

5.1) List the Features of Digital cellular System:-

- ① Increase in capacity
- ② Long Battery life
- ③ High level of Security
- ④ Information privacy through data encryption
- ⑤ Wider Area coverage
- ⑥ Less RF Transmission power
- ⑦ Reduction of mobile unit size
- ⑧ Reduction of power requirements

5.2) Explain the frequency Spectrum of Global System for mobile communication (GSM) System:-

GSM is Second Generation (2G) cellular phone technology. Speech or voice calls are the primary function of GSM technology. It supports variety of other data services.

Frequency spectrum of GSM is

Multiple access Technology	FDMA/TDMA
Uplink frequency Band	890-915 MHz
Downlink frequency Band	930-950 MHz
Channel Spacing	200KHz
Channel data rate	270.833 Kbps
Frame duration	4.615 ms

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Explain the architecture of GSM?

GSM System architecture consists of three major inter-connected Subsystems that interact among one another.

- ① Base Station Subsystem (BSS)
- ② Network Switching Subsystem (NSS)
- ③ Operational Support Subsystem (OSS)

→ Mobile Station :- The Mobile Station consists of mobile handset with battery and Subscriber identity module (SIM)

→ It is also a subsystem but considered to be part of BSS.

① Base Station Subsystem (BSS) :-

It is sometimes called as radio system because it provides and manages radio frequency transmission paths between MS and MSC.

→ It consists of 2 main parts. They are :-

- ① Base Transceiver Station (BTS)
- ② Base Station Controller (BSC)

→ BTS :- It consists of antennas that transmit and receive to directly communicate with mobiles. BTS's are connected to BSC.

→ BSC :- It has multiple BTS. It manages channel allocation and hand-off of calls from one BTS to another BTS.

→ BSC's are connected to MSC

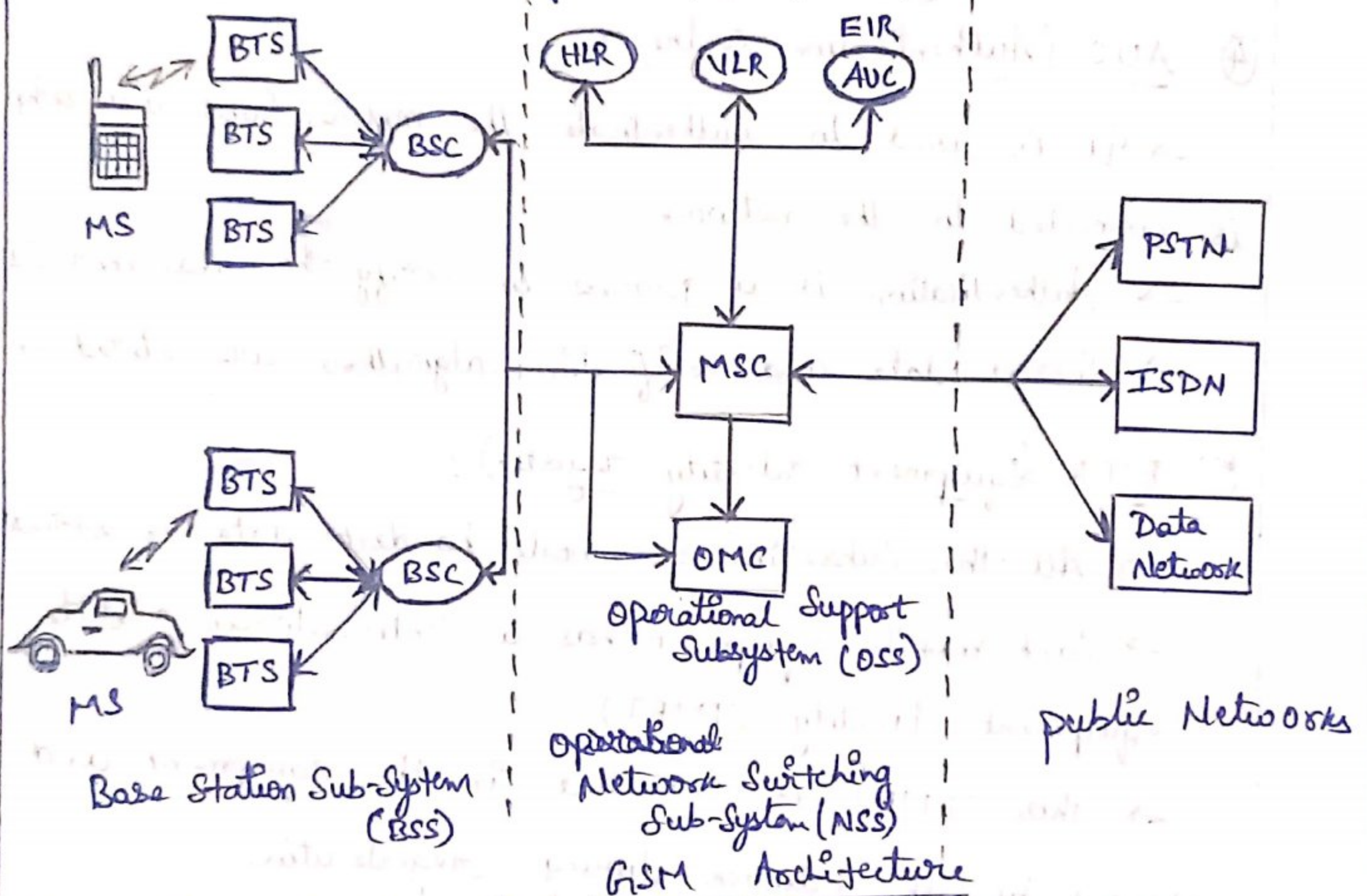
→ It provides path from MS to MSC

② Network Switching Subsystem (NSS):

→ It provides main control and interfacing for whole mobile network.

→ It allows MSC's to communicate with other telephone networks such as PSTN and ISDN.

→ NSS consists of MSC, HLR, VLR, AUC and EIR.



① Mobile Switching Centre :-

→ It is the heart of entire network connecting the fixed line networks (ISDN, PSTN etc) to the mobiles.

→ It manages all call-related functions and billing information.

② Home Location Register (HLR):-

→ All the Subscriber's data is stored in HLR

→ It has a permanent database of all registered Subscribers

→ It contains your Id proof, caller tune etc

③ Visitor Location Register (VLR) :-

→ It has a temporary database which contains exact location of all the subscribers currently present in service area of MSC.

→ If you are moving from one state to another state, then your entry is marked in VLR.

④ AUC (Authentication Centre) :-

→ It is used to authenticate the mobile subscriber who is connected to the network

→ Authentication is a process to verify the subscriber SIM

→ Secret data and verification algorithms are stored in AUC.

⑤ EIR (Equipment Identity Register) :-

→ All the subscriber's mobile handset data is stored in EIR

→ Each mobile equipment has a 'international mobile equipment identity (IMEI)

→ This IMEI is installed in the equipment and is checked by the network during registration

→ PSTN (Public Switched Telephone Network) :-

It is a fixed line network to the mobiles.

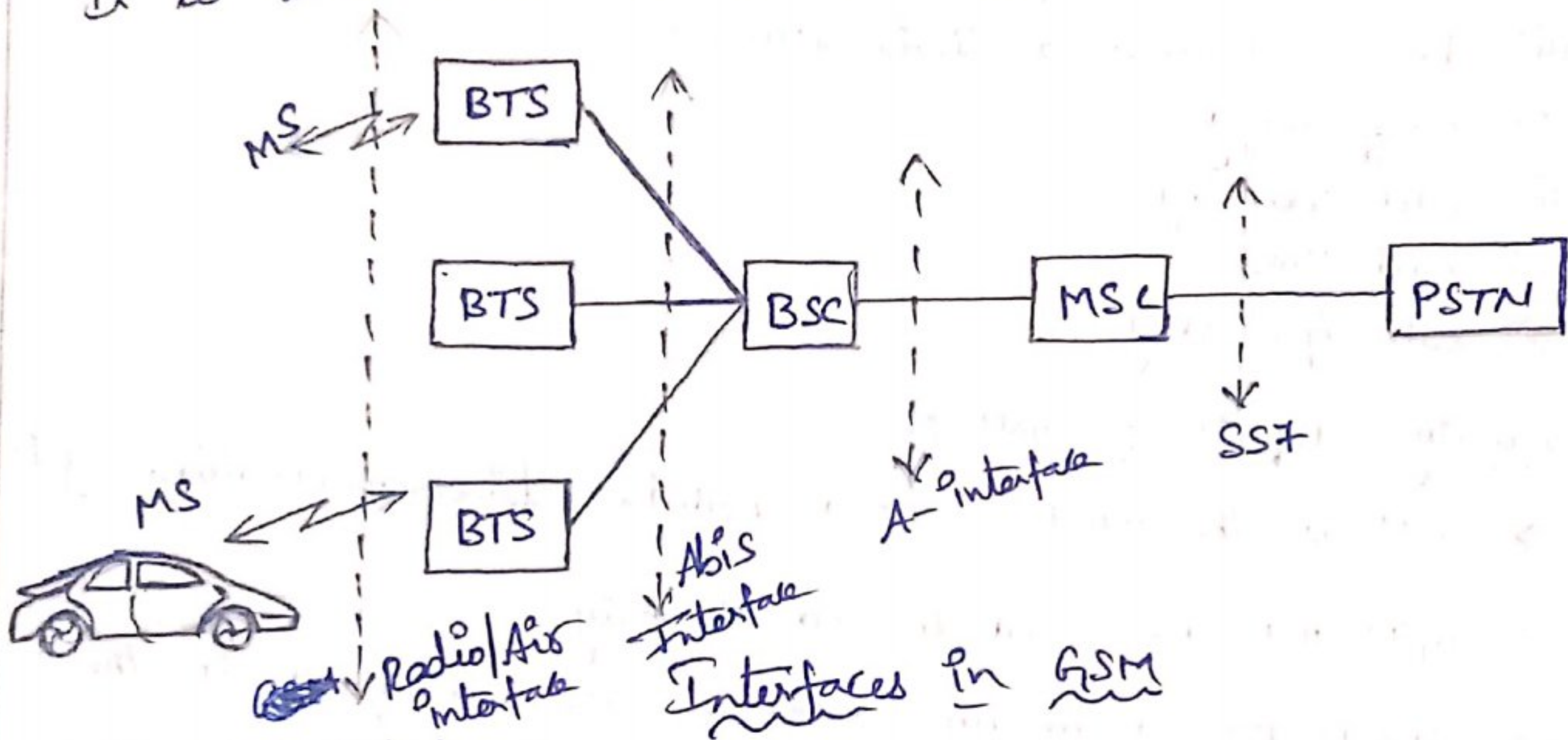
③ Operational Support Subsystem (OSS) :-

It supports one or several operation & maintenance centres (OMC), which is used to monitor and maintain the performance of each MS, BSC & MSC's within a 'GSM system'.

5.4) List Various Interfaces in GSM Architecture :-

The Various interfaces in GSM Architecture are :-

- ① Air Interface :- It is the interface between MS and BTS.
It carries the radio link carrying data and control information.
It is also called as Radio interface.



- ② Abis Interface :-
It is the interface between BTS and BSC which carries traffic (signals transmitted through a communication system) and maintenance data.

- ③ A-Interface :-
It is the interface between BSC and MSC.
It manages the allocation of suitable radio resources to mobile stations and mobility management.

- ④ SS7 Interface :-
It is an interface between MSC and PSTN to communicate with each other in order to provide services to mobile phone users.

5.5) List the Service and Security Aspects of GSM

Service Aspects of GSM:

- ① Voice Calls
- ② Videotext and Facsimile (Fax)
- ③ Short Text Messages (SMS)
- ④ Bearer Services (or) Data Services
- ⑤ Conferencing
- ⑥ Call waiting
- ⑦ Call Hold
- ⑧ Call forwarding

Security Aspects of GSM:-

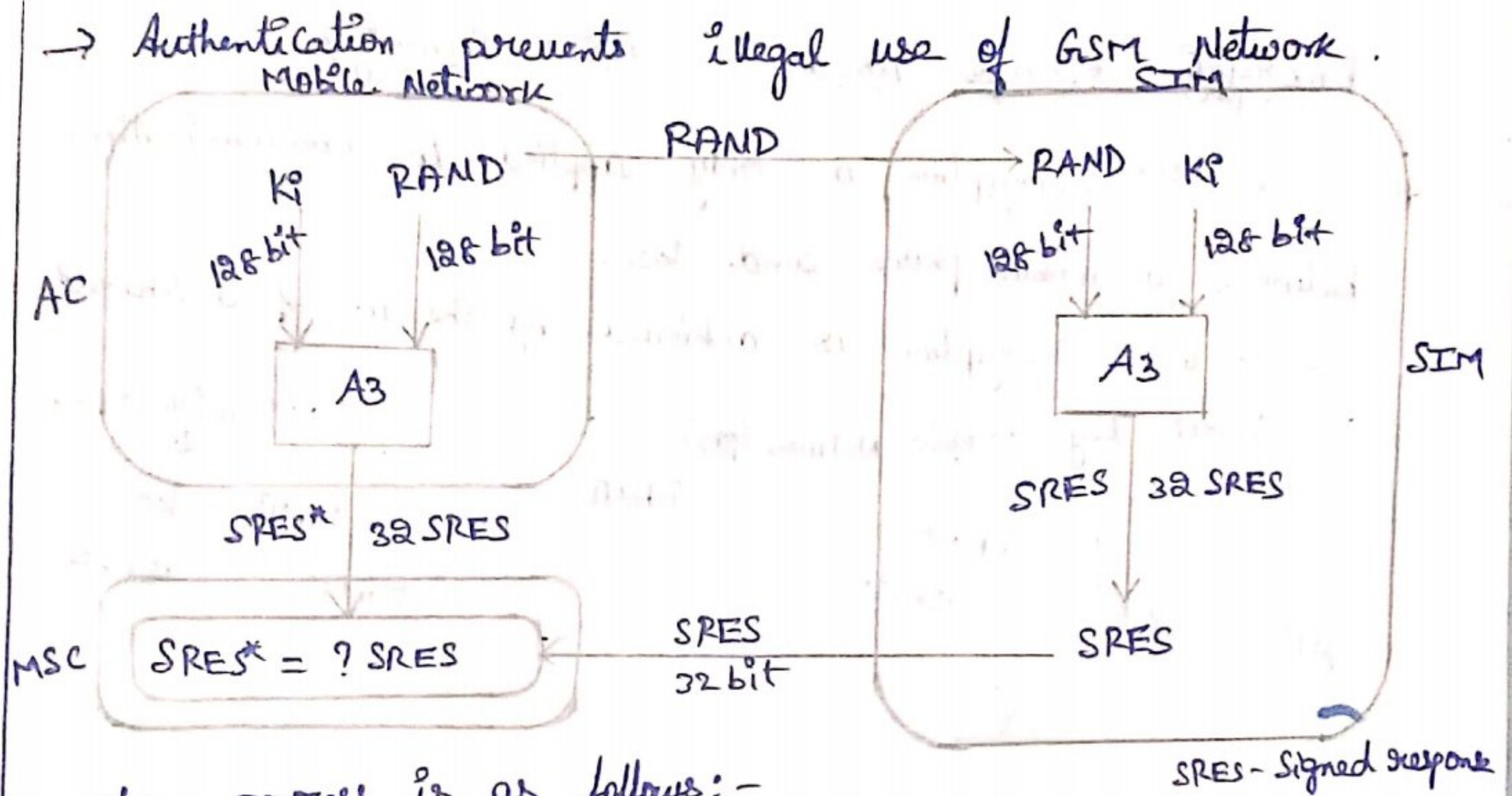
- GSM is the most secured cellular telecommunications system
- GSM maintains end-to-end security
- Temporary identification numbers are assigned to the subscribers numbers to maintain the privacy of the user
- The privacy of communication is maintained by applying encryption algorithms and frequency hopping

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Explain Authentication and Encryption process in

GSM Security:-

- Authentication in GSM system is achieved by the BS sending out a challenge to Mobile Station
- The MS uses a key word on its SIM to send back a response that is then verified
- This only authenticates the MS, not the user.
- To request for a call or to receive a call, MS has to get authenticated.

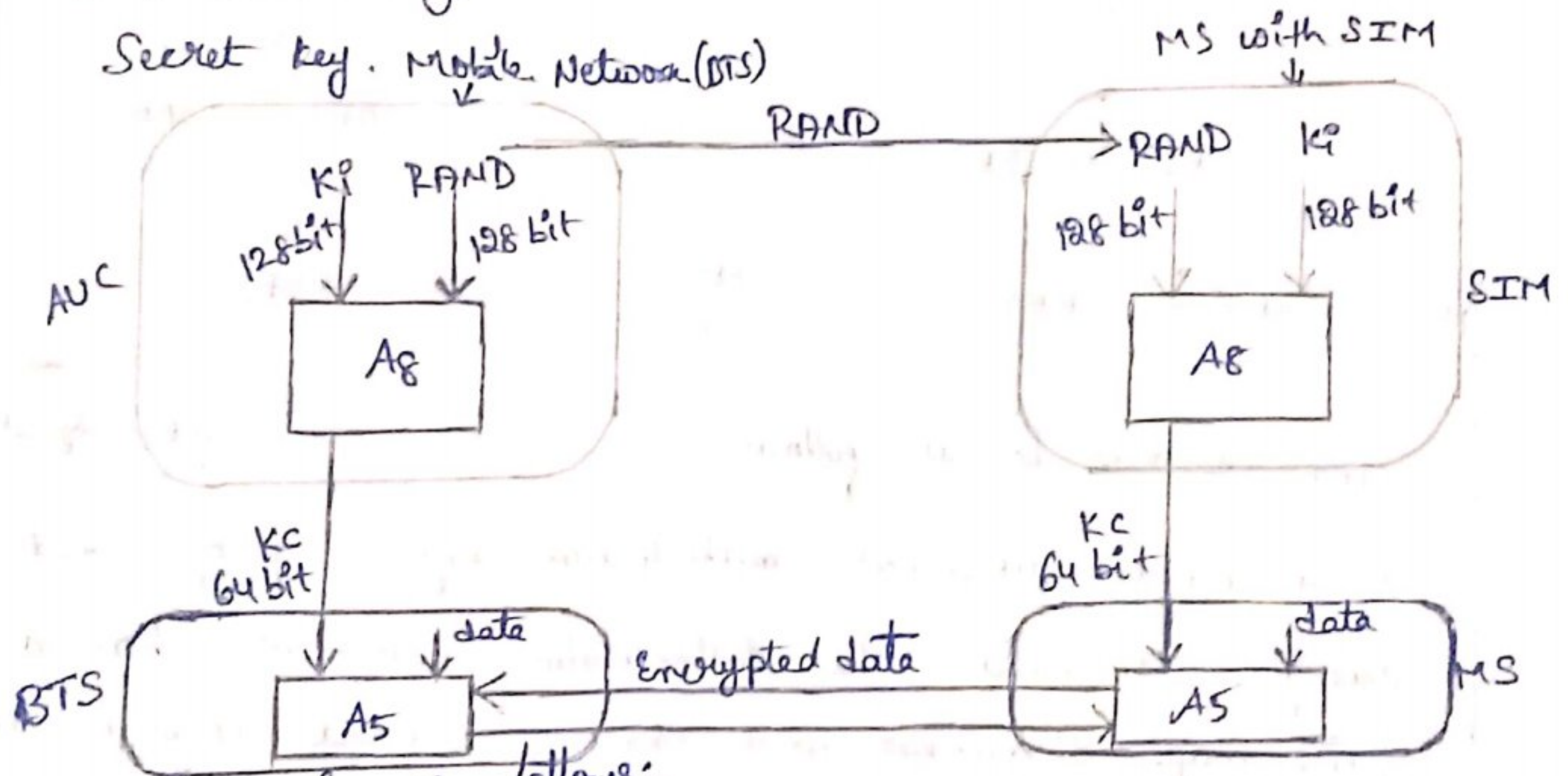


The process is as follows:-

- A unique Subscriber Authentication key is programmed on every SIM card. The Authentication centre (AUC) has a list which maps K_i number with the SIM card. It is a secure database.
- When a SIM card requests for a call, a 128-bit random number is generated by AUC and transmitted to the SIM card.
- The A_3 Algorithm which is programmed inside the SIM card processes the $RAND$ number and K_i number which generates a 32-bit output called Signed Response number ($SRES$).
- The same process is done on the AUC side.
- The SIM card transmits this $SRES$ number to AUC.
- The MSC compares the received $SRES$ with the $SRES$ generated on the network side.
- The SIM is authenticated if and only if the two $SRES$ are same.

Encryption process used in GSM Security:-

- GSM Encryption is only applied to communications between a mobile phone and BS.
- GSM Encryption is achieved by the use of a shared Secret key. Mobile Network (BTS)



The process is as follows:-

- The AUC generates a RAND of 128 bits and sends it to MS
- The RAND and Ki number is processed by A8 algorithm on both the sides.
- The A8 algorithm produces a 64-bit Ciphering Key (Kc).
- The A5 algorithm takes Kc key and data to be transmitted as input and accordingly encrypts the data
- A5 algorithm is different for each service provider and is highly secretive.

5.9) List the features of GPRS and EDGE Systems :-

→ General packet radio Service (GPRS) is a non-voice i.e., data value added service to GSM N/w.

→ GPRS is obtained by doing some changes to upgrade the existing Voice GSM System to Voice plus data

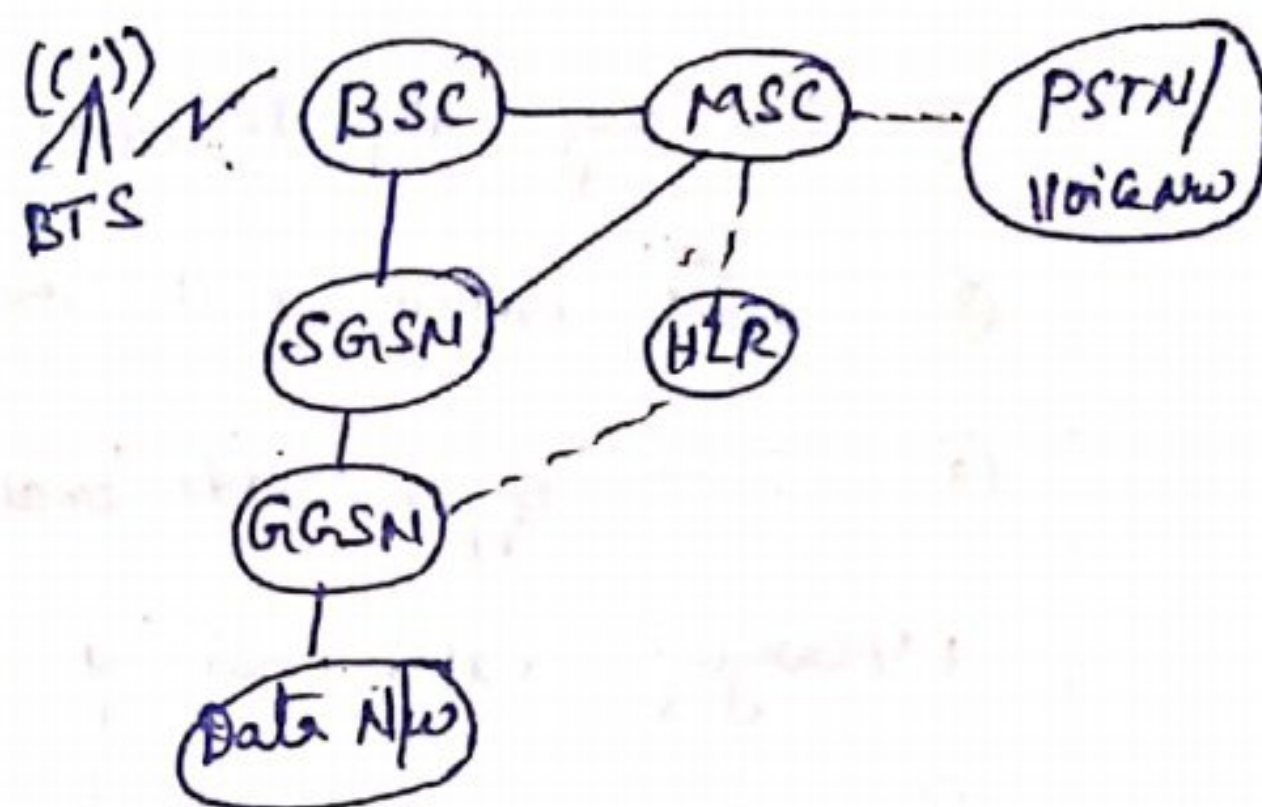
→ EDGE (Enhanced Data rates for GSM evolution) is more advanced upgrade to GSM Standard.

→ EDGE is sometimes referred to as Enhanced GPRS (EGPRS)

→ EDGE requires additional network architecture namely,

① SGSN (Serving GPRS Support Node)

② GGSN (Gateway GPRS Support Node).



* Features of GPRS :-

① packet switching:- It uses packet switched Network i.e., information data is split before transmitting and reassembles at the receiving end.

② Mobile data over GPRS Network:- It uses GSM Network which support data rate upto 171.2 Kbps.

③ Spectrum efficiency

④ Capacity Enhancement

⑤ Device compatibility

⑥ Security Features

* Features of EDGE :-

① High data rate

② Cost effective

③ High Speed Internet on Mobile

④ Video calling

⑤ Compatibility with existing network.

57) List the advantages of GSM:-

- ① Security aspects are more in GSM
- ② GSM carry both voice and data traffic
- ③ GSM offers additional services such as SMS, call forwarding, Messaging, call waiting etc
- ④ Voice is encoded in digital during a call
- ⑤ International roaming would be much easier
- ⑥ GSM use digital technology

58) List the disadvantages of GSM System:-

- ① Security algorithms used in GSM are all undisclosed algorithms. researchers proved that these algorithms cannot guarantee 100% security
- ② GSM has a fixed maximum cell site range of 35km, which is imposed by limitations
- ③ calls made through GSM mobile can be tampered
- ④ Each radio channel uses a frequency guard band and each time slot needs a time guard band which is inefficient.

5.10) compare the features of GSM, GPRS and EDGE:-

parameters	GSM	GPRS	EDGE
1. Data rate	9.6 Kbps	171.2 Kbps	384 Kbps
2. Speed	Low	medium	high
3. Technology	2G	2.5G	2.75G
4. Modulation	GMSK	GMSK	8-PSK
5. Switching Method	Circuit Switching	Packet Switching	packet Switching

5.11) List the salient features of 3G System:

- ① Bluetooth
- ② wireless LAN - Wi-Fi
- ③ Short range wireless communication
- ④ Highly utilised and very popular: offices, airports, universities and schools

5.12) List the advantages of 3G over earlier versions:

- ① 2G has narrow bandwidth. 3G offers wider bandwidth. This enables 3G to carry more data at more speed.
- ② 3G has higher data rate compared to 2G.
- ③ 2G has multiple standards. This causes problem during roaming. On the other hand, 3G has integrated standards.

5.13) List the basic concepts of 4G cellular system:-

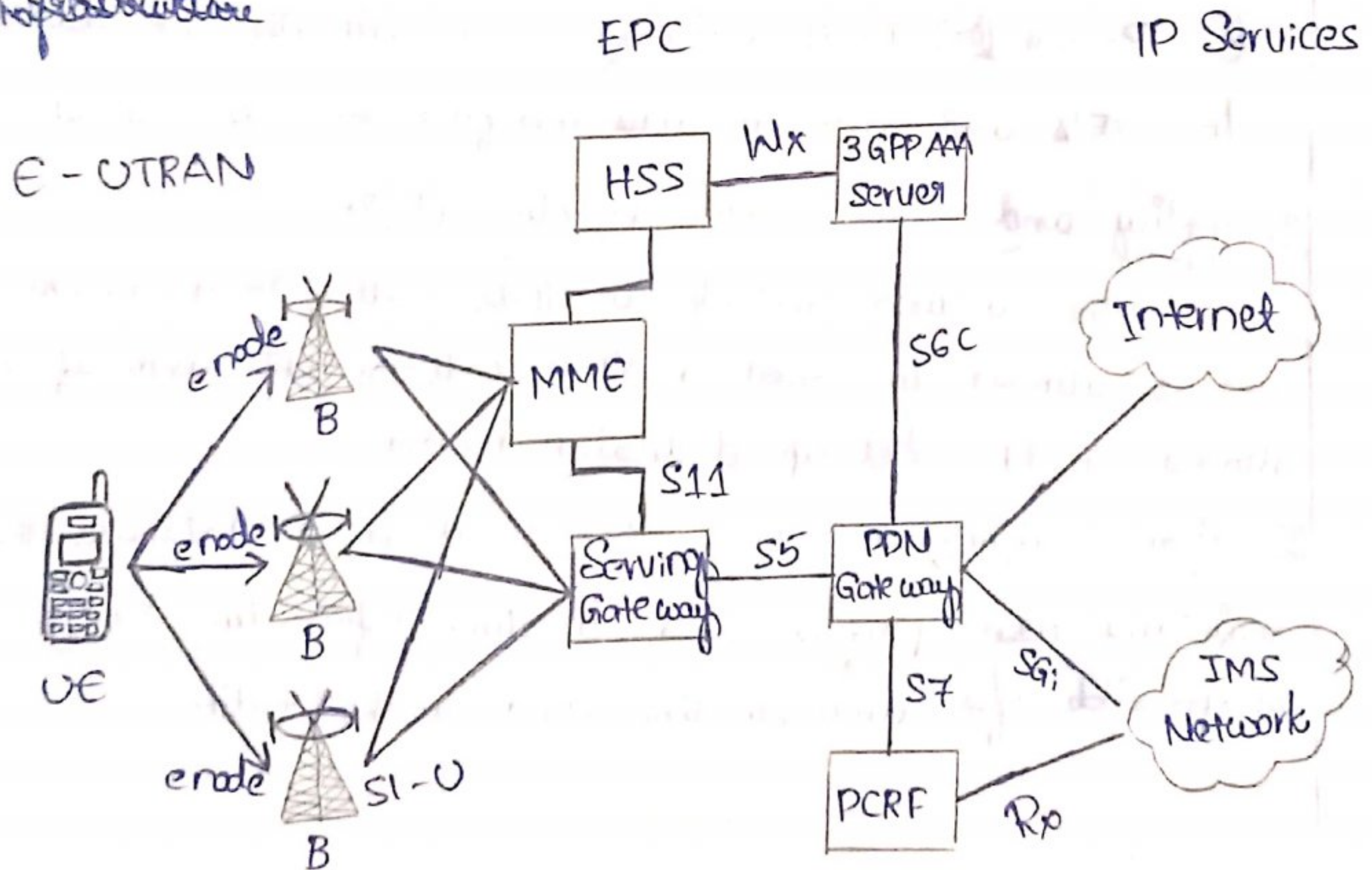
- ① 4G is the Fourth Generation of mobile wireless standards which is the extension of 3G technology with more Bandwidth
- ② It allows users to download a full-length feature film in five minutes.
- ③ It will be able to stream HDTV and radio to hand-held devices
- ④ High Speed, high capacity & low cost per bit
- ⑤ Support interactive multimedia, voice, video, wireless internet and other broadband services
- ⑥ users access to broadband Multimedia services with lower cost

Applications of 4G

- ① Virtual Navigation
- ② Tele-medicine and education
- ③ Multimedia video services
- ④ Tele-geo processing applications
- ⑤ Crisis Management.

5.14) Explain the VOLTE architecture of IP Multimedia Subsystem (IMS)

- The IP Multimedia Subsystem (IMS) is a standardized next generation networking architecture that provides services on top of both mobile and fixed networks.
- The 3rd Generation partnership project (3GPP) and 3GPP2 have developed IMS to provide service delivery platforms.
- IMS offers telecom operators an open IP based service infrastructure



VOLTE Architecture of IMS

VoLTE architecture of IMS consists of:-

① User Equipment (UE):- It is the mobile terminal which may be a Smartphone or tablet or any communication device.

② Evolved Packet Core (EPC):

EPC basically contains three functional elements.

① MME (Mobility Management entity):- It is the most control point in EPC responsible for most of the control functions.

② S-GW (Serving Gateway):- All IP packets in uplink and downlink flow through S-GW.

③ P-GW (or) PDN Gateway:- It allocates IP addresses to UE's and also provides interfaces towards Internet & IMS.

③ Policy and Charging Rule Function (PCRF):-

When a user initiates a VoLTE call, PCRF checks if that user is allowed to start a VoLTE call or not and if it is allowed, PCRF sets up dedicated bearers.

④ Home Subscriber Server (HSS):- It is a database that maintains user profiles and location information. It is also responsible for authentication and authorization.

5-15) List different IMS applications:-

① Web browsing

② Instant messaging

③ Video conferencing

④ Telephony

⑤ Voice over IP

⑥ Multimedia content delivery