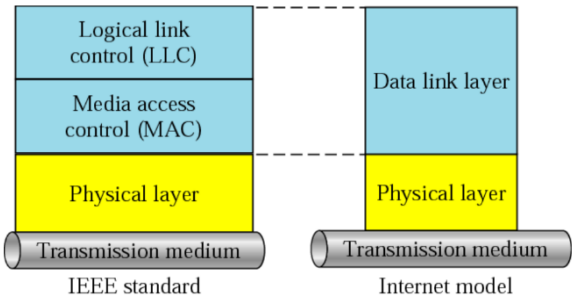
UNIT 2: MAC – Motivation, SDMA, FDMA, TDMA, CDMA, Telecommunication Systems, GSM: Architecture Location tracking and call setup, Mobility management, Handover, Security, GSM, SMS, International roaming for GSM, call recording functions, subscriber and service data management, DECT, TETRA, UMTS, IMT-2000.

MEDIUM ACCESS CONTROL(MAC):

INTRODUCTION TO MAC: Medium Access Control, is a sublayer of the Data Link Layer specified in the seven-layer OSI model (layer 2). The hardware that implements the MAC is referred to as a Medium Access Controller. The MAC sub-layer acts as an interface between the Logical Link Control (LLC) sublayer and the network's physical layer. The MAC layer emulates a full-duplex logical communication channel in a multi-point network. This channel may provide unicast, multicast or broadcast communication service.



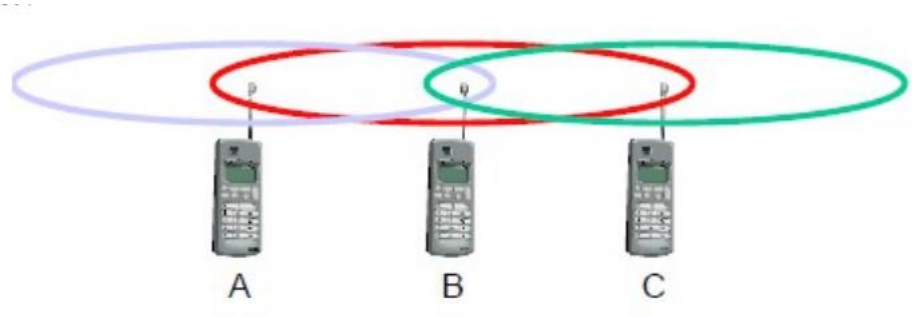
MOTIVATION:

One of the most commonly used MAC schemes for wired networks is carrier sense multiple access with collision detection (CSMA/CD). In this scheme, a sender senses the medium (a wire or coaxial cable) to see if it is free. If the medium is busy, the sender waits until it is free. If the medium is free, the sender starts transmitting data and continues to listen into the medium. If the sender detects a collision while sending, it stops at once and sends a jamming signal. But this scheme doesn't work well with wireless networks. The problems are:

- Signal strength decreases proportional to the square of the distance
- The sender would apply CS and CD, but the collisions happen at the receiver
- It might be a case that a sender cannot "hear" the collision, i.e., CD does not work 1
- Furthermore, CS might not work, if for e.g., a terminal is "hidden"

HIDDEN AND EXPOSED TERMINALS:

Consider the scenario with three mobile phones as shown below. The transmission range of A reaches B, but not C (the detection range does not reach C either). The transmission range of C reaches B, but not A. Finally, the transmission range of B reaches A and C, i.e., A cannot detect C and vice versa.



Hidden terminals:

- A sends to B, C cannot hear A
- C wants to send to B, C senses a "free" medium (CS fails) and starts transmitting
- Collision at B occurs, A cannot detect this collision (CD fails) and continues with its transmission to B
- A is "hidden" from C and vice versa

Exposed terminals:

- B sends to A, C wants to send to another terminal (not A or B) outside the range
- C senses the carrier and detects that the carrier is busy.
- C postpones its transmission until it detects the medium as being idle again
- but A is outside radio range of C, waiting is not necessary
- C is "exposed" to B

Hidden terminals cause collisions, whereas Exposed terminals causes unnecessary delay.

NEAR AND FAR TERMINALS:

Consider the situation shown below. A and B are both sending with the same transmission power.

- Signal strength decreases proportional to the square of the distance
- So, B's signal drowns out A's signal making C unable to receive A's transmission
- If C is an arbiter for sending rights, B drown out A's signal on the physical layer making C unable to hear out A.

The near/far effect is a severe problem of wireless networks using CDM. All signals should arrive at the receiver with more or less the same strength for which Precise power control is to be implemented.

SPACE DIVISION MULTIPLE ACCESS (SDMA):

Space division multiple access (SDMA) is a wireless communication technique that allows multiple users to share the same frequency band by using the spatial dimension. SDMA enables multiple antennas at the transmitter and/or receiver to create multiple beams that can be directed towards different users, effectively separating them spatially.

SDMA is mainly based on the MIMO (MULTIPLE-IN and MULTIPLE-OUT) architecture and used mainly on satellite and wireless communications.

FEATURES OF SDMA:

- All users can communicate at the same time using the same channel.
- SDMA is completely free from interference.
- A single satellite can communicate with more satellite's receivers of the same frequency.
- The directional spot-beam antennas are used and hence the base station in SDMA, can track a moving user.
- Controls the radiated energy for each user in space.

Advantages:

- Increases capacity and spectral efficiency
- Supports high data rates
- Improves coverage

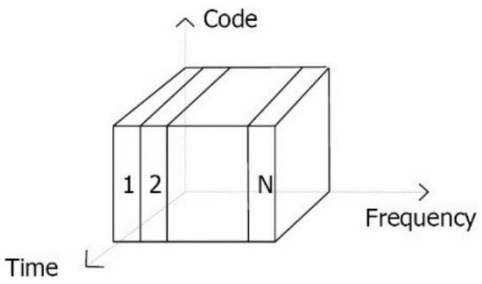
Disadvantages:

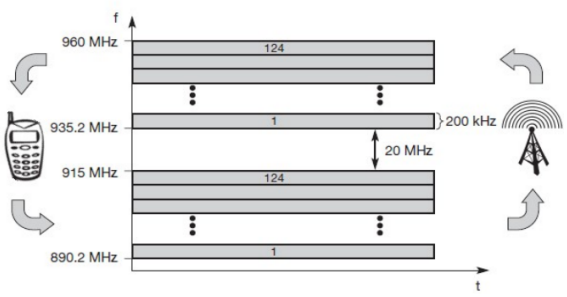
- Complex and costly to implement
- Performance can be impacted by interference, channel conditions, user mobility, and spectrum constraints
- Requires careful channel estimation and spatial filtering
- Requires sufficient radio spectrum resources.

FREQUENCY DIVISION MULTIPLE ACCESS (FDMA):

Frequency division multiple access (FDMA) is a wireless communication technique used to allow multiple users to share the same communication channel by dividing the available frequency spectrum into multiple non-overlapping frequency bands, each assigned to a different user.

In an FDMA system, each user is allocated a unique frequency band or channel, which is used to transmit and receive data.





FDM for multiple access and duplex

For Eliminating interferences, a guard band is used in between frequencies.

FEATURES OF FDMA:

- If FDMA is not in use, the channel is left idle instead of allotting to the other users.
- Tight filtering is done here to reduce adjacent channel interference.
- The base station BS and mobile station MS, transmit and receive simultaneously and continuously in FDMA.

Advantages:

- FDMA is simple to implement and requires less complex signal processing than other multiple access techniques.
- FDMA is well-suited for applications with low to moderate data rates and can support a large number of users.
- FDMA can be used in conjunction with other multiple access techniques, such as TDMA and CDMA, to further increase system capacity.

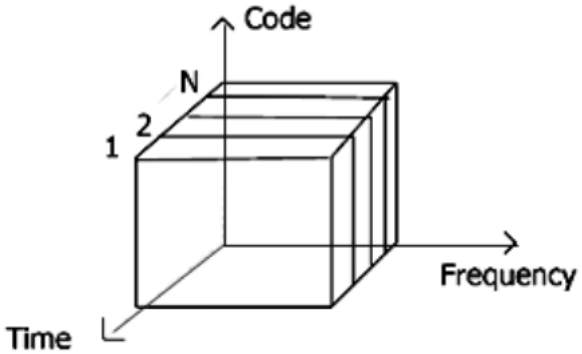
Disadvantages:

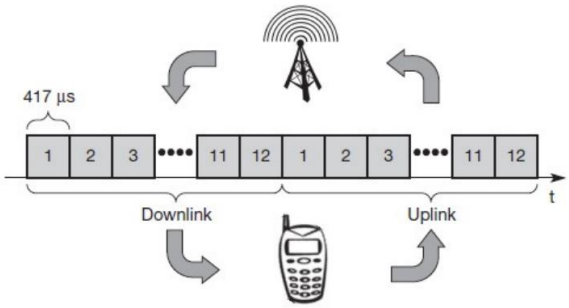
- FDMA is less efficient than other multiple access techniques, such as TDMA and CDMA, in terms of spectrum utilization.
- FDMA is vulnerable to interference and can experience capacity limitations in dense user environments.
- FDMA requires guard bands between frequency channels to prevent adjacent channel interference, which reduces the available bandwidth.
- FDMA is not well-suited for high-speed data applications, as it can be difficult to allocate sufficient bandwidth for each user.

TIME DIVISION MULTIPLE ACCESS (TDMA):

Time division multiple access (TDMA) is a wireless communication technique used to allow multiple users to share the same communication channel by dividing the available time into multiple time slots, with each time slot assigned to a different user.

In a TDMA system, each user is allocated a unique time slot in which they can transmit and receive data.





FEATURES OF TDMA:

- TDMA requires precise time synchronization among users.
- TDMA is used in various wireless communication systems and is more efficient than FDMA.
- TDMA is less vulnerable to channel impairments and uses digital modulation techniques.

ADVANTAGES:

- TDMA is well-suited for applications with moderate to high data rates and can support a large number of users.
- TDMA is less vulnerable to interference than FDMA, as users are assigned unique time slots to transmit and receive data.
- TDMA requires less complex signal processing and synchronization than CDMA.

Disadvantages:

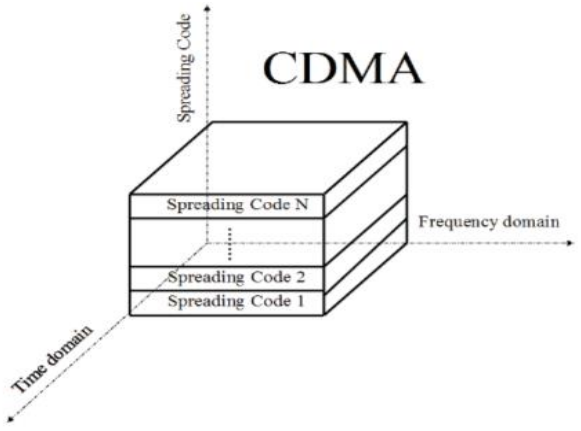
- TDMA requires precise time synchronization among users, which can be challenging to maintain in practical wireless environments.
- TDMA can experience capacity limitations in dense user environments or with high-speed data applications.
- TDMA requires guard times between time slots to prevent overlapping, which reduces the available bandwidth.
- TDMA can be affected by channel fading and multipath propagation, which can degrade system performance.

CODE DIVISION MULTIPLE ACCESS (CDMA):

Code Division Multiple Access (CDMA) is a wireless communication technology that allows multiple users to share the same frequency band by assigning unique codes to each user.

The coded signals are then transmitted simultaneously, and the receiver uses the same code to extract the intended signal and reject others, thus providing multiple access without interference.

CDMA is used in various wireless communication systems, including cellular networks, satellite communication, and wireless local area networks (WLANs).



Advantages:

- CDMA provides efficient spectrum utilization and can support a large number of users.
- CDMA is less vulnerable to interference and fading than FDMA and TDMA, as coded signals can coexist without affecting each other.

- CDMA supports soft handoffs between cell sites, providing seamless coverage and reducing dropped calls.
- CDMA can provide secure communication by using encryption algorithms to scramble signals.

Disadvantages:

- CDMA requires sophisticated signal processing and synchronization, making it more complex and costly to implement than other multiple access techniques.
- CDMA performance can be impacted by near-far problem, where the receiver may be overwhelmed by the signal from a nearby user with a stronger power level.
- CDMA has a limited data rate compared to other multiple access techniques, which can be a limitation for high-speed data applications.
- CDMA is not suitable for applications that require low latency, as signal processing can introduce delays.

Telecommunication systems: Telecommunications systems in mobile computing refer to the networks, devices, and protocols used to enable wireless communication between mobile devices, such as smartphones and tablets, and other networks, such as the internet.

Mobile telecommunications systems are composed of a variety of components, including cellular towers, base stations, antennas, routers, switches, and servers. These components work together to enable the transfer of data between mobile devices and the internet or other networks.

Some of the most common telecommunication systems are WIFI, Cellular networks, Bluetooth, Global systems for mobile communications (GSM) etc.

GSM (Global Systems for mobile communications):

GSM (Global System for Mobile Communications) is a digital cellular telecommunications system that is widely used for mobile communication in most parts of the world. It is one of the most common telecommunications systems used in mobile computing.

GSM uses a combination of time division multiple access (TDMA) and frequency division multiple access (FDMA) techniques to allow multiple users to share the same frequency channel. This enables efficient use of available bandwidth and supports a large number of users on a single network.

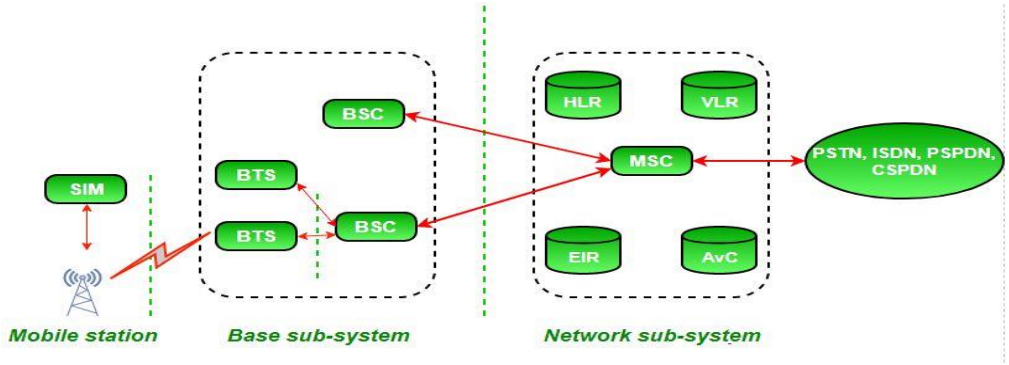
GSM networks consist of a series of interconnected base stations, mobile switching centers, and service providers. Mobile devices such as smartphones, tablets, and other mobile devices connect to the network using a SIM (Subscriber Identity Module) card, which contains information about the user's account and network access privileges.

GSM supports a range of communication services, including voice calls, text messaging, multimedia messaging, and data services such as internet access and email. It also supports features such as call forwarding, call waiting, and caller ID.

GSM ARCHITECHTURE:

GSM (Global System for Mobile Communications) architecture consists of three main components: the Mobile Station (MS), the Base Station Subsystem (BSS), and the Network and Switching Subsystem (NSS).

The Mobile Station (MS) is the mobile device used by the end-user to communicate over the GSM network. The MS comprises two components: the Mobile Equipment (ME), which is the physical device, and the Subscriber Identity Module (SIM), which is the smart card that identifies the user and provides authentication information to the network.



The Base Station Subsystem (BSS) is responsible for managing the radio interface between the MS and the network. The BSS consists of two components: the Base Transceiver Station (BTS) and the Base Station Controller (BSC). The BTS communicates with the MS over the air interface, while the BSC manages the communication between the BTS and the NSS.

The Network and Switching Subsystem (NSS) is responsible for managing the core network functions of the GSM system. The NSS comprises three main components: the Mobile Switching Center (MSC), the Home Location Register (HLR), and the Visitor Location Register (VLR). The MSC is responsible for routing calls and managing the mobility of the MS. The HLR stores the subscriber's profile and location information, while the VLR stores temporary location information for visiting subscribers.

Function of Components:

1. **Mobile station (MS):** It refers for mobile station. Simply, it means a mobile phone.
2. **Base transceiver system (BTS):** It maintains the radio component with MS.
3. **Base station controller (BSC):** Its function is to allocate necessary time slots between the BTS and MSC.
4. **Home location register (HLR):** It is the reference database for subscriber parameters like subscriber's ID, location, authentication key, etc.
5. **Visitor location register (VLR):** It contains a copy of most of the data stored in HLR which is temporary and exists only until the subscriber is active.
6. **Equipment identity register (EIR):** It is a database that contains a list of valid mobile equipment on the network.
7. **Authentication center (AuC):** It performs authentication of subscribers.

- **Location Tracking:**

  Location tracking in GSM is achieved through a process called cell identification. Each BTS covers a specific geographic area known as a cell, and the location of a mobile device can be determined by the cell it is currently connected to. The HLR and VLR maintain location information for each subscriber, which is used by the MSC to route calls and manage mobility.

- **Call Setup:**

  Call setup in GSM involves a series of steps. When a user initiates a call, the MS sends a signal to the nearest BTS, which forwards the signal to the BSC. The BSC determines the MSC responsible for handling the call and forwards the signal to the appropriate MSC. The MSC then checks the subscriber's location information in the HLR and determines the current VLR that holds the subscriber's temporary location information. The MSC sends a signal to the VLR to locate the subscriber and allocate a channel for the call. Once the channel is allocated, the call is established between the MS and the recipient's device.

MOBILITY MANAGEMENT:

Mobility management involves managing the mobility of mobile devices, ensuring that users can stay connected to the network while moving between different locations.

In cellular networks, mobility management is achieved through a process known as handover or handoff. Handover refers to the process of transferring an ongoing call or data session from one cell to another as a mobile device moves from one location to another.

Mobility management also involves location management, which refers to the process of keeping track of the current location of the mobile device within the network. Location management involves two main components: the Home Location Register (HLR) and the Visitor Location Register (VLR).

The HLR stores information about the user's account, including their phone number and service subscription details. It also stores information about the user's current location, such as which MSC and VLR the user is currently registered with.

The VLR stores information about mobile devices that are currently within its coverage area. This includes temporary information about the mobile device's location, such as which cell it is currently connected to and which MSC and HLR it is registered with. When a mobile device moves to a new VLR, the VLR sends a message to the HLR informing it of the device's new location.

Handover:

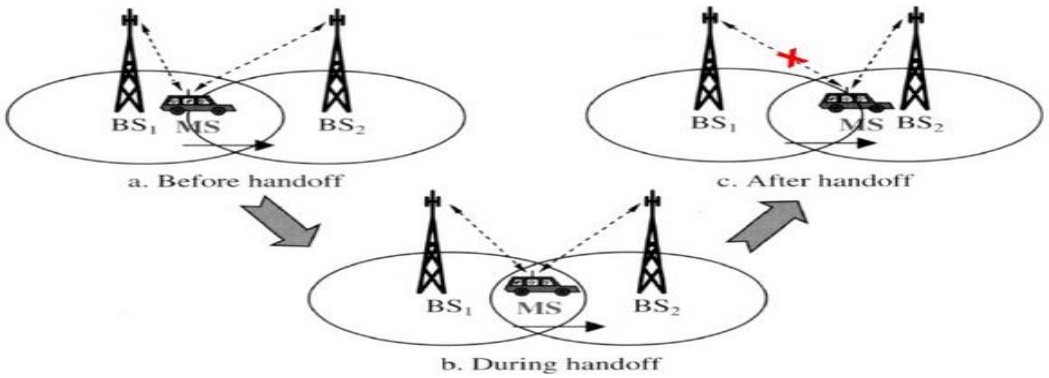
Handover, also known as handoff, is the process of transferring an ongoing call or data session from one cell to another as a mobile device moves from one location to another within the same network.

GSM uses two types of handover:

1.Intracell-handover.

2.Intercell-handover.

- **Intracell-Handover:** Intra-cell handover occurs when a mobile device moves within the coverage area of the same cell, but the signal strength or quality of the signal changes due to obstacles or interference. In this case, the mobile device needs to be handed over to a different frequency or time slot within the same cell. This is typically done using a soft handover, where the mobile device is simultaneously connected to two or more base stations in the same cell, and the signal quality from each base station is measured and compared to determine which one provides the best quality signal.
- **Intercell-Handover:** Inter-cell handover occurs when a mobile device moves from the coverage area of one cell to the coverage area of another cell, and the signal strength or quality of the signal changes. Inter-cell handover is necessary to maintain the call or data session as the mobile device moves from one cell to another.



In GSM, inter-cell handover is performed in two stages: measurement and decision. During the measurement stage, the mobile device measures the signal strength and quality of neighbouring cells to determine if the signal quality in the current cell is deteriorating. The mobile device sends

these measurements to the base station controller (BSC), which uses them to decide whether to initiate a handover.

Once the decision to handover is made, the BSC selects a new cell and allocates a new frequency or time slot for the mobile device to use. The BSC then informs the current base station to release the current connection, and instructs the mobile device to tune to the new frequency or time slot in the new cell.

SECURITY IN GSM:

Security is a critical aspect of GSM (Global System for Mobile Communications) that ensures the confidentiality, integrity, and availability of communications between mobile devices and the network. GSM uses several security mechanisms to protect against unauthorized access, interception, and manipulation of communication data.

One of the primary security mechanisms used in GSM is authentication, which ensures that only authorized users are granted access to the network. Authentication is achieved through the use of SIM (Subscriber Identity Module) cards, which contain a unique identification number and cryptographic keys that are used to authenticate the user to the network.

To protect against fraudulent access and billing, GSM uses authorization mechanisms to ensure that users are only charged for authorized services. This is achieved through the use of the Subscriber Identity Module (SIM) card, which contains information about the user's service subscription and account balance.

GSM also uses encryption to protect the confidentiality of communications between mobile devices and the network. Encryption is achieved through the use of the A5/1 encryption algorithm.

SMS:

SMS (Short Message Service) is a messaging service that allows mobile devices to exchange short text messages. SMS messages can be sent and received by mobile devices that support the GSM (Global System for Mobile Communications) standard, which is used by most mobile networks around the world.

SMS messages are limited to a maximum of 160 characters, and can be sent and received in real-time, or stored in the mobile device's memory for later retrieval. SMS messages are typically sent using the mobile device's messaging application, which allows users to compose, send, and receive messages.

SMS is a popular messaging service that is widely used for personal and business communication. It is commonly used for alerts, notifications, and reminders, as well as for marketing and promotional purposes. SMS is also used for two-factor authentication (2FA) and verification purposes, where a one-time password (OTP) is sent to the user's mobile device to verify their identity or authorization for a particular service or transaction.

INTERNATIONAL ROAMING FOR GSM:

International roaming is a service that allows GSM (Global System for Mobile Communications) subscribers to use their mobile devices to make and receive calls, send and receive SMS messages, and access mobile data services while traveling outside of their home network's coverage area.

When a GSM subscriber travels to a foreign country, their mobile device will typically connect to a local network operator that has a roaming agreement with their home network operator. The local network operator will provide the subscriber with access to their network, and the subscriber can use their mobile device as if they were in their home network's coverage area.

To support international roaming, GSM networks use a number of technologies and protocols, including:

- **Roaming agreements:** These are agreements between network operators that allow subscribers to use each other's networks when traveling outside of their home network's coverage area.
- **Roaming profiles:** These are sets of parameters and settings that are used to configure the subscriber's mobile device for roaming on a particular network. Roaming profiles include information such as the network's frequency band, access point name (APN), and other network-specific settings.
- **Roaming authentication:** This is the process of authenticating the subscriber's mobile device and SIM card on the local network. This is typically done using the same authentication mechanisms that are used on the home network, such as SIM card authentication and AUC (Authentication Center) authentication.
- **Roaming billing:** This is the process of charging the subscriber for the services they use while roaming on the local network. This is typically done using a billing agreement between the home and local network operators, where the home network operator bills the subscriber for the services they use while roaming.

CALL RECORDING FUNCTIONS:

Call recording is a feature that allows mobile devices to record incoming and outgoing phone calls. This feature can be useful for a variety of reasons, such as recording important business conversations, keeping a record of conversations for legal or compliance reasons, or simply for personal use.

The call recording function can be implemented in different ways depending on the mobile device and operating system. In some cases, call recording may be built into the device's operating system, while in others it may require the installation of a third-party app.

Once the call recording function is enabled, the mobile device will automatically record all incoming and outgoing phone calls. The recorded calls can be stored in the device's memory or on an external storage device, depending on the device's configuration.

SUBSCRIBER AND SERVICE DATA MANAGEMENT:

Subscriber and service data management involves the management of subscriber data, such as subscriber identification, service plan information, and billing data, as well as the management of service data, such as network configuration and service activation.

In GSM, subscriber data is typically managed by the home location register (HLR), which is a database that stores information about all subscribers on the network. The HLR is responsible for managing subscriber identification, service plan information, and billing data, as well as providing authentication and authorization for subscribers to access the network.

Service data, on the other hand, is managed by the operations support system (OSS), which is responsible for the configuration and activation of network services. The OSS is responsible for managing network configuration data, such as radio frequency (RF) channel assignments, as well as service activation data, such as service configuration and activation parameters.

In addition to the HLR and OSS, mobile telecommunications systems may also include other databases and systems for managing subscriber and service data, such as the home subscriber server (HSS) in 4G and 5G networks, and the billing and customer care systems (BCCS), which are used for billing and customer service management.

DECT: DECT (Digital Enhanced Cordless Telecommunications) is a digital wireless communication standard used for cordless phone systems. It was first introduced in Europe in the early 1990s and has since become a popular standard for cordless phone systems around the world.

DECT operates in the 1.9 GHz frequency band and uses digital modulation to provide high-quality voice and data transmission. It is a secure communication standard that uses encryption and authentication to ensure the privacy and security of voice and data transmissions.

One of the key advantages of DECT is its range. DECT cordless phones have a range of up to 300 meters in open space, which makes them suitable for use in large homes, small offices, and even warehouses or factories. DECT also supports multiple handsets, allowing users to have several cordless phones connected to the same base station.

DECT also supports a range of advanced features, including caller ID, call waiting, call forwarding, and voicemail. Some DECT phones also support additional features such as Bluetooth connectivity, which allows users to connect their mobile phones or other Bluetooth-enabled devices to the DECT phone system.

Applications of DECT:

- DECT is used in the development of cordless phones which are widely used for residential, work, and business purposes.
- It is used in the development of many industry applicants, baby monitors, remote controls.
- It is used in Public Switched Telephone Network (PSTN)
- It is also used in fax, e-mail, Local Area Networks (LAN), etc.
- The end-user can move the handset to a specific range which gives the feature of Cordless Terminal Mobility.

Advantages of DECT:

- **Reliability:** DECT is designed for voice. It makes sure that voice will not interfere with another communication process.
- **Isolated frequency:** Since DECT has its own spectrum, it operates on its isolated frequency which reduces the competition of airways between computer and wi-fi devices.
- **Less Power Consumption:** The handset is designed in such a way it acquires less power compared with wi-fi which allows the user to have more talk time.
- **Cost-efficient:** The cost that needs to be afforded to use these services is less compared to others which causes the increase of subscribers from enterprises to residents.
- **Less exposure to HF waves:** DECT telephone users face less exposure to High-Frequency waves than mobile transmission users. This is due to the short-range feature of DECT.
- **Stability and Security:** DECT is used for seamless communications and it is highly secure. The stability of DECT is due to the exclusive base station only being available for the handsets.
- **High Quality:** The high quality of the DECT ensures uninterrupted roaming between the base stations.

Disadvantages of DECT:

- **Multi-Cell Systems:** This is one of the negative aspects of DECT. Though it is highly reliable and has mobility, problems arise when we want to provide multi-cell systems with numerous handsets and base stations. When multicellular systems are involved, it becomes a pitfall and gives a look that wi-fi is more engaging.
- **Less Coverage:** Due to its short-range feature, it covers less area and the transmission is also limited.
- **Eye on battery:** This is one small disadvantage where the user has to keep an eye on batteries and they should make sure that the handsets are on their base when not used.

TETRA: TETRA (Terrestrial Trunked Radio) is a digital trunked mobile radio communications standard that was designed specifically for use by public safety, emergency services, transport and utility companies, and other organizations that require highly reliable, secure, and efficient communication.

TETRA uses a digital modulation scheme to provide secure and efficient voice and data communication. It operates in the 380-430 MHz frequency band and uses time-division multiple access (TDMA) to enable multiple users to share the same radio channel. This allows for efficient use of the available radio spectrum, providing more capacity than traditional analog radio systems.

Applications:

- TETRA is commonly used by public safety organizations, such as police, fire, and emergency medical services.
- It is also used by transport and utility companies, security organizations, and other businesses that require reliable and secure communication.

Advantages:

- TETRA provides highly reliable and secure communication, which is essential for public safety organizations and other critical communication users.
- It supports a range of advanced features, such as group calls, individual calls, and emergency calls, and it can provide location information for users in real-time.
- TETRA uses digital modulation and TDMA, which allows for efficient use of the available radio spectrum, providing more capacity than traditional analog radio systems.

Disadvantages:

- TETRA requires specialized equipment, which can be expensive to purchase and maintain.
- It operates in a specific frequency band (380-430 MHz), which can be subject to interference and regulatory restrictions in some regions.
- TETRA may not be as widely available as other communication technologies, such as cellular networks or Wi-Fi.

UMTS:

UMTS (Universal Mobile Telecommunications System) is a 3rd generation (3G) mobile communication technology that provides high-speed data and voice communication services to mobile phone users. It is a successor to the second-generation (2G) GSM technology.3G UMTS employments a completely diverse radio interface based around the utilize of Coordinate Grouping Spread Range as CDMA or Code Division Multiple Access.

UMTS Applications:

- Streaming / Download (Video, Audio)
- Videoconferences.
- Fast Internet / Intranet.
- Mobile E-Commerce (M-Commerce)
- Remote Login
- Background Class applications
- Multimedia-Messaging, E-Mail
- FTP Access
- Mobile Entertainment (Games

UMTS Advantages:

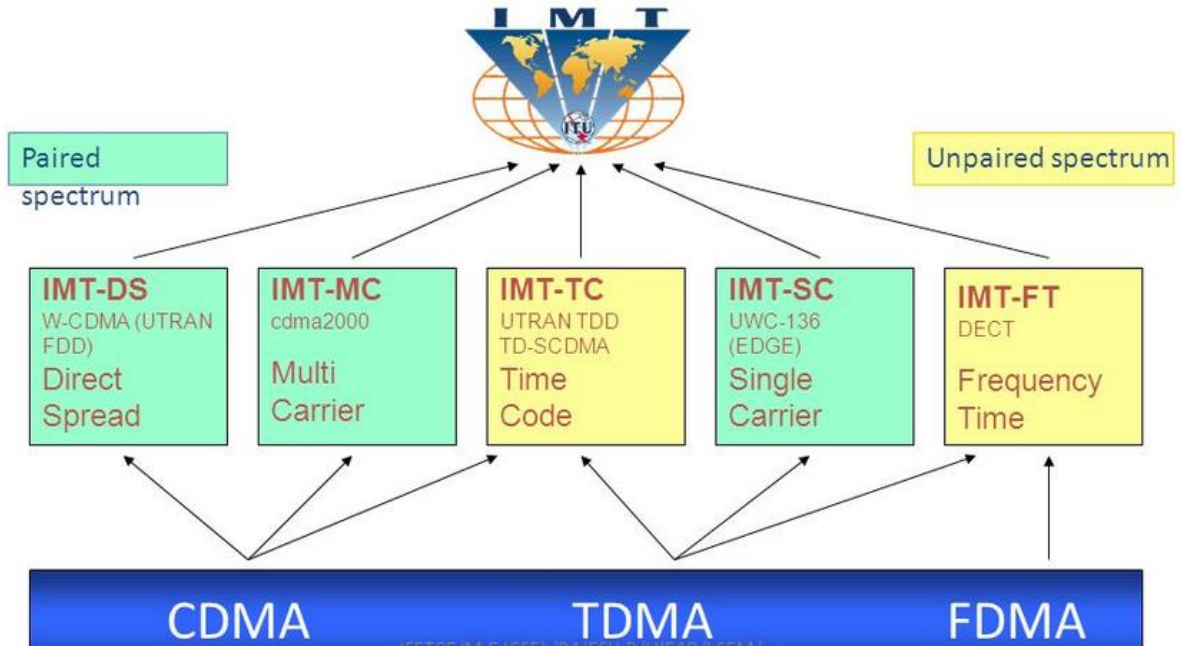
- UMTS could be a successor to 2G based GSM advances counting GPRS and EDGE . Gaining a 3rd title 3GSM since it could be a 3G relocation for GSM
- Support 2Mbit/s information rates.
- Higher Information rates at lower incremental costs.
- Benefits of programmed universal wandering also necessarily security and charging capacities, permitting administrators emigrate from 2G to 3G whereas holding numerous of their existing back-office frameworks
- Gives administrators the adaptability to present unused mixed media administrations to trade clients and buyers
- This not as it were gives client a valuable phone but moreover deciphers higher incomes for the administrator.

Disadvantages of UMTS

- It is more expensive than GSM.
- Universal Mobile Telecommunication System has poor video experience.
- Universal Mobile Telecommunication System still not broadband.

IMT-2000:

IMT-2000 (International Mobile Telecommunications-2000) is a global standard for 3rd generation (3G) mobile communication systems. It is a set of technical specifications developed by the International Telecommunication Union (ITU) to ensure interoperability and global compatibility among different 3G systems.



IMT-DS:

1. It is used the direct spread technology.
2. It is also called Wideband CDMA.
3. It is part of Third Generation Partnership Project(3GPP)

IMT-TC:

1. It uses Time Code Technology.
2. It further divided into 2 standards TDD and TD-SCDMA.

IMT-MC:

1. It uses Multi Carrier Technology.
2. CDMA is multi carrier technology and it is part of 3GPP2.

IMT-SC:

1. It uses Single Carrier Technology.
2. It is enhancement of US TDMA System.

IMT-FT:

1. It uses Frequency Time Technology.
2. It is enhancement version of the digital cordless telephone standard DECT.

Features:

- IMT-2000 uses a range of different radio access technologies, including CDMA (Code Division Multiple Access), TDMA (Time Division Multiple Access), and FDMA (Frequency Division Multiple Access), to provide high-speed data and voice communication services.
- It operates in a range of different frequency bands, including 800 MHz, 900 MHz, 1800 MHz, and 2100 MHz, to ensure global compatibility and interoperability.
- IMT-2000 supports high-speed data transmission rates of up to 2 Mbps, as well as multimedia services such as video calling, video streaming, and mobile TV.

Applications:

- IMT-2000 is used for high-speed data and voice communication services, such as internet browsing, email, and voice calling.
- It is also used for multimedia services such as video calling, video streaming, and mobile TV.
- IMT-2000 is widely used in various industries, including healthcare, transportation, and finance, to support critical communication needs.

Advantages:

- IMT-2000 provides high-speed data transmission and low-latency communication, which is essential for many applications, such as video calling and online gaming.
- It supports a wide range of multimedia services, which makes it a popular choice for entertainment and business purposes.
- IMT-2000 has global compatibility and interoperability, making it widely accessible and available in most regions.

Disadvantages:

- IMT-2000 requires specialized network infrastructure and equipment, which can be expensive to deploy and maintain.
- It has limited capacity compared to newer technologies such as LTE, which can result in slower speeds during peak usage times.
- IMT-2000 is gradually being phased out in favor of newer technologies such as 4G and 5G.