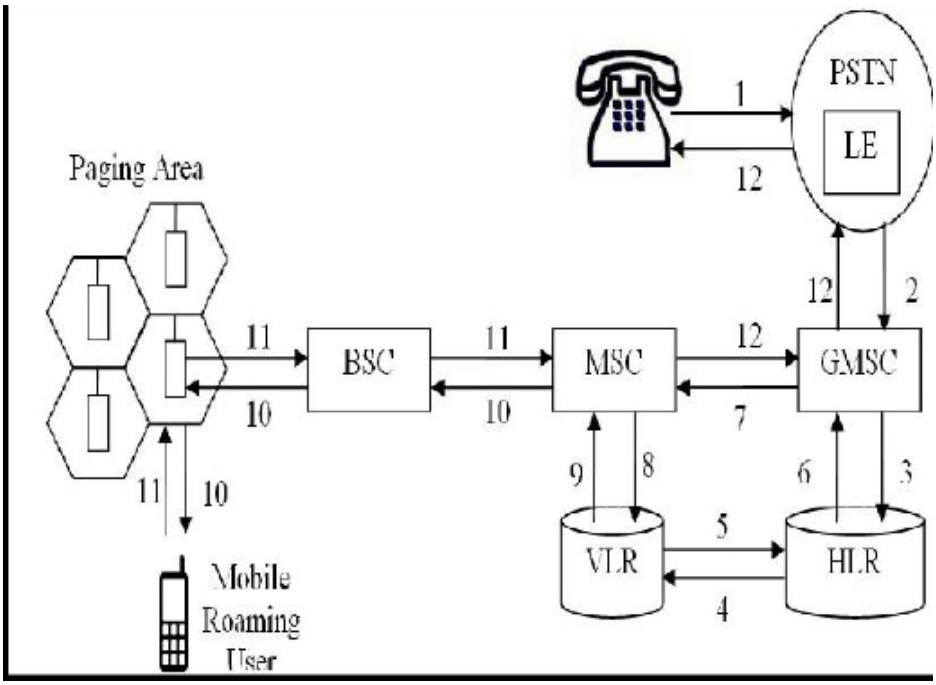
- # Chapter 3

Describe the process of mobile terminated call (Incoming call) in GSM with neat call flow sequence diagram.



Explanation:

1) The PSTN user dials the MSISDN of the called user in GSM.
2) The LE routes the call to the GMSC of the called GSM user.
3) The GMSC uses the dialed MSISDN to determine the serving HLR for the GSM user and interrogates it to obtain the required routing number.
4) The HLR requests the current serving VLR for the called MS for a MSRN(MS
5) roaming number so that the call can be routed to the correct MSC.
6) The VLR passes the MSRN to the HLR.
7) The HLR passes the MSRN to the GMSC.
8) Using the MSRN, the GMSC routes the call to the serving MSC.
9) The MSC interrogates the VLR for the current location area identity (LAI) for the MS. The VLR provides the current location for the MS.
10) The MSC pages MS via the appropriate BSS. The MS responds to the page and sets up the necessary signaling links.
11) When the BSS has established the necessary radio links, the MSC is informed an the call is delivered to the MS.
12) When the MS answers the call, the connection is completed to the calling PSTN user.

Draw GSM system architecture and explain function of HLR and OMC units.

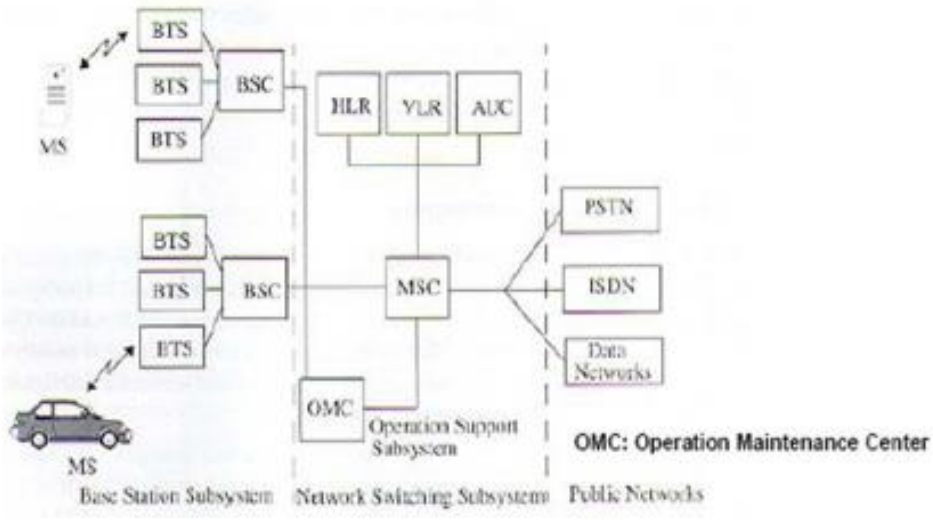


Fig. GSM system architecture

Home Location Register (HLR):

This **database contains all the administrative information about each subscriber along with their last known location.**

In this way, the GSM network is able to route calls to the relevant base station for the MS. When a user switches on their phone, the phone registers with the network and from this it is possible to determine which BTS it communicates with so that incoming calls can be routed appropriately.

Even when the phone is not active (but switched on) it re-registers periodically to ensure that the network (HLR) is aware of its latest position.

There is one HLR per network, although it may be distributed across various sub-centres for operational reasons.

Operation maintenance center (OMC):

Network operation and maintenance functions, subscription, management including charging and billing and also mobile equipment management.

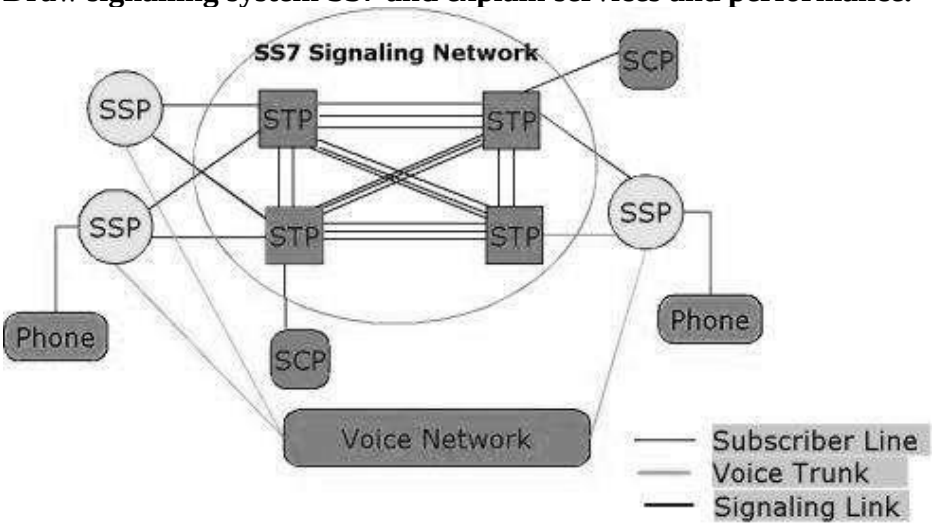
The OMC also has provision for adjusting all base station parameter and billing procedure as well as providing system operators with the ability to determine the performance and integrity of all equipments in the system.

List out any four features of IS-95-CDMA system.

Compare IS95 with GSM. (any four points)

Sr .No.	Parameters	IS-95	GSM
1	Number of full duplex channel	20	125
2	Bandwidth of each channel	1.25MHz	200KHz
3	Muliple Access method	CDMA	TDMA
4	Number of users per channel	64	8
5	Type of Modulation	BPSK / QPSK	GMSK
6	Data rate	9.6 / 14.4 Kbps	27.833Kbps
7	Frame duration	20ms	4.615ms
8	Hand off	Soft	Hard
9	Frequency spectrum	800 or 1900 MHz	890-915 MHz 935-960MHz

Draw signalling system SS7 and explain services and performance.



SS7 Services:

- **Touch star:**

This kind of service is also known as CLASS and is a group of switch- controlled services that provide its users with certain call management capabilities.

Services such as call return, call forwarding, repeat dialing, call block, call tracing and caller ID are provided

or

- **800Services:**

These services were introduced by Bell Systems to provide toll-free access to the calling party and to the services and database which is offered by the private parties.

The costs associated with the processing of the calls are paid by the service subscriber.

The service is offered in **two plans** known as the **800-NXX plan and the 800 database plan**.

In the **800-NXX plan the first six digits of an 800 call are used to select the interexchange carrier(IXC).**

In the **800 database plan, the call is looked up in a database to determine the appropriate carrier and routing information**.

- **Alternate Billing Service and Line Information Database(ADB/LIDB):**

These services **use the common channel signaling (CCS) network to enable the calling party to bill a call to a personal number (third party number, calling card or collect, etc.) from any number.**

Performance of SS7

- Performance of signaling network is studied by connection set-up time (response time) or the end-to-end Signaling information transfer time.
- The delays in the signaling point (SP) and the STP depend on the specific hardware configuration & switching software

Illustrate with the help of neat timing diagram, the process of cell initiation from mobile handset to a landline phone (PSTN) 6M

MSC			Receives call initiation request from base station & verifies that the mobile has a valid MIN, ESN pair.	Instructs FCC of originating base station to move mobile to a pair of voice channels.		Connects the mobile with the called party on the PSTN.	
BASE STATION	FCC				page for called mobile, instructing the mobile to move to voice channel.		
	RCC	Receives call initiation request and MIN,ESN,Station Class Mark.					
	FVC						Begin voice transmission
	RVC						Begin Voice reception
MOBILE	FCC				Receives page & matches the MIN with its own MIN. Receives instruction to move to voice channel.		
	RCC	Sends a call initiation request along with subscribe MIN & number of called party					
	FVC						Begin Voice reception
	RVC						Begin voice transmission

Timing diagram illustrating how a call initiated by mobile is established

OR

A **call initiation request is sent** on the **reverse control channel (RCC).**
Mobile unit transmits its telephone number (MIN), Electronic Serial Number (ESN), Station Class Mark (SCM) which indicates power level and telephone number of called party.
The **cell BS receives** this **information and sends it to MSC**.
The **MSC validates the request**, **makes connection to called party through the PSTN**.
MSC instructs BS and mobile user to move to an unused voice channel pair to allow the conversation to begin.

OR

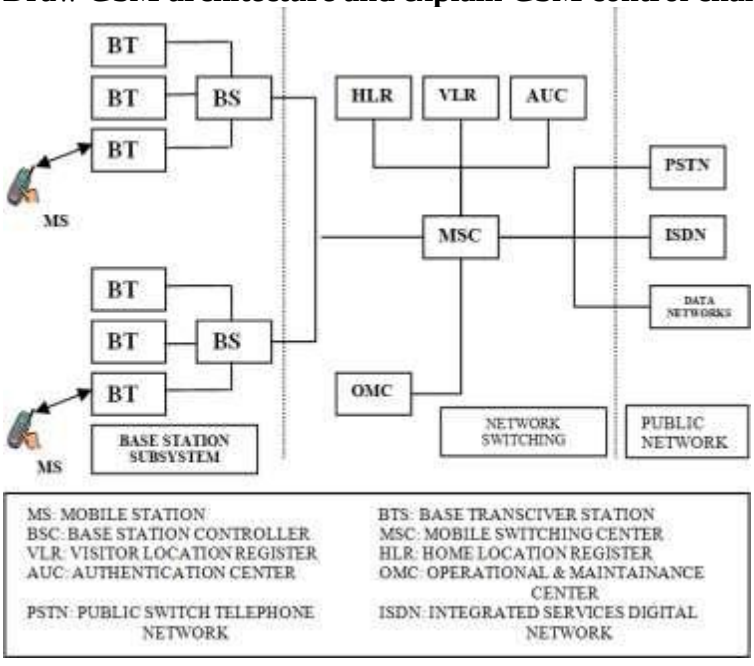
When a mobile originates a call, a call initiation request is sent on the reverse control channel.
With this request the mobile unit transmits its telephone number (MIN), Electronic Serial Number (ESN) and the telephone number of the called party.
The base station receives the MIN, ESN of called party along with Station Class Mark (SCM) which indicates what is the maximum transmitting power level.
The received details are forwarded to MSC.
The MSC validates the request by checking the MIN, ESN etc. in its records.

After validation, MSC instructs the originating Base station to move mobile to a unused pair of voice channels (FORWARD & REVERSE VOICE CHANNEL).
The called party telephone number, is then broadcast as paging message over all forward control channel throughout the cellular system (If the called number is another mobile phone) .
The mobile receives the Paging message sent by base station which it monitors, and matches the received MIN with its own MIN.
With MIN the called mobile phone number receives the instruction of moving itself to unused pair of voice channel.
And then it makes connection to the called party.
This connection is made with the called party through the PSTN, if the called party number is a landline telephone

Compare IS 95 standard with GSM standard with respect to the following points:
1) Frequency band
2) Multiple access
3) Modulation technique
4) Channel bandwidth
5) No of voice channel
6) SMS length.

Parameter	GSM	IS-95
Frequency band	890-915 MHz 935-960MHz	800 or 1900 MHz
Multiple access	TDMA	CDMA
Modulation technique	GMSK	QPSK /BPSK
Channel bandwidth	200KHz	1250KHz or 1.25MHz
No of voice channel	8 per channel	64 per channel
SMS length.	160	120

Draw GSM architecture and explain GSM control channels.



GSM control channel (CCH):

1) Broadcast channel (BCH):

Broadcast control channel (BCCH):

The BCCH is a forward control channel that is used to broadcast information such as cell and network identity, operating characteristics of the cell (current control channel structure, channel availability and congestion).

The BCCH also broadcast a list of channels that are currently in use within the cell.

(a) Frequency correction channel(FCCH):

The FCCH allows each subscriber unit to synchronize its internal frequency standard (local oscillator) to the exact frequency of the base station.

(b) **Synchronization channel (SCH):** SCH is used to identify the serving BS while allowing each mobile to frame synchronizes with the BS. The frame number (FN) is sent with the base station identity code (BSIC) during the SCH burst.

2) Common control channel (CCCH):

(a) **Paging channel (PCH):**The PCH provides paging signals from the BS to all mobiles in the cell, and notifies a specific mobile of an incoming call which originates from PSTN.PCH may be used to provide cell broadcast ASCII text messages to all subscribers.

(b) **Random Access Channel (RACH):**The RACH is a reverse link channel used by a subscriber unit to acknowledge a page from the PCH and is also used by mobiles to originate a call.

(c) **Access grant channel (AGCH):**The AGCH is used by the BS to provide forward link communication to the mobile, and carries data which instructs the mobile to operate in a particular physical channel.

3) Dedicated control channel (DCCH):

(a) **Stand-alone Dedicated control channel (SDCCH):**The SDCCH carries signaling data following the connection if the mobile with the BS, and just before TCH assignment issued by the BS. The SDCCH ensures that the mobile station and base station remain connected while the BS and MSC verifies subscriber unit.

(b) **Slow Associated Control Channel (SACCH):**On the forward link the SACCH is used to send slow but regularly changing control information to the mobile such a transmit power level instruction. On the reverse link the SACCH carries information about the received signal strength.

Fast Associated Control Channel (FACCH):FACCH carries urgent messages and contains essentially the same type of information as SDCCH.

Explain step by step procedure of landline originated call with neat timing diagram. 6M

Ans

:

When a cellular phone is turned ON, but not yet engaged in a call, it first scans the group of forward control channels to determine the one with the strongest signal, and then monitors that control channel until the signal level drops below a usable level.

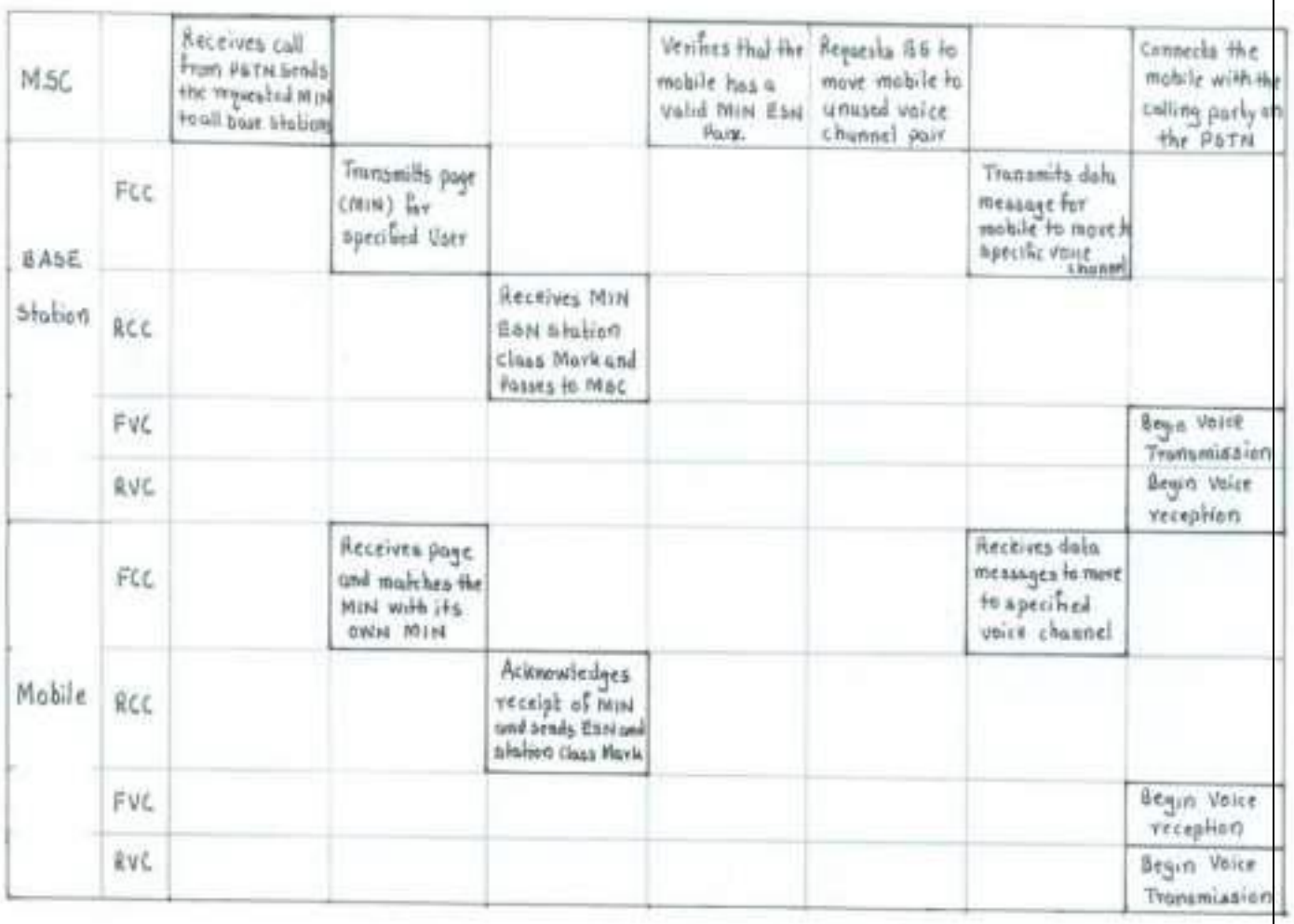
Call initiation by a landline (PSTN) subscriber to mobile user:

- The mobile switching centre (MSC) dispatches the request to all base station in a cellular system.
- The Mobile Identification Number (MIN) which is subscriber telephone number is then broadcast as a paging message over all of the forward control channels throughout the cellular system.
- The mobile receives the paging message sent by BS which s monitors, and responds by

identifying itself over the RCC.

- The BS relays the acknowledgement sent by the mobile and informs the MSC of handshake.
- The MSC instructs the BS to move the call to an unused voice channel pair within the cell.
- The BS signals the mobile to change frequencies to an unused forward and reverse voice channel pair.
- Another data message is transmitted on forward channel to instruct the mobile telephone to ring and mobile user to answer the phone.

Figure below shows sequence of events involved in call connection



Call Procedure initiated by landline user/Call initiated by Landline Telephone

CDMA 2000 is more advantages over 3G GSM standards. Justify. 4M
Ans
:
Advantages of CDMA 2000
1 .Increased voice capacity.
2. Higher data throughput.

3. Multicastervices.
4. Frequency band flexibility.
5. Migration paths.
6. Serves multiple markets.
7. Supports multiple service performances.
8. Full backward compatibility.
9. Increased battery life.
10. Power control.

It provides high data rate internet access capabilities in gradual manner within the existing systems.

List various 3G standards and state any four features of third generation (3G) standard Systems

Various 3G standards are:

(1) W-CDMA
(2) IMT 2000
(3) CDMA 2000
(4) TDSCDMA

Features of Third generation (3G) standard system:

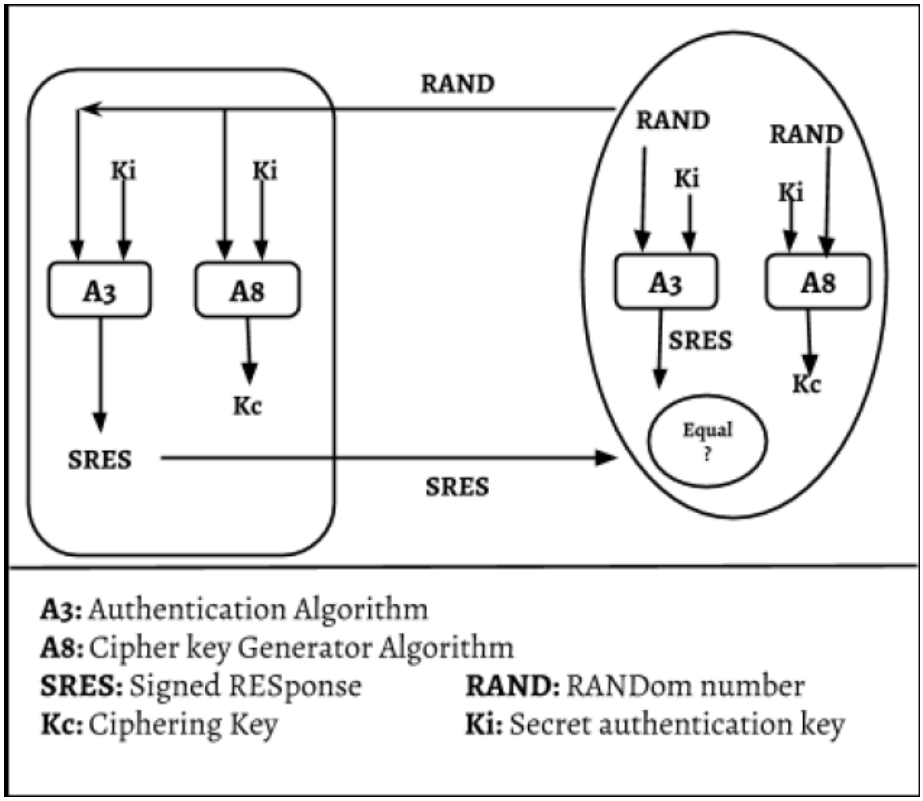
- Multi-megabit internet access.
- Voice activated cells.
- Unparalleled network capacity.
- Ubiquitous " always on" access.
- Communications using voice over internet protocol

Compare GSM system with IS-95 standard w.r.t.
(i) Data rates
(ii) Handoff used
(iii) Channel Bandwidth

(iv) Modulation used

PARAMETER	GSM	IS-95
Data Rate	9.6 kbps	14.4 Kbps
Handoff used	HARD	SOFT
Channel Bandwidth	200KHZ	1.23MHZ
Modulation used	GMSK	QPSK/BPSK

Explain Authentication process in GSM with suitable diagram. 4M
Ans:



1.At terminal location update, VLR sends IMSI to the HLR.
2. HLR returns security triplets (RAND, SRES, Kc) to the VLR.
3. For authentication and ciphering the VLR sends RAND to the MS.
4. Using stored A3 algorithm and secret key Ki stored in the SIM, and RAND provided by the VLR, the MS calculates the SRES and returns it to the VLR.
5.Using the A8 algorithm and Ki, the MS also calculates the cipher key Kc.
6. If the SRES returned by the MS matches with the stored SRES in the VLR, the VLR sends the cipher key Kc to the BTS which uses Kc for ciphering the radio path (downlink).
7.The MS uses its Kc to cipher the radio path (uplink) using encryption algorithm A5.

OR

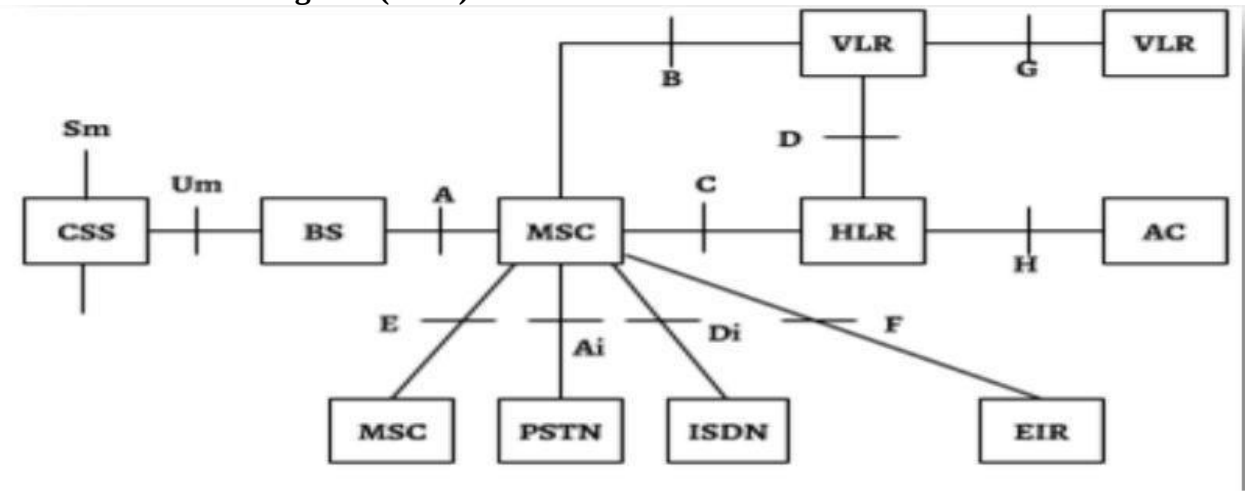
Explanation

Authentication refers to process by which station confirms the identity of mobile station.
It protects GSM network against unauthorized access.
The Authentication Centre is responsible for all security aspects.

- The AUC generates the Ki"s associates them with IMSI and provides for each IMSI a set of triplets consisting of **RAND(Random Number), SERS (signed Response), Kc (Cipher key)** Authentication center first authenticate the subscriber mobile station and only then MSC provides service.
- At MS- SIM contains the entire authentication data along with A3 and A8 algorithm and signed response is generated using this.
- At network side signed response is generated using same algorithm and random number and if both the signed response matches then mobile phone authenticated.

List various key features of IS-95 CDMA system. 4M
Ans: (Note: 1M each for correct features of IS-95 CDMA (Any 4 correct features)
Key features of IS-95 CDMA system:
1. Diversity
2. Power Control
3. Soft handoff
4. IS-96 system capacity
5. soft capacity
6. Quality of service
7. Economics

Draw system architecture of IS-95. Explain working of mobile switching center (MSC) and Home location register (HLR) in it.



CSS- Cellular Subscriber Station
BS-Base station
MSC- Mobile switching center
HLR-Home location registers
EIR-Equipment identity register
VLR- Visiting location registers
AC- Authentication center
Explanation :
Home Location Register: Permanent database about mobile subscribers in a large service area. Database contains subscriber & location information. Database contains prepaid/postpaid, roaming restrictions, supplementary services.
Mobile Switching Center: It co-ordinates the activities of all the base stations and connects the entire cellular system to the PSTN. A typical MSC handles 100,000 cellular subscribers and 5,000 simultaneous conversations at a time, and accommodates all billing and system maintenance functions as well.

State two features of CDMA 2000. 2M
Ans
:
1. It has very high packet data rates.
2. It has high radio channel bandwidth of 1.25 MHz
3. It has global seamless connectivity.
4. Very good performance
5. Support for advanced mobile services
6. Efficient use of spectrum
7. selection of device
8. Evolution path
9. Flexible
10. CDMA2000 uses Frequency Division Duplexing-Multicarrier (FDD-MC) mode. Here, multicarrier implies N × 1.25 MHz channels overlaid on N existing IS-95 carriers or deployed on unoccupied spectrum. CDMA2000 includes −
11. 1x — uses a spreading rate of 1.2288 Mcps.
12. 3x — uses a spreading rate of 3 × 1.2288 Mcps or 3.6864 Mcps.
13. 1xEV-DO (1x Evolution – Data Optimized) — uses a spreading rate of 1.2288 Mcps, optimized for the data..

State the advantages of CDMA 2000 over 3G-GSM standards. 4M
Ans
:
Advantages of CDMA 2000 over GSM:-
1. Increased voice capacity
2. Higher data throughput
3. Multicast services
4. Frequency band flexibility
5. Incresed battery life
6. Synchronization
7. Power control and supplemental channels
8. Flexible channel structure in support of multiple services with various QoS and variable transmission rates.

Write GSM Air interface specification for the following parameters :
(i) Reverse channel frequency
(ii) Forward Channel frequency
(iii) ARFCN number
(iv) Modulation
(v) TX/RX Frequency spacing
(vi) Users per frame

Sr. No.	Parameter	Specification
1.	Reverse Channel Frequency	890-915 MHz
2.	Forward Channel Frequency	935-960 MHz
3.	ARFCN Number	0 to 124 and 975 to 1023
4.	Modulation	0.3 GMSK
5.	Tx/Rx Frequency Spacing	45 MHz
6.	User per Frame (Full rate)	8

Explain the working of different levels of SS7 protocol architecture with neat sketch. 6M

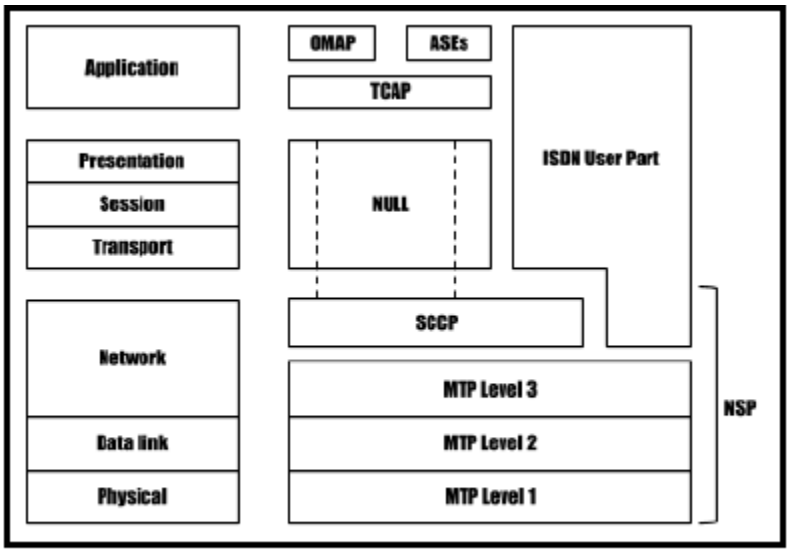


FIGURE: SS7 PROTOCOL ARCHITECTURE

I. NETWORK SERVICE PART (NSP) OF SS7:

- The NSP provides ISDN nodes with a highly reliable and efficient means of exchanging traffic using connectionless services.

MESSAGE TRANSFER PART (MTP) OF SS7:

- The function of MTP is to ensure that signaling traffic can be transferred and delivered reliably between the end-users and the network.
- MTP is provided at three levels.

1. Signaling Data Link Functions (MTP Level 1):

- This level provides an interface to the actual physical channel over which communication takes place.
- Physical channels may include copper wire, twisted pair, fiber, mobile radio or satellite link.

- This level uses 64 kbps transmission.

2. Signaling Link Function (MTP Level 2):

- It provides a reliable link for the transfer of traffic between two directly connected signaling points.
- Variable packet messages, called message signal units (MSUs) are defined in MTP level 2.
- MTP level 2 also provides flow control data between two signaling points as a means of sensing link failure.

3. Signaling Network Function (MTP Level 3):

- It provides procedures that transfer messages between signaling nodes.
- There are two types of MTP Level 3 functions: signaling message handling and signaling network management.

4. Signaling Message Handling:

- This is used to provide routing, distribution and traffic discrimination (discrimination is the process by which a signaling point determines whether or not a packet data message is intended for it‘s user or not).

5. Signaling Network Management:

- This allows the network to reconfigure in case of node failures and has provisions to allocate alternate routing facilities in case of congestion or blockage in parts of the network.

II. SIGNALING CONNECTION CONTROL PART (SCCP):

- The SCCP provides enhancement to the addressing capabilities provided by the MTP.
- SCCP also provides the ability to address global title messages or non-billed numbers.
- Different classes of service provided by SCCP are:
  - **Class 0**: Basic connectionless.
  - **Class 1**: Sequenced connectionless.
  - **Class 2**: Basic connection-oriented.
  - **Class 3**: Flow control connection oriented.
  - **Class 4**: Error recovery and flow control connection oriented.

III. SS7 USER PART:

- SS7 user part provides call control and management functions and call setup capabilities to the network.

The SS7 user part includes the following:

a) Integrated Services Digital Network User Part (ISUP):

- The ISUP provides the signaling functions for carrier and supplementary services for voice, data and video in an ISDN environment.
- ISUP uses the MTP for transfer of messages between different exchanges.
- In addition to the basic bearer services in an ISDN environment, the facilities of user-touser signaling, closed user group, calling line identification and call forwarding are provided.

b) Transaction Capabilities Application Part (TCAP):

- The TCAP part in SS7 refers to the application layer which invokes the services of the SCCP and the MTP in a hierarchical format.
- One application at a node is thus able to execute an application at another node and use these results.

c) Operation Maintenance and Administration Part (OMAP):

- The OMAP functions include monitoring, coordination and control function to ensure that trouble-free communications are possible.

State the various services offered by GSM Standard. Describe these services in detail. 4M

Ans: (State = 1M, Describing = 3M)

The three services offered by GSM systems are;

1. Telephone services
2. Bearer services
3. Supplementary ISDN services

Telephone Services:

- Teleservices include
- Standard mobile telephone
- Mobile-originated
- Base-originated traffic.
- emergency calling
- Fax
- Videotext
- Tele text,
- SMS
- MMS.

Bearer services:

The data services include the communication between computers and packet switched traffic. These services are limited to the first three layers of the OSI reference model. Data may be transmitted using either a Transparent Mode or Non-Transparent Mode.

Transparent Mode:-Where GSM provides standard channel coding for user data

Non-Transparent Mode: - Where GSM offers special coding efficiencies based on the particular data interface.

Supplementary ISDN services:

- This service are digital in nature and include • Call diversion
- Caller line ID
- Closed user group
- Call barring
- Call waiting
- Call hold
- Connected line ID
- Multiparty (Teleconferencing)
- Call charge advice
- This service also include the Short Messaging Service (SMS) which allow GSM subscriber and BS to transmit alphanumeric pages of limited length (160 -7 ASCII characters) while simultaneously carrying normal voice traffic.