed antennas	Omnidirectional antennas	Expensive wires
High Channel reuse	Less Channel reuse	Reuse Limited by wiring
Simple design, constant channel	Expensive DSPs, power control	Expensive to build and maintain
Low in-premises mobility only, easy access	High mobility allowed, easy access	Low in-premises mobility, wiring of distant areas cumbersome
Weather conditions effects	Not very reliable	Very reliable

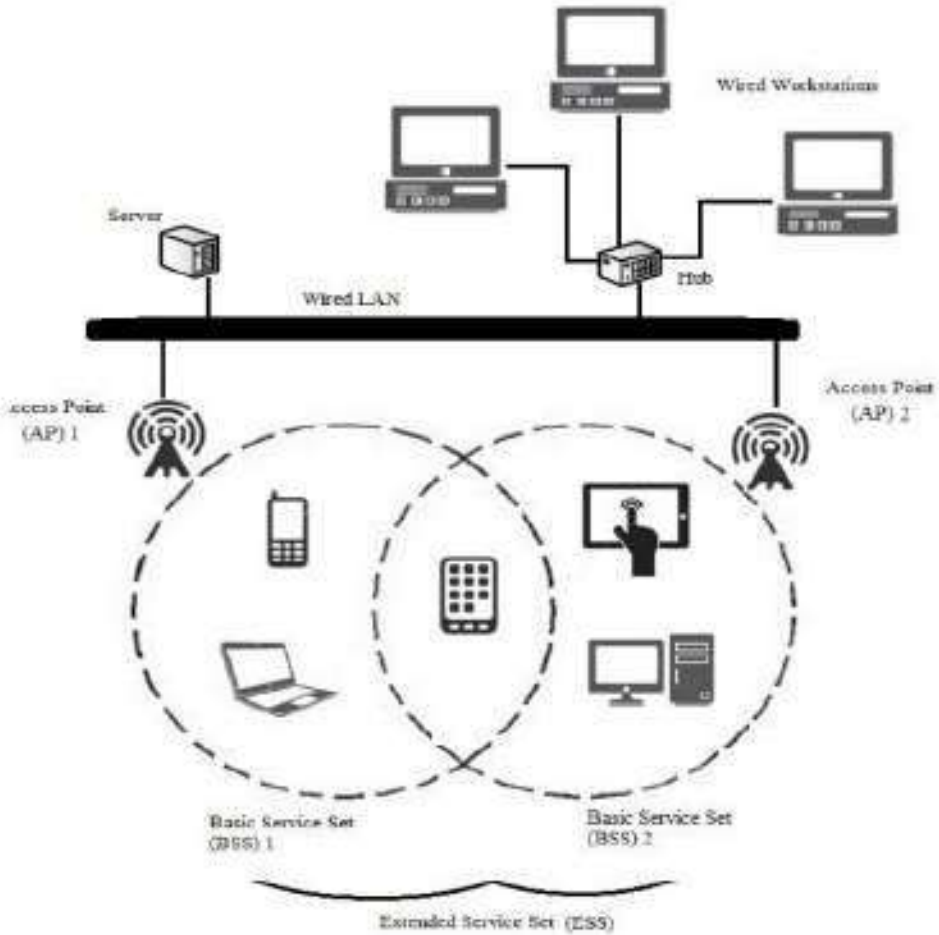
WLL systems can be based on one of the four below technologies:

1. Satellite-based systems.
2. Cellular-based systems.
3. Microcellular-based Systems
4. Fixed Wireless Access System

Wireless Local Area Network –WLAN

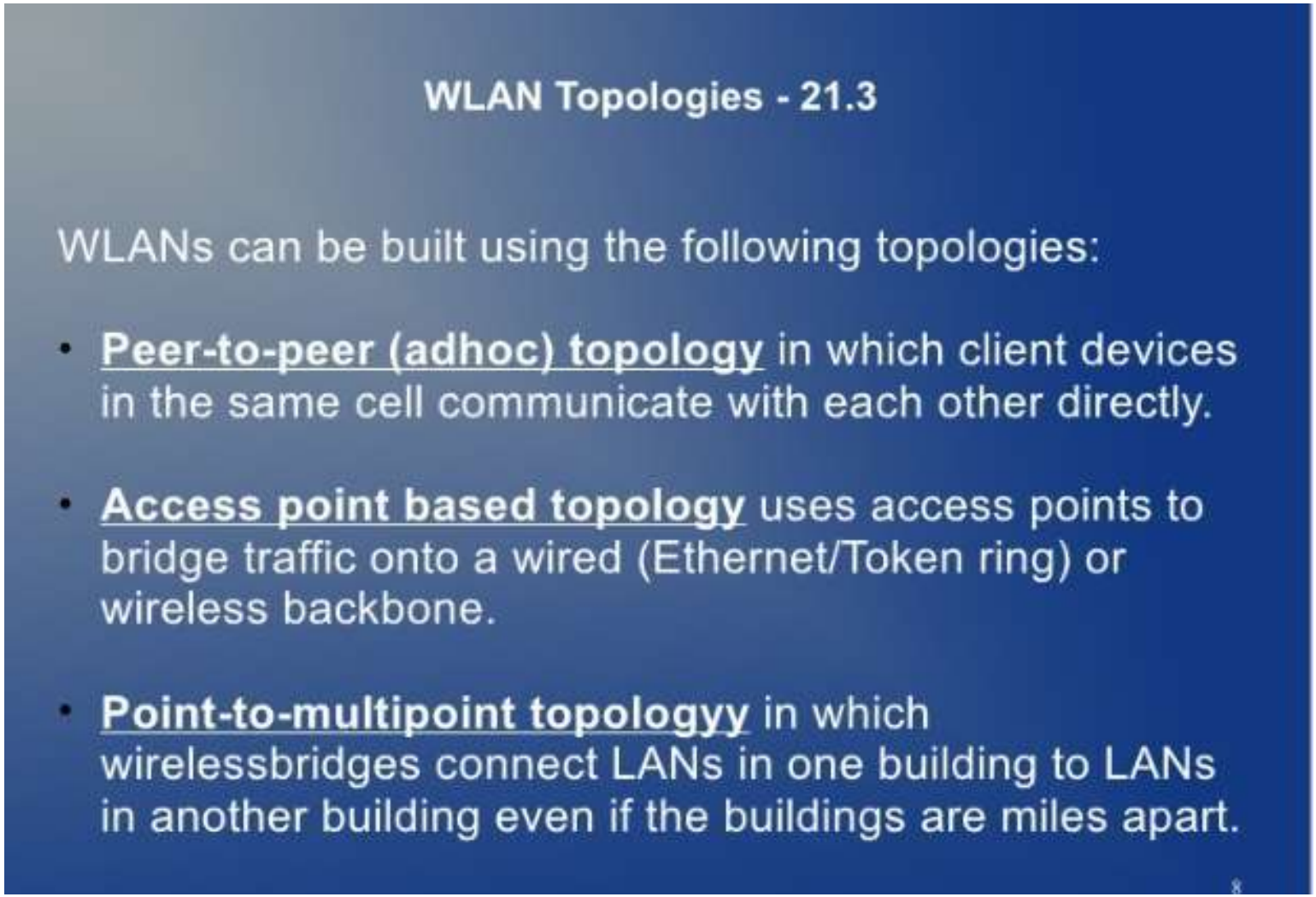
- ✓A wireless local area network (WLAN) links two or more devices using some wireless distribution method (typically spread-spectrum or OFDM radio), and usually providing a connection through an access point to the wider Internet.
- ✓It's a flexible data communication systems that can be used for applications in which mobility is required.
- ✓devices on a WLAN communicate via Wi-Fi.
- ✓It allows users to move around the coverage area, often a home or small office, while maintaining a network connection.
- ✓It is sometimes call a local area wireless network (LAWN).
- ✓In a WLAN, data is transmitted over the air using one of Wi-Fi 802.11 protocols.
- ✓Most modern WLANs are based on IEEE 802.11 standards and 11 Mbps for 802.11b
- ✓54 Mbps for 802.11a/g (GSM:9.6Kbps, HCSCD:~40Kbps, GPRS:~160Kbps, WCDMA:up to 2Mbps)
- ✓Using WLAN, different devices like laptops and mobile phones can connect to an access point and access internet
- ✓Network spectrum for communication is licence free and its 2.4-2.5 GHz


Architecture for Wireless LANs
Server
Distribution system
Defines the extended service area
AP
Station
Station
First BSS
AP
Station
Second BSS
Station
Ad hoc station
Ad hoc station
Ad hoc network


Wired Workstations
Server
Hub
Wired LAN
Access Point (AP) 2
(AP) 1
Basic Service Set (BSS) 1
Basic Service Set (BSS) 2
Extended Service Set (ESS)

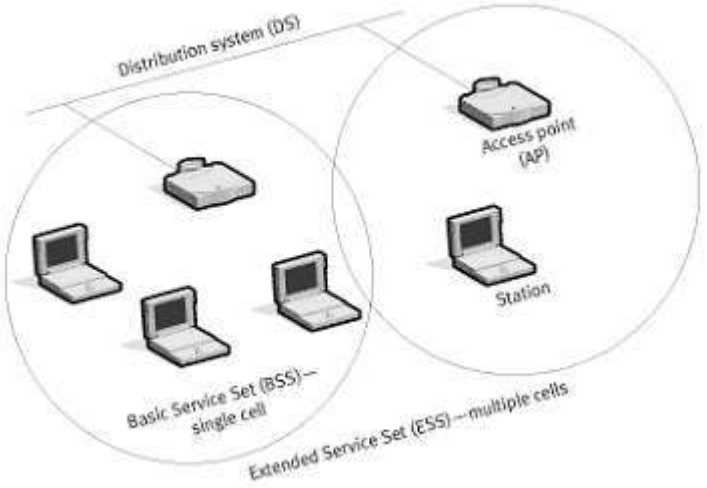
WLAN TECHNOLOGY

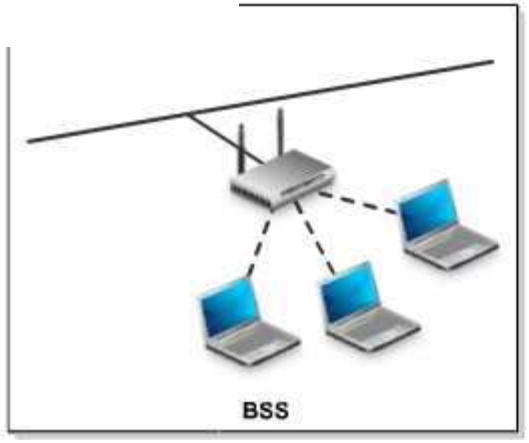
1. Peer to peer
2. Access point based
3. Point to Multi point bridge

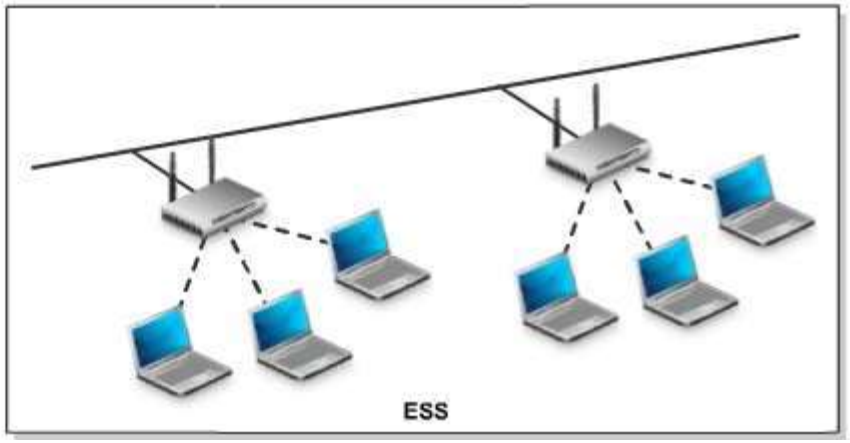


Wireless network implementation

ng alfanumeric string identifying the WLAN

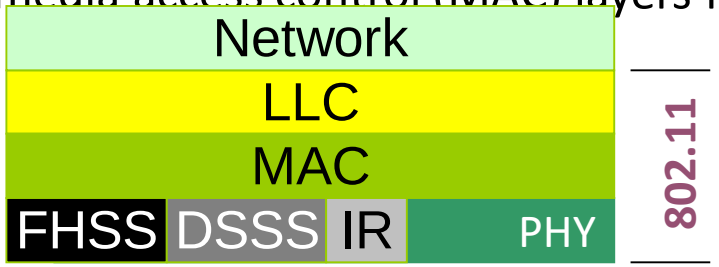






IEEE 802.11 Architecture

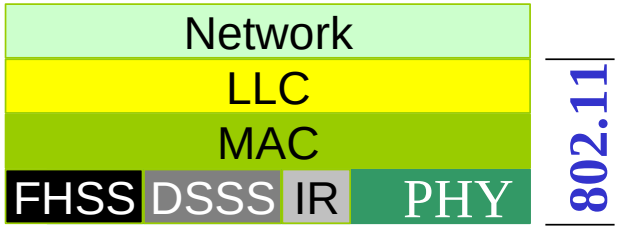
- IEEE 802.11 defines the physical (PHY), logical link (LLC) and media access control (MAC) layers for a wireless local area network
- 802.11 networks can work as
  - basic service set (BSS)
  - extended service set (ESS)
- BSS can also be used in ad-hoc networking



LLC: Logical Link Control Layer
MAC: Medium Access Control Layer
PHY: Physical Layer
FHSS: Frequency hopping SS
DSSS: Direct sequence SS
SS: Spread spectrum
IR: Infrared light
BSS: Basic Service Set
ESS: Extended Service Set
AP: Access Point
DS: Distribution System

802.11 Logical architecture

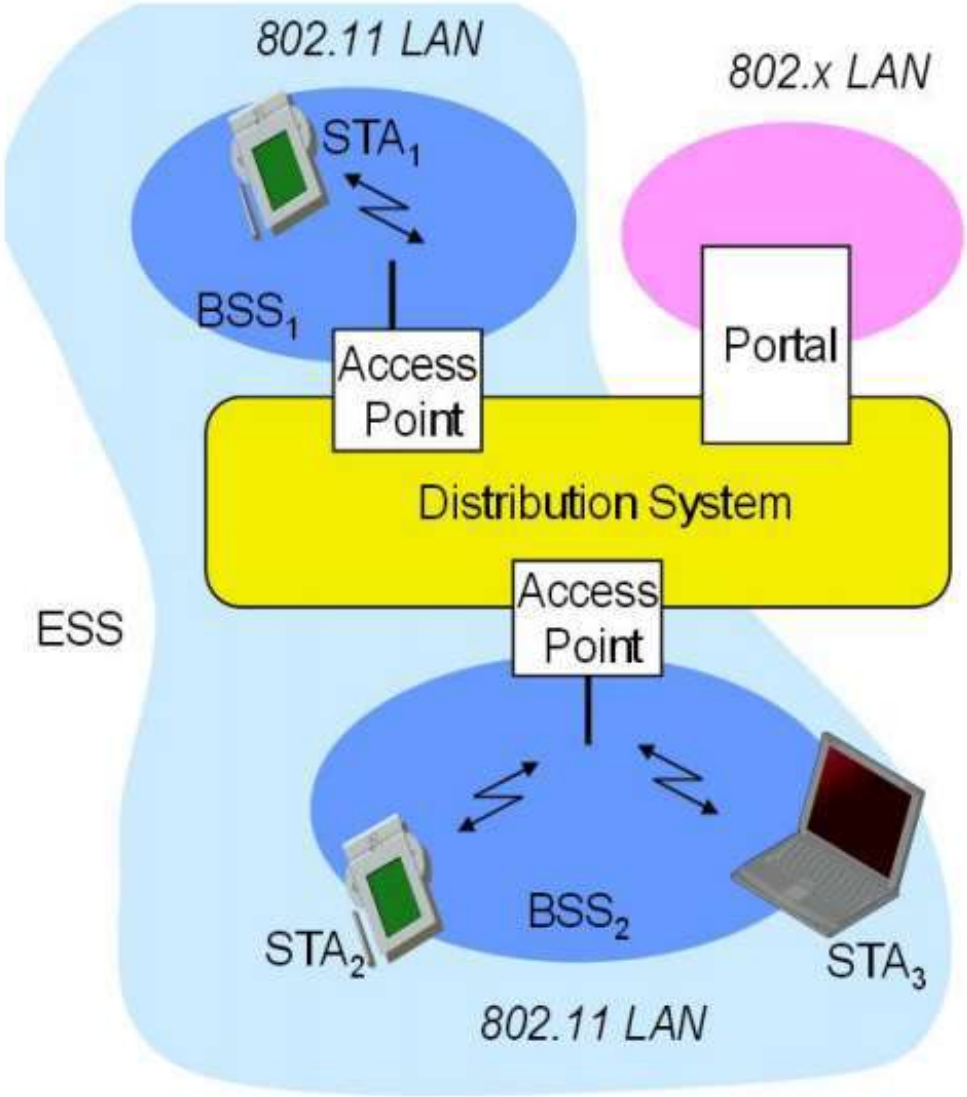
- LLC provides addressing and data link control
- MAC provides
  - access to wireless medium
    - CSMA/CA
    - Priority based access (802.12)
  - joining the network
  - authentication & privacy
  - Services
    - Station service: Authentication, privacy, MSDU* delivery
    - Distributed system: Association** and participates to data distribution
- Three physical layers (PHY)
  - FHSS: Frequency Hopping Spread Spectrum (SS)
  - DSSS: Direct Sequence SS
  - IR: Infrared transmission



LLC: Logical Link Control Layer
MAC: Medium Access Control Layer
PHY: Physical Layer
FH: Frequency hopping
DS: Direct sequence
IR: Infrared light

**MSDU: MAC service data unit*
*** with an access point in ESS or BSS*

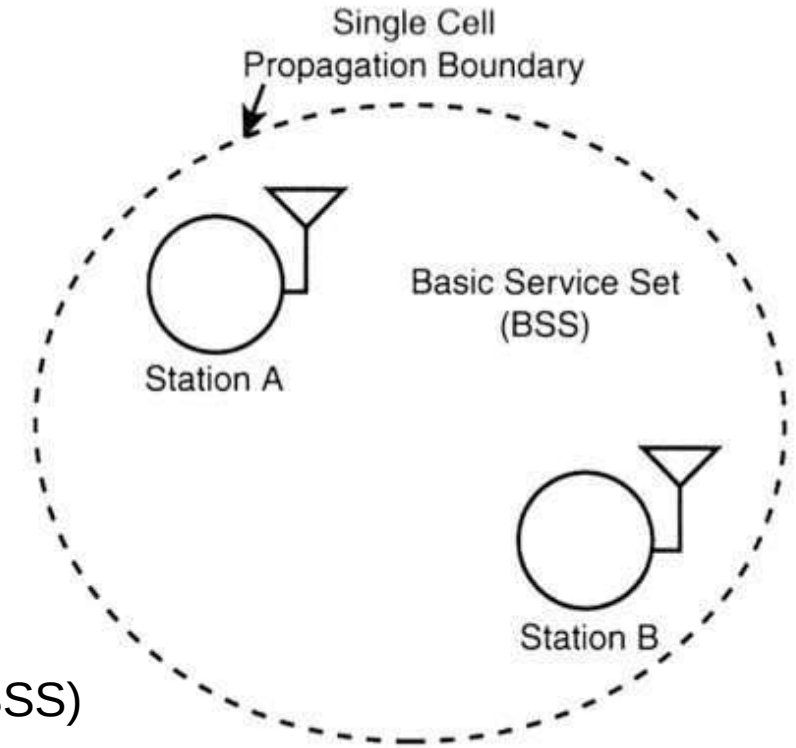
WLAN ARCHITECTURES



1. Station (STA) terminal with access mechanisms to the wireless medium and radio contact to the access point.

2. Access Point or Base Station (AP) integrated into the wireless LAN and the distribution system.

3. Basic Service Set (BSS)-When two or more stations come together to communicate with each other, they form a BSS. The minimum BSS consists of two stations. 802.11 LANs use the BSS as the standard building block.



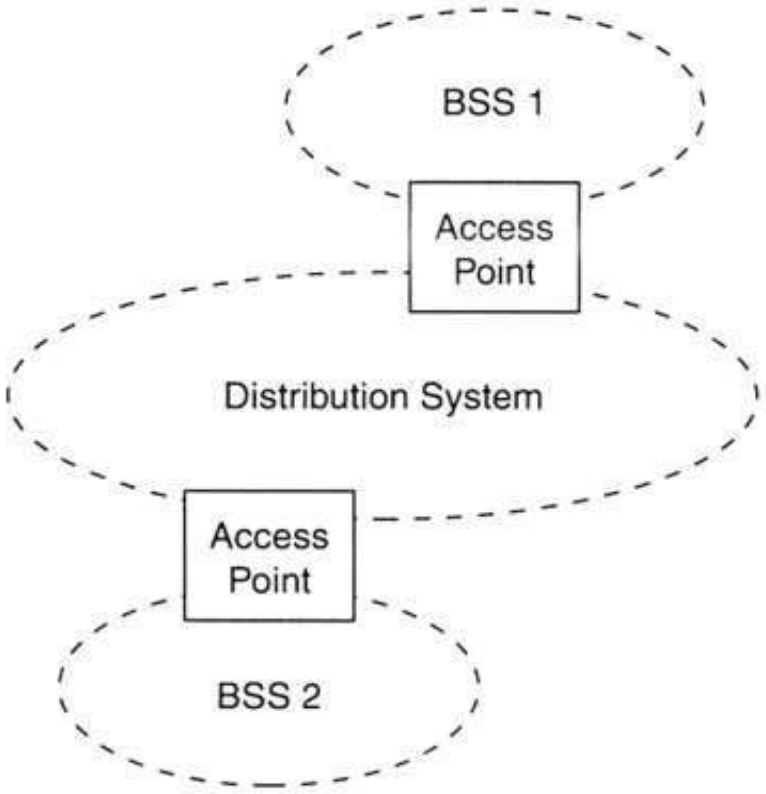
Basic (independent) service set (BSS)

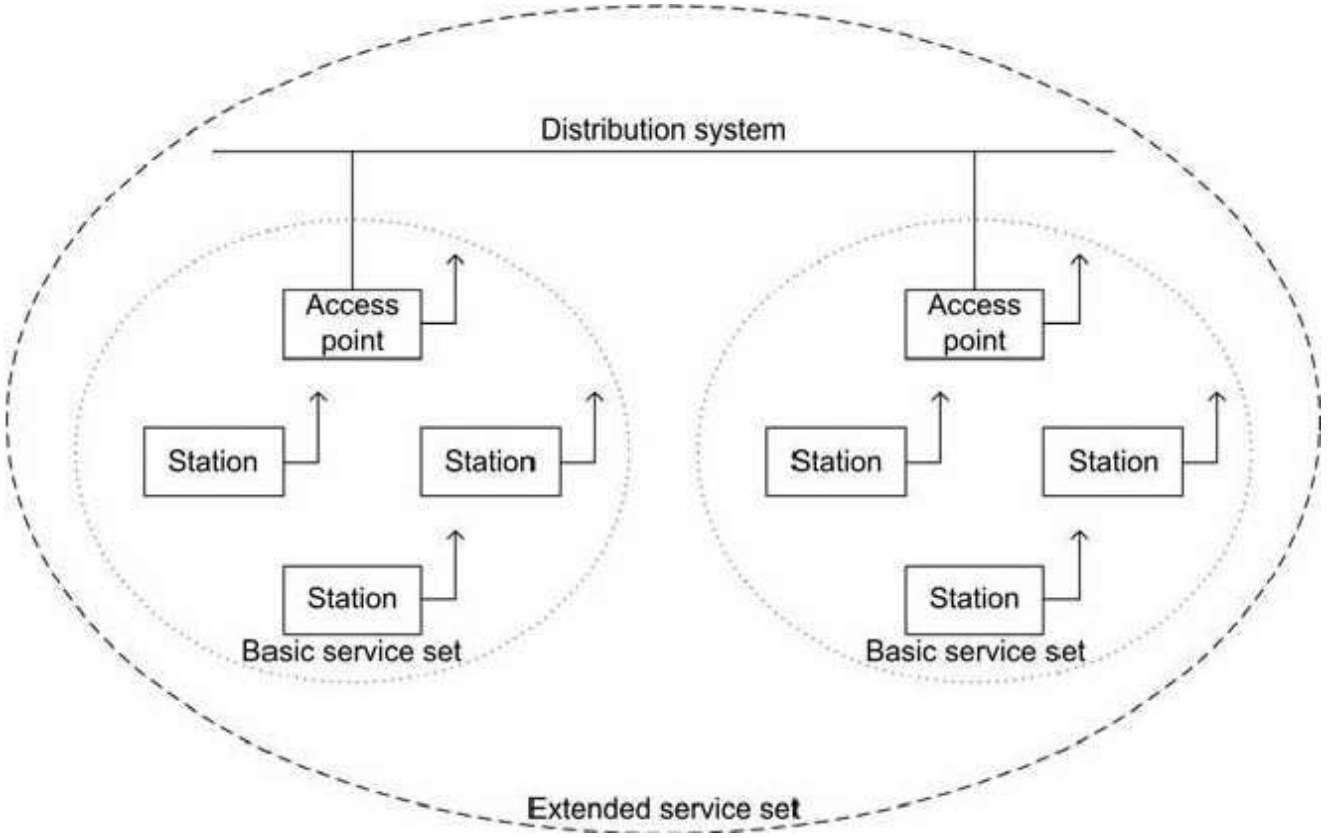
- ✓ BSS is a set of stations that communicate with one another Or it is a network consisting of several clients and a wireless Access Point (AP); use SSIDs
- ✓When all of the stations into the BSS are mobile stations and there is no connection to a wired network, the BSS is called independent BSS (IBSS).
- ✓IBSS is typically short-lived network, with a small number of stations, that is created for a particular purpose.
- ✓When a BSS includes an access point (AP), the BSS is called infrastructure BSS.
- ✓When there is a AP, If one mobile station in the BSS must communicate with another mobile station, the communication is sent first to the AP and then from the AP to the other mobile station.
- ✓This consume twice the bandwidth that the same communication.

4. Extended Service Set (ESS)

- ✓ ESS-a network consisting of several wireless AP; adds mobility, Aps can use different SSIDs

- ✓ SSID -Service Set Identification)is simply the technical term for a network name





Extended service set (ESS)

- ✓A ESS is a set of infrastructure BSSs, where the APs communicate among themselves to forward traffic from one BSS to another and to facilitate the movement of mobile stations from one BSS to another.
- ✓The APs perform this communication via an abstract medium called the distribution system (DS).
- ✓To network equipment outside of the ESS, the ESS and all of its mobile stations appears to be a single MAC-layer network where all stations are physically stationary. Thus, the ESS hides the mobility of the mobile stations from everything outside the ESS.

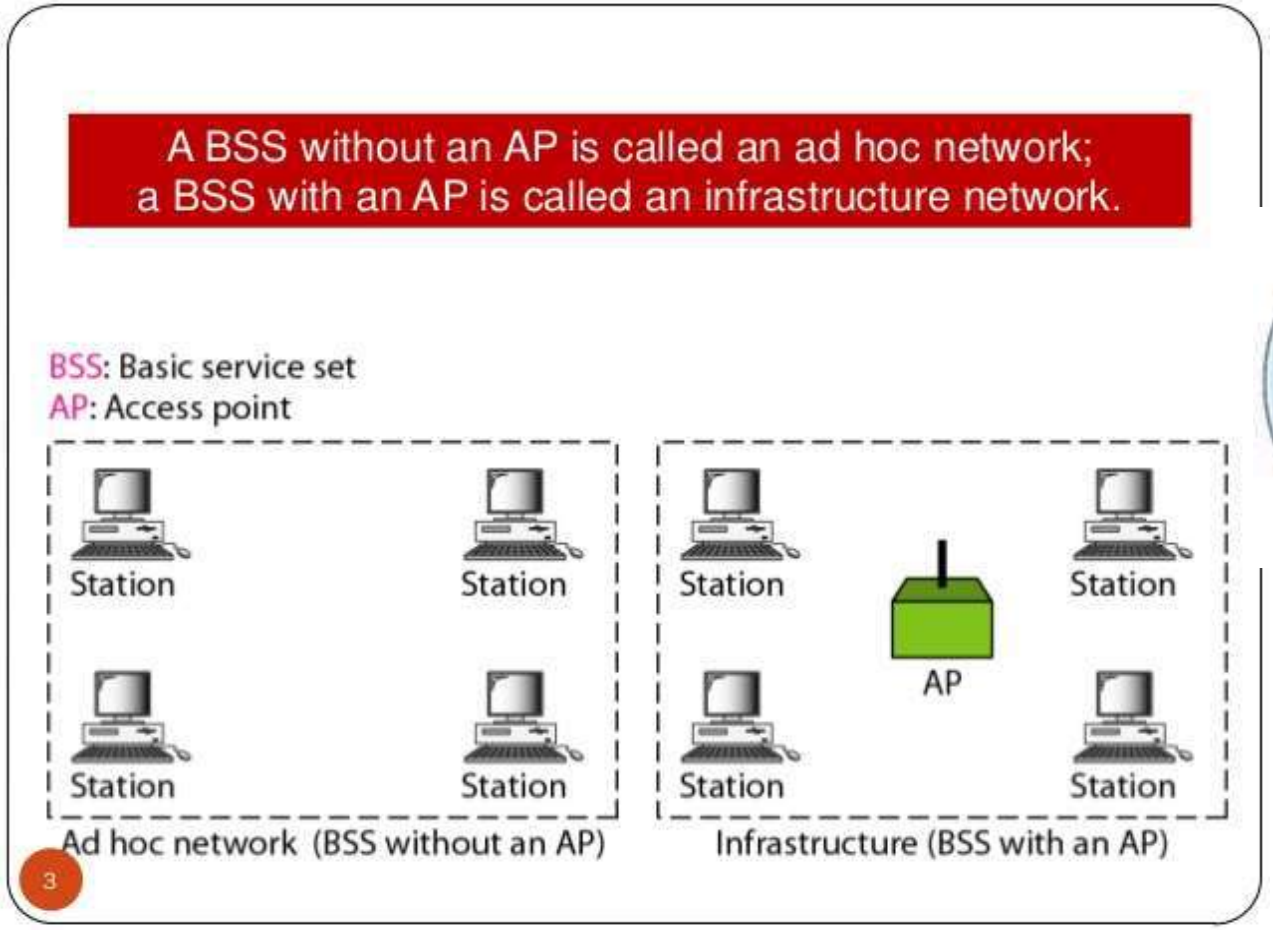
5. Distribution System

- ✓The distribution system (DS) is the mechanism by which one AP communicates with another to exchange frames for stations in their BSSs, forward frames to follow mobile stations from one BSS to another, and exchange frames with wired network.

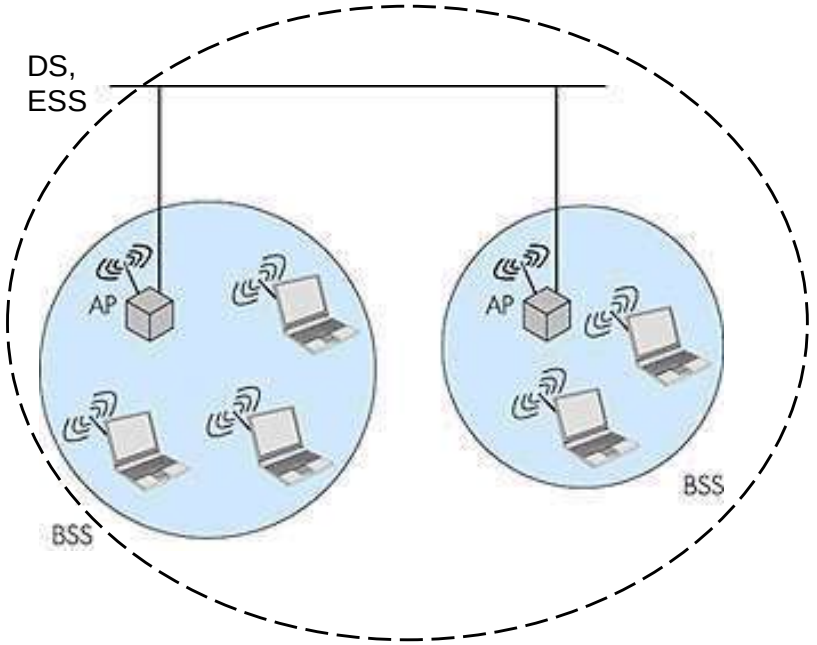
Types of Wireless LAN

Two types of wireless LAN

1. Infrastructure (BSS and ESS)
2. Ad-hoc (BSS)



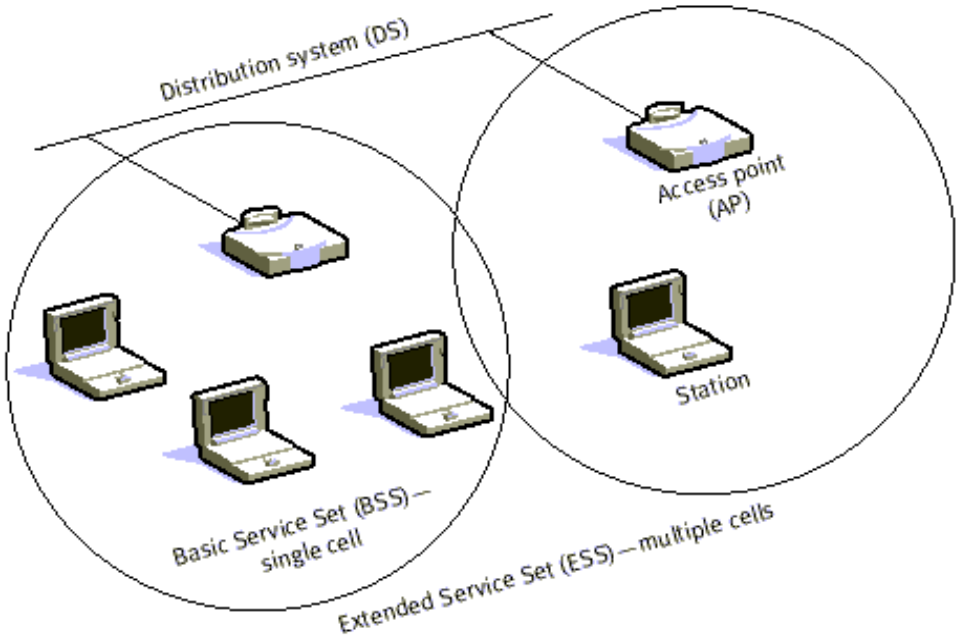
ad-hoc network

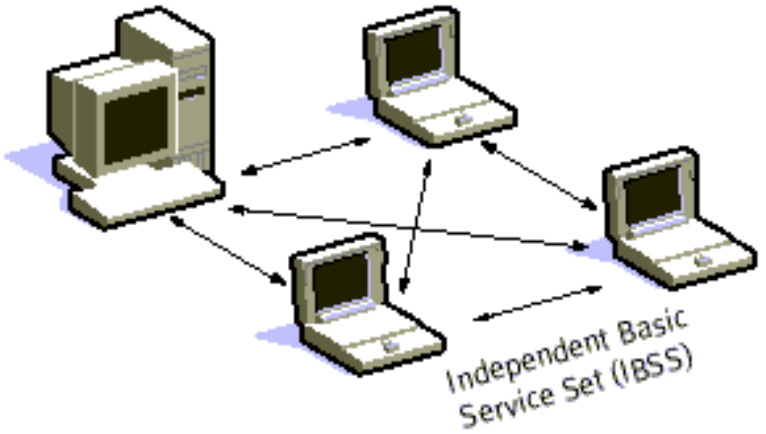


Infrastructure Networks

- ✓When BSS's are interconnected the network becomes one with infrastructure.
- ✓802.11 infrastructure has several elements.
- ✓Two or more BSS's are interconnected using a Distribution System or DS. This concept of DS increases network coverage.
- ✓Each BSS becomes a component of an extended, larger network. Entry to the DS is accomplished with the use of Access Points (AP).
- ✓An access point is a station, thus addressable. So, data moves between the BSS and the DS with the help of these access points.
- ✓Creating large and complex networks using BSS's and DS's leads us to the next level of hierarchy, the Extended Service Set or ESS.
- ✓This type of network allows users to move in a building while they are connected to computer resources.
- ✓The IEEE Project 802.11 specified the components in a wireless LAN architecture.

- ✓In an infrastructure network, a cell is also known as a Basic Service Area (BSA).
- ✓It contains a number of wireless stations.
- ✓The size of a BSA depends on the power of the transmitter and receiver units, it also depends on the environment.
- ✓A number of BSAs are connected to each other and to a distribution system by Access Points (APs).
- ✓A group of stations belonging to an AP is called a Basic Service Set (BSS).





Ad-hoc Networks

- ✓When two or more stations come together to communicate with each other, they form a Basic Service Set (BSS).
- ✓The minimum BSS consists of two stations.
- ✓802.11 LANs use the BSS as the standard building block.
- ✓A BSS that stands alone and is not connected to a base is called an Independent Basic Service Set (IBSS) or is referred to as an Ad-Hoc Network.
- ✓An ad-hoc network is a network where stations communicate only peer to peer.
- ✓There is no base and no one gives permission to talk. Mostly these networks are spontaneous and can be set up rapidly.
- ✓ Ad-Hoc or IBSS networks are characteristically limited both temporally and spatially.
- ✓This network can be set up by a number mobile users meeting in a small room.
- ✓ It does not need any support from a wired/wireless backbone.

There are two ways to implement this network.

- **Broadcasting / Flooding**

✓Suppose that a mobile user A wants to send data to another user B in the same area. When the packets containing the data are ready, user A broadcasts the packets.

✓On receiving the packets, the receiver checks the identification on the packet. If that receiver was not the correct destination, then it rebroadcasts the packets. This process is repeated until user B gets the data.

- **Temporary Infrastructure**

✓In this method, the mobile users set up a temporary infrastructure. But this method is complicated and it introduces overheads. It is useful only when there is a small number of mobile users.

Infrastructure based versus Ad Hoc LANs

- ✓Infrastructure based versus Ad Hoc LANs
- ✓WLANs can be broadly classified into two types, namely **Infrastructure networks** and **Ad hoc LANs**, based on the underlying architecture.
- ✓Infrastructure networks
- ✓Infrastructure networks contain special nodes called **Access Points (APs)**, which are connected via existing networks.
- ✓APs are special in the sense that they can interact with wireless nodes as well as with the existing wired network.
- ✓The other wireless nodes, also known as Mobile stations (STAs), communicate via APs.
- ✓The APs also act as bridges with other networks.
- ✓Ad hoc LANs
- ✓Ad hoc LANs do not need any fixed infrastructure. These networks can be set up on the fly at any place. Nodes communicate directly with each other for forward messages through other nodes that are directly accessible.

Advantages of WLANs

- ✓In WLAN devices can connect wirelessly, eliminating the need for cables
- ✓It also provides a way for small devices, such as smartphones and tablets, to connect to the network.
- ✓can support dozens or even hundreds of devices.
- ✓The range of a WLAN can easily be extended by adding one or more repeaters.
- ✓WLAN can be easily upgraded by replacing routers with new versions.
- ✓They provide clutter free homes, offices and other networked places.
- ✓They are scalable in nature, i.e. devices may be added or removed from the network at a greater ease than wired LANs.
- ✓The system is portable within the network coverage and access to the network is not bounded by the length of the cables.
- ✓Installation and setup is much easier than wired counterparts.
- ✓The equipment and setup costs are reduced.

Disadvantages of WLANs

- ✓Wireless networks are naturally less secure than wired networks. Access is typically done using wireless authentication such as WEP or WPA, which encrypts the communication.(Wired Equivalent Privacy, and **WPA**stands for Wireless Protected Access. WPA2 is the second version of the **WPA** standard.)

- ✓They are more susceptible to interference from other signals or physical barriers, such as concrete walls.

- ✓Since radio waves are used for communications, the signals are noisier with more interference from nearby systems.

- ✓Greater care is needed for encrypting information. Also, they are more prone to errors. So, they require greater bandwidth than the wired LANs.

- ✓WLANs are slower than wired LANs.

WLAN benefits

WLAN benefits

- Mobility
- Installation on difficult-to-wire areas
- Increased reliability
- Reduced installation time
- Broadband
- Long-term cost savings

WLAN problems

- Date Speed
- Interference
- Security
- Roaming
- Inter-operability

WLAN implementation problems

- ✓Lack of wireless networking experience for most IT engineer
- ✓No well-recognized operation process on network implementation
- ✓Selecting access points with ‘Best Guess’ method
- ✓Unaware of interference from/to other networks
- ✓Weak security policy
- ✓As a result, your WLAN may have
  - ➢Poor performance (coverage, throughput, capacity, security)
  - ➢Unstable service
  - ➢Customer dissatisfaction

WiMAX

- Acronym for **Worldwide Interoperability for Microwave Access**.
- Based on Wireless MAN technology.
- A wireless technology optimized for the delivery of IP centric services over a wide area.
- A scalable wireless platform for constructing alternative and complementary broadband networks.
- A certification that denotes interoperability of equipment built to the IEEE 802.16 or compatible standard. The IEEE 802.16 Working Group develops standards that address two types of usage models −
  - A fixed usage model (IEEE 802.16-2004).
  - A portable usage model (IEEE 802.16e).