

# Introduction To WCC

*Unit 1 : WIRELESS  
COMMUNICATIONS*

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**1.2, 1.3 and 1.4**

# Wireless everywhere...

- ✖ *Remote control*
- ✖ *Cordless telephone*
- ✖ *Headsets*
- ✖ *Garage openers*
- ✖ *Badges*
- ✖ *Cell phones/modems*
- ✖ *Radio!*
- ✖ *Pagers*
- ✖ *Satellite TV*
- ✖ *Wireless LAN cards*
- ✖ *Cordless headsets, mouse, keyboards, etc.*
- ✖ *PDA's.*

# What is wireless communication?

*✖ In layman language it is communication in which information is transferred between two or more points without any wire.*

# Advantages and disadvantages of wireless communication

## **✖Advantages:**

- ✖ *Working professionals can work and access Internet anywhere and anytime without carrying cables or wires wherever they go. This also helps to complete the work anywhere on time and improves the productivity.***
- ✖ *A wireless communication network is a solution in areas where cables are impossible to install (e.g. hazardous areas, long distances etc.)***

## **✖Disadvantages:**

- ✖ *Has security vulnerabilities***
- ✖ *High costs for setting the infrastructure***
- ✖ *Unlike wired communication, wireless communication is influenced by physical obstructions, climatic conditions, interference from other wireless devices***

# CURRENT WIRELESS SYSTEMS

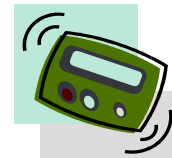
✖ *CELLULAR SYSTEM*

✖ *WIRELESS LANs*

✖ *SATELLITE SYSTEM*

✖ *PAGING SYSTEM*

✖ *BLUETOOTH*



## Wired communications

The communication takes place over a more or less **stable medium like copper wires** or optical fibers. The properties of the medium are well defined and time-invariant.

Increasing the transmission capacity can be achieved by using a different frequency on an existing cable, and/or **by stringing new cables**.

The range over which communications can be performed without repeater stations is mostly limited by **attenuation by the medium** (and thus noise); for optical fibers, the **distortion of transmitted pulses** can also limit the speed of data transmission.

**Interference and crosstalk from other users either do not happen** or the properties of the interference are stationary.

The delay in the transmission process is also constant, determined by **the length of the cable and the group delay of possible repeater amplifiers**.

The **Bit Error Rate (BER)** decreases strongly (approximately exponentially) with increasing **Signal-to-Noise Ratio (SNR)**. This means that a relatively small increase in transmit power can greatly decrease the error rate.

Due to the well-behaved transmission medium, the quality of wired transmission is generally high.

**Jamming and interception of dedicated links** with wired transmission is **almost impossible** without consent by the network operator.<sup>2</sup>

Establishing a link is *location* based. In other words, a link is established from one outlet to another, **independent of which person is connected to the outlet**.

Power is either provided through the communications network itself (e.g., for traditional landline telephones), or from **traditional power mains** (e.g., fax). In neither case is energy consumption a major concern for the designer of the device.

## Wireless communications

Due to user mobility as well as **multipath propagation**, the transmission medium varies strongly with time.

Increasing the transmit capacity must be achieved by more **sophisticated transceiver concepts and smaller cell sizes (in cellular systems)**, as the amount of available spectrum is limited.

The range that can be covered is limited both by the transmission medium (**attenuation, fading, and signal distortion**) and by the requirements of spectral efficiency (cell size).

**Interference and crosstalk from other users are inherent in the principle of cellular communications**. Due to the mobility of the users, they also are time-variant. The delay of the transmission depends partly on the **distance between base station and Mobile Station (MS)**, and is thus time-variant.

For simple systems, the average BER decreases only **slowly (linearly) with increasing average SNR**. Increasing the transmit power usually does not lead to a significant reduction in BER. However, more sophisticated signal processing helps.

Due to the difficult medium, transmission quality is **generally low unless** special measures are used.

**Jamming a wireless link is straightforward, unless** special measures are taken. Interception of the on-air signal is possible. Encryption is therefore necessary to prevent unauthorized use of the information. Establishing a connection is based on the (mobile) equipment, usually **associated with a specific person**. The connection is not associated with a fixed location.

MSs use rechargeable or **one-way batteries**. **Energy efficiency is thus a major concern**.

# Broadcast

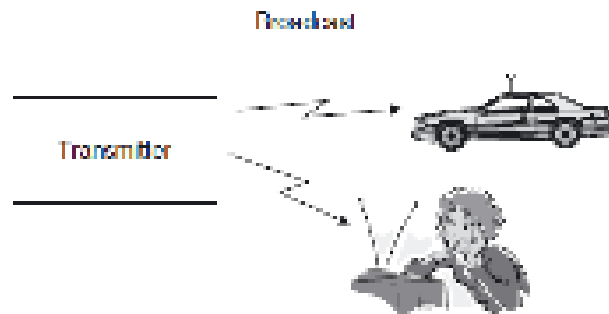


Figure 1.1 Principle of broadcast transmission.

- ✖ The information is only sent in one direction. It is only the broadcast station that sends information to the radio or TV receivers; the listeners (or viewers) do not transmit any information back to the broadcast station.
- ✖ The transmitted information is the same for all users.
- ✖ The information is transmitted continuously.
- ✖ In many cases, multiple transmitters send the same information.



# Paging

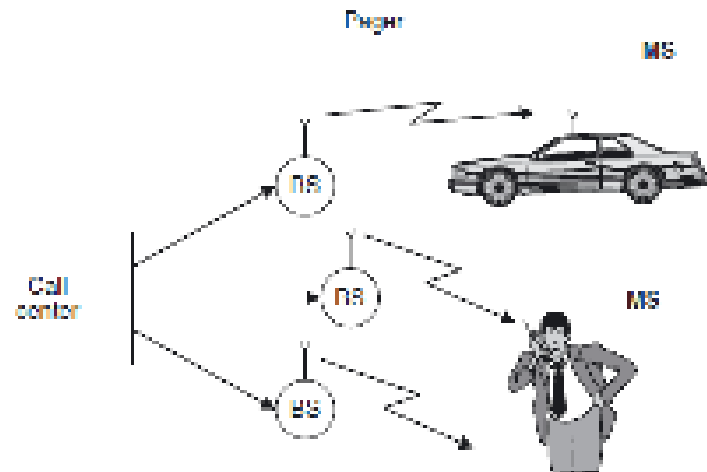


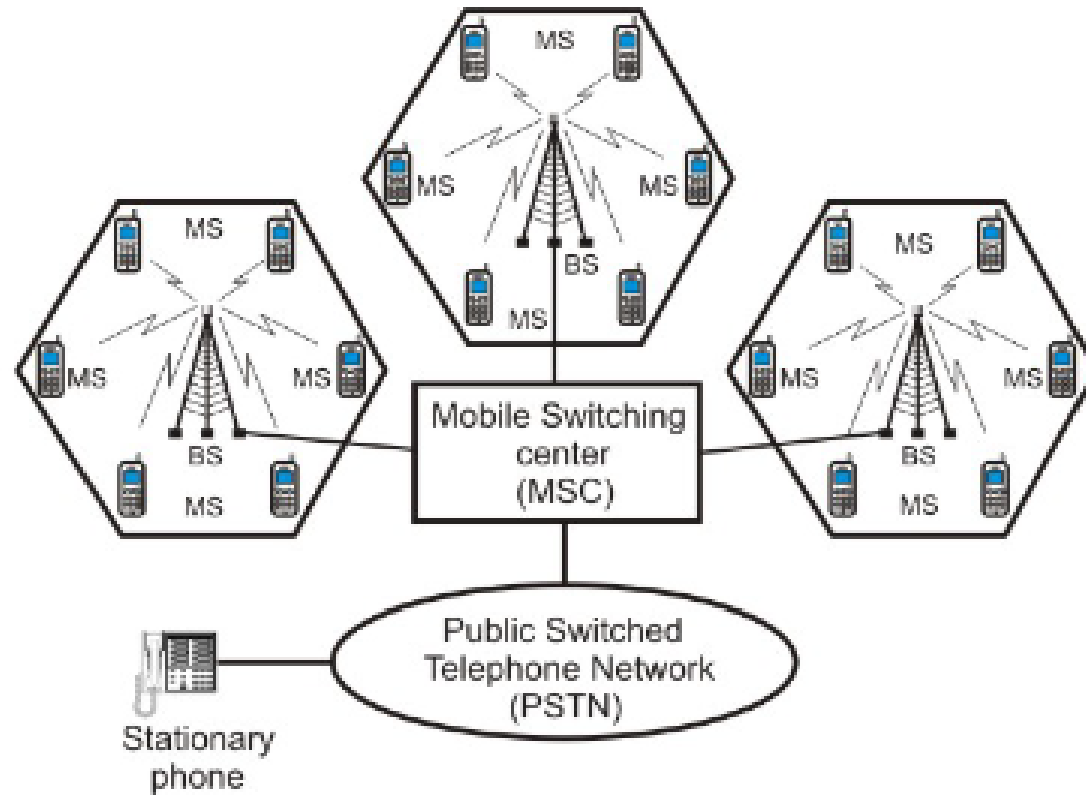
Figure 1.2 Principle of a pager.



- ✗ The user can only receive information, but cannot transmit. Consequently, a “call” (message) can only be initiated by the call center, not by the user.**
- ✗ The information is intended for, and received by, only a single user.**
- ✗ The amount of transmitted information is very small. Originally, the received information consisted of a single bit of information, which indicated to the user that “somebody has sent you a message.”**
- ✗ The user then had to make a phone call (usually from a payphone) to the call center, where a human operator repeated the content of the waiting message.**
- ✗ Later, paging systems became more sophisticated, allowing the transmission of short messages (e.g., a different phone number that should be called, or the nature of an emergency).**

***✖ Due to small amount of information transmission and communication is unidirectional ,the bandwidth requirement is small and service used to be run with smaller carrier frequency of 150 MHz.***

# Components of cellular network



✖ The information flow is bidirectional. A user can transmit and receive information at the same time.

*A cellular system comprises the following basic components:*

✖ *Mobile Stations (MS): Mobile handsets (handheld or installed in vehicles), which is used by an user to communicate with another user.*

✖ *Cell: Each cellular service area is divided into small regions called cell (5 to 20 Km)*

✖ *Base Stations (BS): Each cell contains an antenna (transreciever), which is controlled by a small office.*

✖ **Public Switched Telephone Network (PSTN):** Connects several thousands of miles of transmission infrastructure, including fixed land lines, microwave, and satellite links.

✖ **Mobile Switching Center (MSC):** Each base station is controlled by a switching office, called mobile switching center. The MSC is mostly associated with communications switching functions, such as call set-up, release, and routing. It switches voice traffic from the wireless network to the PSTN if the call is a mobile-to-landline call, or it switches to another MSC within the wireless network if the call is a mobile-to-mobile call.

# Trunking Radio



- ✘ Trunking radio systems are an important variant of cellular phones, where there is no connection between the wireless system and the PSTN; therefore, it allows the communications of closed user groups.
- ✘ Obvious applications include police departments, fire departments, taxis, and similar services.



✖ The closed user group allows implementation of several technical innovations that are not possible (or more difficult) in normal cellular systems:

- ✖ Group calls

- ✖ Call priorities

- ✖ *Relay networks*

# *Cordless Telephony*

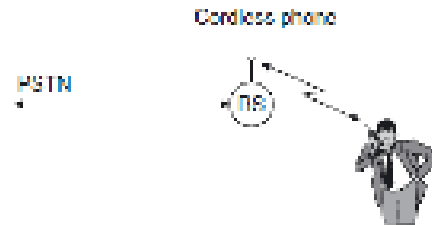


Figure 1.4 Principle of a single cordless phone.

**Private automatic  
branch exchange**

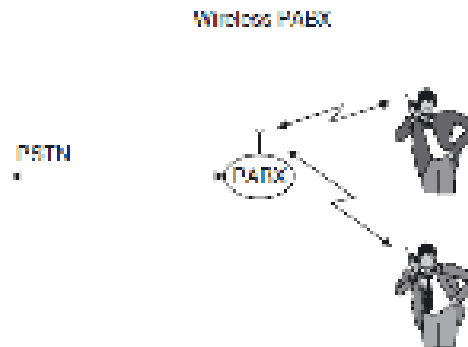


Figure 1.5 Principle of a wireless private automatic branch exchange.

- ✖ Cordless telephony describes a wireless link between a handset and a BS that is directly connected to the public telephone system.
- ✖ The main difference from a cellphone is that the cordless telephone is associated with, and can communicate with, only a single BS . There is thus  
no *mobile switching center*, rather, the BS is directly connected to the PSTN.

- ✗ The BS does not need to have any network functionality.
- ✗ When a call is coming in from the PSTN, there is no need to find out the location of the MS. Similarly, there is no need to provide for handover between different BSs.
- ✗ There is no central system. A user typically has one BS for his/her apartment or business under control, but no influence on any other BSs. For that reason, there is no need for (and no possibility for) frequency planning.

✘ Cordless systems have also evolved into wireless *Private Automatic Branch eXchanges* (PABXs)

✘ In its most simple form, a PABX has a single BS that can serve several handsets

simultaneously – either connecting them to the PSTN or establishing a connection

between them (for calls within the same company or house).

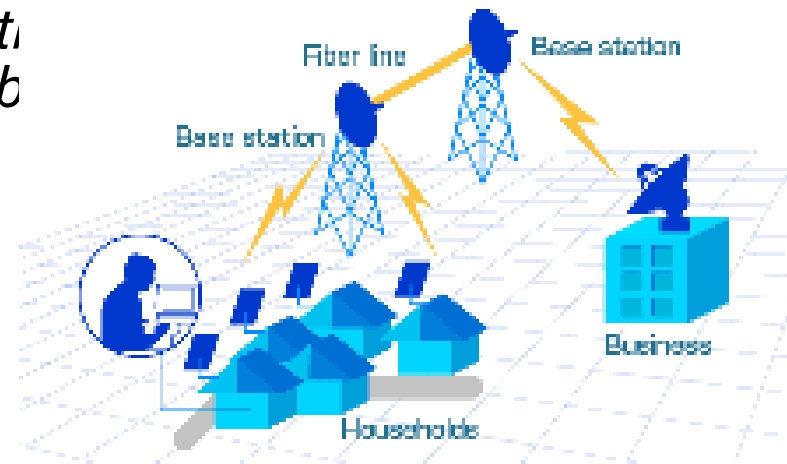
- In its more advanced form, the PABX contains several BSs that are connected to a central control station.
- Such a system has essentially the same functionality as a cellular system; it is only the size of the coverage area that distinguishes such a full functionality wireless PABX from a cellular network.

# The Difference Between a Cordless & Cellular Phone

CORDLESS PHONES	CELL PHONES
Cordless phones consist of a base station and the cordless phone itself. A cordless phone will not work if it is outside of the range of the base station.	If the cell phone moves outside of the tower's range, the cell phone network automatically transfers the call to another tower so that the user can continue his call as long as he is within range of at least one tower.
Cordless phones do not need to be registered with the phone company.	Before using a cell phone, you need to activate the device with the cellular service provider either by installing an activated SIM card or by contacting the service providers.

# Fixed Wireless Access (FWA)

- ✖ *It is a type of wireless broadband data communication, which is performed between two fixed locations - connected through fixed wireless access devices and equipment..*
- ✖ *Traditionally, enterprises used leased lines or cables to connect two different locations. FWA is cheaper alternative, specifically in densely populated areas.*
- ✖ *Typically, FWA employs radio links as the communication and connecting medium between both locations. Usually, the equipment is hoisted at building roofs on both obstruction free data transmission.*



# Wireless local area networks

- ✖ The functionality of Wireless Local Area Networks (WLANs) is very similar to that of cordless phones – connecting a single mobile user device to a public landline system. The “mobile user device” in this case is usually a laptop computer and the public landline system is the Internet.



# Personal area networks

- ✖ Devices following the *Bluetooth* standard allow to connect a hands-free headset to a phone without requiring a cable;

# Ad-Hoc Networks

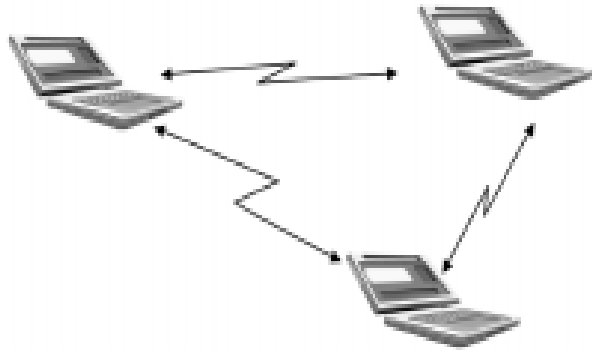
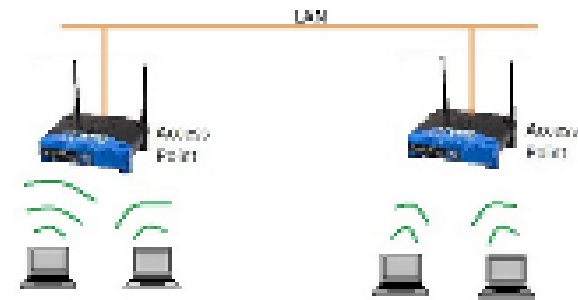


Figure 1.6 Principle of an ad hoc network.

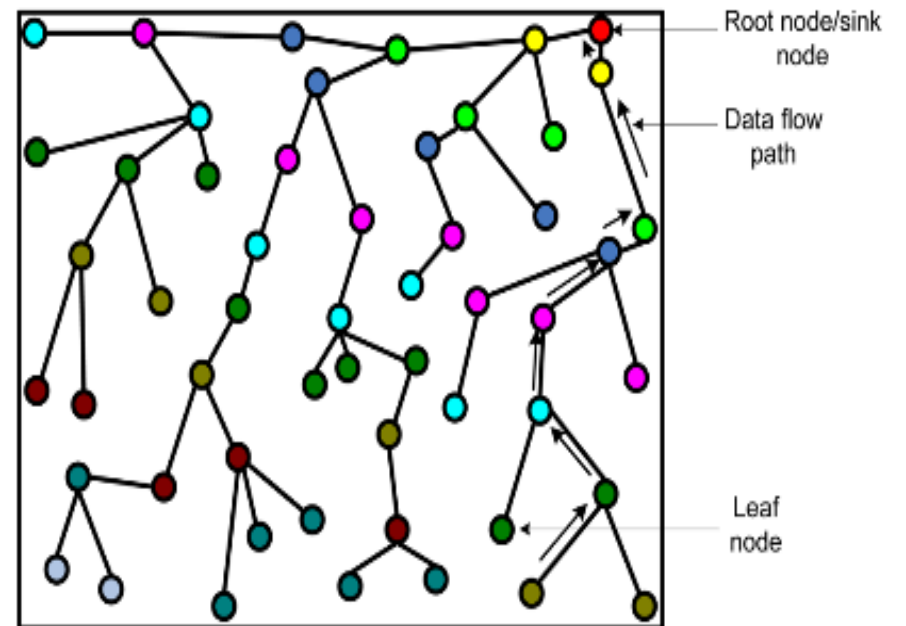
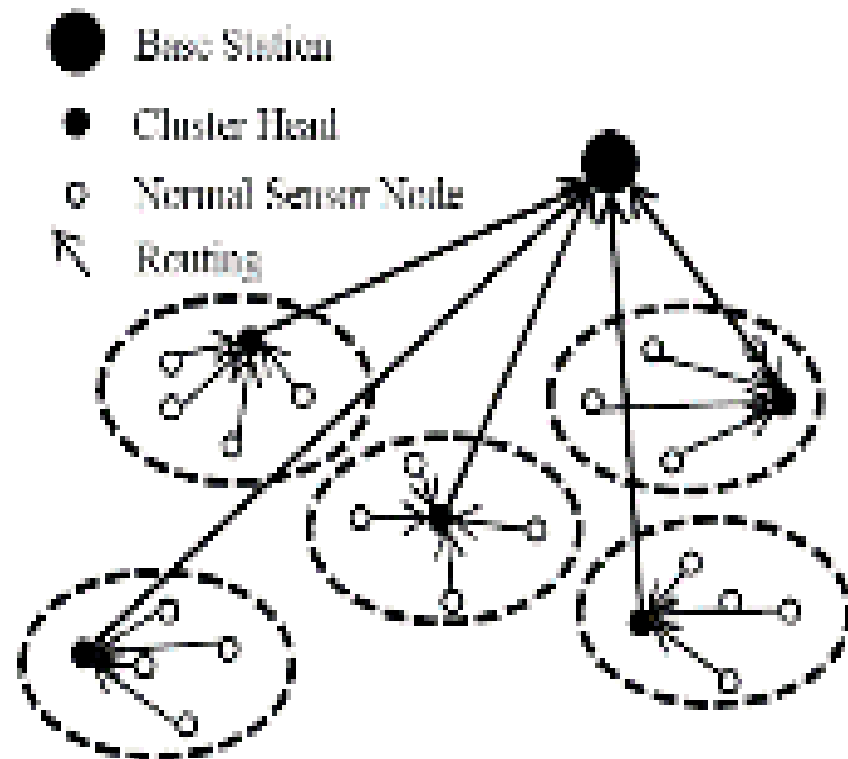
## WLAN Infrastructure Mode



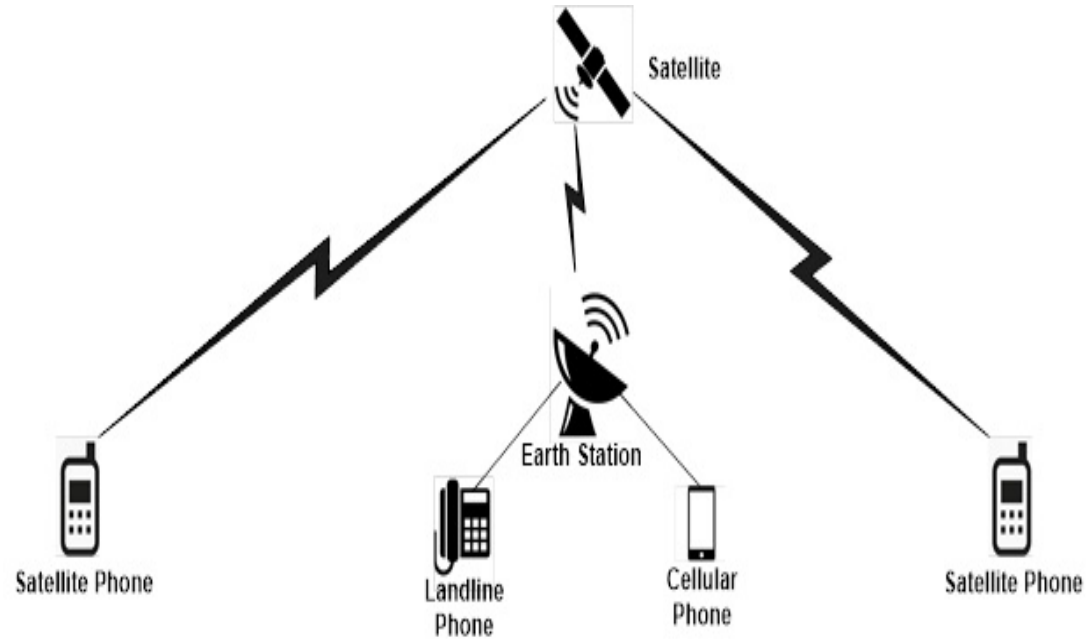
## WLAN Adhoc Mode



EX: Sensors



# Satellite Communication



- ✖ *The distance between base station and mobile station is much larger.*
- ✖ *The cell size is larger.*
- ✖ *Expensive.*
- ✖ *Used by emergency users like reporters, war areas, ship based communications.*

# Requirements for the Services

- ✗ *Data Rate*
- ✗ *Range and no. of users*
- ✗ *Mobility*
- ✗ *Energy Consumption*
- ✗ *Direction of transmission*
- ✗ *Service Quality*

# Data Rates

- ✗ *Sensors : up to 1 kbits/s ; central nodes upto 10Mbits*
- ✗ *Speech: 5 to 64kbits/s; cordless phones : 32 kbits/s and cellphones : 10kbits/s*
- ✗ *Elementary data services require between 10 and 100 kbit/s.*
- ✗ *Communications between computer peripherals and similar devices: 1Mbits/s*
- ✗ *High-speed data services: WLANs and 3G cellular systems 0.5 to 100Mbits/s*
- ✗ *Personal Area Networks (PANs): over 100Mbits/s*

## ***Range and Number of Users***

- ✖ Body Area Networks : 1m*
- ✖ Personal Area networks : 10m*
- ✖ Wireless Area Network : 100m; no.of users :10 ; cordless phones :300m*
- ✖ Cellular Systems: 500m; no.of users :5 -50*
- ✖ Fixed wireless access services: between 100m and several tens of kilometers*
- ✖ Satellite Systems*



# Mobility

- ✗ *Fixed Devices : telephones*
- ✗ *Nomadic Devices: laptop*
- ✗ *Low Mobility: cordless*
- ✗ *High Mobility: cellphones*
- ✗ *Extremely High Mobility: cellphones in a moving car*

# Energy Consumption

✖ *Rechargeable Batteries: mobiles*

✖ *One Way Batteries: sensors*

✖ *Power Mains: antennas*

# Use Of Spectrum

- ✗ *Spectrum dedicated to service and operator*
- ✗ *Spectrum allowing multiple operators*
- *Spectrum dedicated to a service*
- ✗ *Free Spectrum :The ISM(industrial, scientific, and medical radio ) **band** at 2.45 GHz is the best known example – it is allowed to operate microwave ovens,WiFi LANs, and Bluetooth wireless links, among others,*

# Direction Of Transmission

- ✖ *Simplex: broadcast systems :TV*
- ✖ *Semi-Duplex: walkie talkie*
- ✖ *Full Duplex: cell phones*
- ✖ *Asymmetric Duplex: digital subscriber line (DSL) technologies*

# Service Quality

- ✖ *Speech quality: Mean Opinion Score*
- ✖ *Data Services : file transfer service:bits/s*
- ✖ *Delay :*
  - ✖ *Voice : 100ms*
  - ✖ *Video : Streaming allowed*
  - ✖ *Critical Services*
- ✖ *Service Quality*
  - ✖ *Cell phones : the complement of “fraction of blocked calls plus 10 times fraction of dropped calls.”*
  - ✖ *For emergency services and military applications: the complement of “fraction of blocked calls plus fraction of dropped calls.”*

## **Economic and Social Aspects**

### *Economic Requirements for Building Wireless Communications Systems*

- ✖ Use less expensive digital circuitry than costly analog components.*
- ✖ Integrate all components into 1 chip rather than using 2 chips (one for analog RF circuitry and one for digital(baseband) processing).*
- ✖ Reduce human labour*
- ✖ Same chips should be used in as many systems as possible.*
- ✖ Reduce price difference between wired and wireless systems.*
- ✖ Cost of building infrastructure should be less than wired systems*

# The Market for Wireless Communications

*Factor influencing the market:*

- ✖ Price of the offered services*
- ✖ Price of MS*
- ✖ Attractiveness of the offered services*
- ✖ General economic situation*
- ✖ Existing telecom infrastructure*
- ✖ Predisposition of the population*