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Internal Assessment Test 1 – Sept. 2017

Sub:	WIRELESS COMMUNICATION					Sub Code:	10TE73	Branch:	TCE
Date:	22.09.2017	Duration:	90 min's	Max Marks:	50	Sem / Sec:	A&B		OBE

Answer any FIVE FULL Questions

		MARKS	CO	RBT
1.	a) Briefly explain the PSTN intraoffice and interoffice call with a block diagram.	[6]	CO1	L4
	b) Discuss the formation of MSISDN and IMSI identification numbers.	[4]	CO2	L2
2.	Discuss the characteristic features of the different generations of cellular systems and give the comparison for the same.	[10]	CO1	L2
3.	Explain in detail AMPS mobile – originated and mobile-terminated call with a flow diagram.	[10]	CO1	L4
4.	a) What is the need of SS7? Explain its working with a neat block diagram.	[05]	CO2	L1
	b) Summarize the hardware and software view of a cellular network with block diagram	[05]	CO2	L2
5.	Explain the OSI layers with a neat block diagram.	[10]	CO1	L4
6.	Discuss the Base Station system components in detail with block diagrams.	[10]	CO1	L2
7.	Explain in detail the steps involved in mobile terminated call operation with diagram.	[10]	CO2	L4

Course Outcomes		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1:	To explain the basics of propagation of radio signals	3	-	-	-	-	-	-	-	-	2	-	-	-	1	-	-
CO2:	To explain how radio signals can be used to carry digital information in a spectrally efficient manner.	3	-	-	-	-	-	-	-	-	2	-	-	-	1	-	-
CO3:	To explain how radio signals can be used to carry digital information in a power efficient manner.	3	1	-	-	-	-	-	-	-	2	-	-	-	1	-	-
CO4:	To identify diversity afforded by radio propagation to improve performance	3	-	2	1	1	-	-	-	-	2	-	-	-	1	-	-
CO5:	To explain the design considerations for effective spectrum sharing through multiple access	3	1	-	-	-	-	-	-	-	2	-	-	-	1	-	-
CO6:	To illustrate technologies used in Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA) and WiFi Networks	3	-	-	-	1	1	-	-	-	2	-	1	-	1	-	-

Cognitive level	KEYWORDS
L1	List, define, tell, describe, identify, show, label, collect, examine, tabulate, quote, name, who, when, where, etc.
L2	summarize, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend
L3	Apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover.
L4	Analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, explain, infer.
L5	Assess, decide, rank, grade, test, measure, recommend, convince, select, judge, explain, discriminate, support, conclude, compare, summarize.

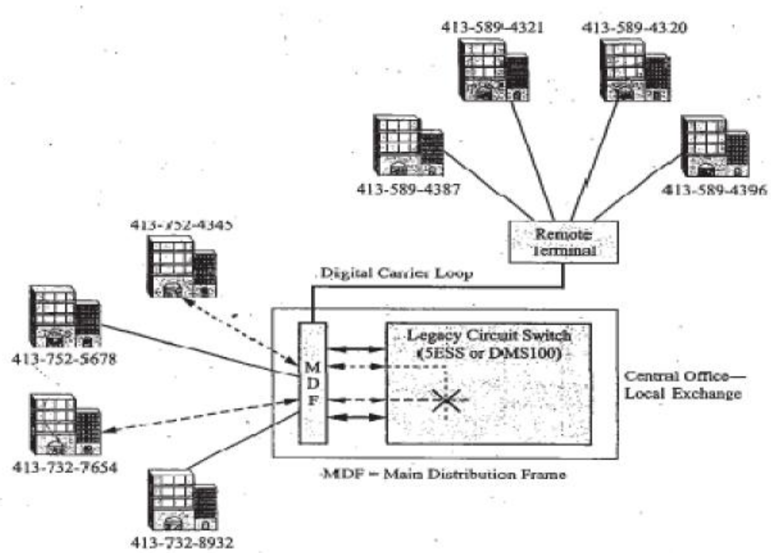
PO1 - *Engineering knowledge*; PO2 - *Problem analysis*; PO3 - *Design/development of solutions*; PO4 - *Conduct investigations of complex problems*; PO5 - *Modern tool usage*; PO6 - *The Engineer and society*; PO7- *Environment and sustainability*; PO8 – *Ethics*; PO9 - *Individual and team work*; PO10 - *Communication*; PO11 - *Project management and finance*; PO12 - *Life-long learning*

Internal Assessment – I Solution

1) a) Briefly explain the PSTN intraoffice and interoffice call with a block diagram [6]

The Public Switched Telephone Network

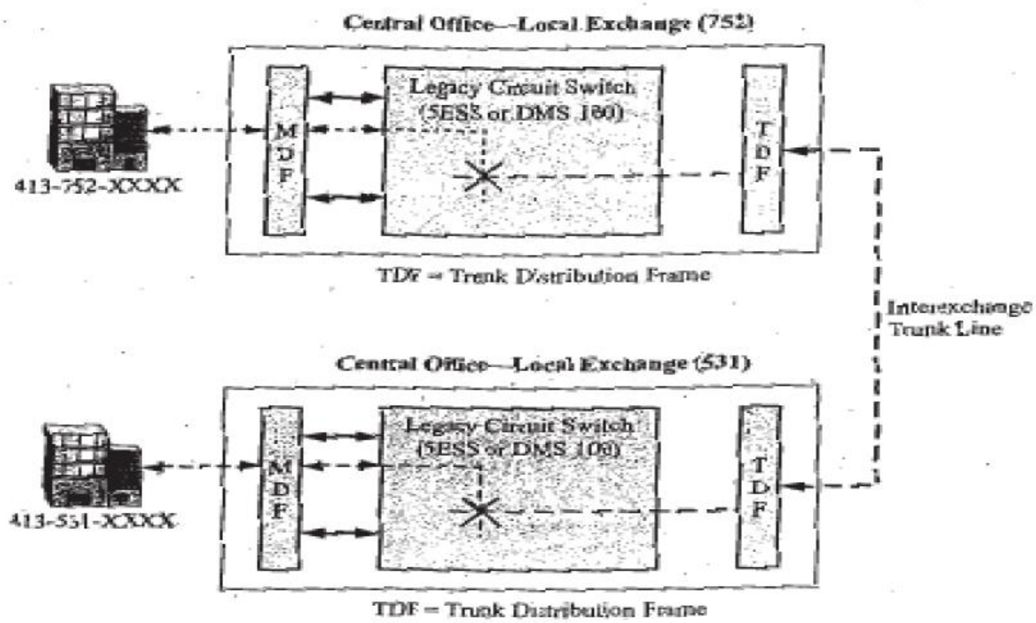
In the United States and most other industrialized nations, the present- day PSTN has evolved over time to become an almost entirely digital network. Deregulation has allowed other competitors to sell telephone service but they all essentially use the same technology. In an effort to explain the physical infrastructure of



the PSTN, it is instructive to consider the various pathways of communication available through the system.

Within a **local exchange** or company office (CO) a subscriber may be connected to the exchange in several different ways as shown in Figure 1–2. For plain-old telephone service (POTS) the subscriber may be connected through a local loop connection consisting of a pair of copper wires. In this case, dialing information (via dual-tone multifrequency [DTMF] or traditional rotary dialing [pulsing]) signals are interpreted by the local exchange switch to set up the correct pathway or connection through the switch to the desired called party. Call signaling information (dial tone, ringing, call-waiting tones, etc.) is sent to the called party and also sent back to the caller.

For an **intraoffice** call between two subscribers connected to the same switch, the analog voice signal from the subscriber's telephone propagates through the copper wire pair to a line card located at the switch. The line card converts the analog signal to a digital pulse code modulated (PCM) DS0 signal, which gets timed through the switch in such a way as to be connected to the corresponding line card of the called party. This counterpart line card performs the complementary conversion of the digital PCM signal from the switch into an analog signal that is sent to the called party over another pair of copper wires. A separate return path or connection is also created from the called party's line card through the switch to the calling party's line card. The line cards also provide the necessary opposite signal conversion functions for this return path and together the two paths through the switch provide for **duplex** operation for the duration of the telephone call. Since the call appears to be physically connected by a circuit and is using the resources of the switch, this type of operation is termed **"connection-oriented"** or in particular a **"circuit-switched"** connection. If the party to be called is connected to a different switch at another exchange within the same calling area (an **interoffice** call), the PCM signal from the calling subscriber's switch is timed through the switch in such a fashion that it is eventually forwarded to a multiplexer and then transmitted over a digital interoffice transmission facility (**trunk** line). Figure 1–3 shows this type of interoffice connection.



This interoffice connection might use some type of T-carrier transport technology (T-1, T-3, etc.) that might be carried over copper wires, but most likely it will be some form of fiber-optic connection that is transporting data at OC-1, OC-3, or OC-12 data rates using SONET transport technology. If the party to be called is in a different calling area (a long- distance call), the local switch will forward the caller's PCM packets to a long-distance carrier's multiplexed facilities using the area code of the called number to direct the call. The long-distance carrier's network will have switching centers located in different parts of the country typically connected by long-haul fiber facilities. Once the caller's signal is delivered by the long-distance carrier's network to the correct local end exchange it is demultiplexed back to a DS0 signal, the process that occurs to connect to the called party is the same as before. The signal is timed through the appropriate end switch to connect it to the called party's line card. Again, a completely separate circuit will be set up in the call's return direction.

1) b) Discuss the formation of MSISDN and IMSI identification numbers[4]

- MSISDN is primary key to the HLR record number with maximum 15 digits without prefixes.
  Example, one number in America
  MSISDN: 13109976224
  MSISDN = CC + NDC + SN
  CC = Country Code
  NDC = National Destination Code
  SN = Subscriber Number

  In the GSM standard PCS 1900, format has next value
  MSISDN = CC + NPA + SN
  CC = Country Code
  NPA = Number Planning Area
  SN = Subscriber Number

- The IMSI is a fixed 15-digit length. It consists of a 3-digit Mobile Country Code (MCC), a 3-digit Mobile Network Code (MNC), and a 9-digit Mobile Station Identification Number (MSIN). Telcordia Technologies is responsible for the assignment and administration of the first six digits (the MCC + MNC) to network operators, and the network operator to which these digits are assigned is responsible for the assignment and administration of the last 9 digits (the MSIN).

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2) Discuss the characteristic features of the different generations of cellular systems and give the comparison for the same. [10]

1G

- 1G (or 1-G) refers to the first-generation.
- It is a analog based voice oriented telecommunications standards
- AMPS (Advanced Mobile Phone system) were the popular 1G cellular system.
- Used analog frequency modulation FM).
- FDD used to achieve Duplexing.
- Type of multiple access is FDMA
- Channel B.W is 30Khz
- Frequency band is 824-894 MHz.
- Forward link and Reverse link separated by 45 MHz.
- ID numbers were assigned to the cellular system (SID) and mobile handset (MIN, SIM).
- The system standard also defines physical layer technical parameters such as max. Permissible power level, Maximum out of band radiation level.
- The standard also prescribes the required protocol for system operations.

2G

- 2G is digital cellular system
- It uses digital modulation techniques.
- Introduce two major multiplexing schemes called TDMA and CDMA.
- Use digital modulation techniques to send digital control messages rather than SAT tones.
- Use Digital encryption used for security and privacy for the mobile network subscriber.
- Use of digital encoding and decoding schemes.
- Use of error detection and correction codes for reliability.
- Two major 2G technologies and standards are GSM and CDMA.

3G

- Support high-speed data transfer from packet networks
- Permit global roaming.
- Advanced digital services (i.e., Multimedia) and
- Work in various different operating environments (low through high mobility, urban to suburban to global locations, etc.).

4G

- It is an IP based packed switched network.
- 4G networks are projected to provide speeds of 100 Mbps while moving and 1 Gbps while stationary.
- High usability: anytime, anywhere, and with any technology.
- Support for multimedia and integrated services at low transmission cost.
- Smooth Handoff across heterogeneous networks.
- Seamless connectivity and global roaming across multiple networks.
- High quality of service for next generation multimedia support (real time audio, high speed data, HDTV video content, mobile TV, etc.)
- Interoperability with existing wireless standards.
- It provides Dynamic bandwidth allocation, QoS and advanced Security
- It is Self organizing networks.

Comparison

Technology / Features	1G	2/2.5G	3G	4G	5G
Start/ Deployment	1970/ 1984	1980/ 1999	1990/ 2002	2000/ 2010	2010/ 2015
Data Bandwidth	2 kbps	14.4-64 kbps	2 Mbps	200 Mbps to 1 Gbps for low mobility	1 Gbps and higher
Standards	AMPS	2G: TDMA, CDMA, GSM 2.5G: GPRS, EDGE,1xRTT	WCDMA, CDMA-2000	Single unified standard	Single unified standard
Technology	Analog cellular technology	Digital cellular technology	Broad bandwidth CDMA, IP technology	Unified IP and seamless combination of broadband, LAN/WAN/	Unified IP and seamless combination of broadband,

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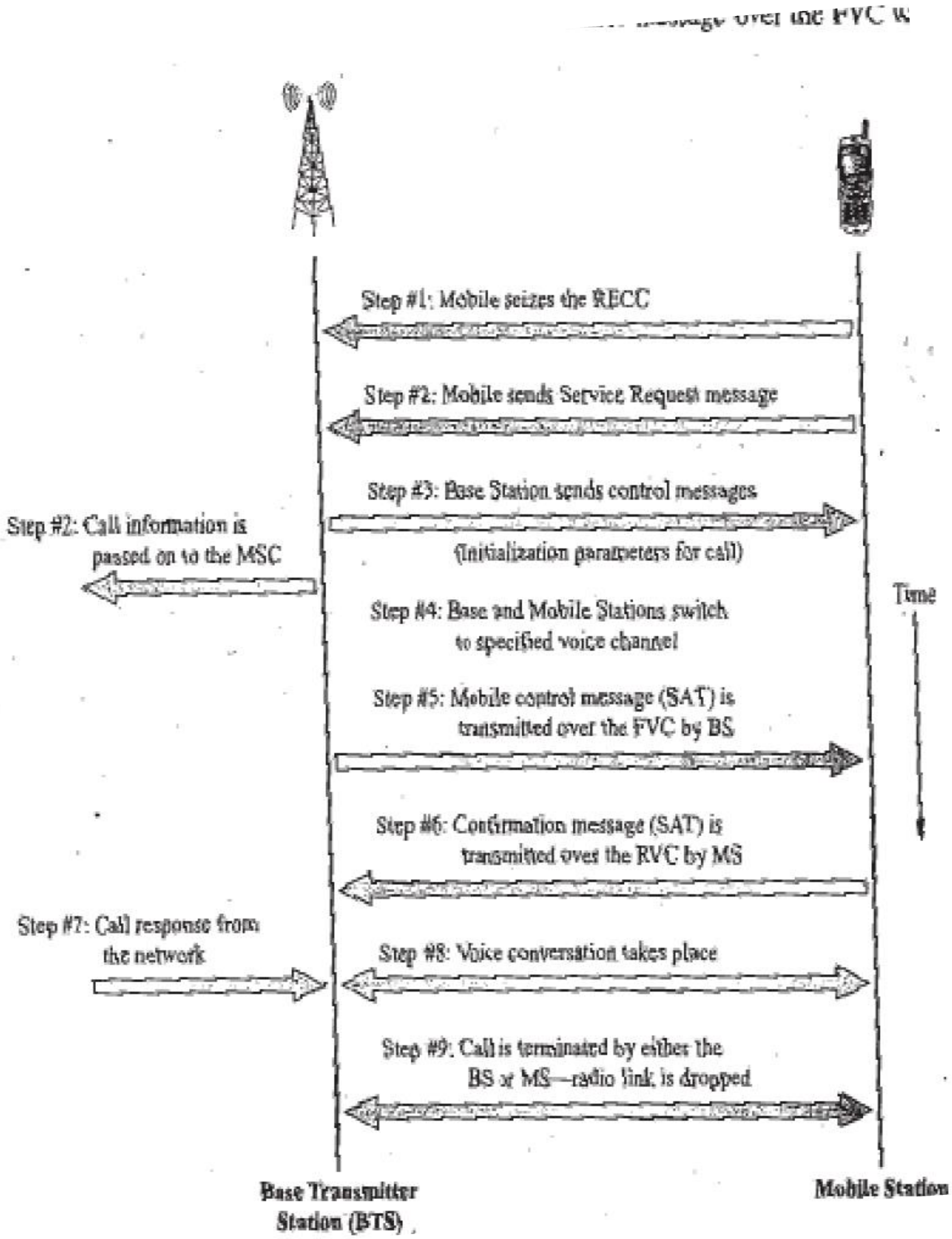
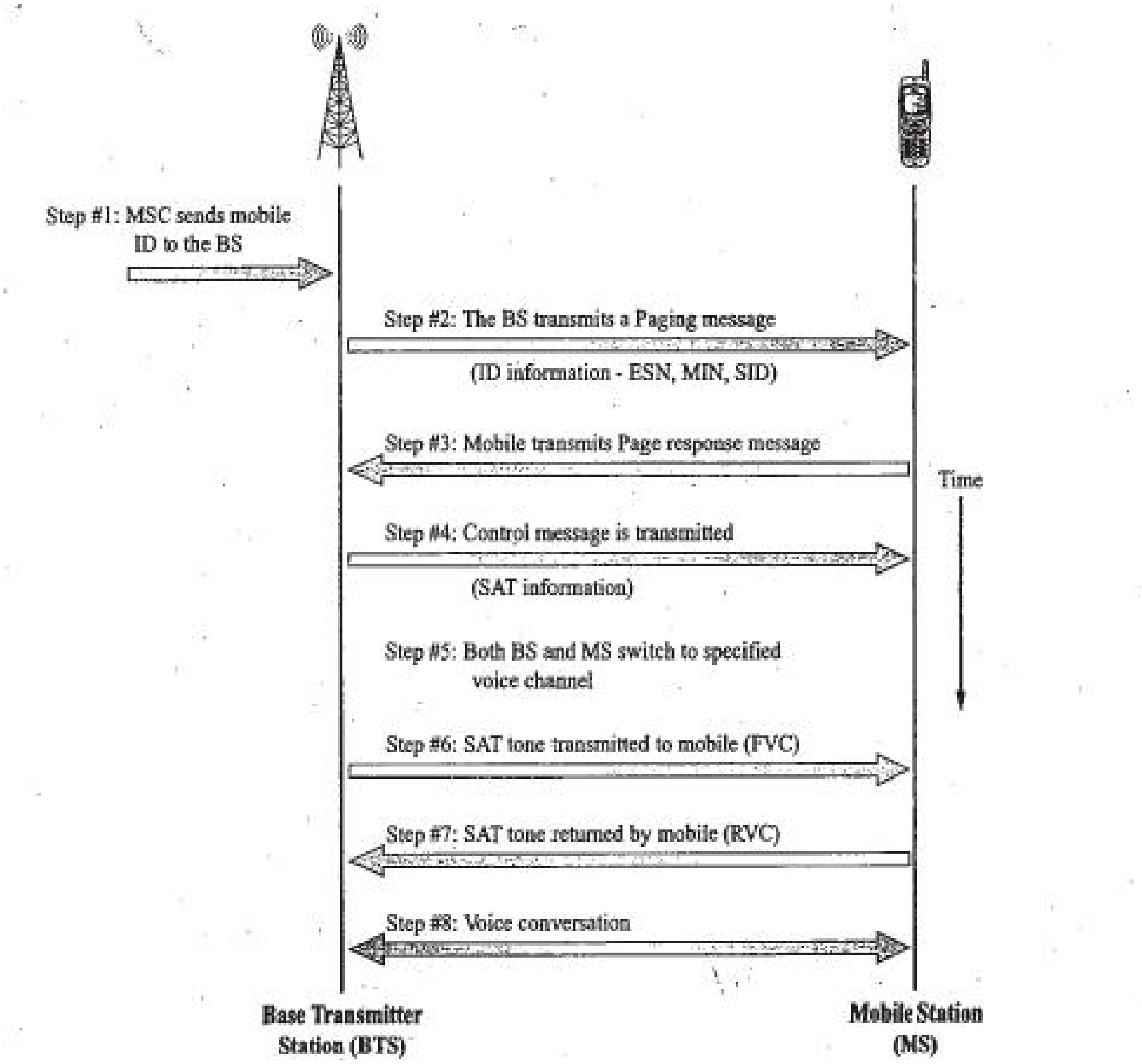
3) Explain in detail AMPS mobile – originated and mobile-terminated call with a flow diagram. [10]





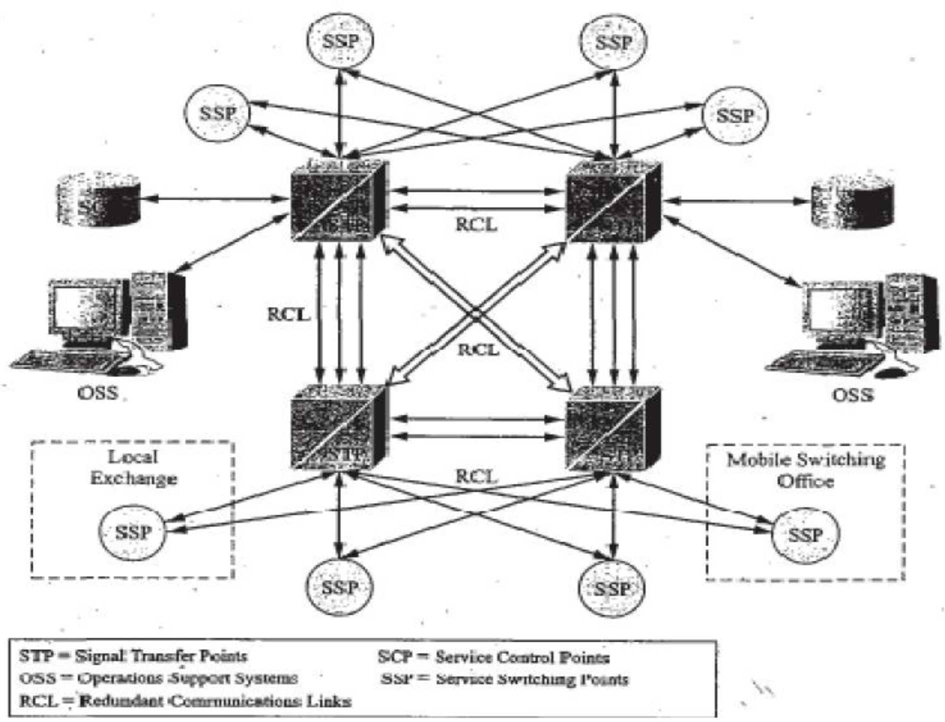
Step #1: MSC sends mobile ID to the BS
Step #2: The BS transmits a Paging message
(ID information - ESN, MIN, SID)
Step #3: Mobile transmits Page response message
Time
Step #4: Control message is transmitted
(SAT information)
Step #5: Both BS and MS switch to specified voice channel
Step #6: SAT tone transmitted to mobile (FVC)
Step #7: SAT tone returned by mobile (RVC)
Step #8: Voice conversation
Base Transmitter Station (BTS)
Mobile Station (MS)

4) a) What is the need of SS7? Explain its working with a neat block diagram.[5]

Signaling System #7

The early PSTN used "in-band" signaling to set up and tear down interoffice and long-distance telephone calls. By this, we mean that the same facilities used to transport the call were first used to create an actual physical circuit for the call to be sent over. A big disadvantage of this type of system is that a voice trunk (an interoffice facility) or possibly many trunks had to be "seized" in order to do the signaling necessary to set up the call. If the call is nonchargeable (the called party is unavailable or the line is busy), the charges for the seizure of the trunk circuits must be paid for by the service provider that owns the local exchange. Furthermore, this type of system was very prone to fraud since the signaling was performed by sending easily reproducible audio tones over the trunking circuits. As the PSTN evolved into a digital network, for economic reasons and for both efficiency and security, an entirely separate network was created for the purpose of routing long-distance calls (calls between different exchanges or switches). This system of using a separate facility or channel to perform the call routing function is known as "out-of-band" signaling. AT&T's early out-of-band system was called Common Channel Interoffice Signaling (CCIS). With advances in technology, this common channel signaling system has been adopted by the international telecommunications community for use with both PSTNs and public land mobile networks (PLMNs). Today, it is known as CCIS #7 or simply Signaling System #7 (SS7).

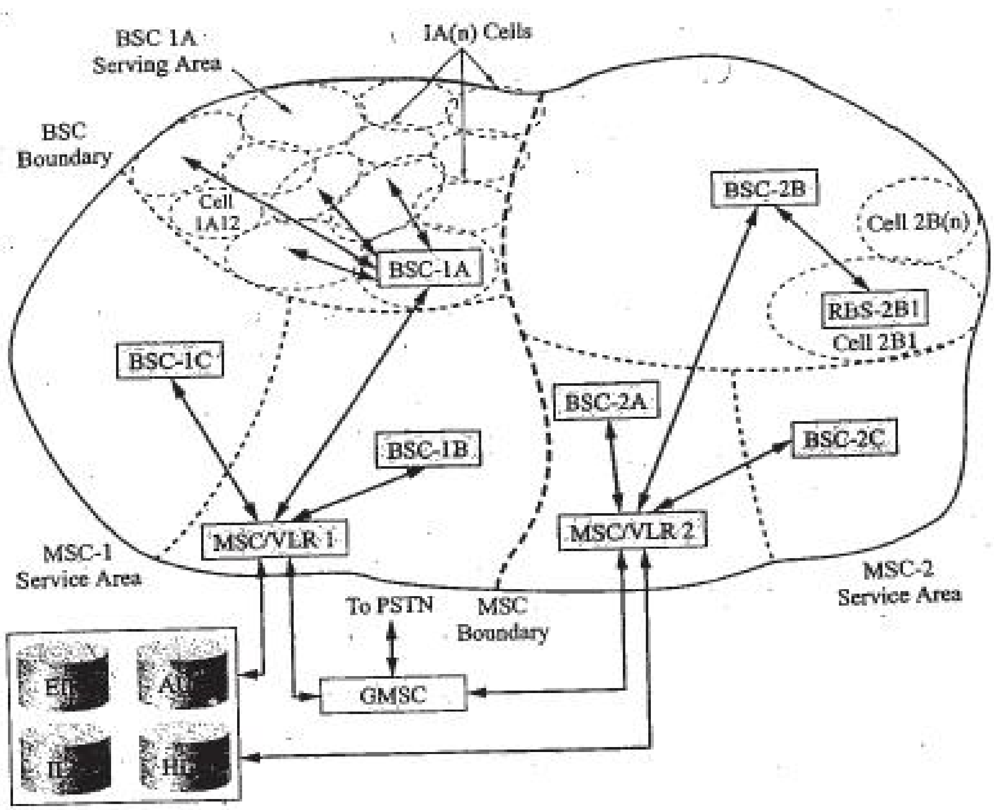
The **SS7** system is a packet network that consists of **signal transfer points** (STP) and transmission facilities linking the signal transfer points as shown in Figure 1–4. The signal transfer points connect to **service switching points** (SSP) at the local exchange and interface with the local exchange switch or mobile switching center in the case of a PLMN. The service switching points convert signaling information from the exchange voice switch into SS7 signaling messages in the form of data packets that are sent over the

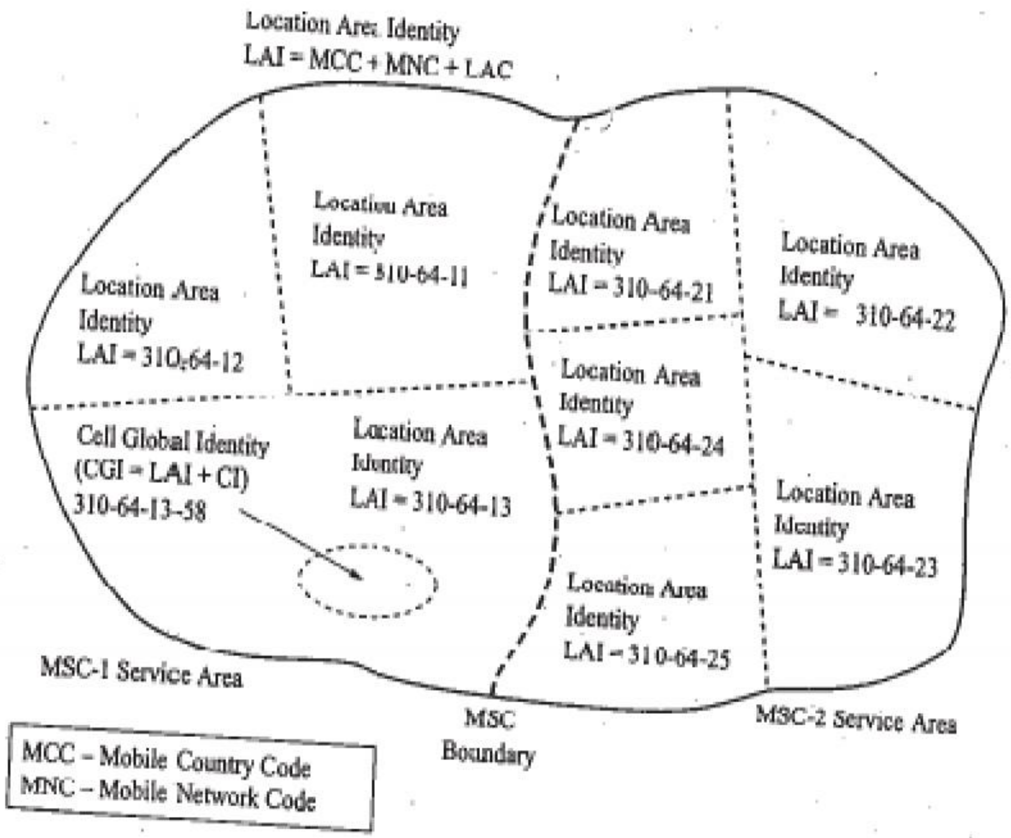


SS7 network. All SS7 data packets travel from one service switching point to another through signal transfer points that serve the network as routers, directing the packets to their proper destination. There are several different types of redundant links between the signal transfer points to provide the SS7 network with a high degree of reliability.

The SS7 ...

4) b) Summarize the hardware and software view of a cellular network with block diagram [5]





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5) Explain the OSI layers with a neat block diagram.[10]

Layers of OSI model:

Physical layer

The Physical layer is also called as the Layer 1. Here are the basic functionalities of the Physical layer:

- Responsible for electrical signals, light signal, radio signals etc.
- Hardware layer of the OSI layer
- Devices like repeater, hub, cables, ethernet work on this layer
- Protocols like RS232, ATM, FDDI, Ethernet work on this layer

Data Link layer

The data link layer is also called as the Layer 2 of the OSI model. Here are the basic functionalities of the data link layer:

- Responsible for encoding and decoding of the electrical signals into bits.
- Manages data errors from the physical layer
- Convers electrical signals into frames
- The data link layer is divided into two sub-layers
    - The Media Access Control (MAC) layer
    - Logical Link Control (LLC) layer.
- The MAC sublayer controls how a computer on the network gains access to the data and permission to transmit it.
- The LLC layer controls frame synchronization, flow control and error checking.
- MAC address is a part of the layer 2.
- Devices like Switch work at this layer

Network Layer

The Network layer is also called as the layer 3 of the OSI model. Here are the basic functionalities of the network layer:

- Switching and routing technologies work here
- Creates logical paths between two hosts across the world wide web called as virtual circuits
- Routes the data packet to destination
- Routing and forwarding of the data packets.
- Internetworking, error handling, congestion control and packet sequencing work at this layer
- Router works at layer three
- Different network protocols like TCP/ IP, IPX, AppleTalk work at this layer

Transport layer

The Transport layer is also called as the layer 4 of the OSI model. Here are the basic functionalities of the Transport layer:

- Responsible for the transparent transfer of data between end systems
- Responsible for end-to-end error recovery and flow control
- Responsible for complete data transfer.
- Protocols like SPX, TCP, UDP work here

Session layer

The Session layer is also called as the layer 5 of the OSI model. Here are the basic functionalities of the Session layer:

- Responsible for establishment, management and termination of connections between applications.
- The session layer sets up, coordinates, and terminates conversations, exchanges, and dialogues between the applications at each end.
- It deals with session and connection coordination.
- Protocols like NFS, NetBios names, RPC, SQL work at this layer.

Presentation layer

The Presentation layer is also called as the layer 6 of the OSI model. Here are the basic functionalities of the presentation layer:

- Responsible for data representation on your screen
- Encryption and decryption of the data
- Data semantics and syntax
- Layer 6 Presentation examples include encryption, ASCII, EBCDIC, TIFF, GIF, PICT, JPEG, MPEG, MIDI.

Application Layer

The Application layer is also called as the layer 7 of the OSI model. Here are the basic functionalities of the Application layer:

- Application layer supports application, apps, and end-user processes.

- Quality of service
- This layer is responsible for application services for file transfers, e-mail, and other network software services.
- Protocols like Telnet, FTP, HTTP work on this layer

6) Discuss the Base Station system components in detail with block diagrams[10]

Base Station System Components

The **base station system** handles all radio interface-related functions for the wireless network. The BSS typically consists of several to many radio base stations (RBSs), a base station controller (BSC), and a transcoder controller (TRC). It should be noted that these last two network elements did not exist in the first analog cellular systems. In 1G systems the RBSs were connected directly to the MSC. The radio equipment required to serve one cell is typically called a base transceiver system (BTS). A single radio base station might contain three base transceiver systems that are used to serve a cell site that consists of three 120-degree sectors or cells. The radio base station equipment includes antennas, transmission lines, power couplers, radio frequency power amplifiers, tower-mounted preamplifiers, and any other associated hardware needed to make the system functional.

The base station controller's function is to supervise the operation of a number of radio base stations that provide coverage for a contiguous area (see Figure 3–3). It provides the communication links to the fixed part of the wireless network (PSTN) and the public data network (PDN) and supervises a number of air interface mobility functions. Some of these tasks include location and handoff operations and the gathering of radio measurement data from both the mobile device and the radio base station. The base station controller is used to initially set up the radio base station parameters (channels of operation, logical cell names, handoff threshold values, etc.) or change them as needed. The BSC is also used to supervise alarms issued by the radio base stations to indicate faults or the existence of abnormal conditions in system operation (including those of its own). For some faults the BSC can bring the reporting subsystem back into operation automatically (i.e., clearing the fault or alarm) whereas other faults require operator intervention in the form of an on-site visit by a field service technician.

The transcoder controller performs what is known as rate adaptation. Voice information that has been converted to a standard digital pulse code modulation (PCM) format is transmitted within the PSTN over standard T1/E1/J1 telephone circuits at 64 kbps. Both TDMA and CDMA systems use data rates of 16 kbps or less for the transmission of voice and control information over the air interface. The transcoder controller's function is to convert the PCM data stream to a format suitable for the air interface. **Vocoding** is

Radio Base Station

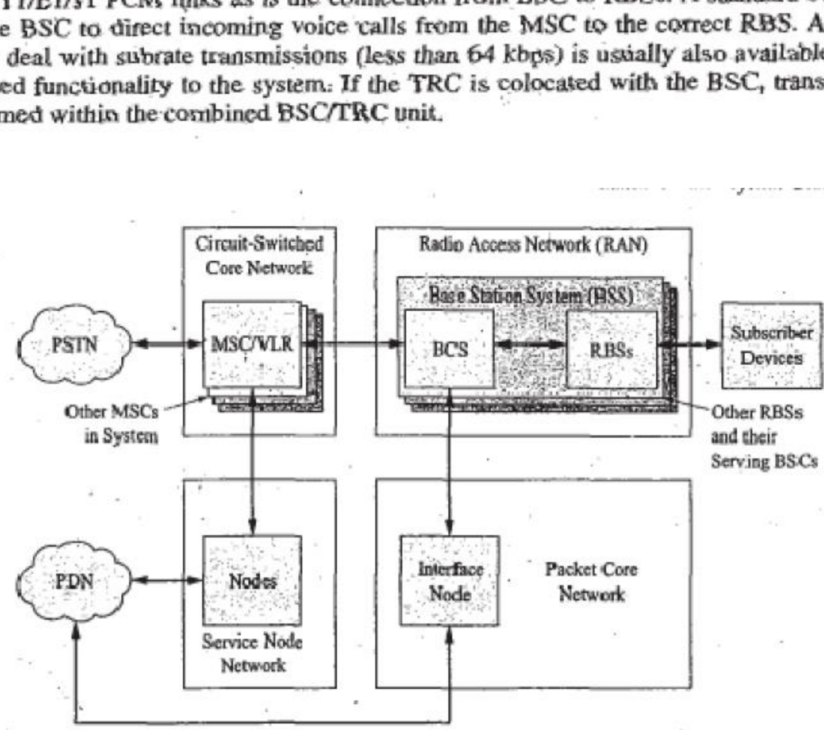
The **radio base station** consists of all radio and transmission interface equipment needed to establish a radio link with the MS. The typical RBS is composed of several subsystems that allow it to transmit to the MS on one frequency and to receive signals from the MS on another frequency. The two major wireless cellular systems used today for the air interface function are a form of either time division multiple access (TDMA) or code division multiple access (CDMA). The architecture and functionality of the air interface components of the RBS will depend upon the particular type of access system it is used in.

For TDMA systems, since frequency spectrum is a scarce resource, the primary function of the BSS is to optimize the use of available frequencies. The RBS supports this goal by having the ability to perform frequency hopping and support dynamic power regulation and the use of discontinuous transmission modes. All of these features tend to reduce interference levels within a TDMA system. For CDMA systems, all transmission is performed on the same frequency. However, precise timing, power control, and CDMA encoding and decoding are required to optimize system operation. The necessary subsystem components required for the proper functioning of a CDMA radio base station reflect this fact.

Base Station Controller

The **base station controller** functions as the interface between the mobile switching center and the **packet core network** (PCN) and all of the radio base stations controlled by the BSC. The PCN is a term used for the interface node (network element) between the BSC and the public data network. Figure 3–5 shows how the systems are interconnected.

Aside from the necessary power supply and environmental conditioning components, the BSC typically consist of several subsystems all colocated in a main cabinet or possibly several cabinets. The system organization tends to divide up these subsystems into those that are used to provide a connection or link between the MSC and the radio base stations and those subsystems that control the operation of these aforementioned units. The typical connection from BSC to the MSC or TRC (if it is not integrated into the BSC) is over standard T1/E1/J1 PCM links as is the connection from BSC to RBSs. A standard switching fabric is used within the BSC to direct incoming voice calls from the MSC to the correct RBS. Another switching fabric that can deal with subrate transmissions (less than 64 kbps) is usually also available within the BSC adding increased functionality to the system. If the TRC is colocated with the BSC, transcoding functions are also performed within the combined BSC/TRC unit.

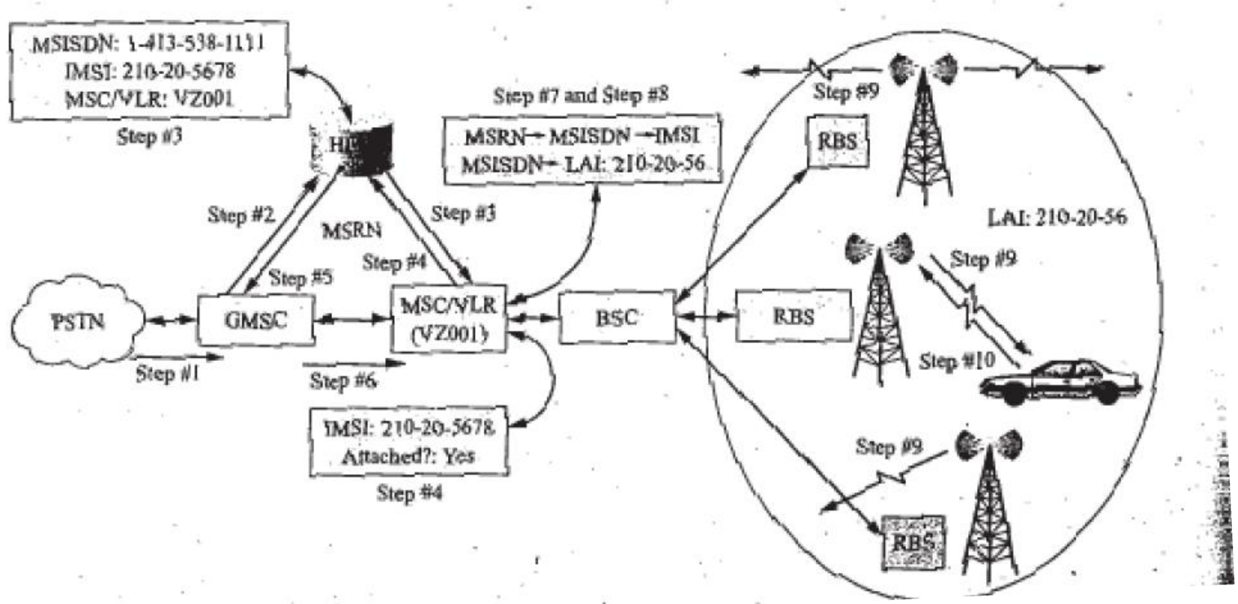


Transcoder Controller

The **Transcoder Controller** (TRC) consists of subsystems that perform transcoding and rate adaptation. The TRC can be either a stand-alone unit or, more commonly, combined with the BSC to yield an integrated BSC/TRC. The TRC also can support the power saving option of discontinuous transmission. If pauses in speech are detected, the mobile station will discontinue transmission and the TRC will generate "comfort noise" back toward the MSC/VLR. An integrated BSC/TRC can typically handle many 100s of RBS transceivers.

7) Explain in detail the steps involved in mobile terminated call operation with diagram[10]

The mobile-terminated call consists of the steps shown in Figure 3-17. Step #1: Any incoming call to a mobile system from the PSTN is first routed to the network's gateway mobile switching center (GMSC). Step #2: When the wireless mobile system detects an incoming call at the GMSC, the mobile system must first determine where the mobile is located at that particular moment in time. To determine the mobile's location, the GMSC will examine the mobile station's MDISDN to find out which home location register (HLR) the mobile subscriber is registered in. Using SS7 (SCCP), the MSISDN is forwarded to the HLR with a request for routing information to facilitate the setup of the call. Step #3: The HLR looks up which MSC/VLR is presently serving the MS and the HLR sends a message to the appropriate MSC/VLR requesting an MS roaming number (MSRN), so that the call may be routed. This operation is required since this information is not stored by the HLR; therefore, a temporary MSRN must be obtained from the appropriate MSC/VLR. Step #4: An idle MSRN is allocated by the MSC/VLR and the MSISDN number is linked to it. The MSRN is sent back to the HLR. Step #5: The MSRN is sent to the GMSC by the HLR. Step #6: Using the MSRN, the GMSC routes the call to the MSC/VLR. Step #7: When the serving MSC/VLR receives the call, it uses the MSRN number to retrieve the mobile's MSISDN. At this point the



temporary MSRN number is released. Step #8: Using the mobile's MSISDN, the MSC/VLR determines the location area where the mobile is located. Step #9: The MS is paged in all the cells that make up this location area. Step #10: When the MS responds to the paging message, authentication is performed and encryption enabled. If the authentication and encryption functions are confirmed, the call is connected from the MSC to the BSC to the RBS where a traffic channel has been selected for the air interface.