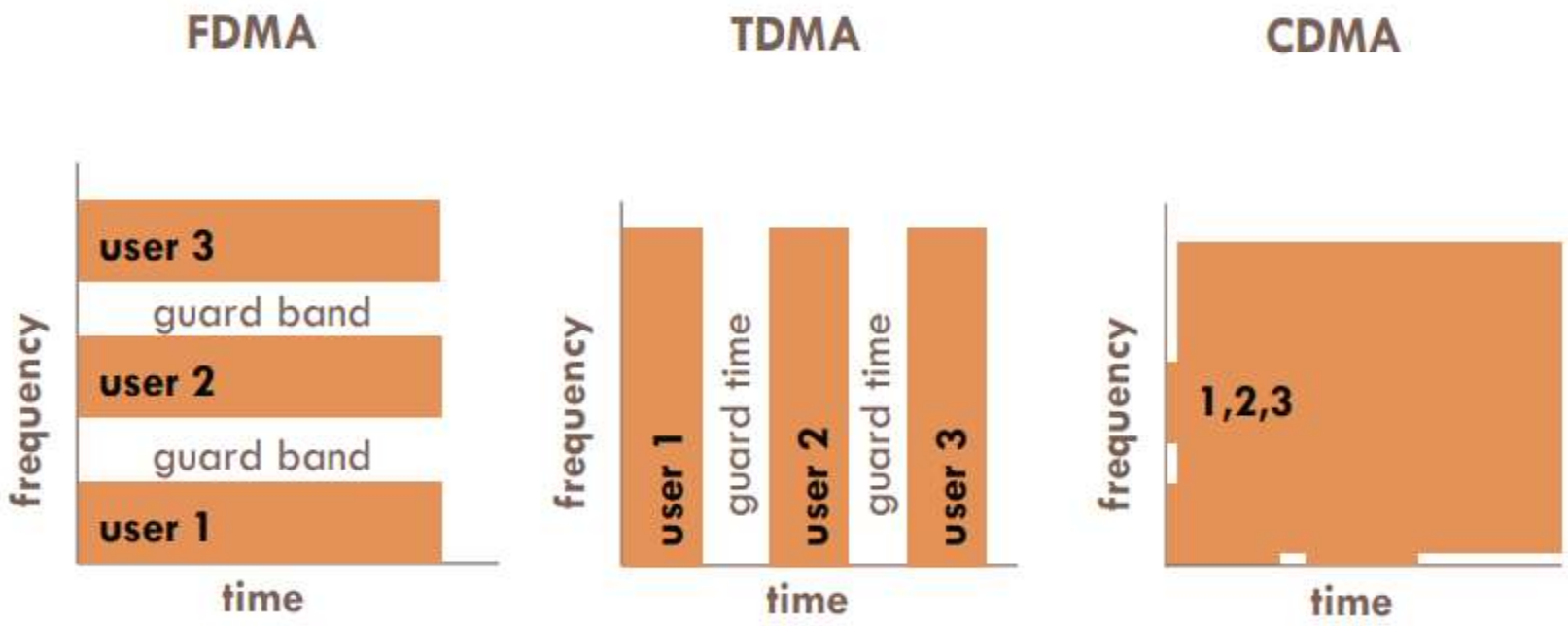
Multiple access technique

- Access methods are multiplexing techniques that provide communications services to multiple users in a single-bandwidth wired or wireless medium. Communications channels, whether they're wireless spectrum segments or cable connections, are expensive.
- Communications services providers must engage multiple paid users over limited resources to make a profit.

Types of Multiple access technique

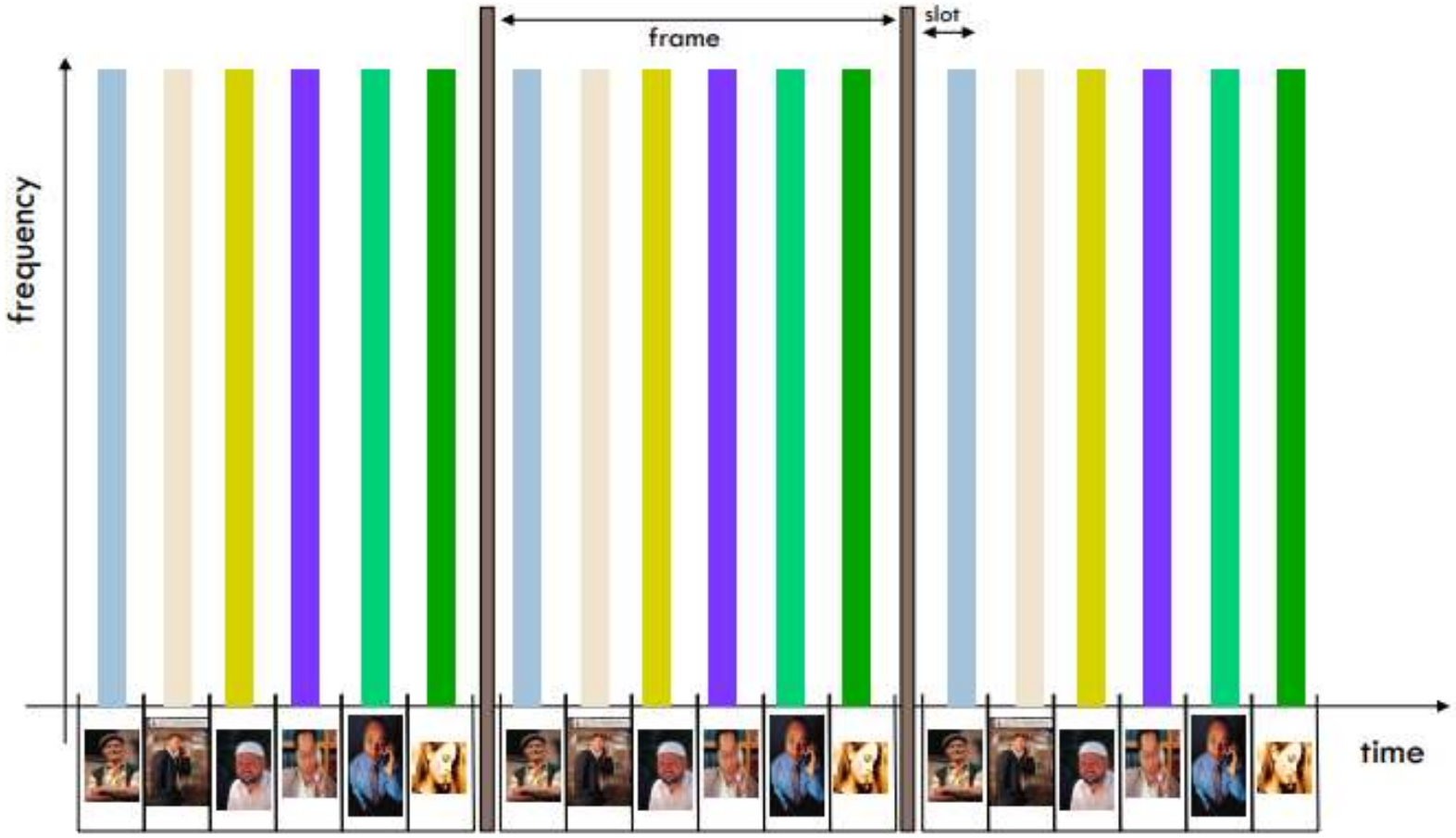
- Frequency Division Multiple Access(FDMA)
- Time Division Multiple Access (TDMA)
- Code Division Multiple Access(CDMA)
- Orthogonal Frequency Division Multiple Access(OFDMA)
- Spatial Division Multiple Access(SDMA)

- Each one of these takes advantage of multiplexing methods, dividing the bandwidth of the signal into different sub-bands, which are then assigned to different users in order to allow multiple users to share a single channel.
- Multiplexing is a communications technique that multiplexes, or combines, multiple signals into a single signal. The reverse process is called demultiplexing. For example, the voice signals of many telephone callers can be multiplexed over a single data link by using time-division multiplexing (TDM).



Wireless systems often use a combination of schemes; GSM – FDD/FDMA/TDMA

TDMA



TDMA

- Each user is allowed to transmit only within specified time intervals (Time Slots).
- Different users transmit in different time Slots. When users transmit, they occupy the whole frequency bandwidth (separation among users is performed in the time domain).
- Data rate is high.

Time frame

- Preamble consists of address(location of the user) and synchronization bits used by base station to identify the user.
- Information consists of slots-user information.
- Each slot will have trail bits, synchronization bits , information bits , guard bits.
- Trails bits helps in power control mechanism which help in transmission of signal.

- Synchronization bits synchronizing the transmitter and receiver at the time of communication.
- Information bit have the data about the user.
- Guard bits are allotted to avoid interference.

- Example is the widely used T1 transmission system, which has been used for years in the telecom industry. T1 lines carry up to 24 individual voice telephone calls on a single line .
- Each voice signal usually covers 300 Hz to 3000 Hz and is digitized at an 8-kHz rate, which is just a bit more than the minimal Nyquist rate of two times the highest-frequency component needed to retain all the analog content.

FDMA

- Different frequency for different users.
- Gaud band(gap between the users) is used to avoid ISI.
- The data to be transmitted is modulated on to each subcarrier, and all of them are linearly mixed together.
- But gaud band reduces the bandwidth efficiency. It also results in unused bandwidth and delay.
- Data rate is less.

- The best example of this is the cable television system. The medium is a single coax cable that is used to broadcast hundreds of channels of video/audio programming to homes.
- The coax cable has a useful bandwidth from about 4 MHz to 1 GHz.
- This bandwidth is divided up into 6-MHz wide channels. Initially, one TV station or channel used a single 6-MHz band. But with digital techniques, multiple TV channels may share a single band.

- This technique is also used in fiber optic communications systems. A single fiber optic cable has enormous bandwidth that can be subdivided to provide FDMA.
- Fiber optic FDMA is called wavelength division multiple access (WDMA) or just wavelength division multiplexing (WDM).

CDMA

- In CDMA each user is assigned a unique code sequence (spreading code), which it uses to encode its data signal.
- The receiver, knowing the code sequence of the user, decodes the received signal and recovers the original data.
- The bandwidth of the coded data signal is chosen to be much larger than the bandwidth of the original data signal, that is, the encoding process enlarges (spreads) the spectrum of the data signal.

- CDMA is based on spread-spectrum modulation.
- If multiple users transmit a spread-spectrum signal at the same time,the receiver will still be able to distinguish between users, provided that each user has a unique code that has a sufficiently low crosscorrelation with the other codes.

- For example, using 64 unique chipping codes allows up to 64 users to occupy the same 1.25-MHz channel at the same time. At the receiver, a correlating circuit finds and identifies a specific caller’s code and recovers it.
- The third generation (3G) cell-phone technology called wideband CDMA (WCDMA) uses a similar method with compressed voice and 3.84-Mbit/s chipping codes in a 5-MHz channel to allow multiple users to share the same band.

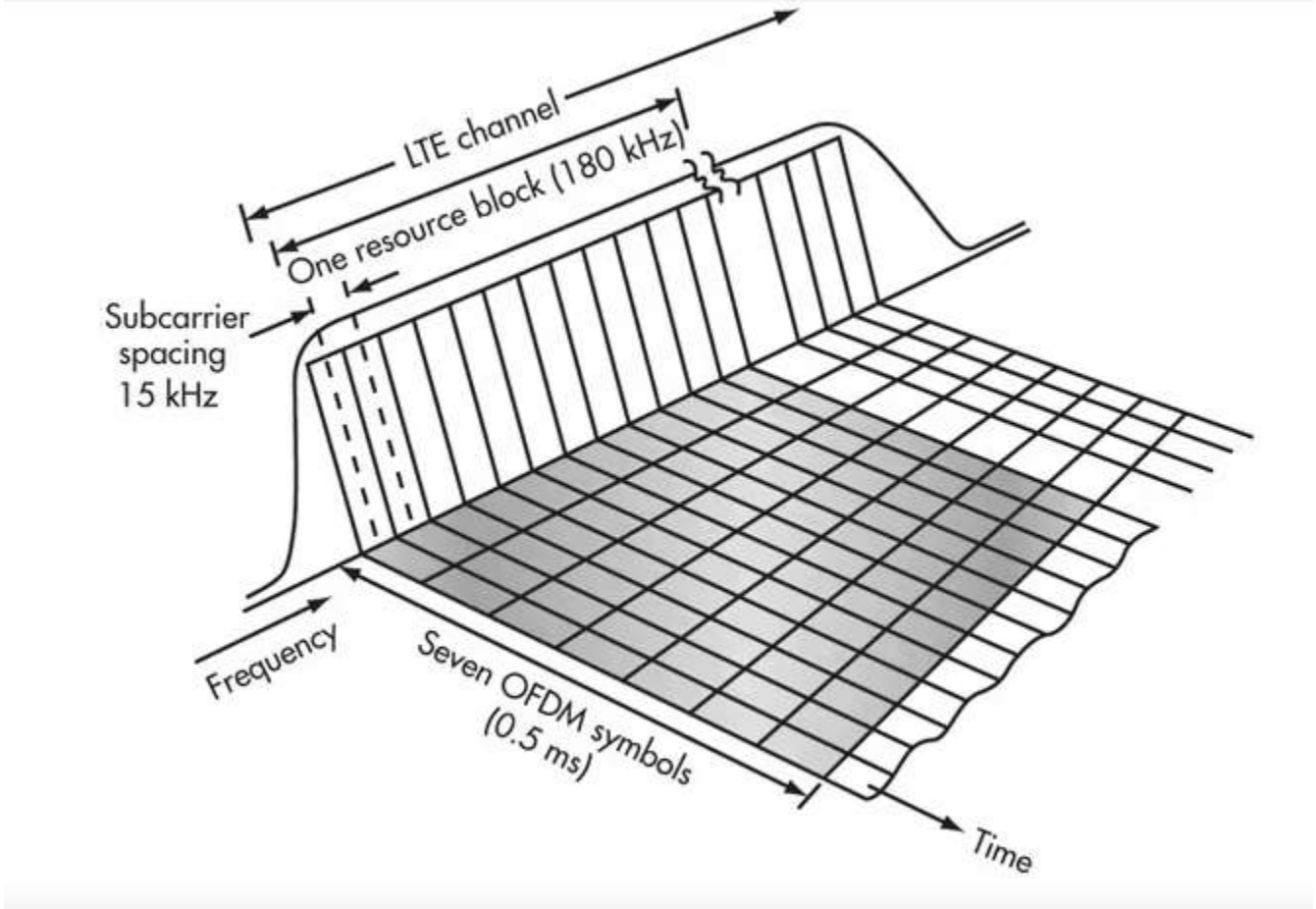
Space Division Multiple Access (SDMA)

Space division multiple access or spatial division multiple access is a technique which is MIMO (multiple-input multiple-output) architecture and used mostly in wireless and satellite communication. It has the following features.

- 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 satellites 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.

OFDMA

- OFDMA is the access technique used in Long-Term Evolution (LTE) cellular systems to accommodate multiple users in a given bandwidth.
- Orthogonal frequency division multiplexing (OFDM) is a modulation method that divides a channel into multiple narrow orthogonal bands that are spaced so they don’t interfere with one another. Each band is divided into hundreds or even thousands of 15-kHz wide subcarriers.
- The data to be transmitted is divided into many lower-speed bit streams and modulated onto the subcarriers. Time slots within each subchannel data stream are used to package the data to be transmitted . This technique is very spectrally efficient, so it provides very high data rates. It also is less affected by multipath propagation effects.


LTE channel
One resource block (180 kHz)
Subcarrier spacing 15 kHz
Frequency
Seven OFDM symbols (0.5 ms)
Time

- GSM(Global system for mobile)/FDMA and TDMA
- UMTS(Universal Mobile telecommunication system)/WCDMA
- LTE(Long term Evolution)/OFDMA and SC-FDMA

Contemporary Issues

LTE

- The high-level network architecture of LTE is composed of the following three key components:

- The User Equipment (UE).
- The Evolved UMTS Terrestrial Radio Access Network (E-UTRAN).
- The Evolved Packet Core (EPC).

UE(User Equipment)

The internal architecture of the user equipment for LTE is exactly the same as that of UMTS and GSM, which is mobile equipment (ME). The mobile equipment has the following core modules:

- All communication functions are handled by Mobile Termination (MT).
- The data streams are terminated in Terminal Equipment (TE).
- The SIM card for LTE equipment is known as the Universal Integrated Circuit Card (UICC). This application is known as the Universal Subscriber Identity Module (USIM).

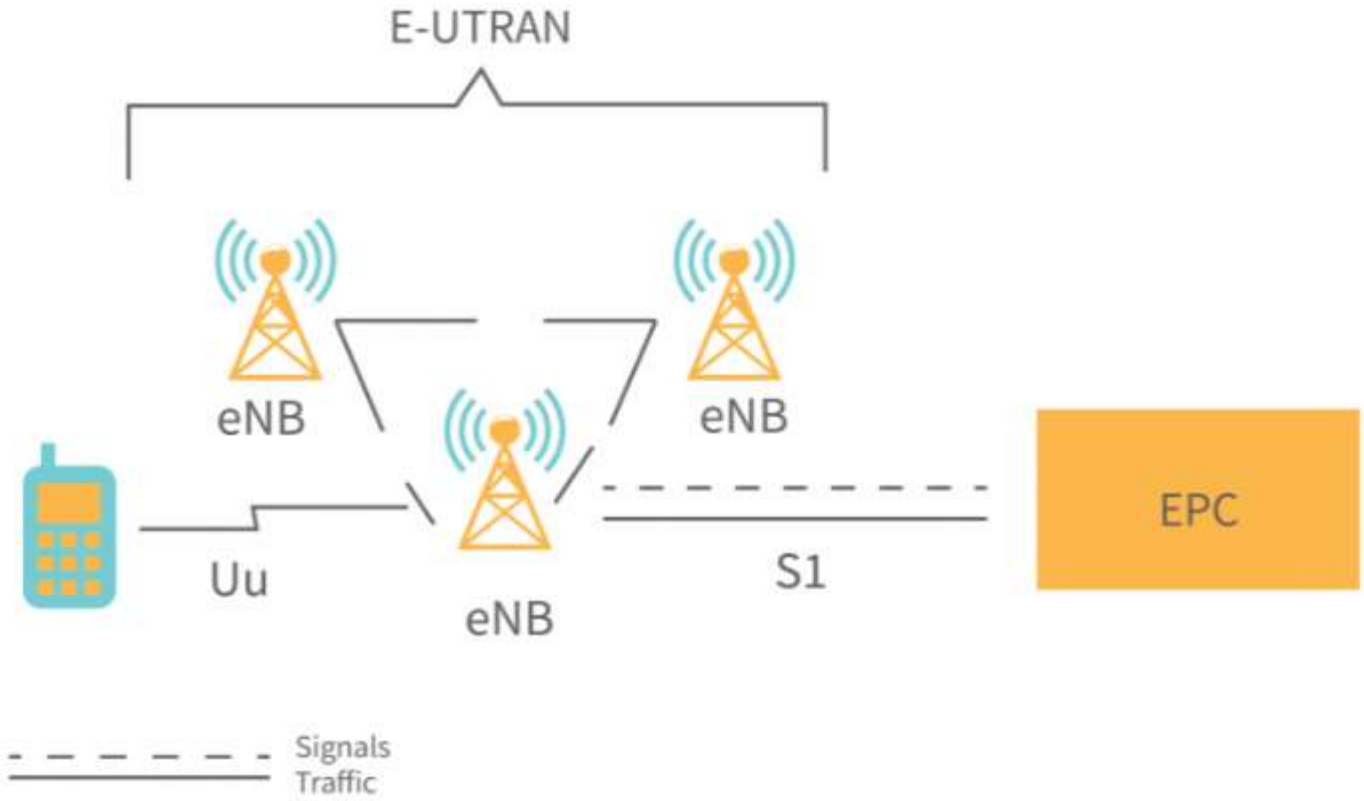
The information stored on a USIM card is similar to that of a 3G SIM card, including the user's telephone number, home network identity, and security keys.

The E-UTRAN (The Access network)

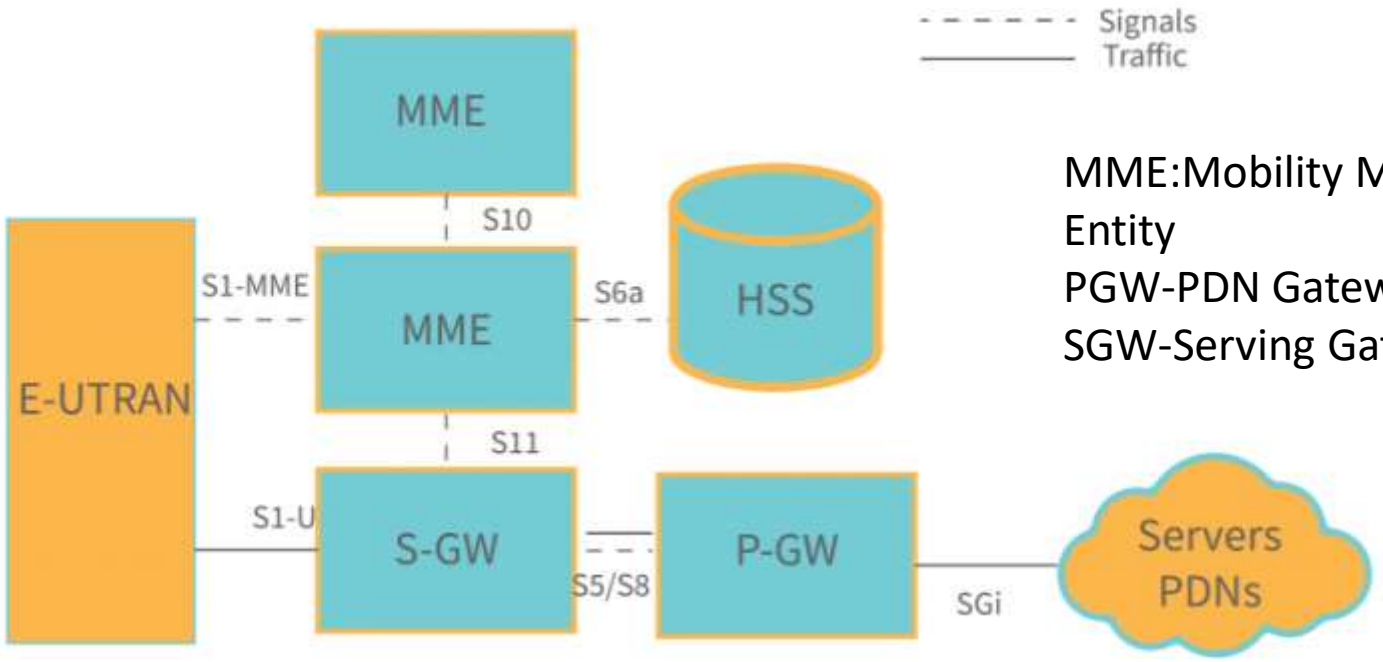
- An evolved packet core or ePC controls the various information packets that are sent between mobile devices and the core network. In contrast to an eNB, which is a base station that controls mobile devices in one or more cells, an eNodeB controls radio communication between an evolved packet core or ePC and mobile devices.
- An eNB can perform two main functions when connected to an LTE mobile device:

- The eBN sends and receives radio signals to and from all the mobile devices using the analogue and digital signal processing functions of the LTE air interface.
- The eNB sends handover commands to all of its mobiles at a low level, controlling their operation.
- The EPC(evolved packet core) allows each eBN to be connected to the S1 interface of nearby base stations and the X2 interface for signalling and packet forwarding during handover, but it can also be connected to them via the S1 interface.

- A home eNB (HeNB) is a user-owned base station for providing femtocell coverage in the home. A home eNB is part of a closed subscriber group (CSG) and may only be reached by mobile phones with a USIM that also belongs to the CSG.


E-UTRAN
eNB
eNB
eNB
Uu
S1
EPC
Signals
Traffic

The Evolved Packet Core (EPC) (The core network)



MME:Mobility Management Entity
PGW-PDN Gateway
SGW-Serving Gateway

- The central database that contains information about all the network operator’s subscribers is known as the Home Subscriber Server (HSS). This information is carried over from UMTS and GSM and is located in the Home Subscriber Server (HSS) component.
- SGi is used to communicate with the outside world, i.e. packet data networks PDN, in which the P-GW is located. An APN is used to identify each packet data network. In addition to functioning as a GPRS support node (GGSN) and a serving GPRS support node (SGSN) for UMTS and GSM, the P-GW is comparable to the GSN and SGSN in packet data networks.
- The S-GW acts as a router between the base station and the PDN gateway, handling data forwarding.

Advantages of LTE

- Data and voice can be exchanged between participants using LTE. Because of packet switching, data and voice can be sent using the same network.
- Data sent between the sender and receiver can be high amounts.
- The better life of smartphone batteries is caused by all data exchange being done with very little power consumption.
- It has fast file upload and download speeds.
- It reduces the load on the network by releasing network usage faster.
- Reducing service traffic and favouring fewer crashes is the aim of this initiative.
- You can watch live shows, matches, and events using LTE.

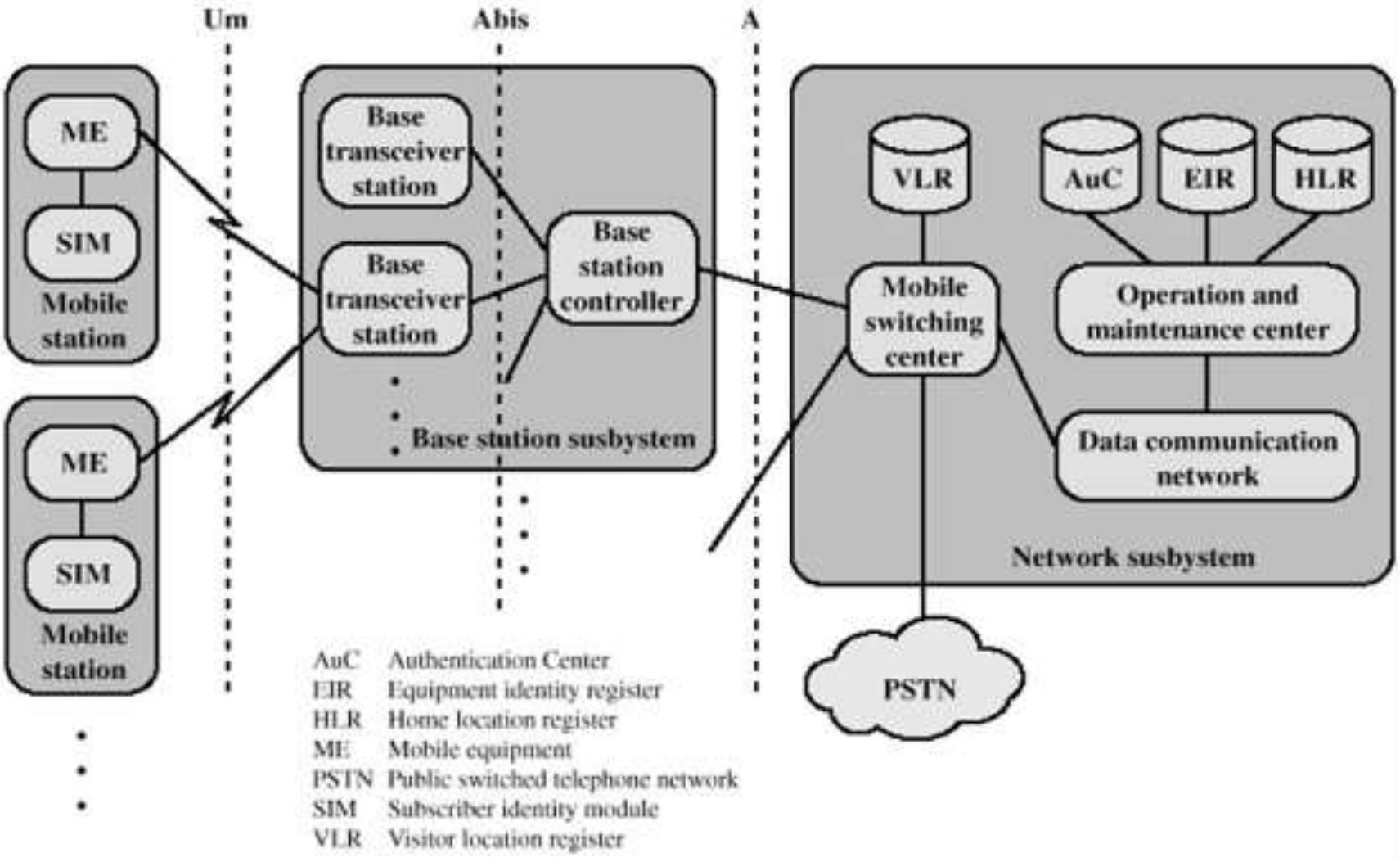
Disadvantages of LTE

- Some cities do not have this service.
- Signals in transit, such as buses and trains, need to be improved by increasing the number of towers and introducing new technologies.
- The complexity of LTE makes it necessary for competent people to manage the system. They might even need to be paid a higher salary.
- Old versions of smartphones cannot make use of this technology.
- The cost of buying new LTE smartphones is high.

GSM

- A GSM network comprises of many functional units. These functions and interfaces are explained in this chapter. The GSM network can be broadly divided into –

- The Mobile Station (MS)
- The Base Station Subsystem (BSS)
- The Network Switching Subsystem (NSS)
- The Operation Support Subsystem (OSS)


Um
Abis
A
ME
SIM
Mobile station
ME
SIM
Mobile station
Base transceiver station
Base transceiver station
Base station controller
Base station susbystem
VLR
AuC
EIR
HLR
Mobile switching center
Operation and maintenance center
Data communication network
Network susbystem
PSTN
AuC Authentication Center
EIR Equipment identity register
HLR Home location register
ME Mobile equipment
PSTN Public switched telephone network
SIM Subscriber identity module
VLR Visitor location register