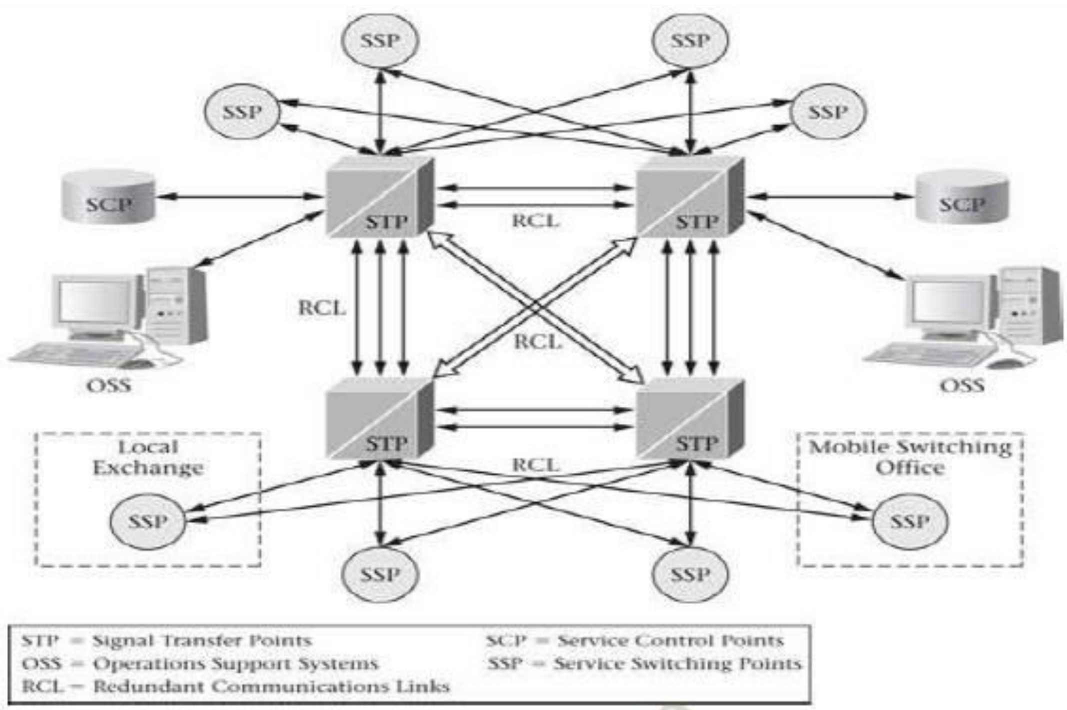
IAT-1 Solutions

1.a) What is the need of SS7? Explain its working with a neat block diagram. [05]

- Signaling System No. 7 (SS7) is Data communications network standard. It is intended to be used as a *control and management* network for telecommunication networks.
- SS7 provides call management, data base query, routing, and flow and congestion control functionality for telecommunication networks.
- SS7 is specifically designed to support the functions of an ISDN.
- The early PSTN used "in band" signaling to set up and tear down interoffice and long distance telephone calls.



- *The network elements of the SS7 system:* SS7 is packet network shown in figure 1.5. It consists of three main elements, they are:

1. Service Switching Point (SSP): It communicates with the voice switch via primitives and creates signal units for communication over SS7 network. It converts signaling from voice switch into SS7 format. It may send messages for data base queries through SS7 network. Voice connection is established through look-up of routing tables and sending SS7 messages to adjacent switches to request circuit connection.

2. Signal Transfer Point (STP) : It connect to service switching points (SSP) at the local exchange and the interface with the local exchange switch or mobile switching center in the case of a PLMN. SS7 messages travel from one SSP to another through the services of a Signal Transfer Point (STP). It acts as a router for SS7 messages. It exchanges information in form of packets related to either call connections or database queries. Other tasks of the STP include: Traffic measurements for performance monitoring of the SS7 and telecommunication network and Usage measurements for billing purposes. Three levels of STP

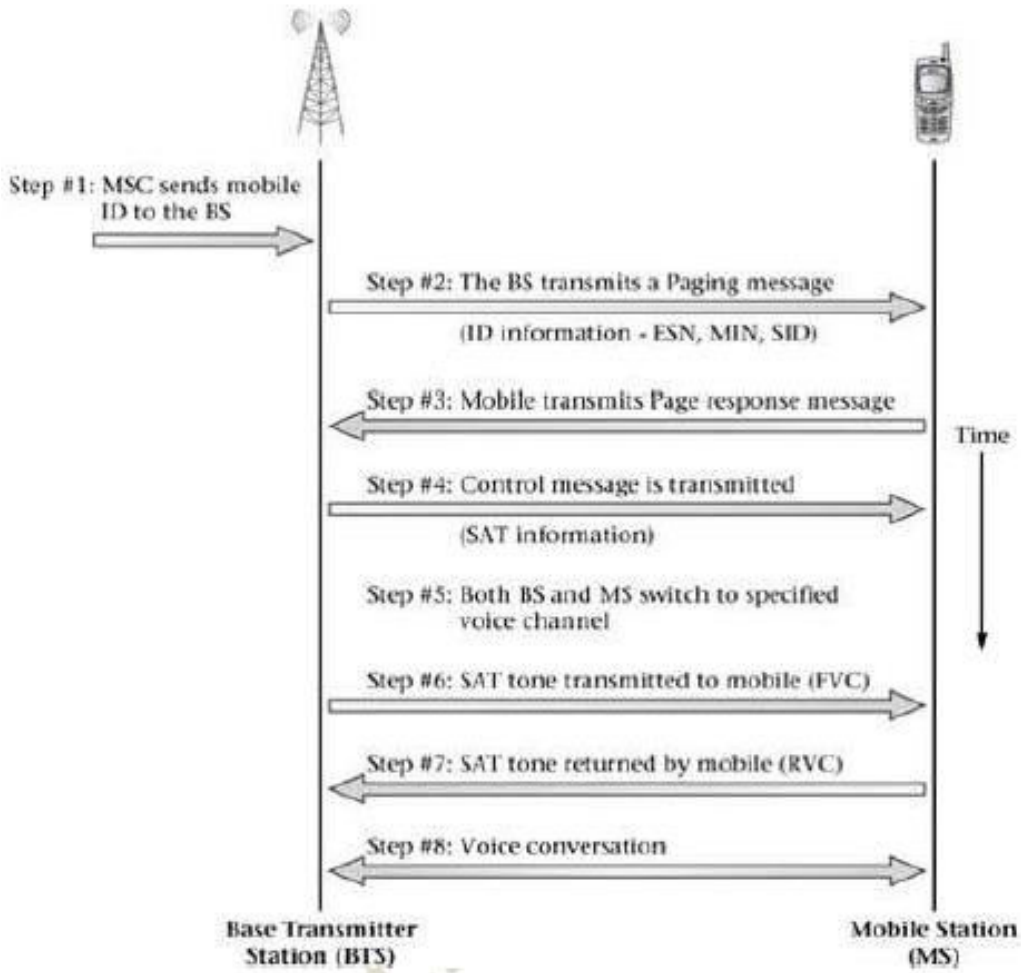
1. *National STP*: It exists in one network, no capability to convert messages into other formats.
2. *International STP*: It provides SS7 based interconnection between national networks.
3. Gateway STP: It provides protocol conversion between a national and international network or with other non-SS7 networks

3. Service Control Point (SCP): It is a computer used as a front-end to a database. SCP serves as interface to a telephone company's database. It stores

- Subscriber's services, Routing of special service numbers
- Calling card validation and fraud protection, advanced intelligent network features for service creation.

b)

Summarize the AMPS mobile terminated call operation with a neat flow diagram.[05]


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)

- Step #1: MSC sends the ID of the MS to the BS.
- Step #2: The BS constructs a page control message. The ID information (ESN, MIN, and SID) is added to the message as s the initial voice channel information.
- Step #3: The MS responds to the page by returning identification information over the RECC in a page response message.
- Step #4: Another control message is sent over the FOCC by the BS that contains an SCC value to inform the mobile as to the correct SAT to be used on the voice channel.
- Step #5: The base and mobile station both switch to the voice channels and alternately use SAT tones to verify the radio link (step #6 and #7).
- Step #8: After this last handshake occurs, the traffic channel is then opened to conversation.

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

1G Cellular Systems

- 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 Cellular Systems

- 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.

2.5g Cellular Systems

- Main limitation in 2G networks are slow data transmission.
- 2.5g uses protocol such EDGE (*Enhanced Data over GSM Evolution*) used for increase data service.
- Different technologies to increase the data services are over 2g networks:
  1. CDPD (*Cellular Digital Packet Data*)
  2. HSCSD (*High Speed Circuit Switched Data*)
  3. GPRS (General Packet Radio Service)
  4. Packet data over CDMA and other technologies.

3G Cellular Systems

- 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 Cellular Systems and Beyond

- 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.

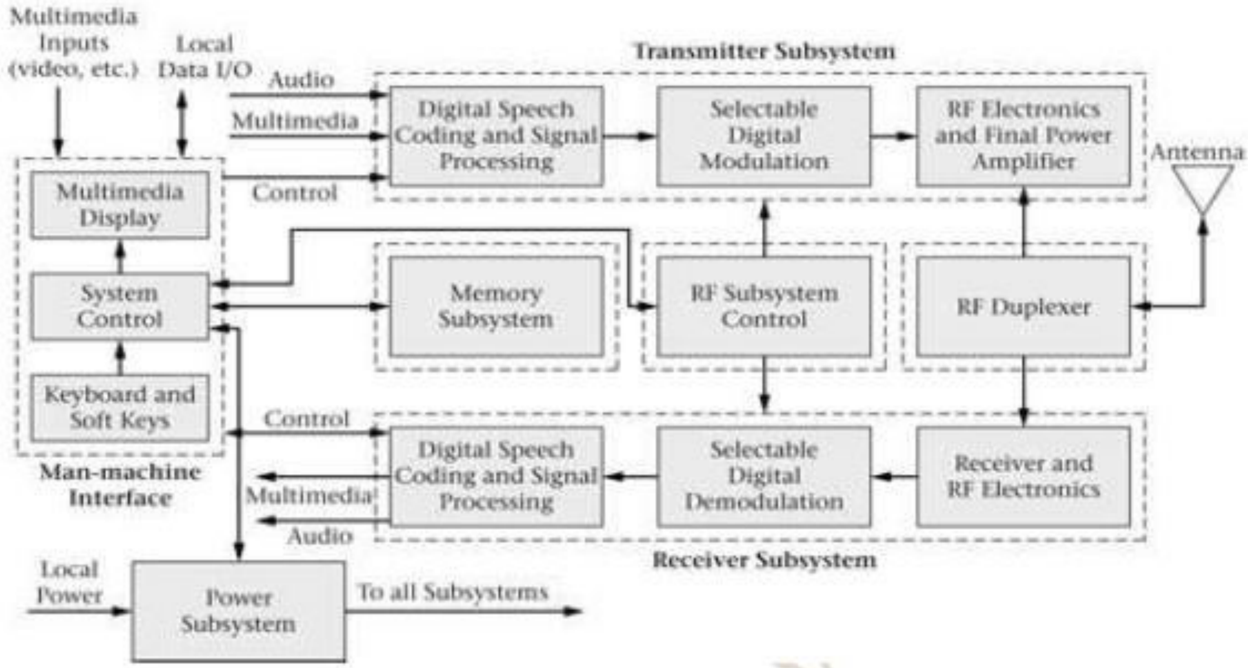
Comparison

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,

3.a) Briefly explain subscriber device with a neat block diagram. [06]

- **Subscriber Device (SD):**
  - Basically it is for voice communication (1G)
  - Later called Mobile station.(2G and 2.5G)
  - Now it is called End Terminal (ET), since it connect to all IP n/w and then provide the function of a terminal device.
  - Main functions of SD are:

- Main functions of SD are:
  - It link between customer and wireless N/w
  - It must be able to provide a means for the subscriber to control i/p information to the phone and display its operational status.
  - It must be able to sample digitize and process audio and other multimedia signals
  - Transmit and receive RF Signals
  - Process the system control messages
- Main sections of SD are:
  1. The man-machine interface
  2. The RF transceiver section
  3. The signal processing section
  4. The system control processor
  5. power supply /management section


Multimedia Inputs (video, etc.)
Local Data I/O
Audio
Multimedia
Control
Transmitter Subsystem
Digital Speech Coding and Signal Processing
Selectable Digital Modulation
RF Electronics and Final Power Amplifier
Antenna
Multimedia Display
System Control
Keyboard and Soft Keys
Memory Subsystem
RF Subsystem Control
RF Duplexer
Control
Digital Speech Coding and Signal Processing
Selectable Digital Demodulation
Receiver and RF Electronics
Man-machine Interface
Multimedia
Audio
Receiver Subsystem
Local Power
Power Subsystem
To all Subsystems

1. *The man-machine interface*: It can be
   - Standard telephone keypad
   - Alphanumeric text display
   - Microphone/speaker combination.
   - It may be more sophisticated with soft-key keypad functions with multimedia capability and a high-resolution color display
   - Video camera or cameras for the transmission and display of video messages.
   - Service port or a data port for connection to a PC.

2. *The RF transceiver section:*
   - It Provide the proper digital modulation and demodulation of the air interface RF signals and the ability to transmit and receive these RF signals.
   - This section must also permit both variable power output and frequency agility under system software control.

3. *The signal processing section:*
   - Some of the functions performed by this section are speech sampling and coding, channel coding, and audio and video processing.

4. *The system control processor*:
   - It provides overall subscriber device management.
   - It implements the required interface with the other wireless network elements to provide radio resource, connection management, and mobility management functions through software control of the various functions and operations.
   - It must perform to set up and maintain the air interface radio link.

5. *Power supply/ management*:
   - It provides the power to energize the entire system.
   - SD is battery operated with sophisticated algorithms built in to the system to save and minimize power usage as much as possible in an effort to extend the battery life.

b)	Discuss the formation of MSISDN and IMSI identification numbers.	[04]

(a). Mobile Station ISDN Identification Number(MSISDN)

- It is a dialable number that is used to reach a mobile telephone.
- It is a number uniquely identifying a subscription in a GSM or a UMTS mobile network
- It is the telephone number to the SIM card in a mobile/cellular phone.
- In North America an MSISDN number consists of the following.

  MSISDN=CC+ NPA+ SN

  Where, CC = Country Code

  NPA = Number Planning Area, and

  SN = Subscriber Number
- In the rest of the world an MSISDN number consists of the following:

  MSISDN = CC+ NDC+ SN

  Where NDC = National Destination Code.
- Figure3.6 shows: Formation of the MSISDN number

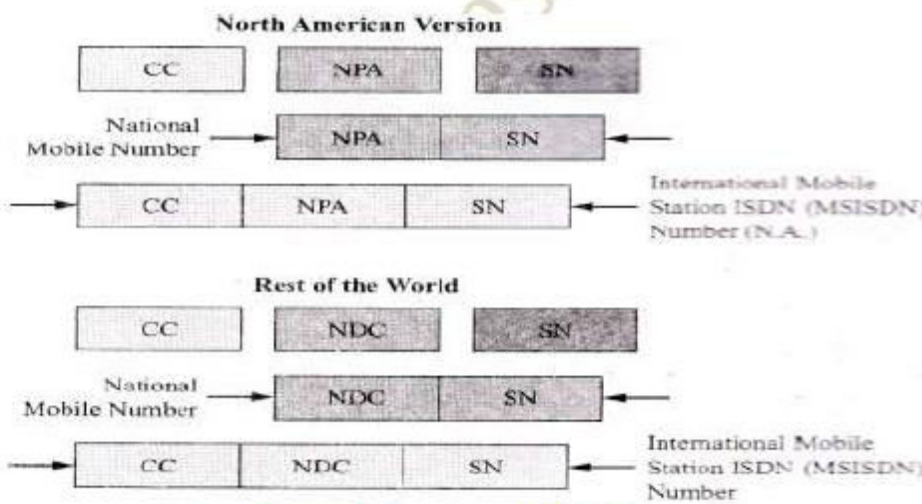


Figure 3.6 Formation of the MSISDN number

(b). International Mobile Subscriber Identity (IMSI)

- ☐ It is assigned to each subscriber of international public land mobile networks.
- ☐ It is also used for acquiring other details of the mobile in HLR or in VLR
- ☐ IMSI number consists of the following:

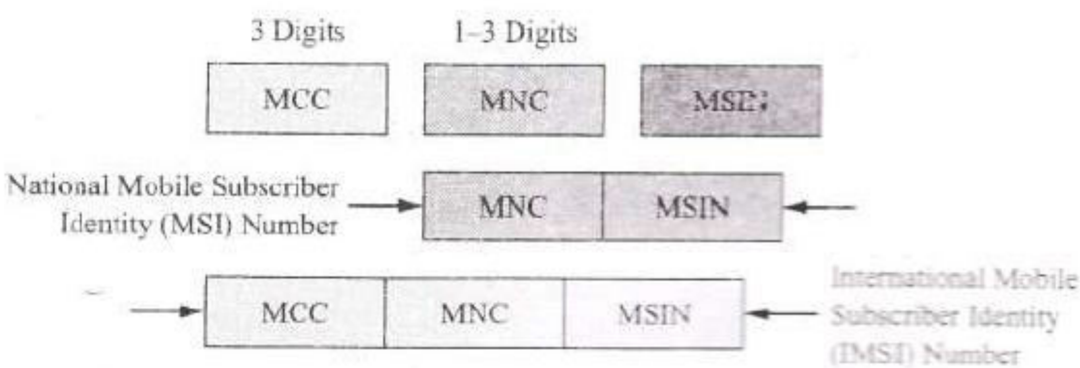
IMSI = MCC + MNC + MSIN

Where, MCC = Mobile Country Code

MNC = Mobile Network Code, and

MSIN = Mobile Subscriber Identification Number.

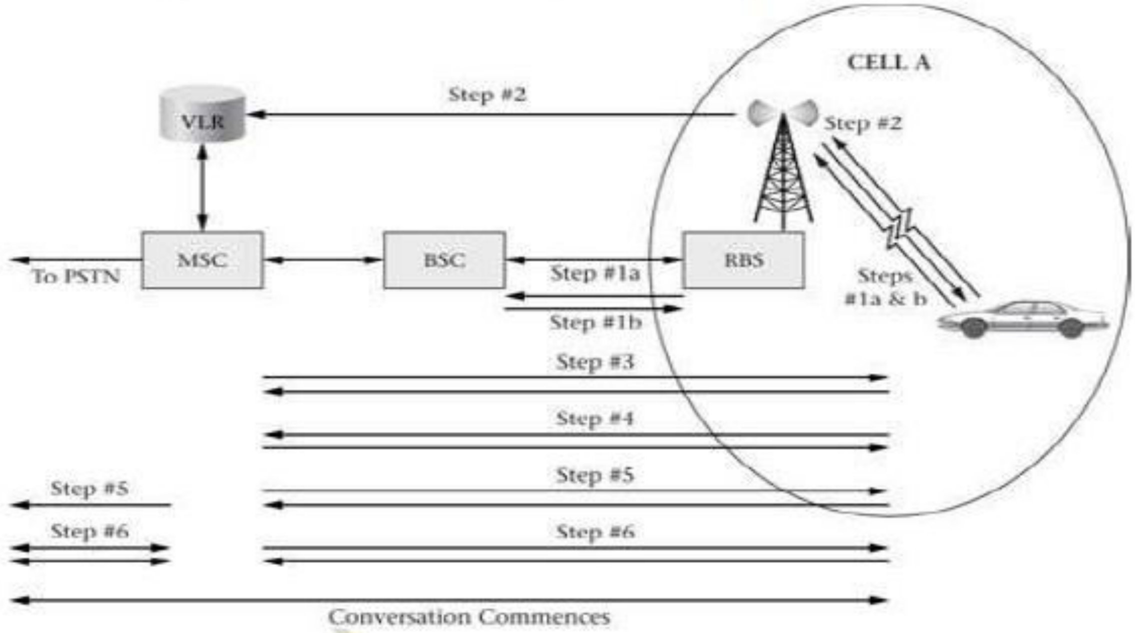
- Figure below indicates how the IMSI is formed.



- For a GSM network the IMSI number is stored in the SIM.
- There is also a Temporary Mobile Subscriber Identity (TMSI) number that may be used instead of IMSI. This TMSI number is used to provide security over the air interface and therefore only has local significance within an MSC/VLR area.

4. **Explain in detail the steps involved in mobile originated call operation.** **[10]**

- A mobile-originated call consists of the steps shown in figure below



Description

Step #1: The originating mobile subscriber call starts with a request by the mobile for a signaling channel using a common control channel. If possible, the system assigns a signaling channel to the mobile.

Step #2: Using its assigned signaling channel, the MS indicates that it wants service from the system. The VLR sets the status of the mobile to "busy. "

Step #3: Authentication and encryption are performed.

Step #4: The mobile specifies what type of service it wants (assume a voice call) and the number of the party to be called. The MSC/VLR acknowledges the request with a response.

Step #5: A link is set up between the MSC and the BSC and a traffic channel is seized.

The acquisition of the traffic channel requires several steps:

- The MSC requests the BSC to assign a traffic channel
- The BSC checks to see if there is an idle channel available

- If a channel is idle the BSC sends a message to the RBS to activate the channel
- The RBS sends a message back to the BSC indicating that the channel has been activated
- The MS responds on the assigned traffic channel,
- The BSC sends a message back to the MSC to indicate that the channel is ready, and finally the MSC/VLR sets up the connection to the PSTN.

Step #6: An alerting message is sent to the mobile to indicate that the called party is being sent a ringing tone. The ringing tone generated in the PSTN exchange that is serving the called party is transmitted through the MSC back to the mobile. When the called party answers, the network sends a Connect message to the mobile to indicate that the call has been accepted. The mobile returns a Connect Accepted message that completes the call setup process.

5.	With a neat block diagram, explain the GSM network architecture	[10]

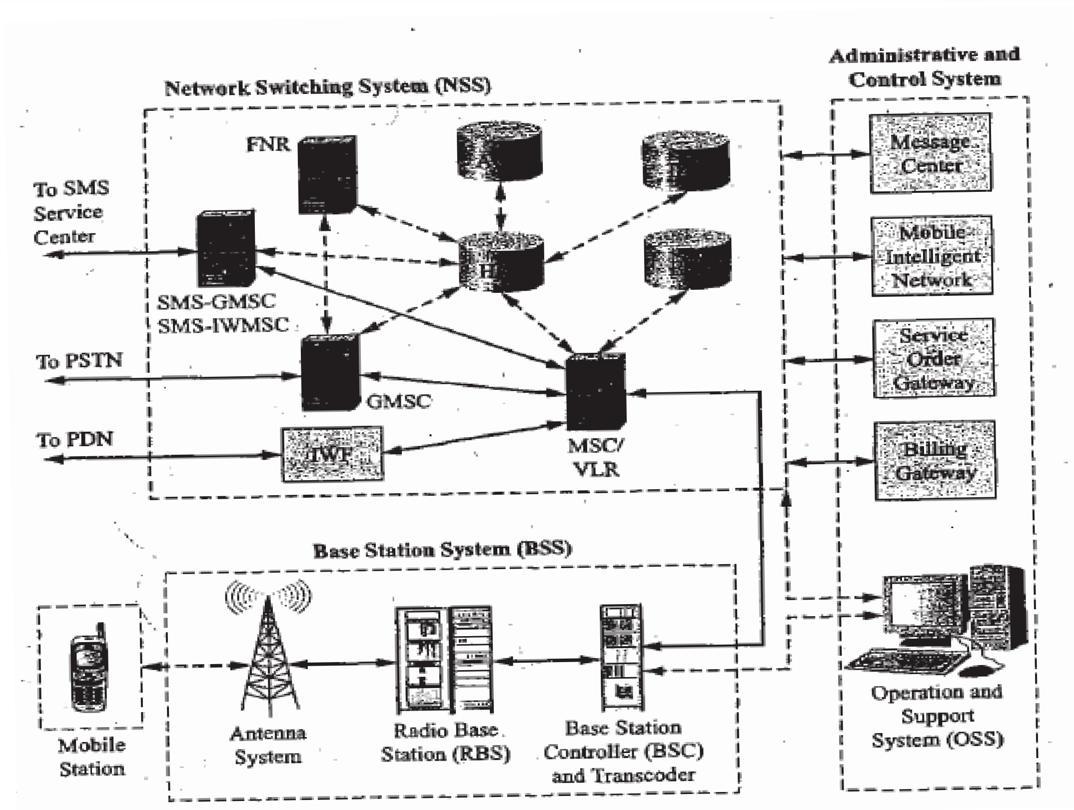


Figure 5–4 shows the basic system architecture for a GSM wireless cellular network. As can be seen from the figure, the major GSM subsystems are the network switching system (NSS), the base station system (BSS), and the mobile station (MS). Most of these wireless network subsystems and their components have been discussed previously in Chapter 3 as the common components of cellular systems. Contained within the description of these components was a brief overview of their function and relationship to the other components in the wireless system. This section will provide a brief review of the description of the common components and their system functions. Components that are specific to GSM systems or not previously introduced to the reader will receive more complete coverage.

Mobile Station

The mobile station (MS) is the device that provides the radio link between the GSM subscriber and the wireless mobile network. In the GSM system, the MS provides subscribers the means to control their access to the PSTN and PDN and also to facilitate their mobility once connected to the network. The MS is a multifunctional system with a fairly large amount of signal and data processing power. It is constantly monitoring messages being broadcast from the base transceiver system (BTS) to support the setup and clearing of radio channels used for the transmission of various forms of subscriber traffic. In addition, the MS is constantly performing power and bit error rate (BER) measurements on signals being received from the BTS that it is attached to and the neighboring BTSs in the MS's general vicinity. These measurements, in conjunction with the handover (handover is the term used by the GSM standard) algorithms performed by the BSS, support the MS's mobility as the subscriber moves about the GSM network.

The GSM system also makes use of a **subscriber identity module** or SIM card that when inserted into the MS makes it functional (the MS can only make emergency calls without the SIM card). The SIM is a smart card that is issued to the subscriber when the subscriber signs up for service with the wireless network operator. Besides containing information about the types of service available to the subscriber, the card contains the subscriber's IMSI number, the mobile MSISDN number, a SIM personal identification number (PIN), security/authentication parameters, and address book contact information (i.e., names and numbers) stored by the subscriber. The SIM card also stores SMS messages that the subscriber receives and saves. The SIM card allows for some unique possibilities for GSM subscribers. A single GSM phone can be shared by several users with different SIM cards or a subscriber could visit other countries and purchase a country-specific SIM card for use with a single GSM mobile that was carried by the subscriber.

In the GSM standard, the MS consists of two elements: the mobile equipment (ME), which is the physical phone itself, and the SIM card. The mobile is constantly being redesigned to incorporate new features and different form factors (mobile size, screen size, etc.) that the public is perceived to desire. Today, the newest mobile phones contain several video cameras with which the subscribers can use to send pictures or short video clips to each other or use as a videophone. Traditionally, the service providers have subsidized the cost of the rather expensive electronics incorporated into the mobiles to encourage more users to subscribe to the wireless services that they offer.

Base Station System

The base station system (BSS) is the link between the MS and the GSM mobile-services switching center (MSC). The BSS consists of two elements: a base transceiver system (BTS) and the base station controller (BSC). The BTS communicates with the MS over the air interface using various protocols designed for the wireless channel. The BSC communicates with the MSC through the use of standard wireline protocols. The BSC and BTS communicate with each other using **LAPD protocol,** which is a data link protocol used in ISDN. In essence, the BSS provides a translation mechanism between the wireline protocols used in the fixed portion of the wireless network and the radio link protocols used for the wireless portion of the network.

Today, the two elements of the BSS may be physically implemented by either two or three hardware systems depending upon the GSM hardware vendor. The BTS (often called a radio base station or RBS) is the BSS air interface device that corresponds to the subscriber's MS. It provides the radio link to the MS over the air interface. The usual basic components of the BTS are radio transceiver units, a switching and distribution unit, RF power combining and distribution units, an environmental control unit, a power system, and a processing and database storage unit. The BTS is physically located near the antenna for the cell site. Radio base station is the term usually used to describe the cellular radio transmitting and receiving equipment located at the cell site. Typically, an RBS may consist of three BTSs that service a standard sectorized cell site.

The functional elements needed by a base station controller to implement its operations may be all located in a single physical unit or split out into several separate units. The basic BSC components are input and output interface multiplexers, a timeslot interchange group switch, a subrate switch, speech coder/decoders, transcoders and rate adaptors, SS7 signaling points, environment control units, power supply and power distribution units, and various signal and control processors. As mentioned, the transcoder and rate adaptation unit is sometimes split out from the BSC to be a stand-alone unit that is known as a transcoder controller (TRC). Some system economies for suburban and rural areas can be gained through the use of separate BSCs and a shared transcoder controller. Urban and heavy-traffic areas are best served

Network Switching System

The wireless cellular network switching system (NSS) provides the necessary interface for the connection of the wireless network to other networks (i.e., the PSTN, PDN, and other wireless PLMNs). Additionally, it provides support for the mobility of the GSM subscriber within the GSM network. The switching system maintains databases that are used to store information about the system's subscribers and facilitate the connection of a mobile to the system as long as it has connection privileges. The GSM switching system was designed to communicate with the PSTN through ISDN protocols. The basic components of the network switching system include at least one mobile-services switching center (MSC), a gateway MSC, the visitor and home location registers, the equipment identity register, and the authentication center. In addition to these basic components, the switching system may also have a flexible numbering register and an interworking location register to provide more system functionality.

To handle short message service (SMS) the wireless switching system will need to have an SMS gateway MSC (SMS-GMSC) and an SMS-interworking MSC (SMS-IWMSC). The implementation of general packet radio service (GPRS) for high-speed data transmission and reception requires the use of two additional switching system elements: a serving GPRS support node (SGSN) and a gateway GPRS support node (GGSN). These last two units connect to IP networks and will be discussed along with the SMS elements in more detail in Chapter 7.

The MSC, in conjunction with several of the databases listed previously, performs the necessary telephony switching functions required to route incoming mobile-terminated telephone calls to the correct cell site and connect mobile-originated calls to the correct network (i.e., PSTN or PLMN). The MSC communicates with the PSTN and other MSCs using the SS7 protocol. The MSC that is connected to the PSTN is commonly referred to as the gateway MSC (GMSC). Additionally, the MSC is instrumental in the supervision and administration of mobility and connection management and authentication and encryption.

The GSM network switching system databases provide the wireless network with the necessary information to facilitate subscriber mobility. The visitor location register (VLR) is a temporary database used to hold information about mobile subscribers within the coverage area of a particular MSC. The temporary subscriber information contained in the VLR allows the MSC to provide service to the visiting mobile subscriber. Commonly, the MSC will be integrated with the VLR to create a combined MSC/VLR and hence reduce system signaling operations. For security reasons the VLR will assign a temporary mobile subscriber number (TMSI) to the visiting MS so as to avoid using the IMSI over the air interface. The home location register (HLR) database contains information about the subscriber's account. Commonly stored information will include such items as the MSISDN and IMSI numbers and types of services that have been subscribed to. Also included in the HLR database will be dynamic data such as the subscriber's current location (i.e., VLR address) and presently activated services. The HLR together with the VLR and the MSC provide support for the connection and mobility management of mobile stations either in their home location area or roaming within the GSM system. The authentication center (AUC) and the equipment identity register (EIR) in conjunction with the MSC/VLR and HLR provide additional GSM network security and help facilitate international roaming within the GSM network. The **flexible numbering register** (FNR) is used by the GSM system to provide number portability to a subscriber. With this feature a subscriber may change GSM operators and still maintain the same MSISDN number. The network switching system will use the FNR to redirect messages sent by a GMSC toward a particular HLR to the correct HLR. The interworking location register (ILR) is used to allow intersystem roaming. In the United States, this operation supports roaming between the legacy AMPS system and GSM 1900 system.

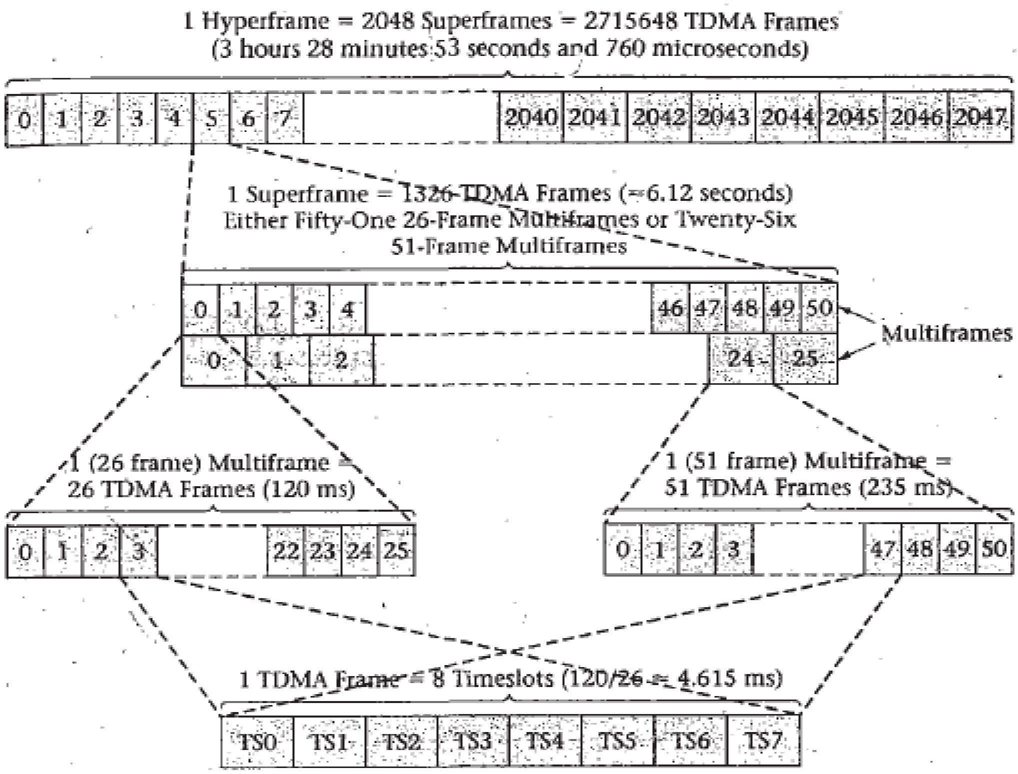
Operation and Support System and Other Nodes

As shown by Figure 5–4, the entire GSM wireless network is monitored and controlled by an **operation and support system** (OSS) (the GSM standard refers to this functional entity as a operation and maintenance center). This centralized system can be used to provide surveillance of the complete network and thus provide the operator a means to support operation and maintenance of the entire network. Usually, there are several sublevels to the management functions that cover the circuit, packet, and radio network portions of the GSM network. The OSS software usually provides the system operator with the ability to perform configuration, performance evaluation, and security management of each portion of the wireless network along with the traditional display of alarms or fault indicators for specific system elements.

The other nodes shown in Figure 5–4 are used to interface the wireless network switching system with the operator's administrative computer systems and software. The titles of billing gateway and service order gateway are descriptive of the functions performed by these elements. The reader may refer back to Chapter 3 to review additional detail about these nodes.

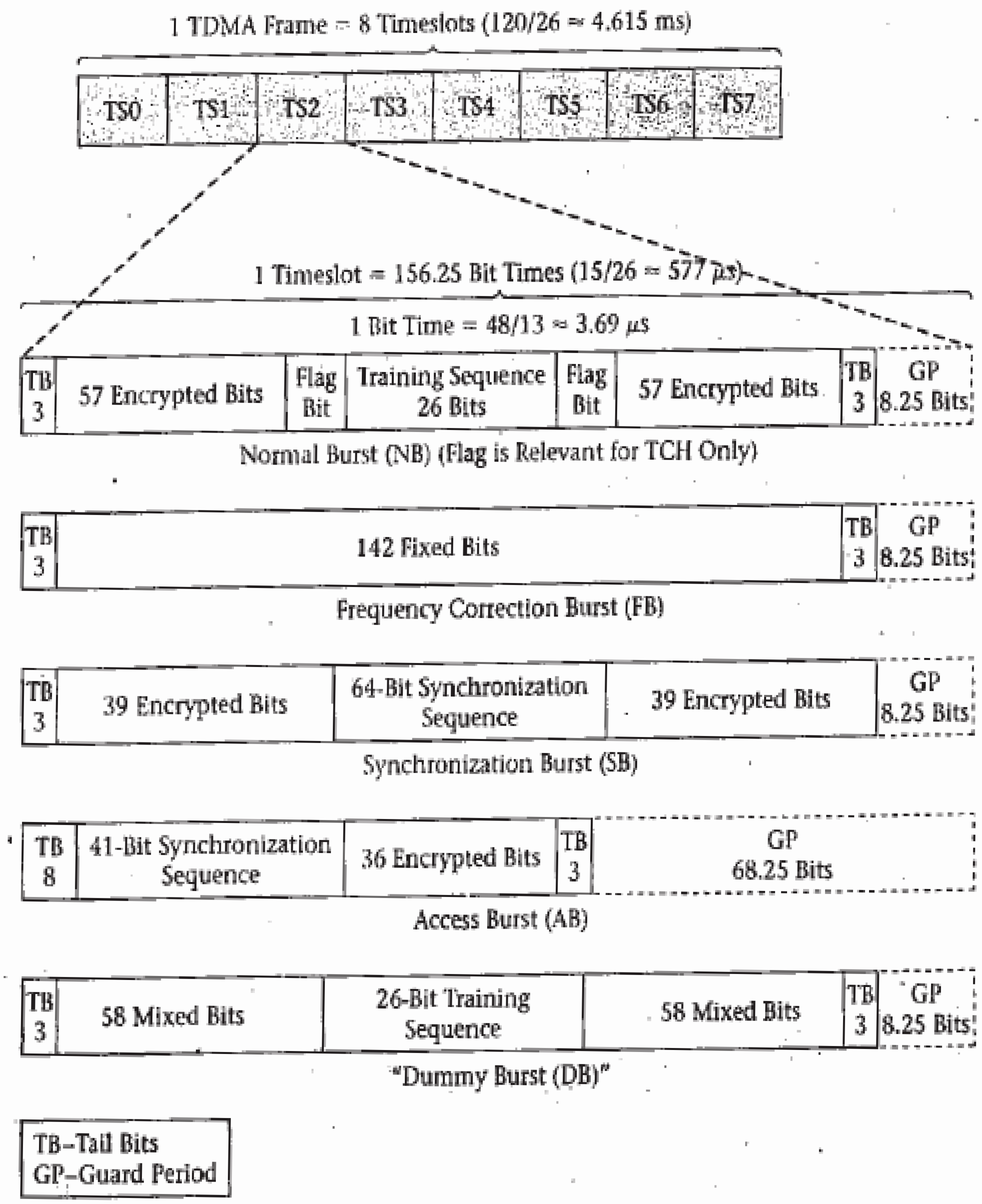
6. **Discuss the frame format of the GSM system and draw the different time slot bursts used in GSM. [10]**

Frame Format of a GSM System:



In the GSM system, eight timeslots constitute a TDMA frame. The system assigns numbers to the frames sequentially from 0 to 2,715,648 and then the process repeats itself. Our description of GSM timing will start with the largest system time period. This grouping of successive TDMA frames is known as a hyperframe. The hyperframe (as shown in Figure 5–12) consists of 2,048 superframes (2,715,648 frames) and takes 3 hours 28 minutes 53 seconds and 760 milliseconds to complete. Each superframe consists of 1,326 TDMA frames that take approximately 6.12 seconds to complete. These superframes may take on one of two possible formats. An explanation of why this is the case will be forthcoming shortly. One form of a superframe consists of 51 (26 frame) multiframes (i.e., each multiframe consists of 26 TDMA frames that take 120 ms to complete). The other superframe format consists of 26 (51 frame) multiframes (i.e., each multiframe consists of 51 TDMA frames that take about 235 ms to complete). Finally, as previously mentioned, within a TDMA frame there are eight timeslots that take approximately 4.615 ms to complete.

GSM Time Slot Bursts



Timeslot Bursts The transmission of a normal (traffic and control channels) burst and the other types of burst signals are shown in Figure 5–15. In the case of a normal **burst**, two groups of 57 encrypted bits are transmitted on either side of a training sequence of bits. This **training sequence** consists of alternating 0s and 1s and is used to train the adaptive equalizer incorporated into the GSM mobile receiver. Three (3) tail bits precede the first group of traffic bits and 3 tail bits trail the last group of traffic bits. These tail bits consist of three zeros (unmodulated carrier) that provide time for the digital radio circuitry to initialize itself. Two single flag bits separate the training bit sequence from the encrypted bit groups. The flag bits are used to indicate whether the encrypted bits contain traffic or control information. The normal burst has an 8.25-bit long guard period at the end of the burst where no transmission activity takes place. When used as a traffic channel, a total of 114 encrypted bits are delivered per timeslot. Details of the encryption process will be presented later.

The frequency correction burst is used by the mobile to obtain frequency synchronization. It consists of 142 fixed bits (binary 0s or an unmodulated carrier) proceeded by 3 tail bits and followed by 3 tail bits. It also has the same 8.25-bit long guard period after it. The repetition of the frequency correction burst by the BTS within the GSM frame structure becomes the frequency correction channel (FCCH).

The synchronization burst is used by the mobile to obtain timing synchronization. It consists of 3 tail bits, followed by 39 encrypted bits, a 64-bit synchronization sequence, 39 more encrypted bits, 3 tail bits, and the same 8.25-bit long guard period. The encrypted bits contain information about the frame number (FN) and the base station identity code (BSIC). The repetition of the synchronizing sequence burst by the BTS within the GSM frame structure becomes the synchronizing channel (SCH).

The access burst is used by the mobile to facilitate random access requests by the mobile and handover operations. It consists of 8 tail bits followed by a 41-bit synchronization sequence, then 36 encrypted bits, and 3 tail bits. In this case, the length of the guard bit time period is equal to 252 μs or 68.25 bits. The reason for the long guard time is so a mobile that has just become active or has just been handed off and does not know the system timing advance can be accommodated. The value chosen allows for a cell radius of 35 km. The access burst is used on both the random access channel (RACH) and on the fast associated control channel (FACCH) during handover.

The dummy burst is transmitted on the radio frequency designated as c_0 when no other type of burst signal is being transmitted. It consists of 3 tail bits, 58 mixed bits, a 26-bit training sequence, 58 more mixed bits, 3 tail bits, and the same 8.25-bit long guard period. The purpose of the dummy burst is to ensure that the base station is always transmitting on the frequency carrying the system information. This affords the mobile the ability to make power measurements on the strongest BTS in its location and thus determine which BTS to attach to when first turned on. Furthermore, the mobile can also make measurements of other BTSs and therefore provide information to the system if handover is needed.

7. Explain the GSM signal

ing Model. [10]

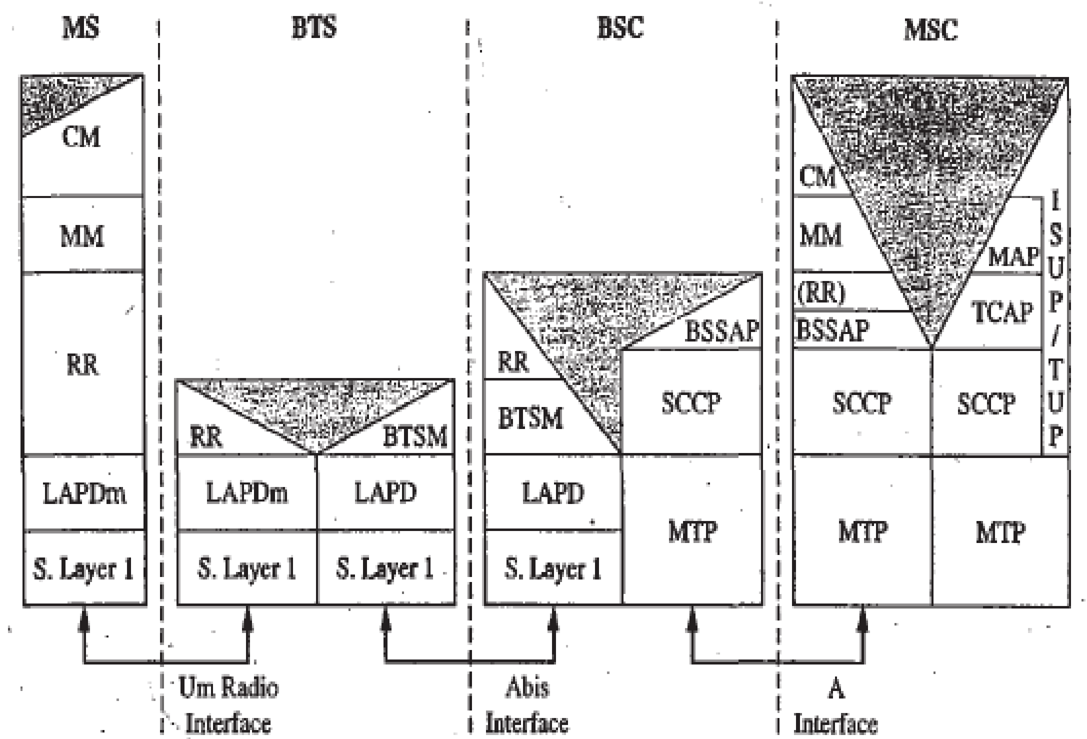


Figure 5–6 shows a signaling model for the GSM system. As shown by the figure, the MS communicate with the MSC to provide system connection, mobility, and radio resource management by sending mes sages back and forth over the air interface from the MS to the BTS, between the BTS and the BSC, an between the BSC and the MSC. The figure indicates the various protocols that are used between the diffe ent GSM interfaces and at the different OSI layer levels. Additionally, the MSC communicates with th various networks that it is connected to (PSTN, PLMN, etc.) by using the various protocols shown in th figure. These operations will be briefly summarized in the next several sections and then explained in mo detail in Section 5.6 of this chapter.

Um Interface The Layer 1, Um, air interface specifications will be detailed more extensively in Sectio 5.6 of this chapter and in Chapter 8. The Layer 2 protocol used on the Um interface is LAPDm, a modifie version of the ISDN protocol LAPD. The major differences between LAPD and LAPDm protocol are the following: for LAPDm no error detection is employed since it has been built into Layer 1 signaling and LAPDm messages are segmented into shorter messages than LAPD to be compatible with the TDMA frame length used in GSM.

Abis Interface The Abis interface exists between the BSC and the BTS. The Layer 2 protocol used on the Abis interface is LAPD. At the Layer 3 level, most messages just past through the BTS transparently. However, there are some radio resource management messages that are closely linked to the system radio hardware that must be handled by the BTS. The BTS management (BTSM) entities manage these messages. An example of this type of radio resource message involves encryption. The ciphering message sends the cipher key, K_c, to the BTS and then the BTS sends the ciphering mode command to the MS. Abis Layer 1 signaling details will also be discussed further in Chapter 8.

A Interface The A interface exists between the BSC and the MSC. Signaling over the A interface is done according to base station signaling application part (BSSAP) using the network service part of SS7. In the MSC, in the direction of the MS, Layer 3 is subdivided into three parts: radio resource management (RR), mobility management (MM), and connection management (CM). More will be said about these sublayers in Section 5.6 of this chapter. As mentioned, the protocol used to transfer the CM and MM messages is BBSAP. The BBSAP protocol has two subparts: direct transfer application part (DTAP) and base station system management application part (BSSAMP). DTAP is used to send CM and MM messages between the MSC and the MS transparently through the BSS. BSSAMP is used to send messages between the MSC and the BSC. This operation is detailed in Figure 5–7.

Ater Interface The Ater interface only exists in GSM systems that have separate units for the transcoder controller and BSC (this is typical of some vendors' GSM equipment). Signaling between the BSC and the TRC is performed by the use of BSC/TRC application part (BTAP) protocol (BTAP is a vendor- [Ericsson] specific protocol) over the Ater interface. Figure 5–8 shows this type of operation. The figure indicates how BSSAP signaling is sent transparently through the TRC node. Ater Layer 1 signaling details will also be discussed further in Chapter 8.

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