Modue II

Wireless Network

Satellite systems

- A satellite is an object that moves around a planet
- A satellite is an object that orbits another large object like planet.
- Moon is the natural satellite of earth
- Artificial satellites are launched from earth for communication and weather monitoring.
- Artificial satellites also orbit around the earth
- A communication satellite is a station in space that is used for telecommunication, radio and television signals.
- Communications satellites are used for television, telephone, radio, internet, and military applications.
- There are about 2,000 communications satellites in Earth's orbit, used by both private and government organizations.
- In telecommunication satellite system, helps to:
    - Areas where no networks are present
    - Agencies handling disasters, state police, railways, Border Security Force and other government agencies people while travelling in flight and on ships

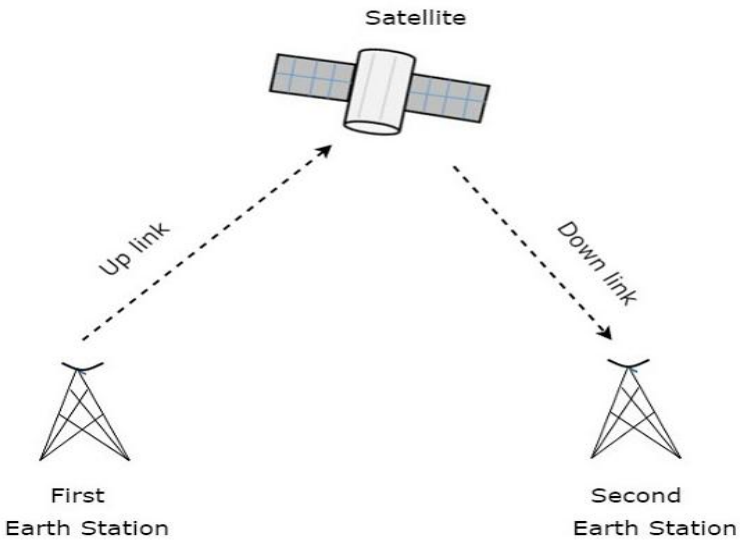
Applications

- Weather forecasting:
    - Several satellites deliver pictures of the earth using infra red or visible light.
- Radio and TV broadcast satellites:
    - Hundreds of radio and TV programs are available via satellite.
- Military satellites:
- Satellites for navigation:
    - Implementation of GPS
- Global telephone backbones
    - For the establishment of international telephone backbones.
- Connections for remote or developing areas
- Global mobile communication
    - The latest trend for satellites is the support of global mobile data communication.

Satellite-Related Terms

- Relay Station - Two or more stations on or near the earth communicate via one or more satellites in space
- Earth Station - Antenna systems on or near earth
- Uplink - Transmission from an earth station to a satellite
- Downlink - Transmission from a satellite to an earth station

- Transponder- Electronics/component in the satellite that convert uplink signals to downlink signals



Ways to Categorizing communications satellites:

1. **Coverage area:** Global, regional, or national. The larger the area of coverage, the more satellites must be involved in a single networked system.
2. **Service type:** Fixed service satellite (FSS), broadcast service satellite (BSS), and mobile service satellite (MSS).
3. **General usage:** Commercial, military, amateur, experimental.

Differences between satellite-based and terrestrial wireless communications - design parameters:

1. The area of coverage of a satellite system far exceeds that of a terrestrial system
2. Spacecraft power and allocated bandwidth are limited resources that call forcareful tradeoffs in earth station/satellite
3. Conditions between communicating satellites are more time invariant thanthose between satellite and earth station or between two terrestrial wirelessantennas. Thus, satellite-to-satellite communication links can be designed withgreat precision.
4. Transmission cost is independent of distance, within the satellite's area ofcoverage.
5. Broadcast, multicast, and point-to-point applications are readily accommodated.
6. Very high bandwidths or data rates are available to the user.
7. The quality of transmission is normally extremely high, even though satellite links are subject to short-term outages or degradations.
8. For a geostationary satellite, the earth-satellite-earth propagation delay is about one-fourth of a second.
9. A transmitting earth station can in many cases receive its own transmission

Classification of Satellite Orbits

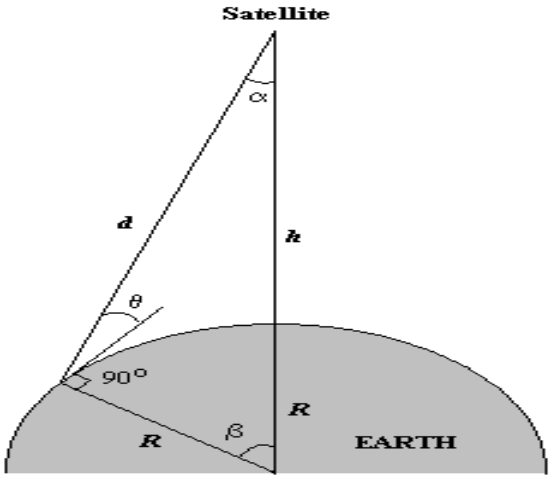
1.Circular/Elliptical

The orbit may be circular, with the center of the circle at the center of theearth.
The orbit may elliptical, one of the foci at the earth's center.

2.Orbit around the earth in different planes

(i) Equatorial Orbit : - An **equatorial orbit** isdirectly above the earth's equator.
(ii) **Polar Orbit :-** Orbit that passes over both poles.
(iii) **Inclined Orbits.**
3. The altitude of communications satellites
   (i) Geo Stationary Orbit (GEO)
   (ii)Medium Earth Orbit (MEO)
   (iii)Low Earth Orbit (LEO)

Geometry Terms /Design Parameters



Elevation angle :

- The angle from the horizontal to the point on the center of the main beam of the antenna when the antenna is pointed directly at the satellite. To obtain maximum satellite coverage, an elevation angle of 0^0.
- For downlinks, use a minimum elevation angle of from 5° to 20° depending on frequency.
- For uplinks, the minimum elevation angle of 5°

Reasons affecting minimum elevation angle of earth station's antenna be greater than 0^0

1. The buildings, trees, and other terrestrial objects that would block the line of sight. These may result in attenuation of the signal by absorption or in distortions due to multipath reflection.
2. Atmospheric attenuation is greater at low elevation angles because the signal traverses the atmosphere for longer distances the smaller the elevation angle.
3. Electrical noise generated by the earth's heat near its surface affects reception.

Coverage Angle (β)

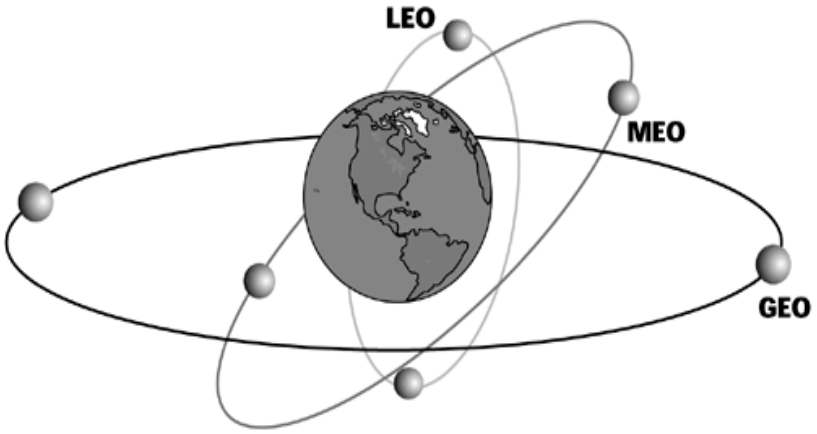
- Measure of the portion of the earth's surface visible to the satellite
- Defines a circle in the surface of the earth centered on the point directly below the satellite.
- Area of coverage expressed as the diameter of the area covered = 2 βR, R – radius of the earth 6370km, β expressed in radians

$$d = \frac{(R+h)\sin(\beta)}{\cos(\theta)}$$

Where , *R* = earth's radius, 6370 km
h = orbit height (altitude from point on earth directly below satellite)
β= coverage angle θ= minimum elevation angle

Types of orbits

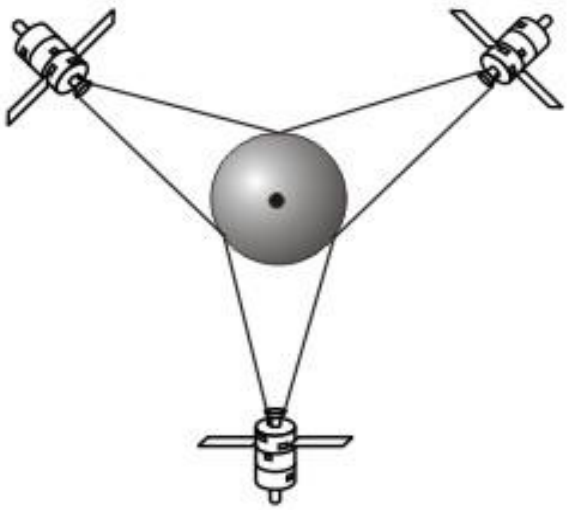
- Geostationary (or geosynchronous) earth orbit (GEO):
- Medium earth orbit (MEO)
- Low earth orbit (LEO)
- Highly elliptical orbit (HEO)



Geostationary (or geosynchronous) Earth Orbit (GEO)

- Most common type of communications satellite.
- The satellite is in a circular orbit of 35,863 km above the earth's surface
- They complete one orbit every 24 hours.
- These Satellites are placed at 35,900kms above the Earth's Equator and they keep on rotating with respect to earth's direction .
- It will rotate at exactly the same angular speed as the earth.
    - One GEO satellite can cover approximately 1/3 of the world's surface

  Examples:
    - almost all TV and radio broadcast satellites,
    - many weather satellites
    - satellites operating as backbones for the telephone network.



Advantages of Geo-Stationary Earth Orbit

- It is possible to cover almost all parts of the earth with just 3 geo satellites.
- Antennas need not be adjusted every now and then but can be fixed permanently.
- The life-time of a GEO satellite is quite high usually around 15 years.
- A GEO satellite's distance from earth gives it a large coverage area

- GEO satellites have a 24 hour view of a particular area.
- Three GEO satellites are enough for a complete coverage of almost any spot on earth and separated by 120^0
- The advantage of Geostationary orbit is that no need to track the antennas in order to find the position of satellites.
- GEOs are ideal for TV and radio broadcasting.

Disadvantages of Geo-Stationary Earth Orbit

- Weak signal after traveling over 35,000 km
- Polar regions on both hemispheres are poorly served
- Northern or southern regions of the earth have more problems receiving these satellites due to the low elevation above a latitude of 60°
- The transmit power needed is relatively high
- Larger antennas are required for northern/southern regions of the earth.
- High buildings in a city limit the transmission quality.
- High transmission power is required.
- These satellites cannot be used for small mobile phones.
- Fixing a satellite at Geo stationary orbit is very expensive.

Low earth orbit (LEO) Satellites

- LEO satellites operate at a distance of about 500-1500 km.
- Circular/slightly elliptical orbit under 2000 km
- LEO satellites don't stay in fixed position relative to the surface, and Maximum satellite visible for 15 to 20 minutes.
- The diameter of coverage is about 8000 Km.
- Orbit period ranges from 1.5 to 2 hours
- Atmospheric drag results in orbital deterioration
- Satellites in low earth orbit change their position relative to the ground position quickly.
- LEO satellites were mainly used for espionage.
- Satellite on this class use altitudes of 500–1,500 km.
- These are less expensive to launch into orbit
- LEOs will orbit at a distance of **500 to 1000 miles** above the earth's surface. These satellites are used for satellite phones and GPS.

Advantages of Low Earth Orbit

- The antennas can have low transmission power of about 1 watt.
- The delay of packets is relatively low.
- Useful for smaller foot prints.

Disadvantages of Low Earth Orbit

- If global coverage is required, it requires at least 50-200 satellites in this orbit.
- Special handover mechanisms are required.
- These satellites involve complex design.

- Very short life: Time of 5-8 years. Assuming 48 satellites with a life-time of 8 years each, a new satellite is needed every 2 months.
- Data packets should be routed from satellite to satellite.

LEOs advantages over GEO satellites

- Reduced propagation delay
- LEO signal ismuch stronger than that of GEO signals for the same transmission power.
- LEOcoverage can be better localized so that spectrum can be better conserved.
- It provide broad coverage over 24 hours

LEO Categories

Little LEOs

- Frequency below 1 GHz
- 5MHz of bandwidth
- Data rates of up to 10 kbps
- Aimed at paging, tracking and low rate messaging
- Example : Orbcomm - first little LEO in operation

Big LEOs

- Frequecies Above 1 GHz
- Support data rates up to a few megabits per sec
- Offer same services as little LEOs in addition to voice and positioning services
- Example : Globalstar

MEO Satellites

- Circular orbit at an altitude in the range 5000 to 12000 Km.
- The orbit period is about 6 hours
- The diameter of coverage is from 10000 to 15000 Km.
- Round trip signal propagation delay is less than 50 ms.
- The maximum time that the satellite is visible from a fixed point on earth (above the radio horizon) is a few hours
    - MEOs can be positioned somewhere between LEOs and GEOs
    - Applications are digital voice,data, facsimile, high-penetration notification, and messaging services

Advantages of Medium Earth Orbit

- Compared to LEO system, MEO requires only a dozen satellites.
- Simple in design.
- Requires very few handovers.

Disadvantages of Medium Earth Orbit

- Satellites require higher transmission power.
- Special antennas are required.

Transmission Impairments

The performance of a satellite link depends on:

- **Distance between earth station antenna and satellite antenna**
- **Atmospheric attenuation**
    - Affected by oxygen, water, angle of elevation, and higher frequencies

- **Terrestrial distance between earth station antenna and the "aim point" of the satellite (footprint)**
    - Footprint is defined as the area on the earth where the signal of the satellite can be received

Satellite Network Configuration

1. Point-to-point

- Point to point communication is the easiest and most effective way to provide a wireless connection from one location or building to another.
- It uses directional antennas, and other similar instruments, to provide a communication connection from one location (or building) to another.
- The end systems are in line of sight
- It works quickly and efficiently
- It is faster than traditional WiFi.

2. Broadcast

- In Broadcast, a piece of information is sent from one point to all other points.
- In this there is one sender, but the information is sent to all connected receivers.
- Broadcast transmission is supported on most of the networks
- It may be used to send the same message to all computers on the network
- Subscribers use low cost VSAT (very small aperture terminal) antenna.
- Stations share a satellite transmission capacity for transmission to a hub station
- Hub can exchange messages with the subscribers and relay messages between the subscribers

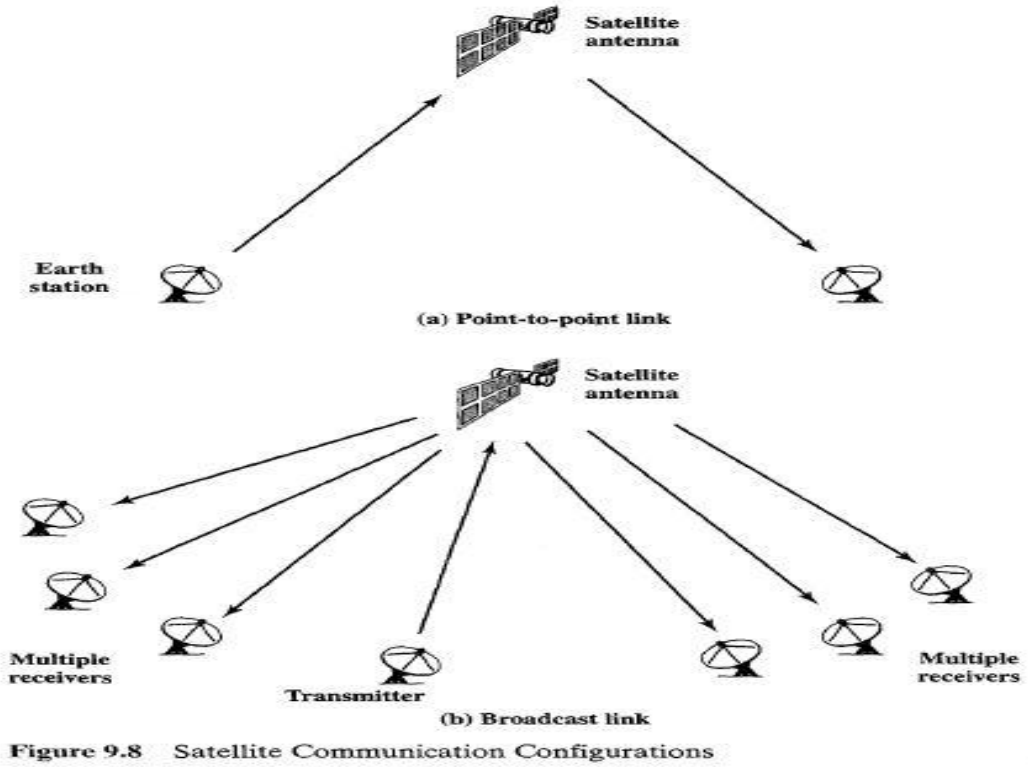


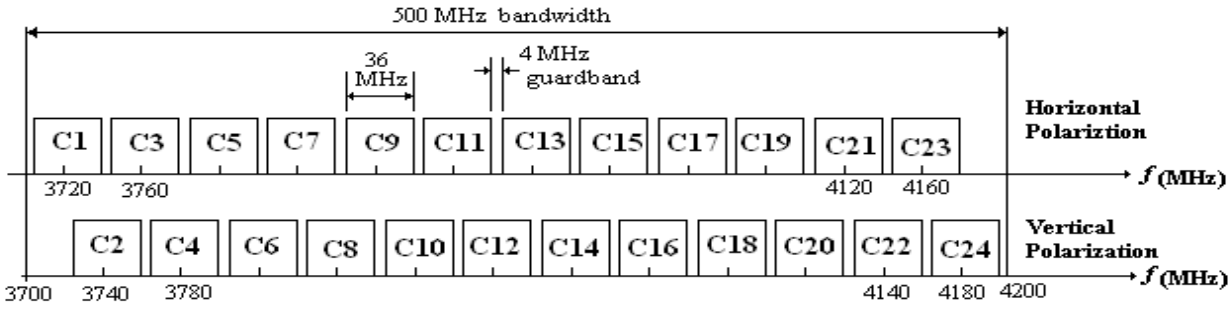
Figure 9.8 Satellite Communication Configurations

Capacity Allocation Strategies

- Frequency division multiple access (FDMA)
- Time division multiple access (TDMA)

Capacity Allocation – Frequency Division

- A GEO satellite will handle large bandwidth (500 MHz)
- Divide the bandwidth into a number of channels of smaller (e.g., 40 MHz).
- Within each channels, capacity allocation task is to be performed.
- The use of the satellite requires that each channel be shared by many users.
- Hence, the task is fundamentally one of multiplexing.
- The overall capacity of a communications satellite is divided into a number of channels. This is a top level of FDM
- A single frequency channel is to be divided into a number of smaller channels using FDM.
- Each of the smaller channels carries a number of voice frequency (VF) signals using FDM.
- The ability of multiple earth stations to access the same channel is referred to as FDMA.



Factors that limit the number of subchannels in satellite communication using FDMA is :

- Thermal noise: **N**oise is generated by thermal agitation of electrons
- Intermodulation noise :In transmission path noise generated by modulation and demodulation .
- Crosstalk: A disturbance, caused by electromagnetic interference.

Types of FDMA

- Fixed-assignment multiple access (FAMA)
  - capacity is distributed in a fixed manner among multiple stations
  - Underuse of capacity due to fluctuations in demand
- Demand-assignment multiple access (DAMA)
  - Capacity assignment is changed as needed to demand changes among the multiple stations

Capacity Allocation – Time Division Multiple Access

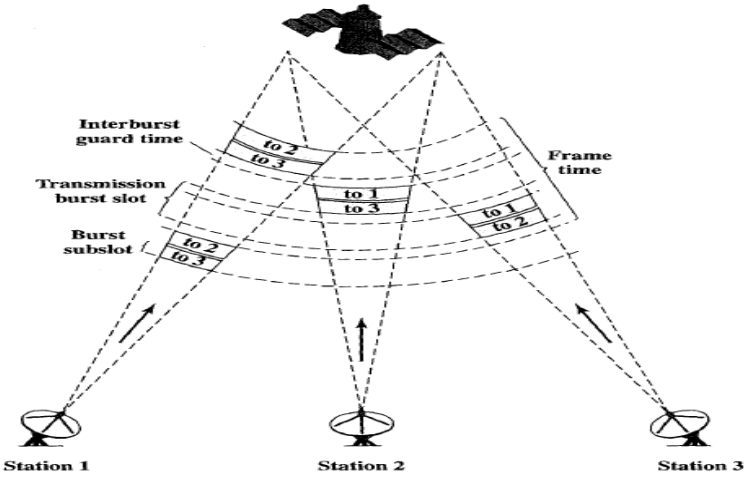
- TDMA (Time Division Multiple Access)

- Breaks a transmission into multiple time slots, each one dedicated to a different transmitter.
- TDMA is increasingly becoming more widespread in satellite communication.

- TDMA uses the same techniques (FAMA and DAMA)
- Advantages of TDMA over FDMA.
  - Digital equipment used in time division multiplexing is increasingly becoming cheaper.
- Advantages of digital components:
  - Ex: error correction.
  - Lack of intermodulation noise

FAMA-TDMA Operation

- Transmission in the form of repetitive sequence of Frames
  - Each frame is divided into a number of time slots,,
  - Each slot is dedicated to a particular transmitter
- Earth stations take turns using uplink channel
  - Sends data in assigned time slot
- Satellite repeats incoming transmissions
- Broadcast to all stations
- Stations must know which slot to use for transmission and which to use for reception



Cordless Systems

- They evolved from cordless telephone technology.
- It provide users with mobility within an area with an analog wireless link.
- Later digital cordless telephones were developed
- Cordless systems can support multiple users from the same base station, which could include either multiple telephone handsets or both voice and data devices (e.g., fax or printer).
- Cordless systems can operate in a number of environments:

Operating Environment

- **Residential:**
  - Within a residence a single base station can provide voice and data support
- **Office:**
  - A single base station can support a small office.
  - Multiple base stations in a cellular configuration support a large office

- **Telepoint:**
  - **A** base station set up in a public place.
  - Eg: airport, shopping mall etc

Design considerations for cordless standards.

1. The range of the handset from the base station is modest (about 200 m.). So low-power designs are used.
2. Inexpensive handset and the base station. So, dictates simple technical approaches, such as in the area of speech coding and channel equalization.
3. Frequency flexibility is limited, So the system needs to be able to seek a low-interference channel wherever used.

Standards for Cordless Systems

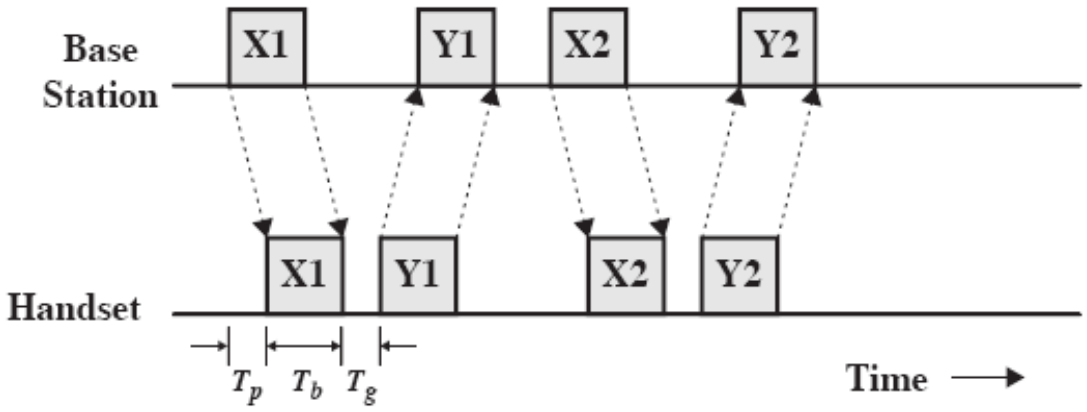
- Most prominent is DECT (Digital Enhanced Cordless Telecommunications)
  - Developed in Europe
- PWT (Personal Wireless Telecommunication)
  - Equivalent Service in U
- Both works on the basis of TDD (Time Division Duplex)

Time Division Duplex

- Also known as time-compression multiplexing (TCM)
- Data are transmitted in one direction at a time, transmission alternating between the two directions.
- Two types
  - Simple TDD
  - TDMA/TDD

Simple TDD

- It is used to achieve the desired subscriber data rate.
- The transmitter's bit stream is divided into equal segments
- Compressed in time to a higher transmission rate, and transmitted in bursts.
- At the receiver side, that are to the original rate.
- A short time period is used between bursts to settle down the channel in both directions.
- The actual data rate on the channel must be greater than twice the data rate required by thetwo end systems.



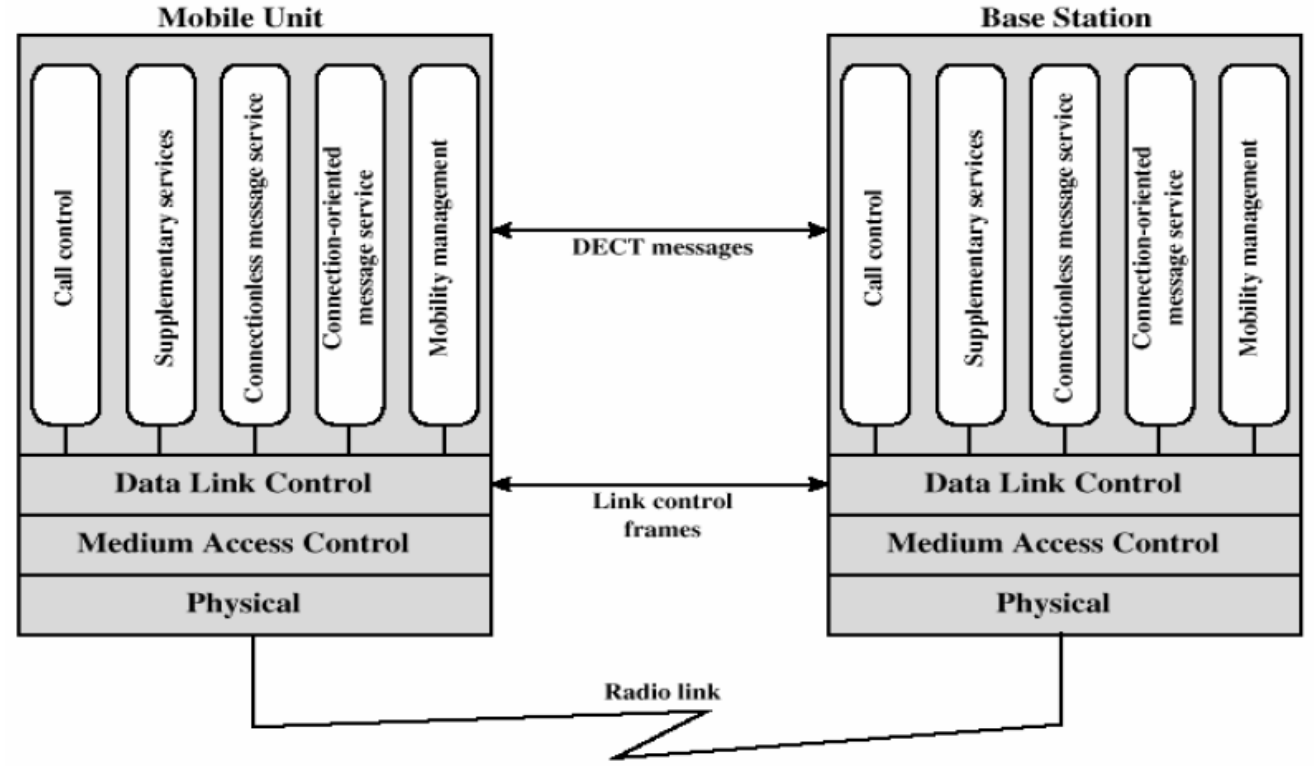
TDMA-TDD

- Wireless TDD is used with TDMA
  - Number of users receive forward (base to handset) channel signals and then transmit reverse (handset to base) channel signals in turn.

- All on the same carrier frequency.
- Advantages:
  - Improved ability to cope with fast fading
  - Improved capacity allocation.

DECT Architecture

- The standard for DECT or Digital Enhanced Telecommunications system was developed by members of the European Telecommunications Standards Institute (ETSI).
- The basic telephony speech quality offered by DECT is very high



- Three Layers
  - **Physical layer**
    - data transmitted in TDMA-TDD frames over one of 10 RF carriers
    - Data rate is 1.152 Mbps
    - Ratio of data rate to band width is 2.
  - **Medium access control (MAC) layer**
    - selects/ establishes/releases connections on physical channels
    - Multiplexes information into TDMA-TDD frame format
    - supported services:
      - Broadcast – send messages
      - Connection oriented – transfer of user data
      - Connectionless – individual DECT messages are send

  - **Data link control layer**

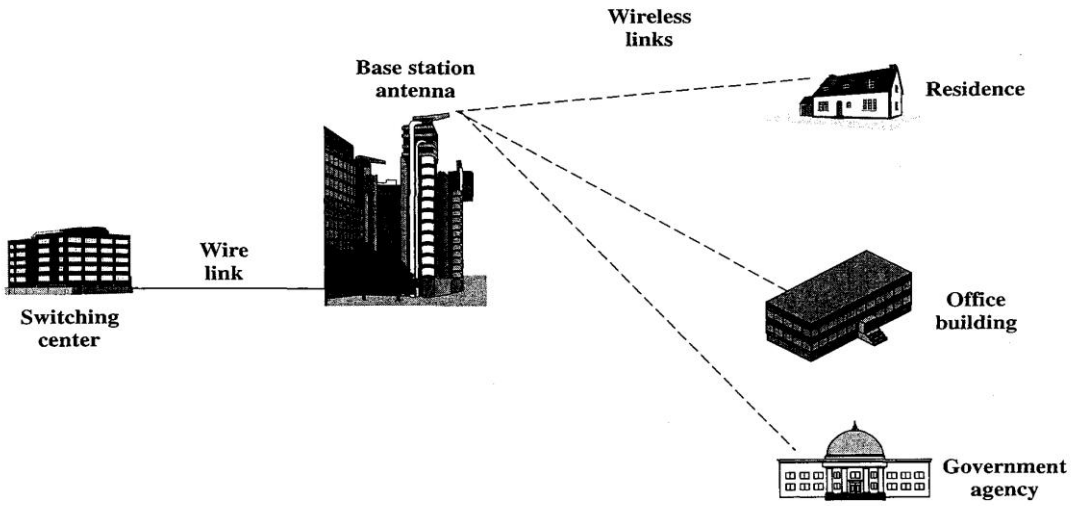
- provides for the reliable transmission of messages using traditional data link control procedures includes error detection and automatic repeat request
- Services are:
  - *Call control:* including connection setup and release.

- *Supplementary services:* Services independent of any call that support operations.
- *Connectionless message service:* Support of connectionless messages.
- *Connection-oriented message service*: Support of connection-oriented messages.
- *Mobility management:*Handles functions necessary for the secure provision of DECT services.

Wireless Local Loop

- **The circuit between the subscriber's equipment and the local exchange is called the local loop**
- For a wired systems, voice and data communications to the end user is carried by the the local loop, or subscriber loop.
- Wired technologies responding the need for reliable, high-speed access by residential, business, and government subscribers
  - ISDN, xDSL, cable modems
- These approaches are generally referred to as wireless local loop (WLL), or fixed wireless access.
- **The function of a WLL is to make primary access to local telephone station using wireless link.**
- In a telephone network **a Wireless Local Loop is an access system that uses a wireless link to connect subscribers to the local telephone station in place of conventional copper wire.**
- WLL has two alternatives
  - Narrowband : offer a replacement for existing telephony services
  - Broadband : which provide high-speed two-way voice and data service
- Thus, WLL is the best system to handle high data traffic in the local loop system.

WLL Configuration (Role of WLL)



- WLL provider services one or more cells.
- Each cell includes a base station antenna.
- Individual subscribers have a fixed antenna that has an unobstructed line of sight to the base station antenna.
- Base station has a link, which may either be wired or wireless, to a switching center.
- The switching center is a telephone company local office, which provides connections to the local and long-distance telephone networks.
- An Internet service provider (ISP) may be collocated at the switch or connected to the switch by a high-speed link.

- A base station may serve a number of subordinate base station antennas, each of which supports a number of subscribers.

Advantages of WLL over a wired

- **Cost:**
  - Wireless systems are less expensive than wired systems.
- **Installation time:**
  - WLL systems can be installed rapidly. WLL system can be installed in a small fraction of the time required for a new wired system.
- **Selective installation:** Radio units are installed only for those subscribers who want the service at a given time.
- With a wired system cable is laid out in anticipation of serving every subscriber in a local area.

IEEE 802.16Broadband wireless access standards

- In 1999, the IEEE 802 committee set up the 802.16 working group to develop broadband wirelessstandards.
- An industry group, the WiMAX (Worldwide Interoperability for Microwave Access) Forum, has been formed to promote the 802.16 standards
- A standards-based technology enabling the delivery of wireless broadband access
- It is one of the hottest broadband wireless technology around today
- This systems are expected to deliver broadband access services to residential and enterprise customers in an economical way.
- Use wireless links with microwave or millimeter wave radios
- Use licensed spectrum (typically)
- Are metropolitan in scale
- Provide public network service to fee-paying customers (typically)
- Use point-to-multipoint architecture with stationary rooftop or tower-mountedantennas
- Provide efficient transport of heterogeneous traffic supporting quality ofservice (QoS)
- Are capable of broadband transmissions (>2 Mbps)
- An industry group, the WiMAX (WorldwideInteroperability for Microwave Access) Forum, has been formed to promotethe 802.16 standards

Features

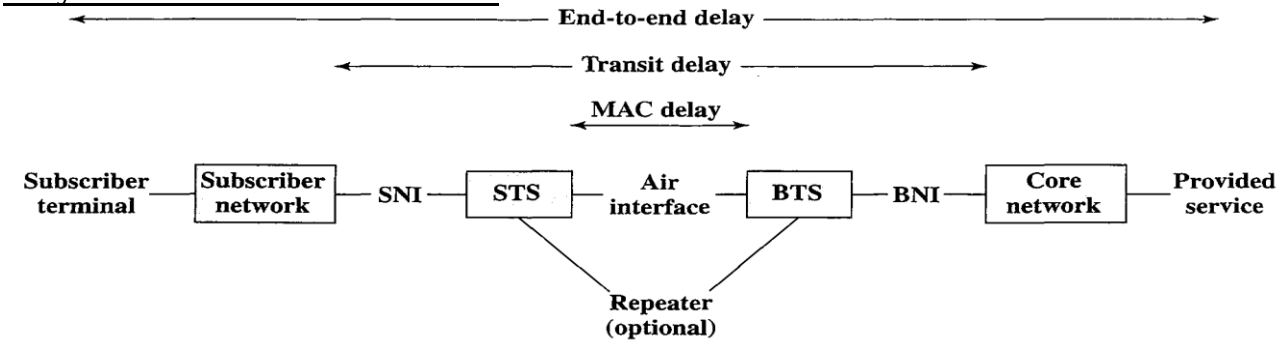
- Higher connection speed than Wi-Fi
- Wider area coverage(called as MAN)
- High data rates with orthogonal frequency Division Multiplexing(OFDM)
- Short timing period
- Supports wider range
- Low cost
- High Quality of Service

IEEE 802.16 standards

Standard	Scope
IEEE 802.16	Medium access control (MAC): one common MAC for wireless MAN standards Physical layer: 10 to 66 GHz
IEEE 802.16a	MAC modifications to 802.16.1 Physical layer: 2 to 11 GHz
IEEE 802.16c	Detailed System Profiles for 10–66 GHz
IEEE 802.16e	Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands
IEEE 802.16.2	Coexistence of Fixed Broadband Wireless Access Systems

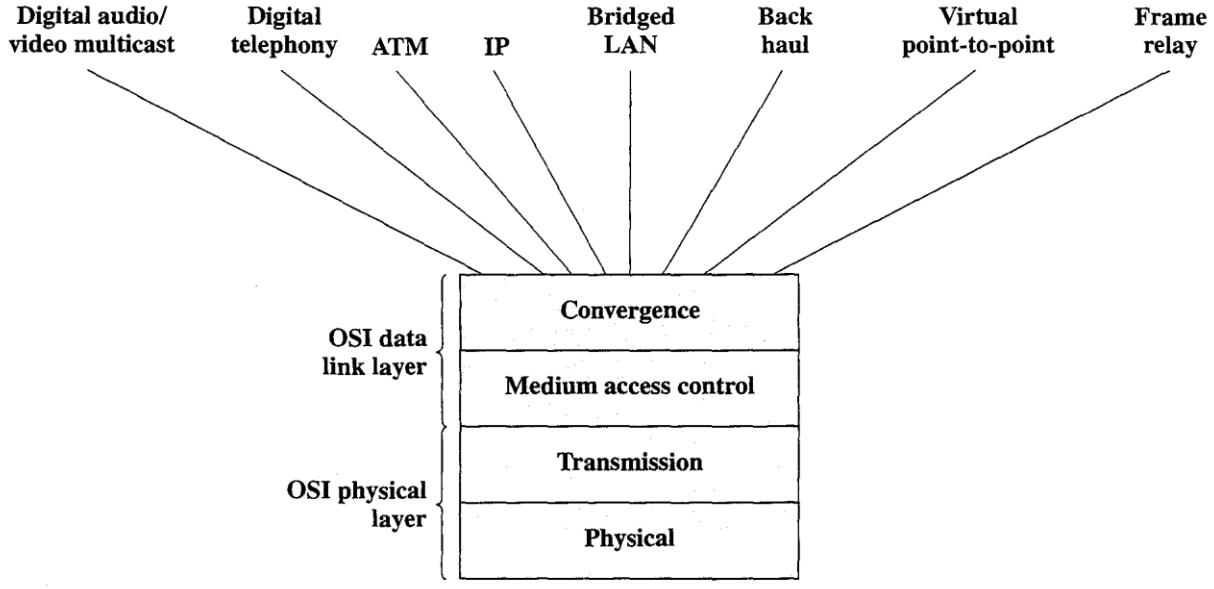
IEEE 802.16 Architecture

1. System Reference Architecture



- The 802.16 standards are designed with respect to the system reference model.
- An 802.16 wireless service provides a communications path between a subscriber and a core network (public telephone network and the Internet)
- The subscriber may be either a single subscriber device or a network (e.g., a LAN, PBX)
- Three interfaces are defined.
    - Air interface between the subscriber's transceiver station and the base transceiverstation.
    - Interface between the subscriber's transceiver station and the base transceiver station.
    - Interfaces between the transceiverstations and the networks behind them (SNI and BNI).
- The air interface specification allows the repeaters orreflectors to bypass obstructions and extend cell coverage.

2. Protocol Architecture



Physical Layer

- Encoding/decoding of signals
- Preamble generation/removal (for synchronization)
- Bit transmission/reception
- Specification of the transmission medium and the frequency band.

Transmission Layer

- On transmission, assemble data into a frame with address and error detection fields.
- On reception, disassemble frame, and perform address recognition and error detection.
- Govern access to the wireless transmission medium.

Medium Access Control Layer

- It is responsible for sharing access to the radio channel between the base station and the subscriber station.
- MAC protocol defines how and when a base station or subscriber station may initiate transmissionon the channel.
- MAC protocol must be able to allocate radio channel capacity so as to satisfy service demands.
- MAC protocol is relatively simplein downstreamand more complex in upstream.

Convergence Layer

- Encapsulate PDU (protocol data unit) framing of upper layers into the native 802.16 MAC/PHY frames.
- Map an upper layer's addresses into 802.16 addresses.
- Translate upper layer QoS parameters into native 802.16 MAC format.
- Adapt the time dependencies of the upper layer traffic into the equivalent MAC service.

WiMAX

- Acronym for Worldwide Interoperability for Microwave Access.
- Based on Wireless MAN technology.
- A wireless technology optimized for delivery of IP centric services over a wide area.
- A scalable wireless platform for constrcuting alternative and complimentary broadband n/w.
- A certificate that denotes interoperability of equipment built to the IEEE 802.16 or compatible standard
- WiMAX is a standard wireless version of broadband access to customer premises.
- WiMAX would operate similar to WiFi but a higher speed over great distance and for a greater number of users.
- WiMAX has the ability to provide services even in areas that are difficult for wired infrastructure

Applications

- Residential or Home and Broadband Internet Access
- Medium and small size business
- Backhaul networks for cellular base stations:
- WiFi Hotspots.

Advantages

- Wimax Coverage
- Wimax High Speed
- Multi-functionality within Wimax Technology
- Potential and development
- Stay in touch with end user
- Wimax Infrastructure

Mobile IP

- The term *mobile* implies that a user is connected to one or more applications across the Internet.
- Mobile IP was enable the computers to maintain Internet connectivitywhile moving from one internet attachment point to another.
- Mobile IPcan work with wired connections also.
- In wired connection computer is unplugged from one physicalattachment point and plugged into another.
- The user's point of attachment changesdynamically, and all connections are automatically maintained
- This temporary IP address is used by the user'scorrespondent for each application-level connection (e.g., FTP, Web connection).

Operation of Mobile IP

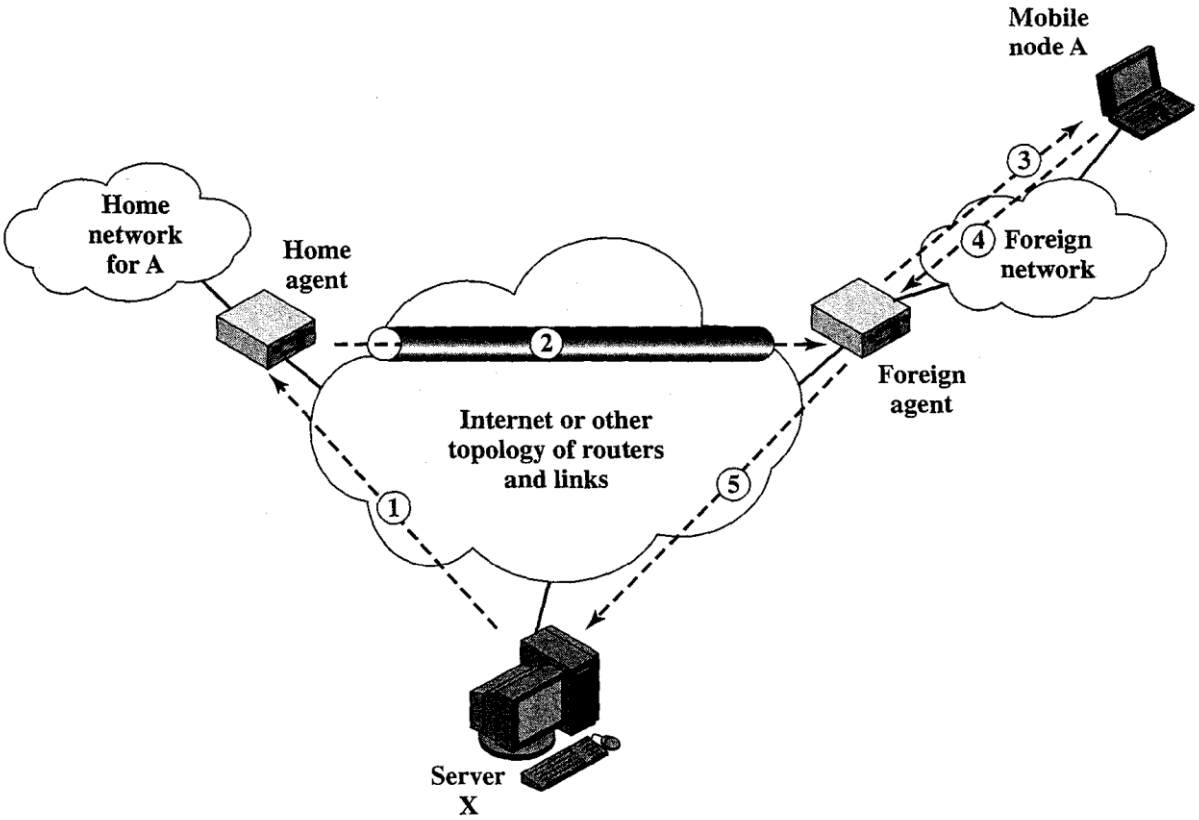
Home Network :A mobile node is assigned to a particular network,
Home Address : IP address on home network and is static.
Foreign Network: When the mobile node moves its attachment point to another network.
Foreign Agent : The presence of mobile node can registered with anetwork node on the foreign network.
Home Agent : The mobile node communicates with a similar agent on the user's home network.
The foreign host contacts the user's home agent and gives the care-ofaddress of the mobile node; own IP of foreign agent. The care-of address identifies the foreign agent'slocation.

When IP datagrams are exchanged over a connection between the mobile node and another host :

1. Server X transmits an IP datagram to mobile node A, with A's homeaddress in the IP header. The IP datagram is routed to A's home network.
2. At the home network, the incoming datagram is intercepted by the home agent and encapsulates the entire datagram inside a new IPdatagram that has the A's care-of address in the header, and retransmits thedatagram. The use of an outer IP datagram with a different destination IPaddress is known as tunneling. This IP datagram is routed to the foreign agent.
3. The foreign agent strips off the outer IP header, encapsulates the original IPdatagram in a network-level PDU (e.g., a LAN LLC frame), and delivers theoriginal datagram to A across the foreign network.
4. When A sends IP traffic to X, it uses X's IP address. (X is a fixed address; X is not a mobile node.) Each IP datagram is sent by A to a router on the foreign network for routing to X. This router is also the foreign agent.
5. The IP datagram from A to X travels directly across the Internet to X, using X's IP address.

Mobile IP capabilities:

- **Discovery**: A mobile node uses a discovery procedure to identify prospectivehome agents and foreign agents.
- **Registration:** A mobile node uses an authenticated registration procedure toinform its home agent of its care-of address.
- **Tunneling:** Tunneling is used to forward IP datagrams from a home address toa care-of address.



WAP (Wireless Application Protocol)

- open standard developed by the WAP Forum to provide telephony and information services, including the Internet and the Web.
- WAP is designed to work with all wireless network technologies (e.g., GSM, CDMA, andTDMA).
- WAP is based on existing Internet standards, such as IP, XML, HTML, and HTTP
- **Wireless Application Protocol** (**WAP**) is a technical standard for accessing information over a mobile wireless network.
- A WAP browser is a web browser for mobile devices such as mobile phones that uses the protocol.
- An application communication protocol
- It is used to access services and information
- It is for hand held devices
- It enables creating of web applications for mobile devices
- WAP uses mark-up language(WML)
- WAP is the set of rules governing the transmission and reception of data by computer applications on a wireless devices like mobile phones.
- WAP allows wireless devices to view specifically designed pages from the Internet, using only plain text and very simple black-and-white pictures.
- WAP is a standardized technology for cross platform, distributed computing.

- It is optimized for:
    - Low-display capability
    - Low-memory
    - Low-bandwidth devices, such as personal digital assistants (PDAs), wireless phones, and pagers.

The WAP specification includes

- A programming model based on the WWW Programming Model
- A markup language, the Wireless Markup Language, adhering to XML
- A specification of a small browser suitable for a mobile, wireless terminal
- A lightweight communications protocol stack
- A framework for wireless telephony applications (WTAs)

WAP Advantages

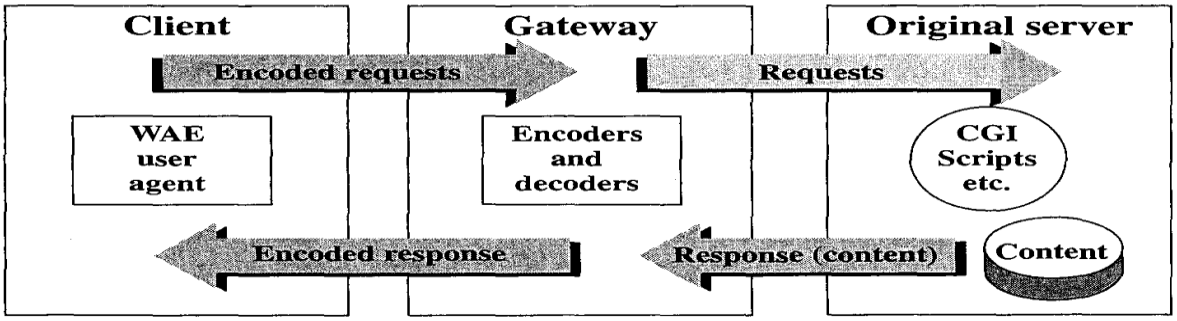
- Implementation near to the Internet model
- Most modern mobile telephone devices support WAP
- Real-time send/receive data
- Easy and fast access to Internet.
- WML(Wireless Markup Language) and WML Script (new language, which is based on HTML).
- Large choice in mobile phones
- Can be used to download abstract data types (Eg:videos)
- Supports most wireless networks (like: CDMA, GSM, PDC(personnal digital cellular), PHS(personal handyphone system), TDMA etc.).
- Can be built on any operating system.
- Open standard and vendor independent.

Disadvantages

- Low speed, security and very small user interface
- Not very familiar to the users
- Business model is expensive
- Forms are hard to design

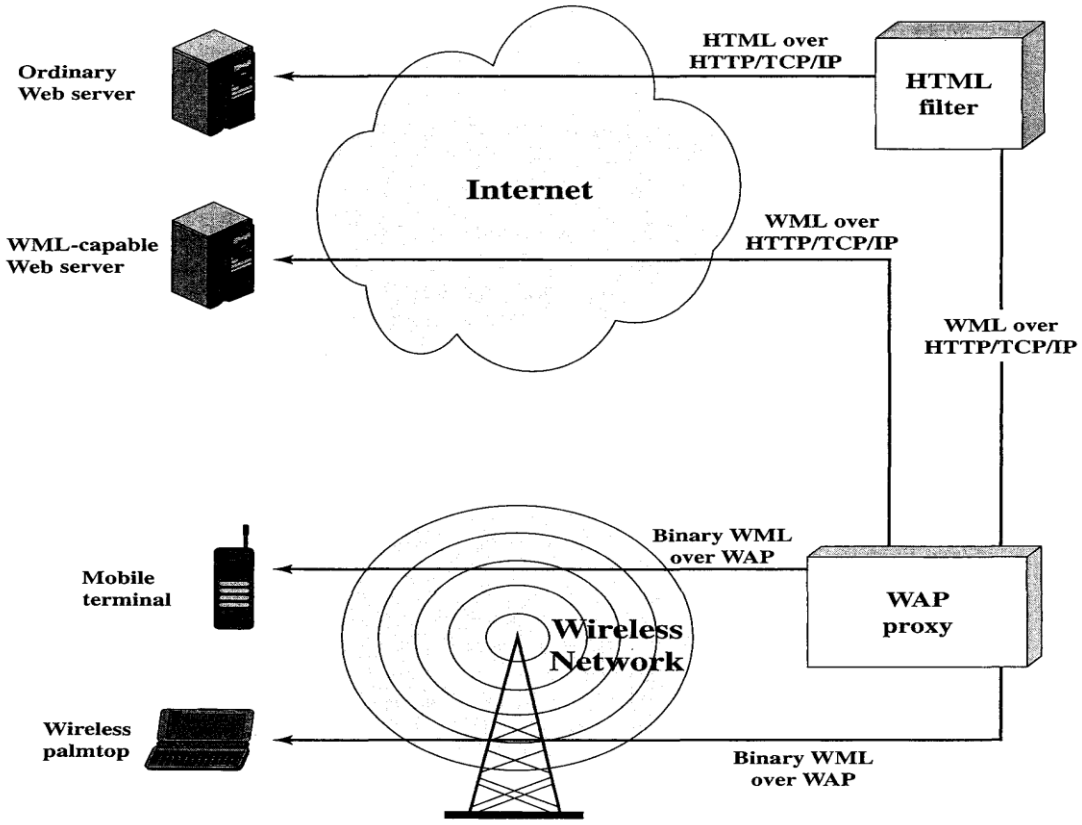
Architectural Overview

The WAP Programming Model is based on: the client, the gateway, and the original server



- HTTP is used between the gateway and the original server to transfer content.
- The gateway acts as a proxy server for the wireless domain.
- Its provide services that offload the limited capabilities of the hand-held, mobile, wireless terminals.
- For example, the gateway provides DNS services, converts between WAP protocol stack and the WWW stack (HTTP and *TCP/IP)*,
- Gateway encodes information from the Web into a compact for in the other direction, decodes the compacted form into standard Web communication conventions.
- The gateway also caches frequently requested information.

WAP environment.



- Using WAP, a mobile user can browse Web content on an ordinary Web server.
- The Web server provides content in the form of HTML-coded pages and are transmitted using the standard Web protocol stack (HTTP/TCP/IP).
- The HTML content must go through an HTML filter, which may either be colocated with the WAP proxy or in a separate physical module.
- The filter translates the HTMLcontent intoWML content.
- If the filter is separate from the proxy, *HTTP/TCP/IP* is used to deliver the WML to the proxy.
- The proxy converts the WML to binary WML and delivers to the mobile user using the WAP protocol.
- If the Web server is capable of directly generating WML content, then the WML is delivered using *HTTP/TCP/IP* to the proxy, which converts the WML to binary WML and then delivers it to the mobile node using WAP protocols.

- Limitations of WAP for wireless Web access are:
  - Limitations of the mobile node (small screen size, limited input capability)
  - Low data rates of wireless digital networks.

- With the introduction of 3G:
  - which provide broadband data rates
  - the small hand-held mobile nodes will continue to have limited input and display capabilities.
- Thus WAP or a similar capability will be needed for the indefinite future.

Wireless Protocol Stack