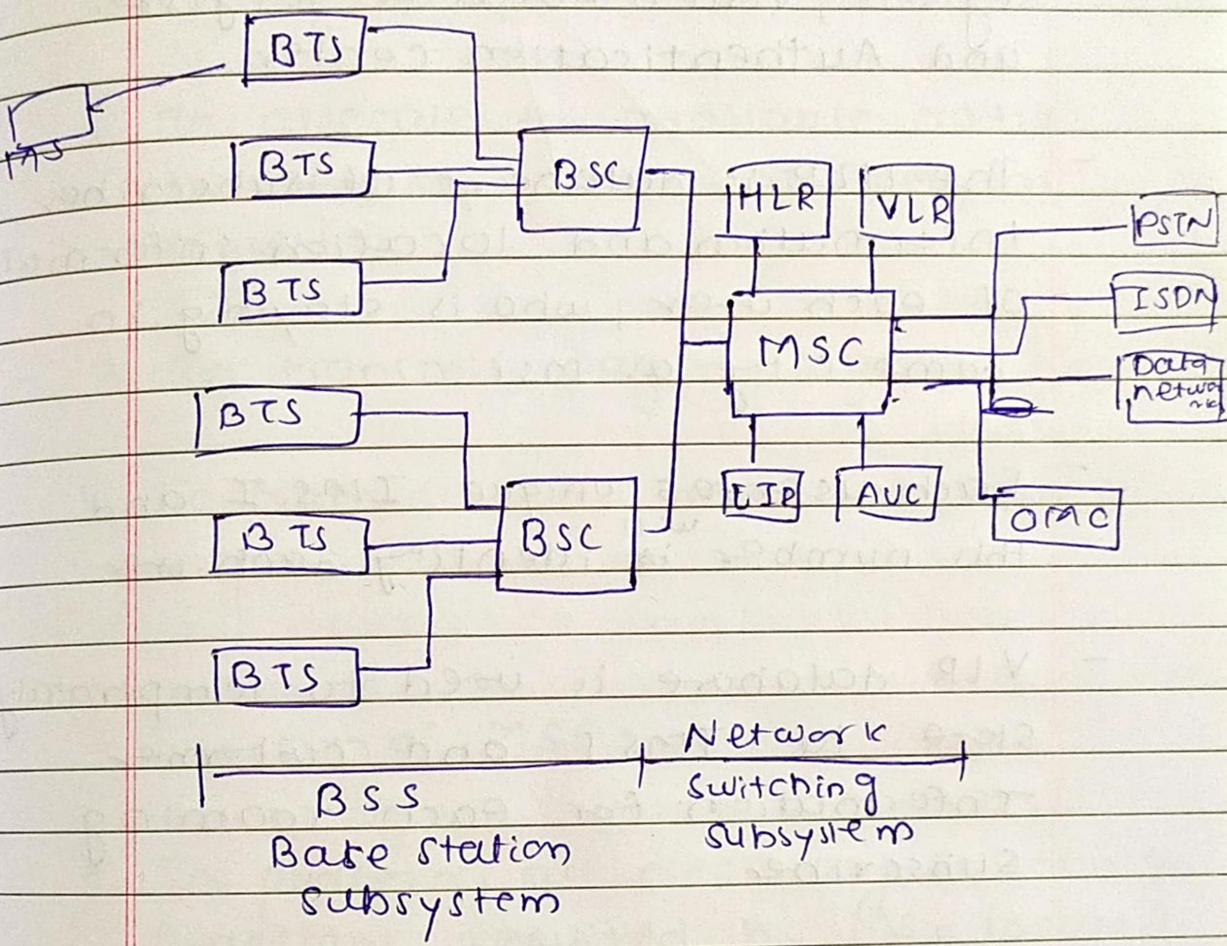
* GSM architecture:-



- BTS and BSC both are part of Base station subsystem

- Each BSC has hundreds of BTs. This BTs are controlled by BSC.
- BTS are connected to BSCs either physicaly or via microwave links or dedicated leased lines

- The BSC are physicaly connected to MSC via lines.

- The NSS contains three different databases called Home Location Register, Visitor Location Register and Authentication center.

- The HLR is database of subscriber information and location information of each user, who is staying in same city as MSC.

- Each user has unique IMSI and this number will identify each user.

- VLR database is used to temporarily store the IMSI and customer Information for each roaming subscriber.

- AUC is strongly protected database which takes care of authentication and handles the encryption keys for all the subscribers in HLR and VLR.

- OMC is used for monitoring and maintaining the performance of each MS, BS, BSC and MSC used in GSM system.

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Function of BSS :-

1. coding of speech channel.

2. To allocate the available radio channels to mobile stations on request.

3. To transmit paging signal.

4. To transmit and receive date signals.

Function of MSC :-

1. To perform all necessary switching functions required by MSs located in MSC area.

2. To communicate with other MSCs present in GSM network.

3. To communicate with other networks like PSTN etc.

4. To track the location of user to handover process whenever necessary.

5. To perform all necessary interworking functions.

Services in GSM:-

~~GS~~ GSM services

Teleservices | Data/Bearer services | Supplementary services

x Teleservices:-

- These services allows subscriber to use terminal equipment functions for communication with other subscribers.

- The tele-services are as follow:-

1. Digital telephony
2. Emergency calling
3. SMS
4. EMS
5. MMS
6. Group 3 FAX.

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* Data/ Bearer Services:-

- These services allow subscriber to transmit appropriate signals across user network interface.

- Data services are a sm services corresponding to communication between computes and packet switched traffic.

- Data can be transmitted in two modes:-

1. Transparent mode :- standard channel coding method.

2. Non-Transparent mode :- special coding methods.

* Bearer services:-

- all those ~~network~~ services that enable the transmission of data between interfaces and network

- packet switching

- Two mods:-

1. Transparent bearer services.

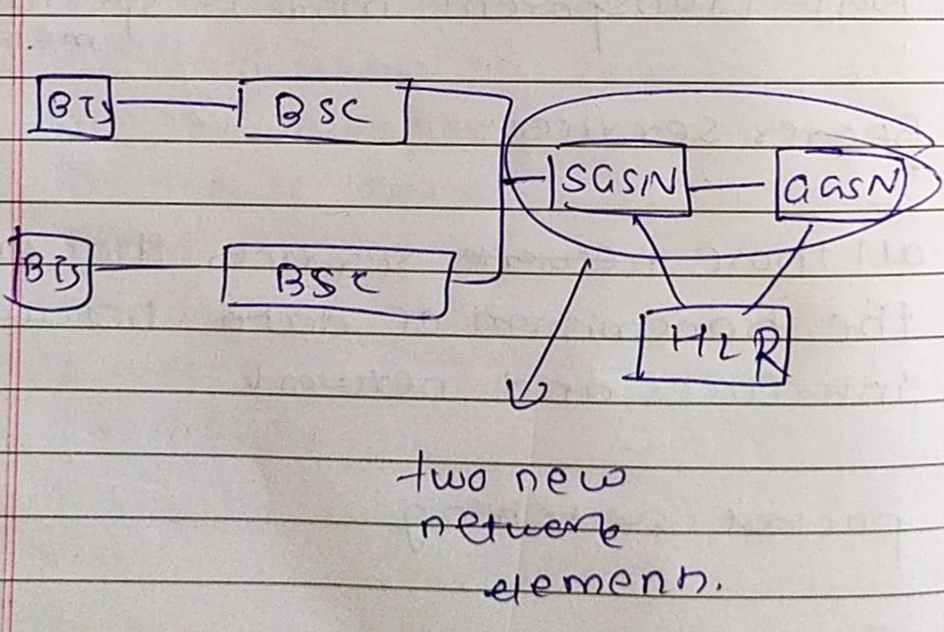
2. Non-Transparent bearer service.

Supplementary service:

- Digital in nature, offered as supplements with basic teleservices.

- Services:-
1. Conference call.
2. Call Hold
3. Call waiting.
4. Call forwarding
5. Call Barring.

* GPRS system:- General Packet Radio services



1- SGSN :- serving GPRS support Node
- Analogous to MSC in GSM.
- within service area, delivers packets to MS.

- Send queries to HLR for subscriber data.

- detect new GPRS MS subscriber and ~~process~~ keep records of their location.

- perform the attaching/ detaching mobile subscriber and its location management.

Function of SGNS :-

1. Mobility Management
2. Authentication.
3. Tracking location.
4. Routing data to and from MS.

2. GGSN :- Gateway GPRS Support Node:

- acts simply as router.

- data addressed to mobile user is received by GGSN, it first checks if the called address is active. If it is active, GGSN forwards.

- Also track mobile user

Advantags:-

1. higher data rate than GSM 171 kbps to 40 kbps.
2. packet switched.
3. Always on capability
4. Better traffic management.
5. for longer data transmission, works efficiently.

Disadvantags:-

1. connection is active, calls related functions cannot be used.
2. Does not provide store and forward service.

Application:-

SMS,
MMS,
Internet acces,
Video conference.
Emails.

	GSM	GPRS
Based system	TDMA	GSM
user per chanel	8	8
	circuit switched Technology	Pact Switche Techno.
	200 KHZ TDMA	200 KHZ.

* LTE:-

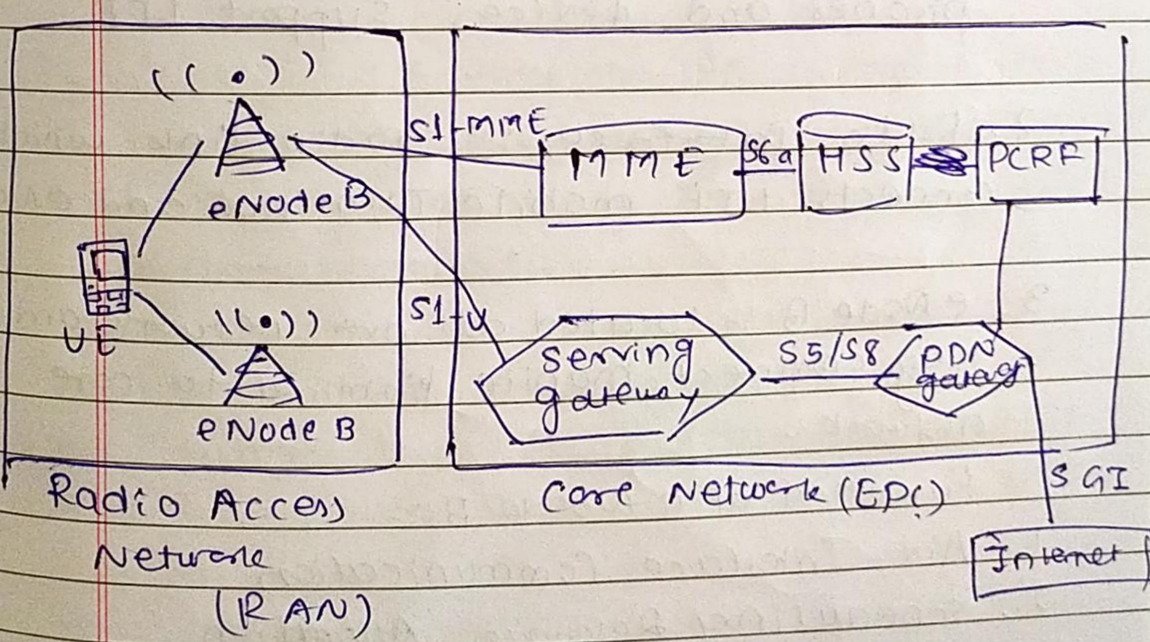
- Long Term Evolution.

- LTE was introduced to get higher data rates, 300 mbps downlink and 75 Mbps uplink.

- Due to use of MIMO, transmission in LTE improved.

- LTE technology supports high data rates for voice over IP, streaming multimedia, video conferencing.

* LTE architecture:-



- LTE architecture ~~is simple~~ contains single type of access points i.e. eNodeB or Base Station.

- LTE-A network consists of

1. Radio ~~A~~. Access Network (RAN)
2. Core Network
3. Radio Interface

1. Radio Access Network :-

- It consists of LTE mobile Terminal, radio interface and eNode B.

1. LTE mobile Terminal :- All mobile phones and devices support LTE.

2. Radio Interface :- radio link which connects LTE mobile Terminal and eNodeB.

3. eNode B :- located all over network and they connect mobile terminal to core network.

Function of eNode B :-
1. Air Interface Communication
2. Scheduling Resource Allocation
3. Physical layer function

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2. Core Network :-

- Enhanced Packet Core (EPC) developed for 4G is based on packet switched transmission.

- The LTE core network is brain of 4G system.

- It consists of :-
1. Mobility management Entity (MME).
2. Serving gateway (S-GW)
3. Packet data network (PDN) gateway.
4. Home Subscriber Server (HSS).
5. Policy and charging Rules Function (PCRF).

1. MME :- function of MME is to handle the signalling of messages, tracking, security and paging of mobile terminals.

2. Serving Gateway :-
- It serves as a router for ~~~~ forwarding the data packets between user and PDN gateway,
- connected to RAN by S1 interface

3. PDN gateway:-

- PDN gateway connects the core network with internet with the SGi interface.
- PDN routes traffic to and from the PDN networks.

4. HSS :-

- Database of all users.
- Responsible for authentication and call setup.

5. ~~Poli~~ PCRF :-

- entity manages policy and charging rules
- It controls and manages all data sessions and offers suitable charging and billing system.

Function of core Network :-

1. Charging and subscriber management.
2. mobility management.
3. Provision of quality of service
4. Connection to other external networks.
4. Policy control of user data flows.

* LTE-A : Key Technologies:-

- LTE-A technology was designed to be compatible with LTE, so it can communicate with base station that is operating LTE and conversely.

- LTE-Advanced was required to deliver a peak data rate of 1000 Mbps in downlink and 500 Mbps uplink.

- Key technologies of LTE-A :-

1. carrier aggregration :-

- A carrier aggregration ensures the wider bandwidth.

- A technique where multiple carriers of maximum bandwidth of 20 MHz would be aggregrated for same user equipment is known as carrier aggregration.

- LTE-A allows a mobile to transmit and receive upto five component carriers, each of 20 MHz.

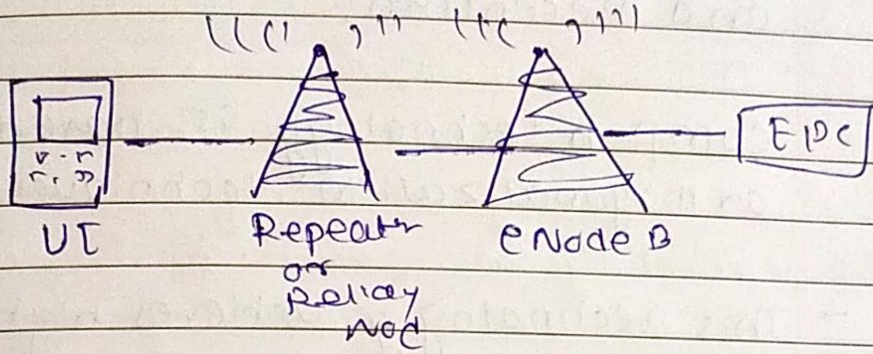
- CA supports continuous and non-continuous carrier.
- continuous carrier aggregation is used for super high bandwidth.
- Non-continuous has more application than continuous.

2. Enhanced MIMO :-

- important aspect of LTE advanced technique.
- Enhanced MIMO expands MIMO capabilities of LTE.
- In LTE-A, enhanced MIMO technique ensures higher efficiency enabled by improved ~~uplink~~ multiple antenna transmission.
- multiple transmit and receive antennas are used to offer an enhanced downlink MIMO and uplink MIMO that improves data rates.

- Enhanced MIMO supports eight downlink and four uplink antennas

3. Wireless Relay :-



- In wireless relay technology, different levels of wireless multihop relays are used.
- Relaying improves performance of LTE.
- The Relay node allows signal forwarding bet^w UE and eNode B.
- Relay Node acts like repeater between UE and eNode B.
- RN improves coverage by expanding to heavily shadowed areas in cell.
- RN increase data rate at edge of cell.

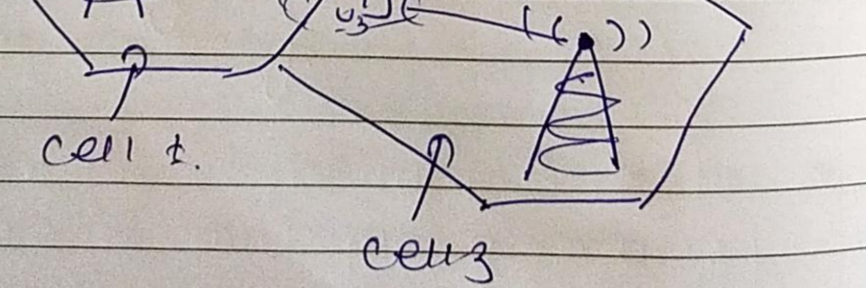
4. Coordinated multipoint Transmission and Reception:-

- CoMP technology is based on orthogonalization techniques.

- This technology achieves higher spectral efficiency and higher peak rates for normal and edge users.

- Coordinated multipoint improves cell-edge user throughput by using multi-cell coordination.

- Users can access smooth and fast Internet whether they are in cell centre or at cell edge.



* Comparison of LTE and LTE-A :-

	LTE	LTE-A
modulation	QPSK, 16QAM, 64QAM	64QAM, 64QAM.
Duplex method	TDD and FDD	TDD and FDD.
spectral efficiency	moderate	3 times higher than LTE.
Peak data rates	Downlink : 300Mbps Uplink : 75 Mbps	Downlink : 1GBps Uplink : 500Mbps
Release	8/9	Release 10

Challenges for 5G Network:-

b. ~~5G should be able to deliver~~

1. The key challenge in establishing 5G network is its flexibility and efficiency in using the available capacity in spectrum for deployment of various networking scenarios.

2. 5G should be able to deliver a connection with suitable QoS as mobile networks have been covering all aspects of our daily communication.

3. 5G networks should be highly reliable and secure.

4. 5G network should support many devices from cars to wearble devices.

5. 5G network should be capable of providing large connectivity and huge capacity.

6. 5G network should provide the data rate of multiple giga bits per second.

* Requirements for 5G Networks:-

1. 5G networks need extreme flexibility to support various application and services.

2. 5G should be able to support at least 1 Gb/s or more data rate for providing ultra-HD video and virtual reality applications.

3. 5G should increase their capacity by factor of 1000 in traffic load.

4. 5G network should consider millimeter waveform for spectrum usage.

5. 5G network should have mobility with maximum speed higher than 350 km/h.

* Open wireless Architecture of 5G:-

- The 5G concept in wireless technology corresponds to open system interconnection OSI layer.

OSI model	5G model
Application layer Presentation layer	Application (Services)
Session Layer Transport Layer	Open transport protocol (OTP)
Network Layer	Upper Network Lower Network
Data link Layer Physical Layer	Open wireless Architecture (OWA)

1. Application Layer:-

- It is lowest layer of 5G model.
- It corresponds to physical and data link layer of OSI model.

2. Network Layer:-

- Network Layer of 5G model is divided into two layers:-
  Upper Network Layer.
  Lower Network Layer.

- corresponds to network layer in OSI model.

- Due to problems in IPV4 and IPV6, all mobile networks will use mobile IP standard in 5G.

- Each mobile terminal in 5G will be a foreign agent (FA), maintaing care of address (COA) mapping between it's fixed IP V6 address and COA for current network.

3. Open Transport Protocol (OTP):-

- It corresponds to transport and session layers in OSI model.

- In wireless technology, losses can occur due to higher bit error ratio.

- It will be suitable to have transport layer for 5G mobile terminals, which can be downloaded and installed.

- Such mobiles will have ability to download the desired version specifying wireless technology installed at Base station. This is known as Open Transport protocol.

4. Application Layer:-

- Topmost layer of 5G and corresponds to application layer of OSI model.

- Application layer provides intelligent QOS management over network.

- In 5G phone, the QOS parameters such as losses, delay, etc will stored in database.

- Application layer selects the best wireless connection for given service.

Advantages:-

1. 5G technology can gather all networks on one platform.
2. It is more effective and efficient.

3. compatible with previous generation

4. can offer uniform, uninterrupted and consistent connectivity across world.

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Disadvantages:-

1. still under process.

2. Claimed speed seems difficult to achieve.

3. Developing infra of 5G is costly.

4. security and privacy issue are yet to be resolved.

Application :-

1. Entertainment and multimedia.
2. IOT.
3. smart cities.
4. Drone operations.
5. Logisticis and shipping.