

IDHAYA COLLEGE FOR WOMEN

KUMBAKONAM – 612 001



DEPARTMENT OF PHYSICS

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MOBILE COMMUNICATION

Cellular Communication Network Technologies

- Cellular communication is a form of communication technology that enables the use of mobile phones.
- A mobile phone is a bidirectional radio that enables simultaneous transmission and reception.
- Cellular communication is based on the geographic division of the communication coverage area into cells, and within cells.
- Each cell is allocated a given number of frequencies (or channels) that allow a large number of subscribers to conduct conversations simultaneously.

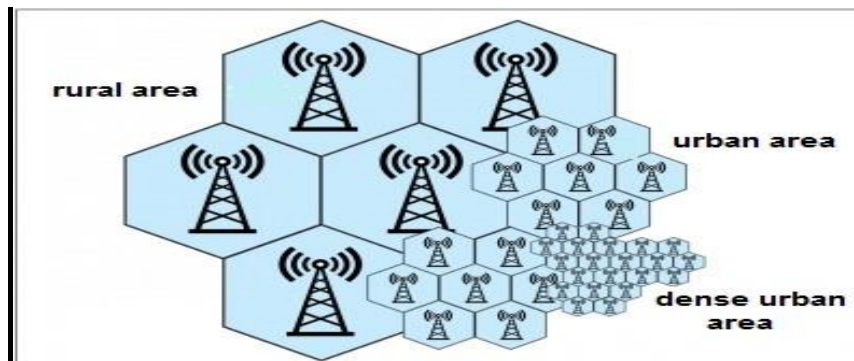


Illustration of communication coverage by spatial division to cells with base stations

- The common element of all generations of cellular communication technologies is the use of defined radiofrequencies (RF), as well as frequency reuse.
- This enables the provision of a service to a large number of subscribers while reducing the number of channels (band width).
- It also enables the creation of wide communication networks by fully integrating the advanced capabilities of the mobile phone.

- The increase in demand and consumption, as well as the development of different types of services, accelerated the rapid technological development of advanced cellular communication networks, together with unceasing improvement of the cellular device.

Most common types of communication technology

- Global Systems for Mobile (GSM) Communications
- Code Division Multiple Access (CDMA)
- Universal Mobile Telecommunication System (UMTS)
- Long Term Evolution (LTE) using the Orthogonal Frequency Division Multiplexing (OFDM) method
- Adaptive communication

Global System for Mobile (GSM) Communication

- ✓ GSM communication technology is based on the GSM standard – the first to use the cellular protocol that replaced the earlier first-generation communication standard.
- ✓ This standard was developed by the European Communications Standards Institute (ETSI), starting from 1982, for the second generation (2G) of digital cellular communication.
- ✓ This standard, defined as digital, was based on optimal switching of a communication network to full duplex speaking telephony, and was subsequently expanded to include data packet transfer communication.
- ✓ In fact, GSM technology replaced the restrictive communication, and was a technological turning point, which was followed by the development of innovative cellular communication technologies. The second generation of GSM thus constituted the foundation for subsequent generations of cellular communication.
- ✓ In Israel a GSM cellular system was set up in 1999 by "Partner", operating under the trade name of "Orange". In 2001 "Cell" joined the providers of GSM in Israel, after installing a GSM network parallel to the time division multiple access (TDMA) network it operated previously. In 2009 "telephone" also began using GSM technology.

Code Division Multiple Access (CDMA) technology

- This method separates different conversations by coding rather than by time sharing (as in the EDMA/GSM technologies) or by frequency sharing (FDMA) as with the NAMPS technology.
- The method of separation by coding enables conducting a large number of conversations simultaneously over the same range of frequencies, with no interference between them.
- "Qualcomm", which developed this technology, applied it to cellular communications that use coded speech at different rhythms – a technology whereby the cellular device receives simultaneous information from a number of base stations.
- This technology ensures the continuity of conversations during movement from one cell to another.

Universal Mobile Telecommunication Systems (UMTS) technology

- ❖ UTMIS technology, based on Wideband Code Division Multiple Access (W-CDMA) technology, is one of the third-generation (3G) technologies of mobile phone telephony.
- ❖ This technology was designed by the Third Generation Partnership Project (3GPP), a collaboration between groups of telecommunications associations to create a globally applicable third-generation mobile phone system, and represents the European-Japanese counterpart to the International Mobile Telecommunications for the year 2000 (IMT-2000) International Telecommunications Union (ITU) specifications for cellular communication systems.
- ❖ In order to differentiate between UMTS and other communication network technologies, it is sometimes marketed under the label GSM3 – a name that emphasizes its place in the third generation, and the fact that it replaced the GSM in the second generation system.

Long Term Evolution (LTE) technology, operating according to the method of Orthogonal Frequency Division Multiplexing (OFDM)

- LTE is not only an additional generation in the evolution of cellular technology, but rather one that is being developed while considering the future requirements of wireless data communication and the scientific and technological developments in this field.
- This is due to its ability to transmit data at a rate of hundreds of megabytes per second, up to a gigabyte per second, at low cost.
- The rise of LTE today and in the near future may resemble the revolution caused by the introduction of mobile phone technology in the 1980s, and even the appearance of Wi-Fi.
- The move from analogue to digital communication with the appearance of 2G devices caused a tremendous revolution.
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- LTE technology operates through the method of orthogonal frequency division multiplexing (OFDM) which is the main characteristic of fourth-generation (4G) technology.
- Unlike the modulation methods of second-generation technology such as time division multiplexing (TDM), and unlike the use of code division multiplexing (CDM)
- Third-generation GSM, the OFDM method provides optimal solutions for the common problems encountered in wireless communication arising from multiple reflections and dispersions of radio waves in a channel, and movement of the transmitter or receiver.
- In Israel this technology is being introduced gradually because it requires redeployment of the cellular networks.

Adaptive communication

- An innovative feature of CDMA technology and other new communication technologies is the close monitoring of power which enables adaptive communication.

- This feature allows the cellular device to vary its power dynamically at any given time.
- This means that a cellular communication network using this technology and others may conduct dynamic communications adapted to the conditions of reception and the quality of communication.
- In other words, the device's power changes in response to factors such as distance, angle of direction or presence or absence of obstructions, thus enabling efficient communication while restricting the power optimally and decreasing the level of radiation exposure.

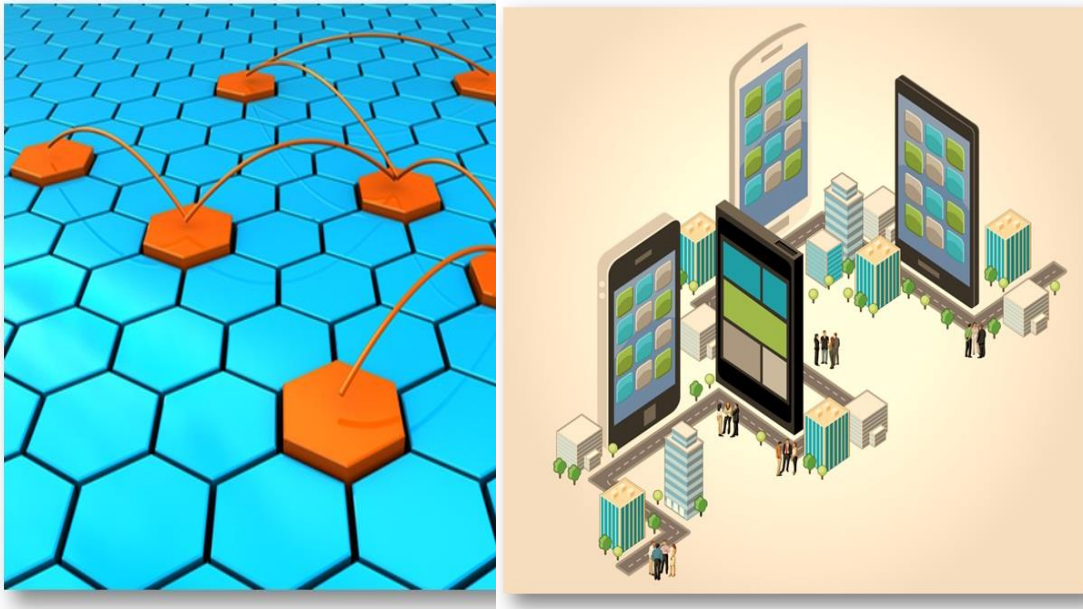


Illustration of Cellular communication

- A mobile phone is an electronic device used for mobile telecommunications over a cellular network of specialized base stations known as cell sites.
- A cell phone offers full Duplex Communication and transfer the link when the user moves from one cell to another.
- The phone user moves from one cell area to another, the system automatically commands the mobile phone and a cell site with a stronger signal, to switch on to a new frequency in order to keep the link.

Signal Frequency in Cell Phone

- ❖ The cellular system is the division of an area into small cells.
- ❖ This allows extensive frequency reuse across that area, so that many people can use cell phones simultaneously.
- ❖ Cellular networks has a number of advantages like increased capacity, reduced power usage, larger coverage area, reduced interference from other signals etc.

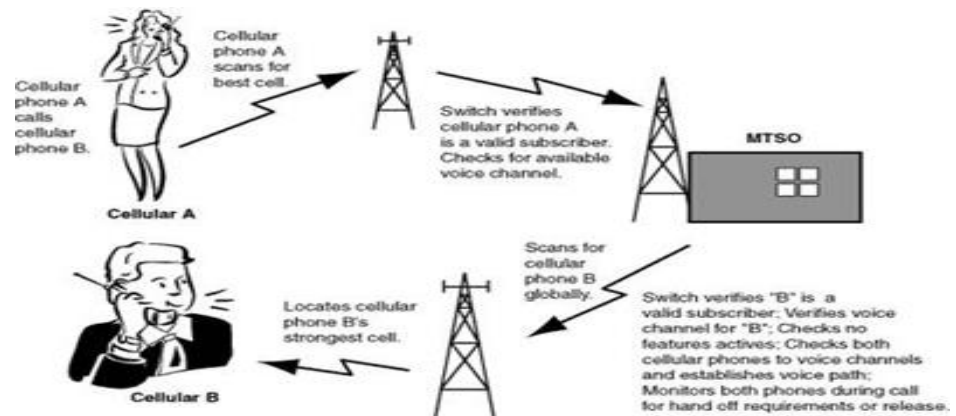
FDMA and CDMA Systems

- ❖ Frequency Division Multiple Access (FDMA) and Code Division Multiple Access (CDMA) were developed to distinguish signals from several different transmitters.
- ❖ In FDMA, the transmitting and receiving frequencies used in each cell are different from the frequencies used in the neighboring cells.
- ❖ The principle of CDMA is more complex and the distributed transceivers can select one cell and listen to it.
- ❖ Other methods include Polarization Division Multiple Access (PDMA) and Time Division Multiple Access (TDMA).
- ❖ Time division multiple access is used in combination with either FDMA or CDMA to give multiple channels within the coverage area of a single cell.

Codes in the Mobile Phone

- Mobile phones have special codes associated with them. These include:
- Electronic Serial Number (ESN) -Unique 32-bit number programmed in the phone
- Mobile Identification Number (MIN) – 10 digit number derived from the phone's number.
- System Identification Code (SID) – unique 5 digit number that is assigned to each carrier by the FCC.

Mobile Network



The GSM System

- ❖ Global System for Mobile Communications is the standard for mobile telephone systems in the world. In GSM, the signalling and speech channels are digital, therefore GSM is considered a 2G (Second Generation) system.
- ❖ This helps wide-spread implementation of data communication applications. There are five different cell sizes in a GSM network These are macro, micro, pico, femto and umbrella cells.
- ❖ Macro cells are cells where the base station antenna is installed on a mast above average roof top level. Micro cells are cells whose antenna height is under average roof top level.
- ❖ Pico cells are small cells whose coverage diameter is a few dozen metres. These are mainly used in indoors applications.
- ❖ Femto cells are cells designed for use in residential or small business environments and connect to the service provider's network via a broadband internet connection.
- ❖ Umbrella cells are used to cover shadowed regions of smaller cells and fill in gaps in coverage between those cells.
- ❖ Horizontal radius of the cell varies depending on the antenna height, antenna gain and propagation conditions.
- ❖ Maximum distance the GSM supports is 35 kilometers. Most 2G GSM networks operate in the 900 MHz or 1800 MHz bands while 3G GSM in the 2100 MHz frequency band.

Time Sharing

- ✓ Time Division Multiplexing technique is used to share eight full-rate or sixteen half-rate speech channels per radio frequency channel.
- ✓ There are eight radio time slots grouped into a TDMA frame.

Mobile Network

- ❖ Mobile phone converts voice, text, multi-media messages or data calls into Radio Frequencies (RF).
- ❖ Mobile phone base stations transmit and receive these RF signals and connect callers to other phones and other networks.
- ❖ Mobile phone network is divided into thousands of overlapping, individual geographic areas or 'cells', each with a base station.
- ❖ The size of a cell depends on the area of coverage and the number of calls that are made in that area.
- ❖ The smallest cells are in crowded urban areas with large buildings and heavy population density, while the biggest cells are in rural areas, where people are dispersed.
- ❖ There are two types of channels used in GSM . These are Control channels and Traffic channels.

Control channels

- ❖ The mobile when a call is coming in and which frequency to use.
- ❖ To ensure this handover works, the phone constantly monitors the broadcast control channel of up to 16 neighboring cells.
- ❖ In normal operation, phones continually adjust the power of the radio waves they send out to be the minimum needed for the base station to receive a clear signal.
- ❖ If a phone moves far away from its base station and if the signal is weak, the network consults the list and triggers a handover to a neighbouring cell with best signal.

Traffic channels

- ❖ It is used to carry calls or other data from the mobile phone to the base station and vice versa.
- ❖ In the Traffic channel, voice or text data is carried in bursts.

- ❖ Each burst comprises two consecutive strings of bits (a series of signals representing 1s and 0s), each 57 bits long.

Range

- ❖ The range within which mobile devices can connect is not a fixed figure.
- ❖ It depends on a number of factors like the frequency of signal in use, the transmitter's rated power, the transmitter's size etc.

3G-NETWORK:

- ❖ The 3G is kind of like "Wi-Fi everywhere," meaning it provides Internet access via the same radio towers that provide voice service to your mobile phone.
- ❖ The (FYI, 4G is the same thing, just faster.) Ah, but not all devices are equipped to access 3G service. The Kindle Fire and Nook Color, for example, are Wi-Fi-only

MODEM:

- ❖ A modem – a portmanteau of "modulator-demodulator" – is a hardware device that converts data into a format suitable for a transmission medium.
- ❖ A modem modulates one or more carrier wave signals to encode digital information for transmission and demodulates signals to decode the transmitted information.
- ❖ The goal is to produce a signal that can be transmitted easily and decoded reliably to reproduce the original digital data.
- ❖ Modems can be used with almost any means of transmitting analog signals from light-emitting diodes to radio.
- ❖ A common type of modem is one that turns the digital data of a computer into modulated electrical signal for transmission over telephone lines and demodulated by another modem at the receiver side to recover the digital data.
- ❖ Modems are generally classified by the maximum amount of data they can send in a given unit of time, usually expressed in bits per second (symbol bit/s, sometimes abbreviated "bps") or rarely in bytes per second (symbol B/s).
- ❖ Modems can also be classified by their symbol rate, measured in baud.

- ❖ The baud unit denotes symbols per second, or the number of times per second the modem sends a new signal.
 - For example, the ITU V.21 standard used audio frequency-shift keying with two possible frequencies, corresponding to two distinct symbols (or one bit per symbol), to carry 300 bits per second using 300 baud. By contrast, the original ITU V.22 standard, which could transmit and receive four distinct symbols (two bits per symbol), transmitted 1,200 bits by sending 600 symbols per second (600 baud) using phase-shift keying.

Fax:

- ❖ Fax (short for facsimile), sometimes called telecopying or telefax (the latter short for telefacsimile), is the telephonic transmission of scanned printed material (both text and images),
 - ❖ Normally to a telephone number connected to a printer or other output device.
 - ❖ The original document is scanned with a fax machine (or a telecopier), which processes the contents (text or images) as a single fixed graphic image, converting it into a bitmap, and then transmitting it through the telephone system in the form of audio-frequency tones.
 - ❖ The receiving fax machine interprets the tones and reconstructs the image, printing a paper copy.
- ✓ Group 1 faxes conform to the ITU-T Recommendation T.2. Group 1 faxes take six minutes to transmit a single page, with a vertical resolution of 96 scan lines per inch. Group 1 fax machines are obsolete and no longer manufactured.
- ✓ Group 2 faxes conform to the ITU-T Recommendations T.3 and T.30. Group 2 faxes take three minutes to transmit a single page, with longer manufactured. Group 2 fax machines can interoperate with Group 3 fax machines.

Very small aperture terminal (VSAT)

- ❖ A very small aperture terminal (VSAT) is a two-way ground station that transmits and receives data from satellites.
- ❖ A VSAT is less than three meters tall and is capable of both narrow and broadband data to satellites in orbit in real-time.
- ❖ The data can then be redirected to other remote terminals or hubs around the planet.
- ❖ The (VSAT) is a two-way satellite ground station with a dish antenna that is smaller than 3.8 meters.
- ❖ The majority of VSAT antennas range from 75 cm to 1.2 m. Data rates, in most cases, range from 4 kbit/s up to 16 Mbit/s.
- ❖ VSATs access satellites in geosynchronous orbit or geostationary orbit to relay data from small remote Earth stations (terminals) to other terminals (in mesh topology) or master Earth station "hubs" (in star topology).
- ❖ VSATs are used to transmit narrowband data (e.g., point-of-sale transactions using credit cards, polling or RFID data, or SCADA), or broadband data (for the provision of satellite Internet access to remote locations, VoIP or video).
- ❖ VSATs are also used for transportable, on-the-move (utilizing phased array antennas) or mobile maritime communications

KEY TAKEAWAYS

- Very small aperture terminal (VSAT) is a data transmission technology used for many types of data management and in high-frequency trading.
- VSAT can be used in place of a large physical network as it bounces the signal from satellites instead of being transported through physical means like an ethernet connection.
- Because the signal needs to bounce, there can be a latency issue that wouldn't exist with a physical network. However, most users feel this is the price you pay for remote access and less infrastructure, and consider it a fair trade.
- Weather can adversely impact the efficacy of a VSAT network.

Advantages

- ❖ VSAT networks have a big advantage when it comes to deployment.
- ❖ The ground station is communicating with satellites, there is less infrastructure required to service remote locations.
- ❖ This was one of the reasons Walmart chose VSAT as it started out heavily leveraged to rural America where telecommunications infrastructure was less dense than in the cities.
- ❖ This has made VSAT networks an ideal choice for providing connectivity to remote work sites like exploratory drilling sites that need to relay daily drill logs back to headquarters.
- ❖ VSAT is also independent of local telecommunications networks, making it an ideal system to back up wired systems and reduce business recovery risk.
- ❖ If the wired network goes down, a business can still go on using the VSAT network.

Disadvantages

- However, VSAT does have limitations.
 - ❖ The most obvious is latency, as it takes time for information to reach the dish and the station due to one part of the system being way up in Geosynchronous orbit above the earth.
 - ❖ Protocols that require a lot of back and forth communication rather than one-way data transfer experience lag.
 - ❖ The signal quality can also be affected by the weather and other buildings getting in the way.

IPTV

- ❖ IPTV is a system used to deliver digital television services to the consumers who are registered subscribers for this system.
- ❖ This delivery of digital television is made possible by using Internet Protocol over a broadband connection, usually in a managed network rather than the public Internet to preserve quality of service guarantees.
- ❖ Often, this service is provided together with Video facility on demand.
- ❖ In addition to this, there is provision to include Internet services such as web

- ❖ Access and Voice over Internet Protocol (VoIP). In cases when internet service is also provided, it may be called Triple Play.

Mobile Communication Protocols

- ❖ Any device that does not need to remain at one place to carry out its functions is a mobile device.
- ❖ Laptops, smart phones and personal digital assistants are some examples of mobile devices.
- ❖ Due to their portable nature, mobile devices connect to networks wirelessly.
- ❖ Mobile devices typically use radio waves to communicate with other devices and networks. Here we will discuss the protocols used to carry out mobile communication.
- ❖ Mobile communication protocols use multiplexing to send information.
- ❖ Multiplexing is a method to combine multiple digital or analog signals into one signal over the data channel.
- ❖ This ensures optimum utilization of expensive resource and time. At the destination these signals are de-multiplexed to recover individual signal.
- ❖ These are the types of multiplexing options available to communication channels –
- ❖ FDM (Frequency Division Multiplexing) – Here each user is assigned a different frequency from the complete spectrum. All the frequencies can then simultaneously travel on the data channel.
- ❖ TDM (Time Division Multiplexing) – A single radio frequency is divided into multiple slots and each slot is assigned to a different user. So multiple users can be supported simultaneously.
- ❖ CDMA (Code Division Multiplexing) – Here several users share the same frequency spectrum simultaneously. They are differentiated by assigning unique codes to them. The receiver has the unique key to identify the individual calls

Radio paging system

- The radio paging service has been defined as, Radio paging system is a non-speech, one-way personal selective calling system with alert, and also with defined message such as numeric and alphanumeric messages

Importance of radio paging

- ✓ Allocating memory is easy and cheap.
- ✓ Any free page is ok, OS can take first one out of list it keeps.
- ✓ Eliminates external fragmentation.
- ✓ Data (page frames) can be scattered all over PM.
- ✓ Pages are mapped appropriately anyway.
- ✓ Allows demand paging and prepaging.
- ✓ More efficient swapping

Video on demand (VOD)

- ❖ Video on demand (VOD) is a video media distribution system that allows users to access video entertainment without a traditional video entertainment device and without the constraints of a typical static broadcasting schedule.
- ❖ In the 20th century, broadcasting in the form of over-the-air programming was the commonest form of media distribution.
- ❖ As Internet and IPTV technologies continued to develop in the 1990s, consumers began to gravitate towards non-traditional modes of content consumption, which culminated in the arrival of VOD on televisions and personal computers.
- ❖ Television VOD systems can stream content, either through a traditional set-top box or through remote devices such as computers, tablets, and smart phones.
- ❖ VOD users can permanently download content to a device such as a computer, digital video recorder or a portable media player for continued viewing.
- ❖ The majority of cable and telephone company-based television providers offer VOD streaming, whereby a user selects a video program that begins to play immediately or downloading to a digital video recorder (DVR) rented or purchased from the provider, or to a PC or to a portable device for delayed viewing

Wi-Fi

- ❖ Wi-Fi is the name of a wireless networking technology that uses radio waves to provide wireless high-speed Internet and network connections.
- ❖ A common misconception is that the term Wi-Fi is short for "wireless fidelity," however this is not the case.
- ❖ Wi-Fi is simply a trademarked phrase that means IEEE 802.11x.