MOBILE COMMUNICATION

- Mobile telephone or cellular phone was introduced in the year 1946.
- With the development of the cellular concept in the 1960s at the **Bell Laboratories**, mobile communications began to be a promising field of expanse.
- In1970s the mobile users were connected to the **Public Switched Telephone Network (PSTN)**.

1G: First Generation Networks

- **Advanced Mobile Phone System (AMPS)** was the first U.S. cellular telephone system and it was deployed in 1983.

- The main technology used was Analog FM.

2G: Second Generation Networks

- Digital modulation formats were introduced with the main technology as TDMA and CDMA.
- Introduced **three** popular TDMA standards and **one** popular CDMA standard in the market.

2G: Second Generation Networks contd.

TDMA standards

- **Global System for Mobile (GSM):** introduced by Group Special Mobile and was the first fully digital system utilizing the 900 MHz frequency band.
- **Interim Standard 136 (IS-136)**
- **Pacific Digital Cellular (PDC)**

CDMA standard

Interim Standard 95 (IS-95)

2G: Second Generation Networks contd.

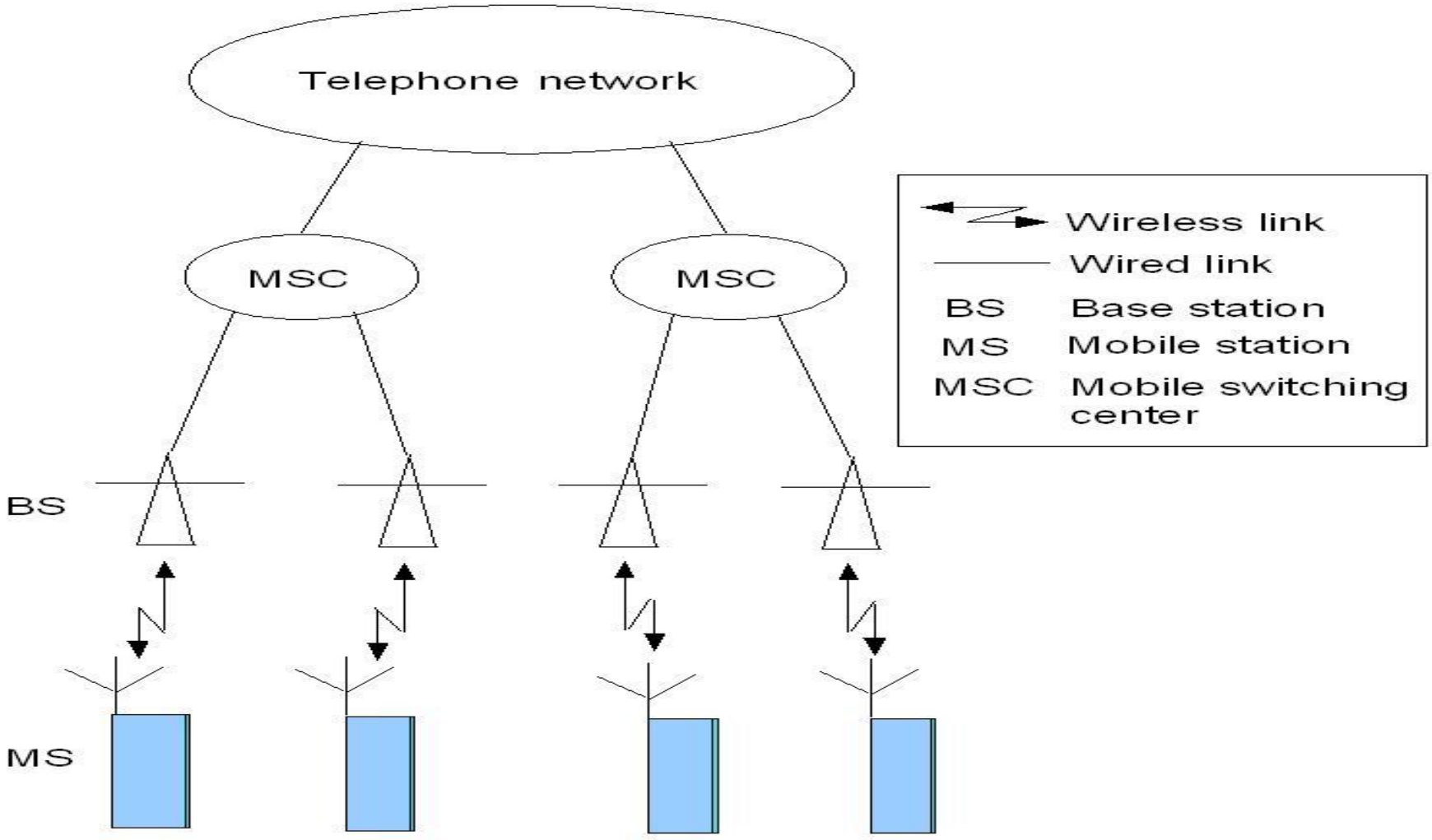
2.5G Mobile Networks

- supporting higher data rate transmission for web browsing
- supporting e-mail traffic
- enabling location-based mobile service
- Wireless Application Protocol (WAP), General Packet Radio Service (GPRS), High Speed Circuit Switched Data (HSCSD), Enhanced Data rates for GSM Evolution (EDGE)

3G: Third Generation Networks

- Offers a wider range of more advanced services while achieving greater network capacity through improved spectral efficiency.
- Services include wide-area wireless voice telephony, video calls, and broadband wireless data, all in a mobile environment.

Basic mobile communication structure:



- Present day cellular communication uses a basic unit called cell.
- A Mobile Station (MS) or subscriber unit communicates to a fixed Base Station (BS) which in turn communicates to the desired user at the other end.
- **The MSC consists of transceiver, control circuitry, duplexer and an antenna.**
- **The BS consists of transceiver and channel multiplexer along with antennas mounted on the tower, power source for the transmission a fixed backbone network.**

- The fixed backbone network is a wired network that links all the base stations and also the landline and other telephone networks through wires.
- The MSC is sometimes also called Mobile Telephone Switching Office (MTSO).
- The region over which the signal strength lies above a minimum amount of signal strength threshold value is known as the coverage area of a BS.

Elements of the BTS

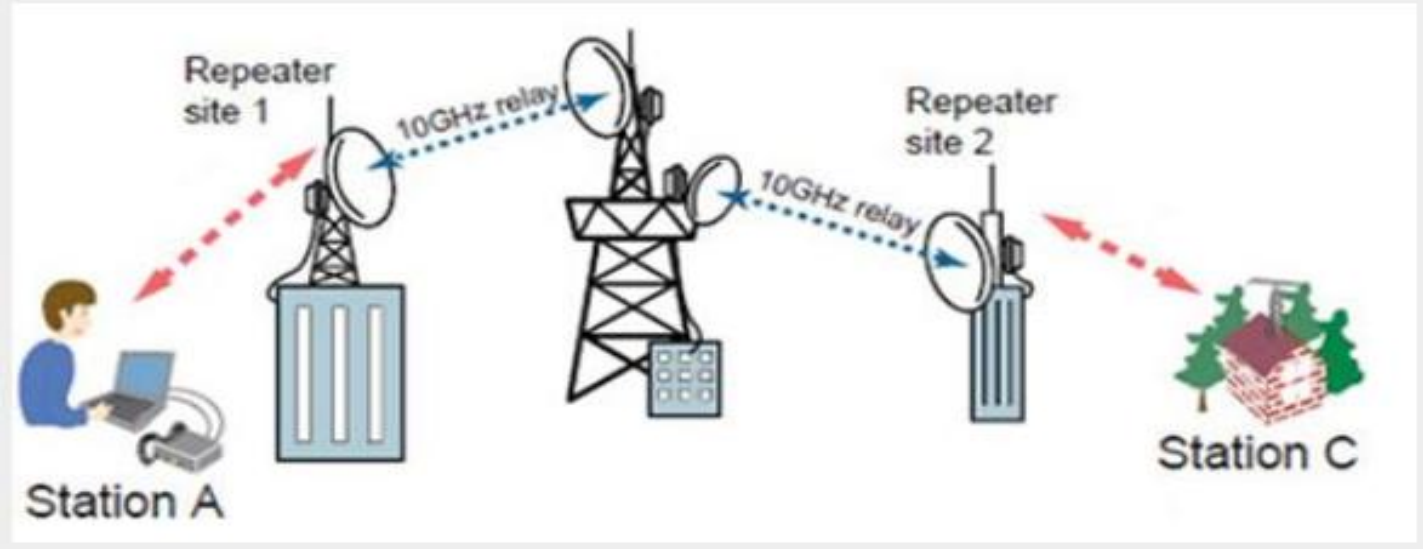
- **Mast/Tower**-to have a clear Line of Sight for microwave antenna & give room for easy radiation of radio signals by the sartorial antenna.
- Height is between 35-40m approximately.

Elements of the BTS contd.

- **Sector antenna**–a type of directional microwave antenna.
- Coverage 60°/90°/120°

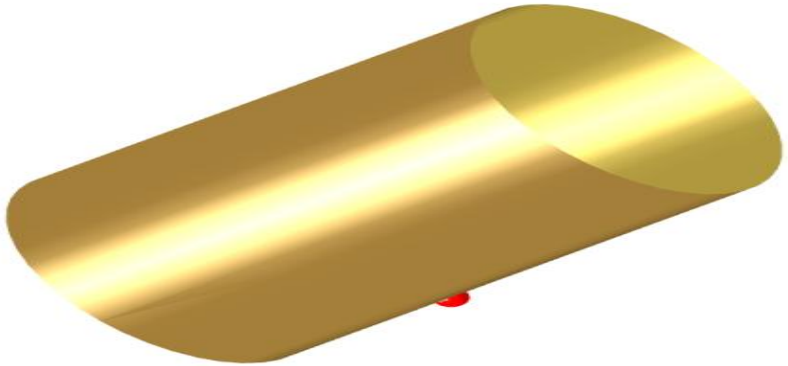
Elements of the BTS contd.

- **Microwave antenna**– Point to Point (p2p) & Point to Multipoint transmission
- Root/Hub station to other BTS sites is facilitated via line of sight.



Elements of the BTS contd.

- **Waveguides**- As a result of skin effect, waveguides were invented to eliminate or minimize loss of electro-magnetic signals passing through cables in the course of transmission.

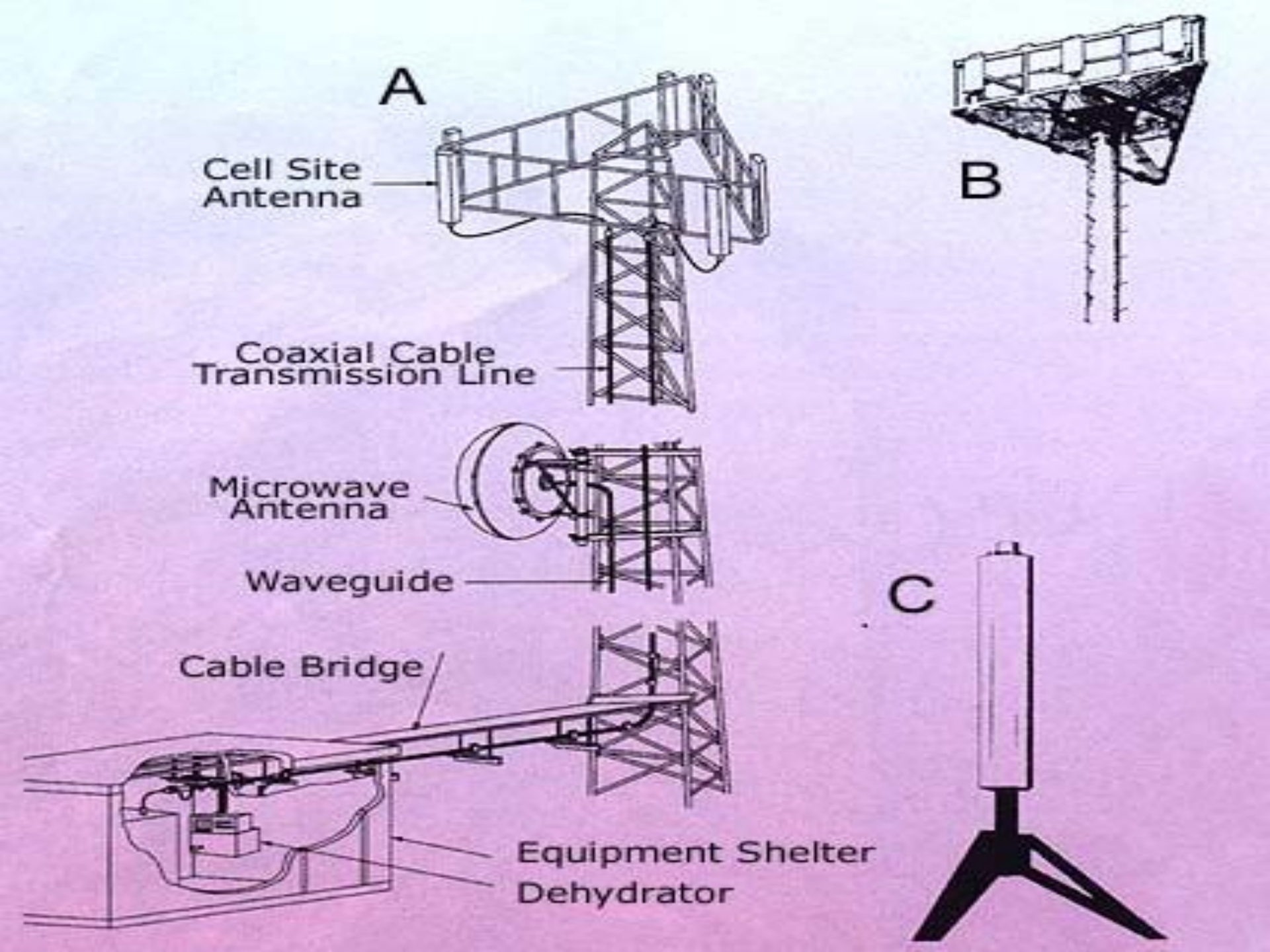


Elements of the BTS contd.

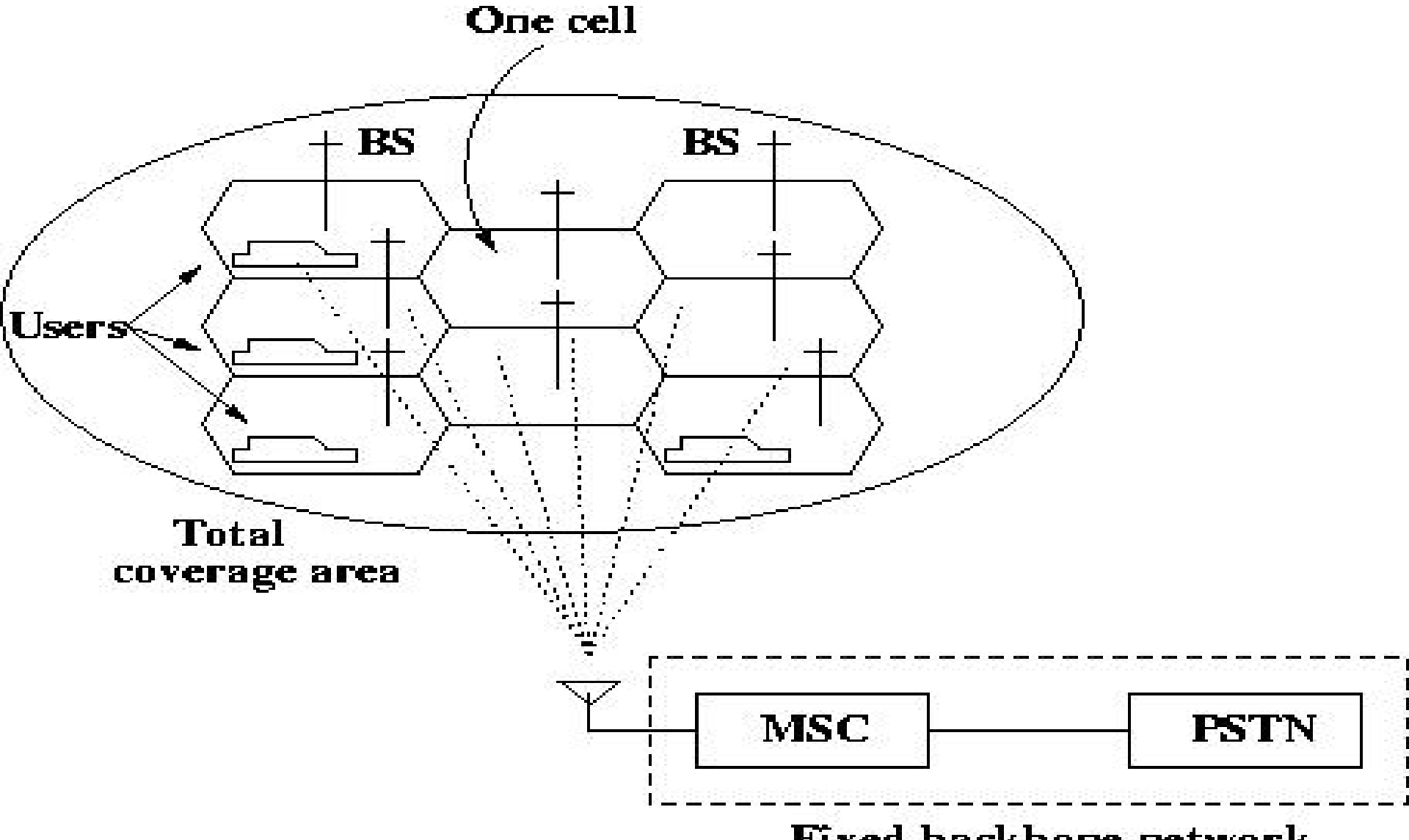
- **Radio Base Station (RBS)**- Radio Base Stations (RBS) handles the modulation of speech signals.
- **Rectifier**- The RBS works on a 48V DC.
- **Transmission Rack**- also known as TX cabinet contains the connectors on which the TX/RX installations are done.
- **Truncking**- Consists of a ladder and a bus like rail on which all installation cables/ waveguides run.

Elements of the BTS contd.

- **Duplexers**- The duplexer does de-multiplexing function between the sectorial antennas and the RBS. The sectorial antenna has a dual frequency input. Waveguides connects the input of these frequencies then de-multiplexes.


A
Cell Site
Antenna
Coaxial Cable
Transmission Line
Microwave
Antenna
Waveguide
Cable Bridge
Equipment Shelter
Dehydrator
B
C

Basic Cellular Structure



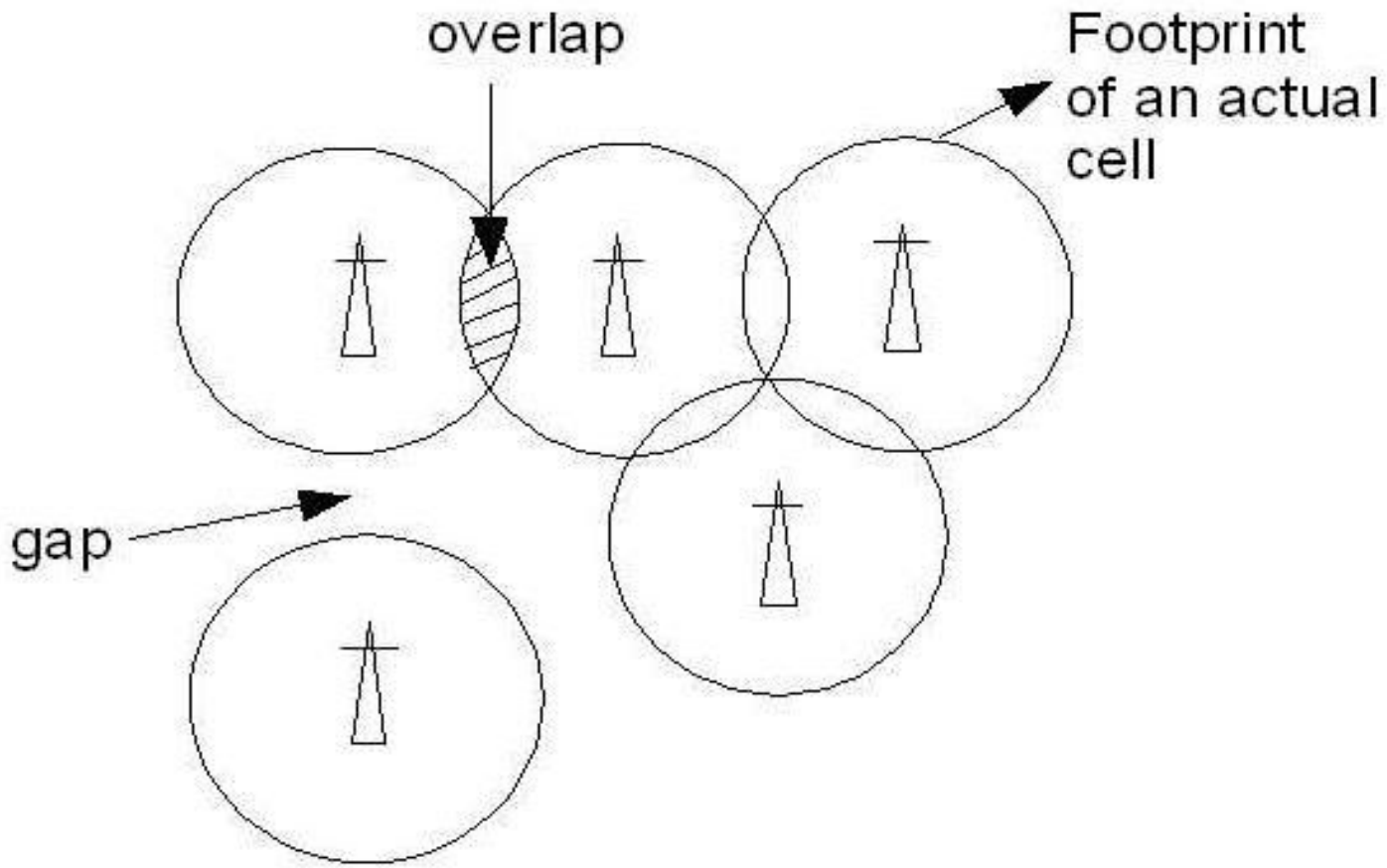
Cell and Cluster:

- Cellular telephone systems must accommodate a large number of users over a large geographic area with limited frequency spectrum.
- If a single transmitter/ receiver is used with only a single base station, then sufficient amount of power may not be present at a huge distance from the BS.
- For a large geographic coverage area, a high powered transmitter therefore has to be used.

Cell and Cluster contd.

- Thus low power transmitters with small coverage areas are used called cells.
- Each cell uses a certain number of the available channels.
- A group of adjacent cells having all the available channels is called a cluster.
- This cluster can repeat itself and hence the same set of channels can be used again and again.
- Each cell has a low power transmitter with a coverage area equal to the area of the cell.

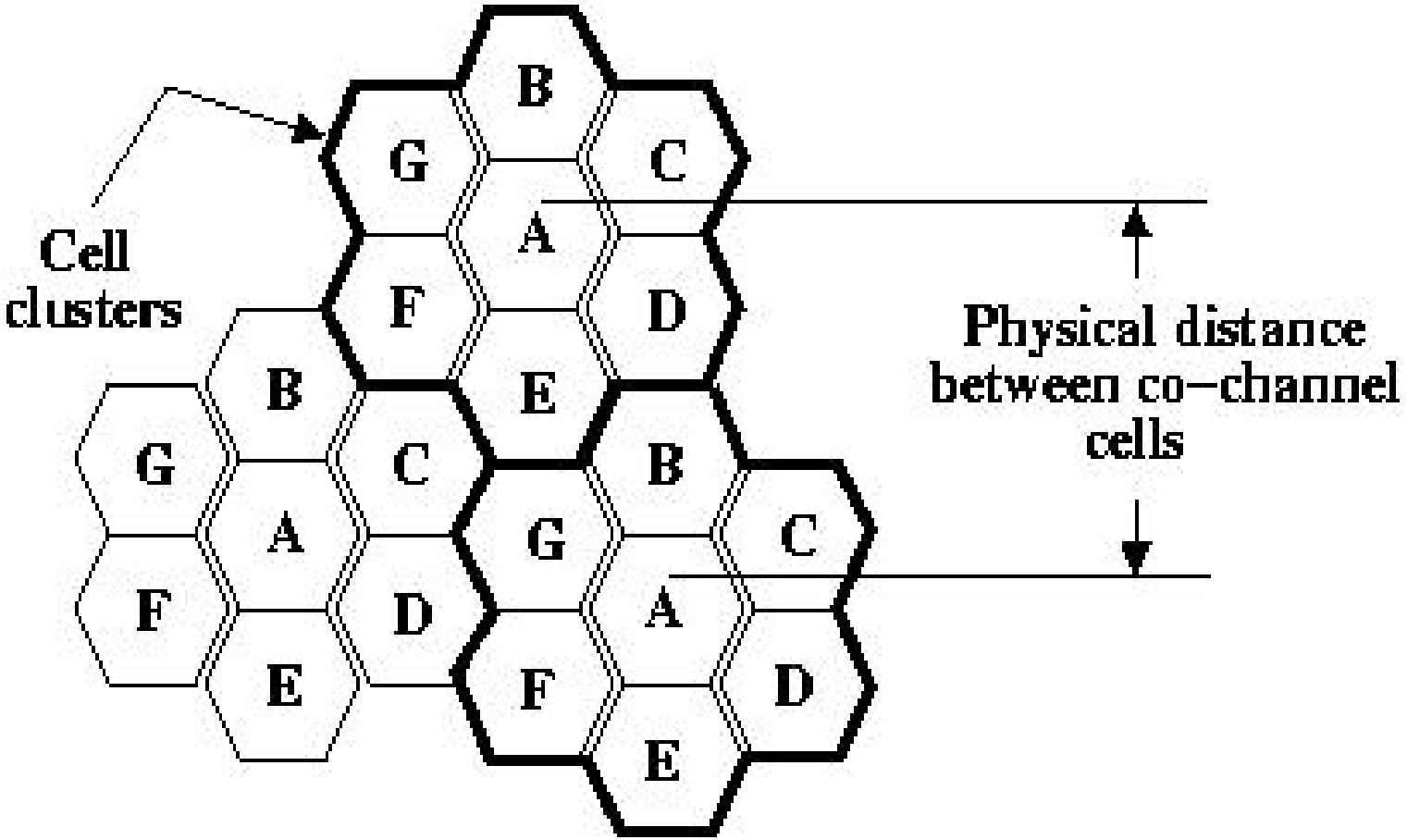
Footprint of cells showing the overlaps and gaps



Frequency Reuse

- Reusing frequencies and channels within a communication system to improve capacity and spectral efficiency.
- Frequencies allocated to the service are reused in a regular pattern of cells, each covered by one base station.
- Since each cell is designed to use radio frequencies only within its boundaries, the same frequencies can be reused in other cells not far away without interference, in another cluster.

Frequency reuse technique of a cellular system



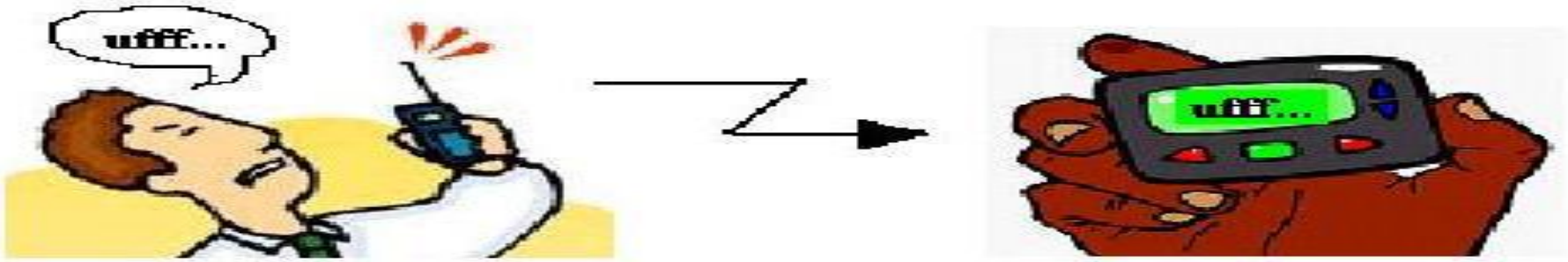
Frequency Reuse (contd.)

- The reuse of frequencies enables a cellular system to handle a huge number of calls with a limited number of channels.

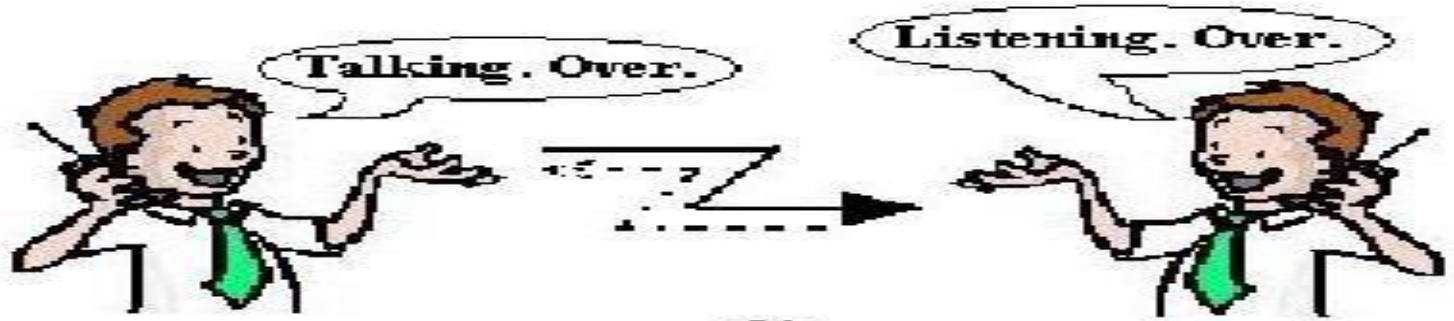
Radio Transmission Techniques

- Simplex System: utilizes simplex channels i.e., the communication is unidirectional.

  e.g. pager
- Half Duplex System: Half duplex radio systems that use half duplex radio channels allow for non-simultaneous bidirectional communication. e.g. walkie-talkie
- Full Duplex System: Full duplex systems allow two way simultaneous communications.

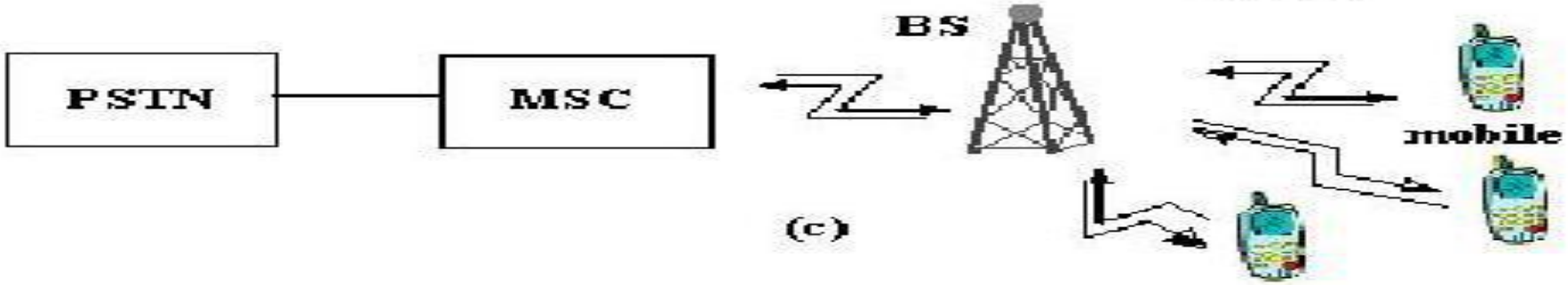

ufff...
ufff...

(a)


Talking. Over.
Listening. Over.

(b)

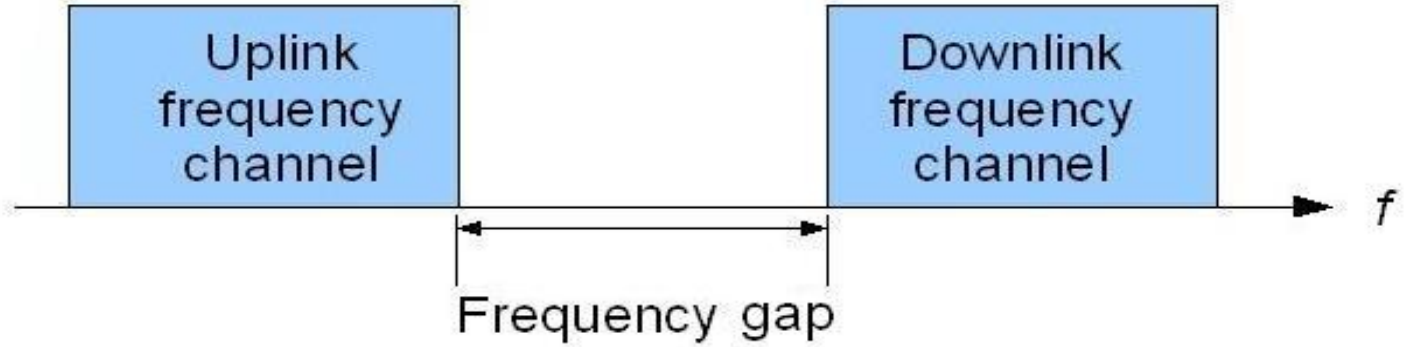

portable
PSTN
BS
cordless
phone


BS
PSTN
MSC
mobile

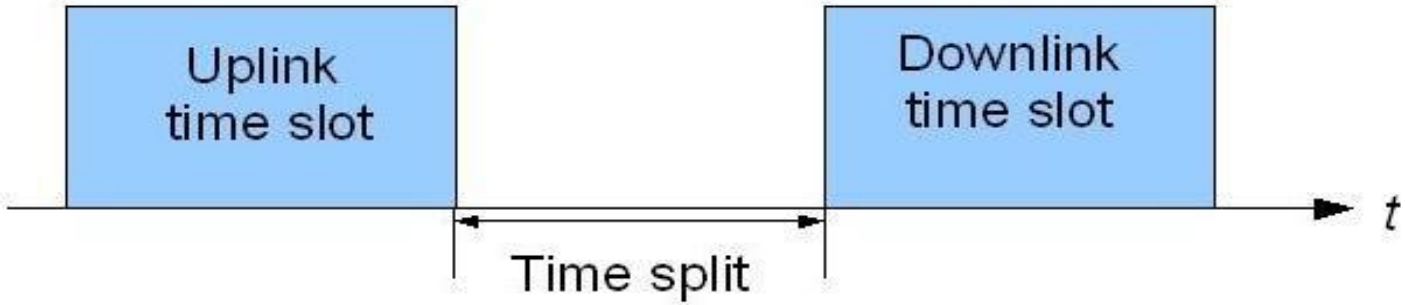
(c)

- Full Duplex System provides two simultaneous but separate channels to both the users by,
- Frequency Division Duplexing (FDD) supports two-way radio communication by using two distinct radio channels.
- TDD uses a single frequency band to transmit signals in both the downstream and upstream directions.

FDD/ TDD



(a) FDD



(b) TDD

- A full duplex mobile system can further be subdivided into two categories
- a single MS for a dedicated BS

  cordless telephone
- many MS for a single BS.

  mobile system

Operational Channels

- Forward Voice Channel (FVC): This channel is used for the voice transmission from the BS to the MS.
- Reverse Voice Channel (RVC): This is used for the voice transmission from the MS to the BS.
- Reverse Control Channel (RCC): Control channels are generally used for controlling the activity of the call. This is used for the call control purpose from the MS to the BS.

Operational Channels (contd.)

- Forward Control Channel (FCC): They are used for setting up calls and to divert the call to unused voice channels. Hence these are also called setup channels. These channels transmit and receive call initiation and service request messages.
- Control channels are usually monitored by mobiles.

Making a Call

- When a mobile is idle then it searches all the FCCs to determine the one with the highest signal strength. It then monitors this particular FCC.
- **Mobile does work in a specific country because for a particular country, the control channels will be the same.**
- Each mobile has a mobile identification number (MIN).

Making a Call (contd.)

- When a user wants to make a call, he sends a call request to the MSC on the reverse control channel.
- He also sends the MIN of the person to whom the call has to be made.
- The MSC then sends this MIN to all the base stations (paging).
- The base station transmits this MIN and all the mobiles within the coverage area of that base station receive the MIN and match it with their own.

Making a Call (contd.)

- If the MIN matches with a particular MS, that mobile sends an acknowledgment to the BS.
- The BS then informs the MSC that the mobile is within its coverage area.
- The MSC then instructs the base station to access specific unused voice channel pair.
- The base station then sends a message to the mobile to move to the particular channels and it also sends a signal to the mobile for ringing.

Making a Call (contd.)

- In order to maintain the quality of the call, the MSC adjusts the transmitted power of the mobile.
- When a mobile moves from the coverage area of one BS to the coverage area of another BS i.e., from one cell to another cell, then the signal strength of the initial BS may not be sufficient to continue the call in progress.
- So the call has to be transferred to the other base station. This is called **handoff**.

Types of Towers

- **Lattice Tower-** also referred to as a self-support tower or SST
- Affords the greatest flexibility
- Often used in heavy loading conditions

Types of Towers contd.

- **Monopole Tower**- a single tube tower.
- Requires one foundation
- Typically don't exceed 200'

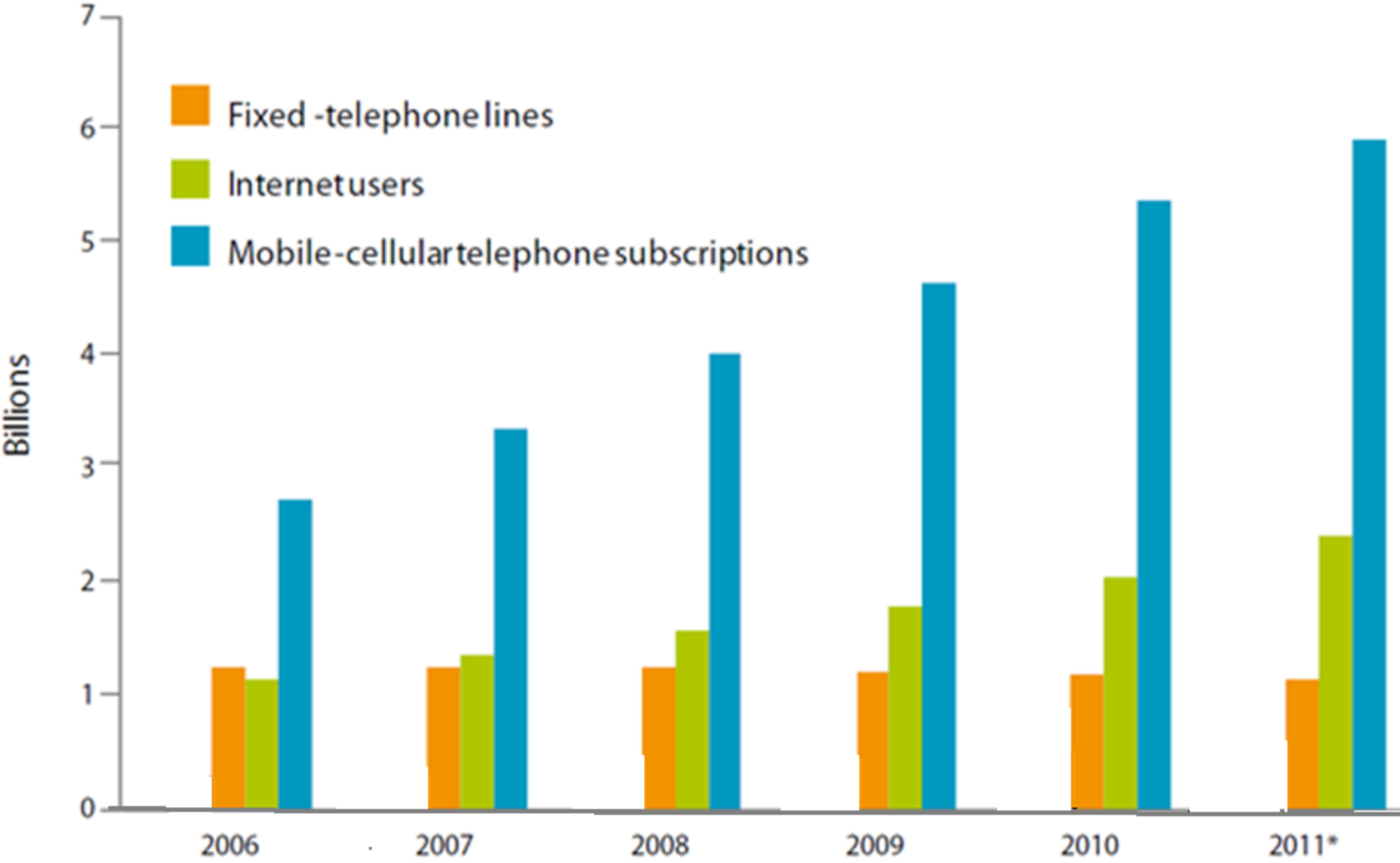
Types of Towers contd.

- **Guyed Tower** – cheapest tower to construct,
- Requires the greatest amount of land.
- Most radio and television towers are guyed towers.
- Supported by guy wires to the ground which anchor the tower.

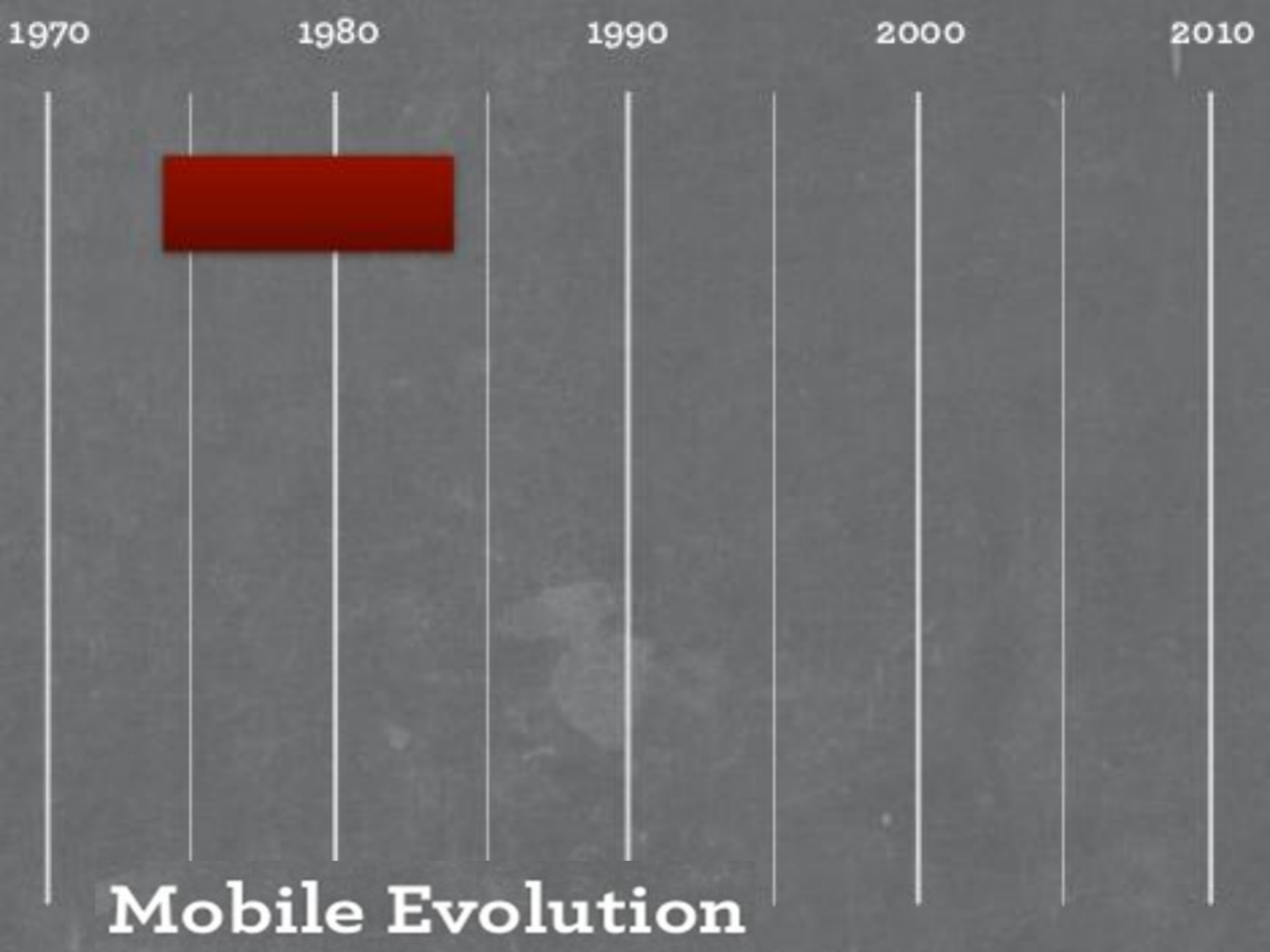
Types of Towers contd.

- **Stealth Tower** – typically required by zoning.
- More expensive
- Require additional material to "Stealth" their appearance
- Don't provide the same amount of capacity for tenants.

- The U.N. telecom agency says there were about 6 billion subscriptions by the end of 2011 – roughly one for 86 of every 100 people.

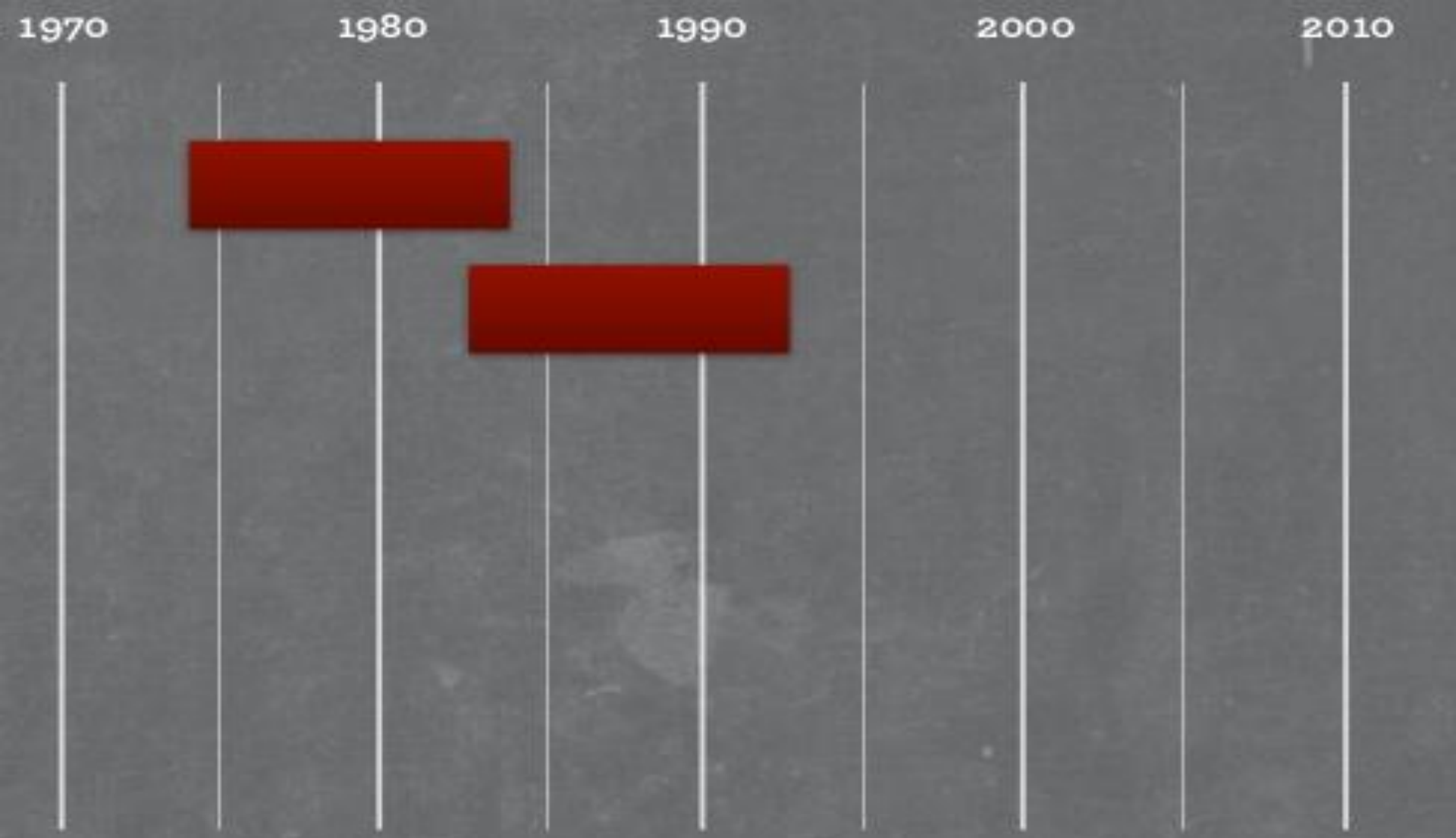


Note: * Estimate
Source: ITU World Telecommunication/ICT Indicators database


1970
1980
1990
2000
2010
Mobile Evolution

1980

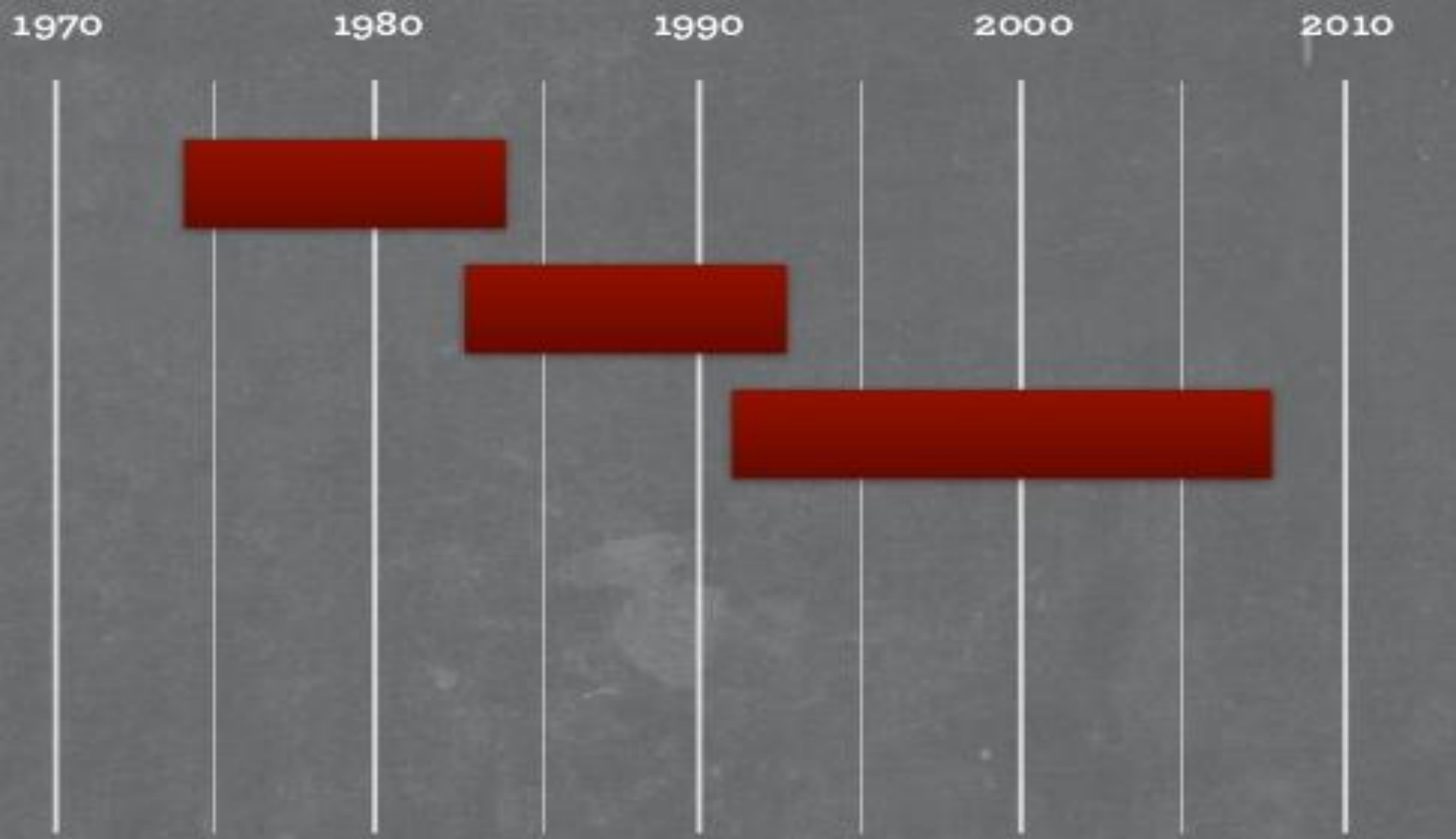
- Fits in a briefcase
- Voice calls only
- Costs more per call



Mobile Evolution

1990

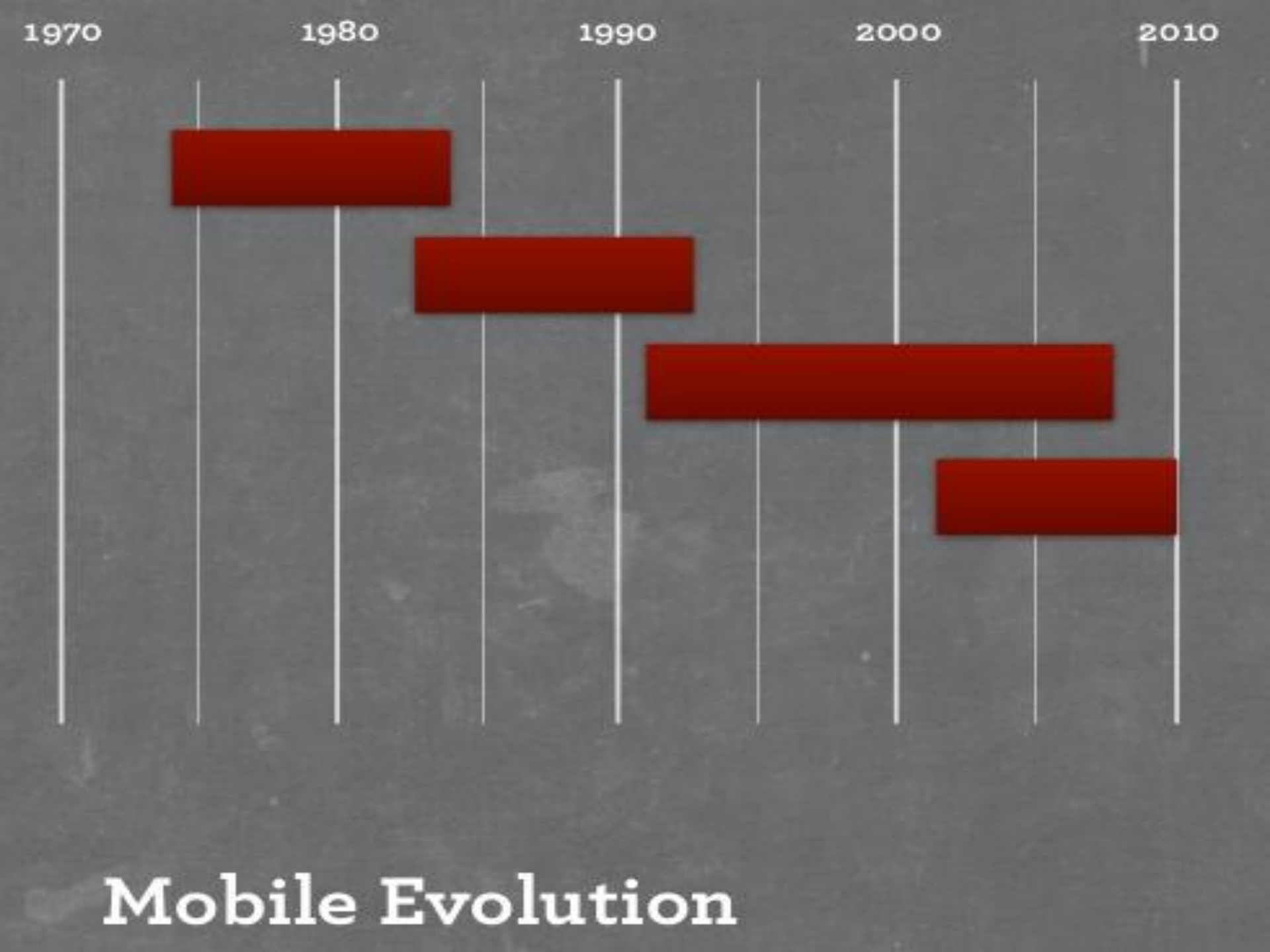
- Less power needed, much smaller
- Better voice quality
- Added SMS
- Still just a phone



Mobile Evolution

2000

- Data capable devices
- Addition of mobile web
- Camera phones and MMS

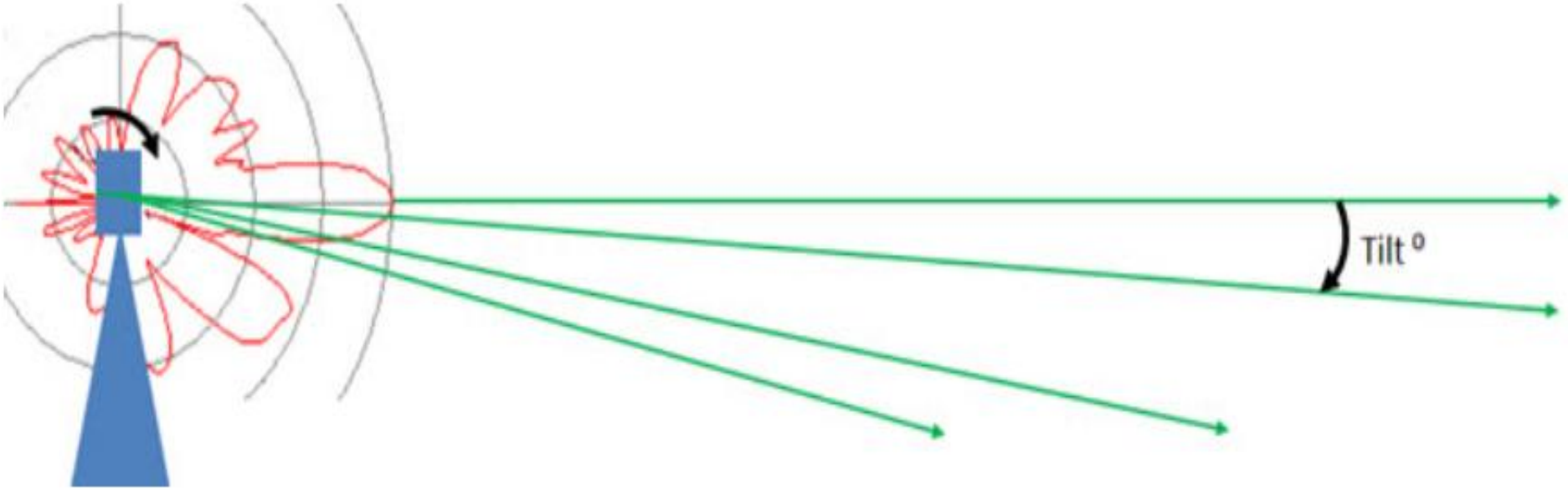

1970
1980
1990
2000
2010
Mobile Evolution

2010

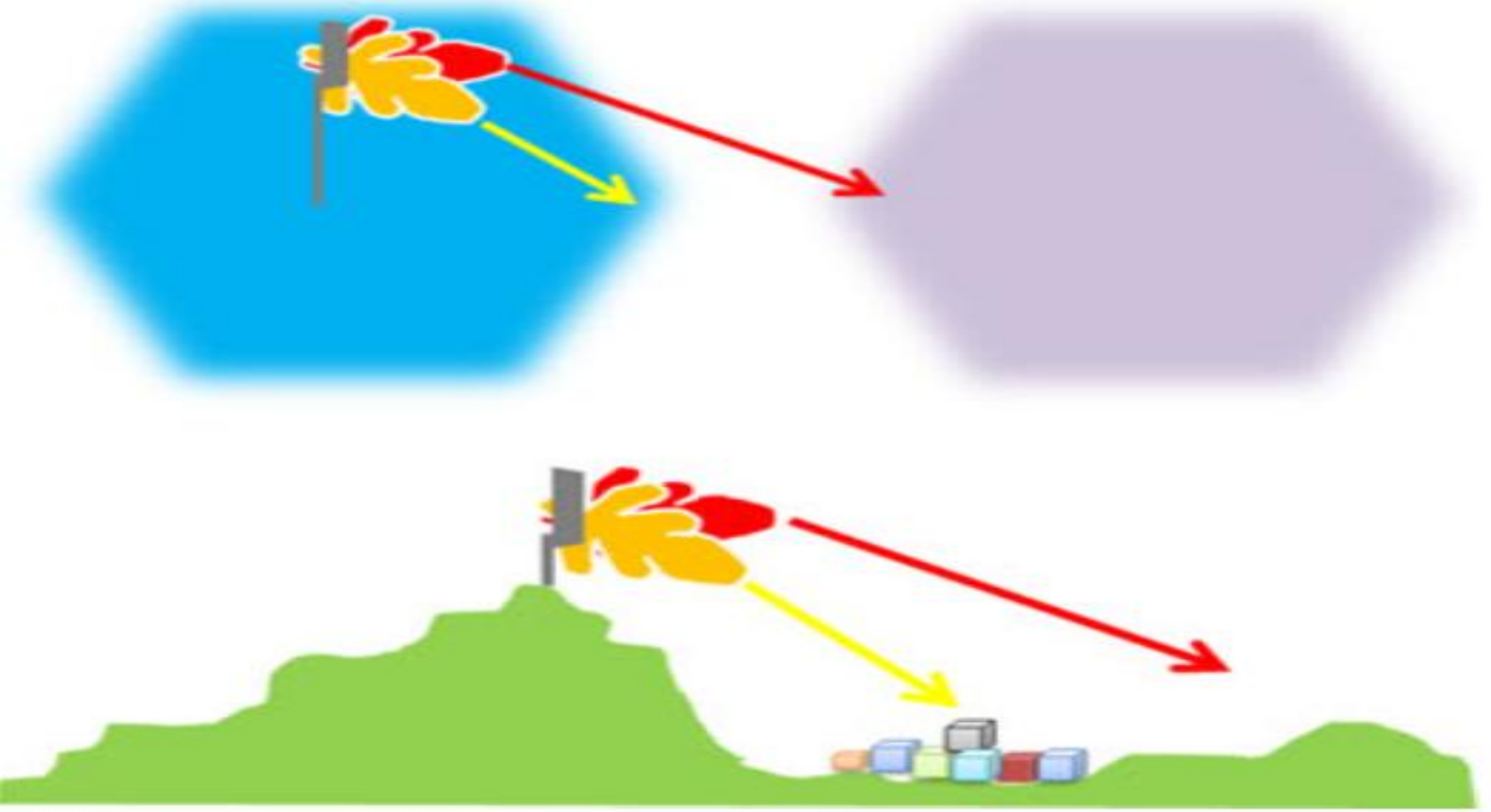
- More smarter
- Wi-Fi
- Rich interfaces

Tilt:

- The tilt represents the inclination or angle of the antenna to its axis.



- To reduce interference and/or coverage in some specific areas, having each cell to meet only its designed area.



QUESTIONS…???