UNIT-VIII

1.Explain in detail about GSM architecture

GLOBAL SYSTEM FOR MOBILE (GSM):

CEPT, a European group, began to develop the Global System for Mobile TDMA system in June 1982.GSM has two objectives: pan-European roaming, which offers compatibility throughout the European continent, and interaction with the integrated service digital network (ISDN), which offers the capability to extend the single-subscriber-line system to a multiservice system with various services currently offered only through diverse telecommunications networks. System capacity was not an issue in the initial development of GSM, but due to the unexpected, rapid growth of cellular service, 35 revisions have been made to GSM since the first issued specification. The first commercial GSM system, calledD2, was implemented in Germany in 1992.

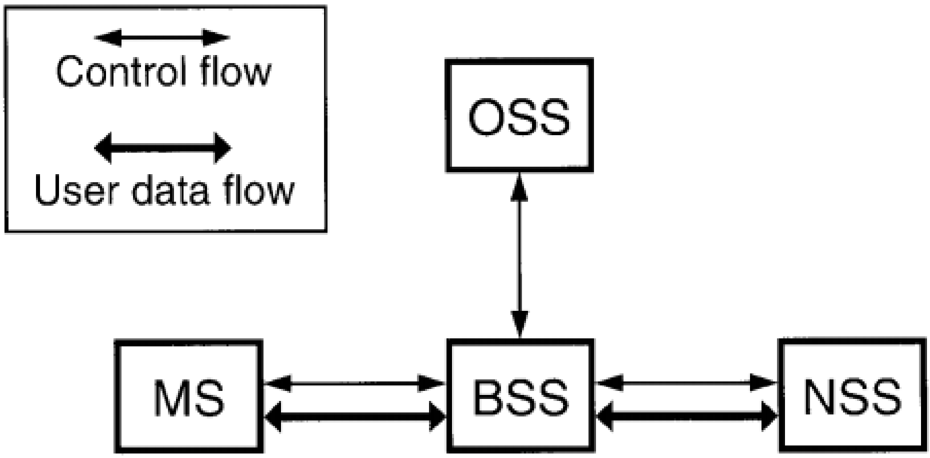


Fig.1.1. The external environment of BSS

GSM Architecture :

GSM consists of many subsystems, such as the mobile station (MS), the base station sub system (BSS), the network and switching subsystem (NSS), and the operation subsystem (OSS) in fig.1.1.

1. The Mobile Station: The MS may be a stand-alone piece of equipment for certain services or support the connection of external terminals, such as the interface for a personal computer or fax. The MS includes mobile equipment (ME) and a subscriber identity module (SIM). ME does not need to be personally assigned to one subscriber. The SIM is a subscriber module which stores all the subscriber-related information. When a subscriber's SIM is inserted into the ME of an

MS, that MS belongs to the subscriber, and the call is delivered to that MS. The ME is not associated with a called number—it is linked to the SIM. In this case, any ME can be used by a subscriber when the SIM is inserted in the ME.

2. Base Station Subsystem: The BSS connects to the MS through a radio interface and also connects to the NSS. The BSS consists of a base transceiver station (BTS) located at the antenna site and a base station controller (BSC) that may control several BTSs. The BTS consists of radio transmission and reception equipment similar to the ME in an MS. A transcoder/rate adaption unit (TRAU) carries out encoding and speech decoding and rate adaptation for transmitting data. As a subpart of the BTS, the TRAU may be sited away from the BTS, usually at the MSC. In this case, the low transmission rate of speech code channels allows more compressed transmission between the BTS and the TRAU, which is sited at the MSC.

GSM uses the open system interconnection (OSI). There are three common interfaces based on OSI (Fig. 1.2.): a common radio interface, called air interface, between the MS and BTS, an interface A between the MSC and BSC, and an A-bis interface between the BTS and BSC. With these common interfaces, the system operator can purchase the product of manufacturing company A to interface with the product of manufacturing company B. The difference between interface and protocol is that an interface represents the point of contact between two adjacent entities (equipment or systems) and a protocol provides information flows through the interface. For example, the GSM radio interface is the transit point for information flow pertaining to several protocols.

3. Network and Switching Subsystem: NSS (see Fig.1.3.) in GSM uses an intelligent network (IN). The IN's attributes will be described later. A signaling NSS includes the main switching functions of GSM. NSS manages the communication between GSM users and other telecommunications users. NSS management consists of:

Mobile service switching center (MSC): Coordinates call set-up to and from GSM users. An MSC controls several BSCs.

Interworking function (IWF): A gateway for MSC to interface with external networks for communication with users outside GSM, such as packet-switched public data network (PSPDN) or circuit-switched public data network (CSPDN).The role of the IWF depends on the type of user data and the network to which it interfaces.

Home location register (HLR): Consists of a stand-alone computer without switching capabilities, a database which contains subscriber information, and information related to the subscriber's current location, but not the actual location of the subscriber. A subdivision of HLR is the authentication center (AUC). The AUC manages the security data for subscriber authentication. Another sub-division of HLR is the equipment identity register (EIR) which stores the data of mobile equipment (ME) or ME-related data.

Visitor location register (VLR): Links to one or more MSCs, temporarily storing subscription data currently served by its corresponding MSC, and holding more detailed data than the HLR. For example, the VLR holds more current subscriber location information than the location information at the HLR.

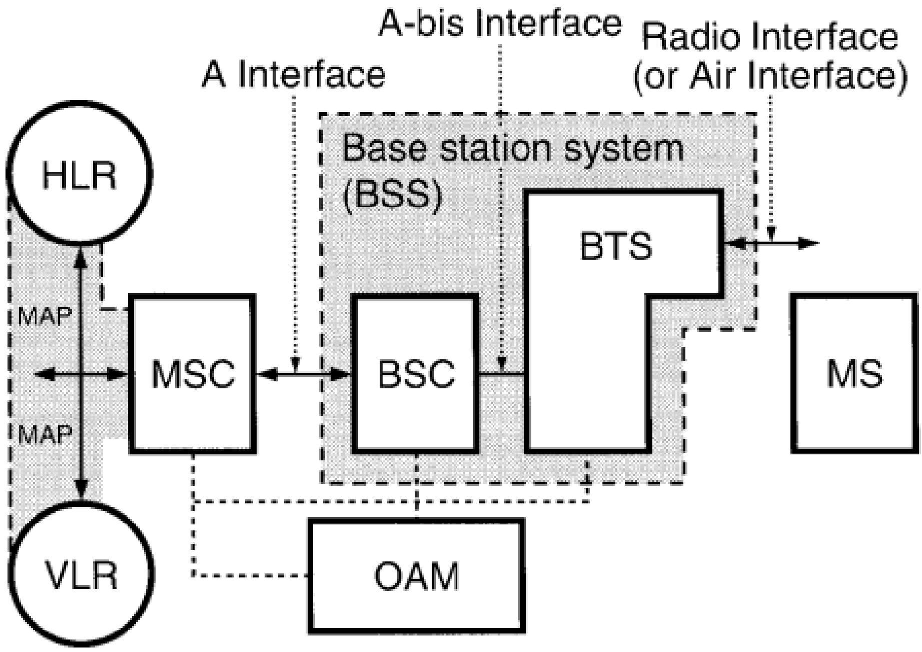


Fig.1.2. Functional architecture and principal interfaces

Gateway MSC (GMSC): In order to set up a requested call, the call is initially routed to a gateway MSC, which finds the correct HLR by knowing the directory number of the GSM subscriber. The GMSC has an interface with the external network for gatewaying, and the network also operates the full Signaling System 7 (SS7) signaling between NSS machines.

Signaling transfer point (STP): Is an aspect of the NSS function as a stand-alone node or in the same equipment as the MSC. STP optimizes the cost of the signaling transport among MSC/VLR, GMSC, and HLR.

As mentioned earlier, NSS uses an intelligent network. It separates the central data base (HLR) from the switches (MSC) and uses STP to transport signaling among MSC and HLR.

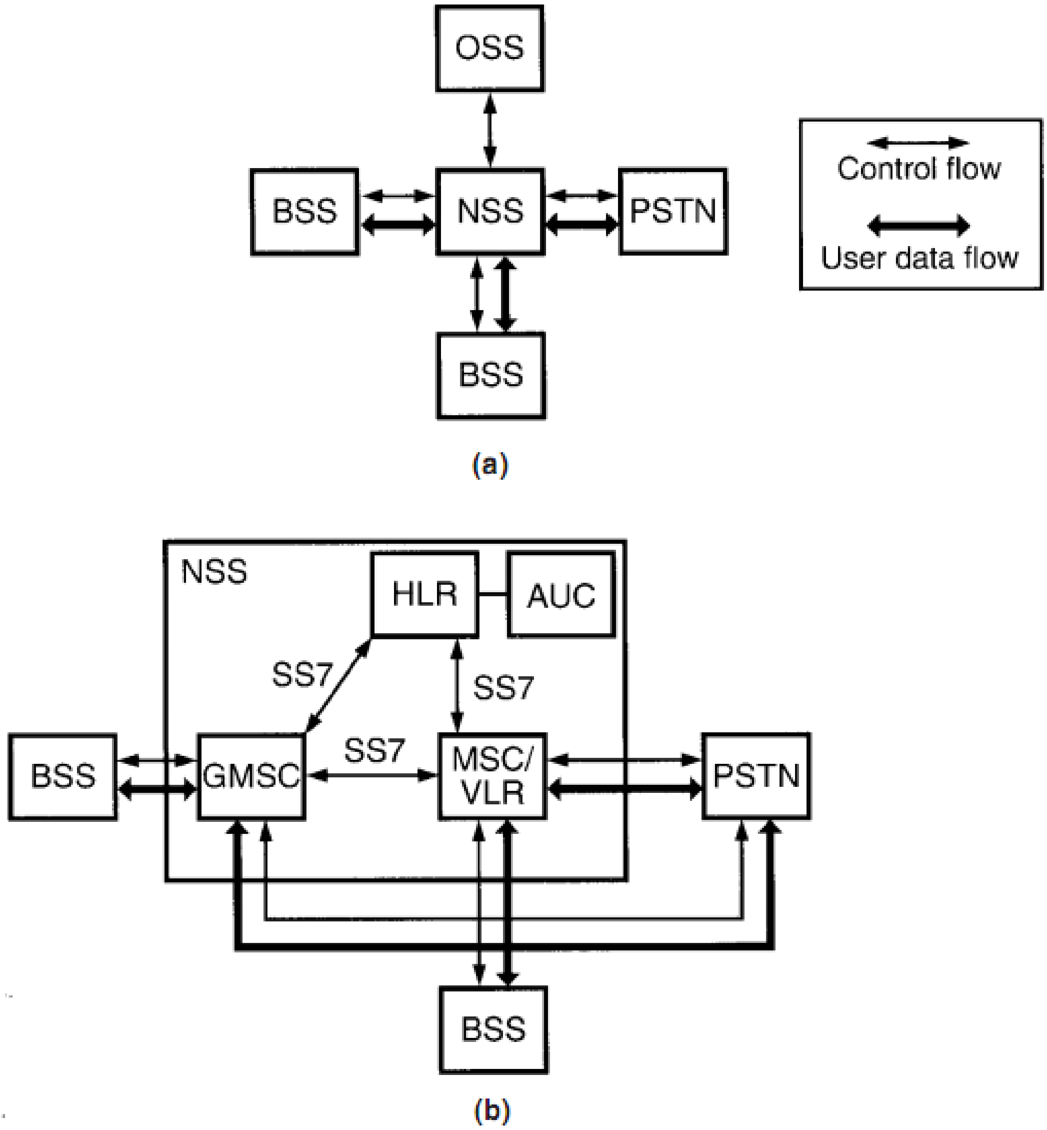


Fig.1.3. NSS and its environment (a) the external environment; (b) the internal structure

4. Operation Subsystem: There are three areas of OSS, as shown in Fig.1.4. (1) network operation and maintenance functions, (2) subscription management, including charging and billing, and (3)mobile equipment management. These tasks require interaction between some or all of the infrastructure equipment. OSS is implemented in any existing network.

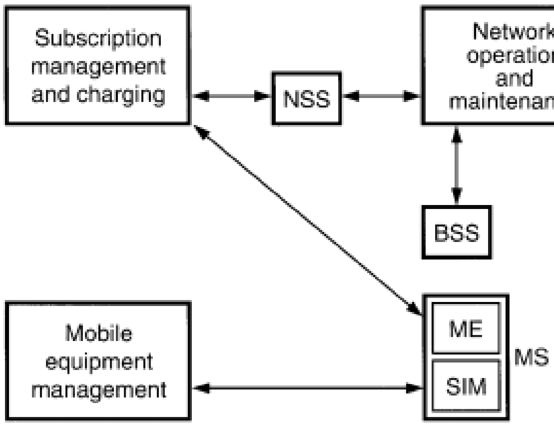


Fig.1.4. OSS organization

2. What are the services offered by GSM channels?

GSM Channel Structure: The services offered to users have four radio transmission modes, three data modes, and a speech mode. The radio transmission modes use the physical channels.

Physical Channels: There are three kinds of physical channels, also called traffic channels (TCHs):

1. TCH/F (full rate): Transmits a speech code of 13 kbps or three data-mode rates, 12, 6, and 3.6 kbps.

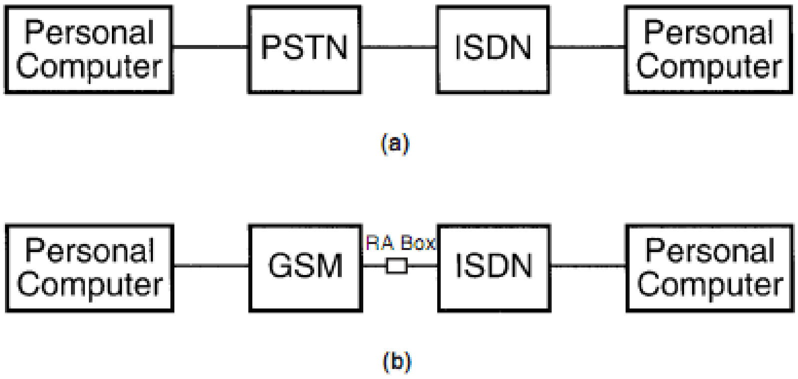


Fig.2.1. Interconnection with ISDN (a) PSTN user to ISDN user (b) GSM user to ISDN user

2. TCH/H (half rate): Transmits a speech code of 7 kbps or two data modes, 6 and 3.6 kbps.

3. TCH/8 (one-eighth rate): Used for low-rate signaling channels, common channels, and data channels.

Logic channels:

1. Common channels: All the common channels are embedded in different traffic channels. They are grouped by the same cycle (51 × 8 BP), where BP stands for burst period (i.e.,time slot), which is 577 μs.

2. Downlink common channels: There are five downlink unidirectional channels, shared or grouped by a TCH.

(i) Frequency correction channel (FCCH) repeats once every 51×8 BPs; used to identify a beacon frequency.

(ii)Synchronization channel (SCH) follows each FCCH slot by 8 BPs.

(iii)Broadcast control channel (BCCH) is broadcast regularly in each cell and received by all the mobile stations in the idle mode.

(iv)Paging and access grant channel (PAGCH) is used for the incoming call received at the mobile station. The access grant channel is answered from the base station and allocates a channel during the access procedure of setting up a call.

(v)Call broadcast channel (CBCH). Each cell broadcasts a short message for 2s from the network to the mobile station in idle mode. Half a downlink TCH/8 is used, and special CBCH design constraints exist because of the need for sending two channels (CBCH and BCCH) in parallel.

The mobile station (MS) finds the FCCH burst, then looks for an SCH burst on the same frequency to achieve synchronization. The MS then receives BCCH on several time slots and selects a proper cell, remaining for a period in the idle mode.

3. Uplink common channels: The random-access channel (RACH) is the only common uplink channel. RACH is the channel that the mobile station chooses to access the calls.

There are two rates: RACH/F (full rate, one time slot every 8 BP), and RACH/H (half rate, using 23 time slots in the 51 × 8 BP cycle, where 8 BP cycle [i.e. a frame] is 4.615ms).

4. Signaling channels: All the signaling channels have chosen one of the physical channels,and the logical channels names are based on their logical functions:

5. Slow Associated Control Channel (SACCH): A slow-rate TCH used for signaling transport and used for non urgent procedures, mainly handover decisions. It uses one-eighth rate. The TCH/F is always allocated with SACCH. This combined TCH and SACCH is denoted TACH/F.

SACCH occupies 1 time slot (0.577 ms) in every 26 frames (4.615ms × 26). The time organization of a TACH/F is shown in Fig.2.2.

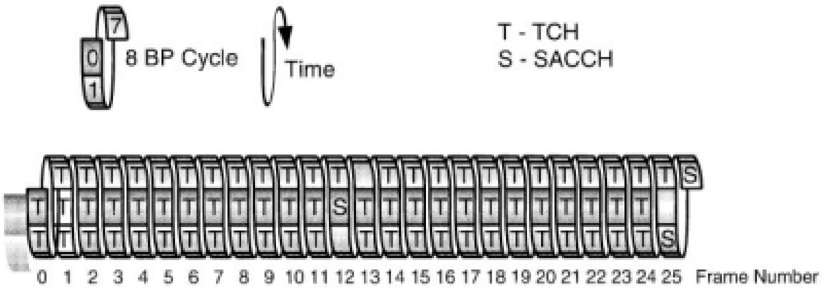


Fig.2.2. Time organization of TACH/F

6. Fast Associated Control Channel (FACCH): Indicates cell establishment, authenticates subscribers, or commands a handover.

7. Stand-alone Dedicated Control Channel (SDCCH): Occasionally the connection between a mobile station and the network is used solely for passing signaling information and not for calls. This connection may be at the user's demand or for other management operations such as updating the unit's location. It operates at a very low rate and uses a TCH/8 channel. Radio slots are allocated to users only when call penetration is needed. There are two modes, dedicated and idle. The mode used depends on the uplink and the downlink. In GSM terminology, the downlink is the signal transmitted from the base station to the mobile station, and the uplink is the signal transmitted in the opposite direction.

8. Voice/data channels: Each time slot of a voice channel contains 260 bits per block. The entire block contains 316 bits. Each time slot of a data channel contains 120 or 240 bits per block.

3. Write short notes on modes in GSM channels.

The different modes of GSM channel are as follows

1. Channel mode

2. Dedicated mode

3. Idle mode

1. Channel modes: Because of the precious value of the radio spectrum, individual users cannot have their own TCH at all times.

2. Dedicated mode: Uses TCH during call establishment and uses SACCH to perform location updating in the dedicated mode. TCH and SACCH are dedicated channels for both uplink and downlink channels.

3. Idle mode: During non call activities, the five downlink channels are in the idle mode: FCCH; SCH; BCCH, which is broadcasting regularly; PAGCH and CBCH, which sends one message every 2 s. During idle mode, the mobile station listens to the common downlink channels, and also uses SDCCH (uplink channel) to register a mobile location associated with a particular base station to the network.

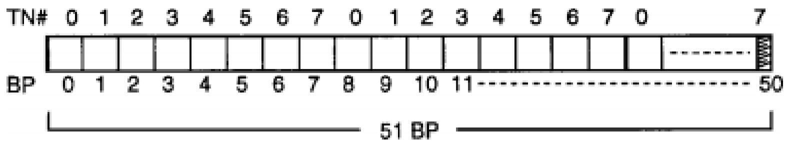
4. Explain in detail about multiple access scheme.

Multiple-Access Scheme: GSM is a combination of FDMA and TDMA. The total number of channels in FDMA is 124, and each channel is 200 kHz. Both the 935–960MHz uplink and 890–916 MHz downlink have been allocated 25 MHz, for a total of 50 MHz Duplex separation is 45 MHz If TDMA is used within a 200-kHz channel, 8 time slots are required to form a frame, frame duration is 4.615 ms, and the time slot duration burst period is 0.577ms. There is a DCS-1800 system, which has the same architecture as the GSM, but it is up converted to 1800MHz. The downlink is 1805–1880 MHz (base TX) and the uplink is 1700–1785 MHz (mobile Tx).

Constant Time Delay between Uplink and Downlink: The numbering of the uplink slots is derived from the downlink slots by a delay of 3 time slots. This allows the slots of one channel to bear the same time slot number in both directions. In this case, the mobile station will not transmit and receive simultaneously because the two time slots are physically separated. Propagation delay when the mobile station is far from the BTS is a major consideration. For example, the round trip propagation delay between an MS and BTS which are 35 km apart is 233 µs. As a result, the assigned time slot numbers of the uplink and downlink channels may not be the same (less than 3 time slots apart). The solution is to let BTS compute a time advance value. The key is to allow significant guard time by taking into account that BCCH is using only even time slots. This avoids the uncertainty of numbering the wrong time slot. Once a dedicated connection is established, the BTS continuously measures the time offset between its own burst schedule and the reception schedule of mobile station bursts on the bidirectional SACCH channel. The time compensation for the propagation delay (sending to the mobile station via SACCH) is 3 time slots minus the time advance.

Frequency Hopping: GSM has a slow frequency-hopping radio interface. The slow hopping is defined in bits per hop. Its regular rate is 217 hops/s, therefore, with a transmission rate of 270 kbps, the result is approximately 1200 bits/hop. If the PAGCH and the RACH were hopping channels, then hopping sequences could be broadcast on the BCCH. The common channel is forbidden from hopping and using the same frequency.

Different Types of Time Slots: Each cell provides a reference clock from which the time slots are defined. Each time slot is given a number (TN) which is known by the base station and the mobile station. The time slot numbering is cyclic. TN0 is a single set broadcast in any given call and repeated every 8 BPs for the confirmation of all common channels. The organization of TN0 (first of eight time slots) in sequence is as follows: FCCH(1), SCH (1), BCCH (4), PAGCH (4), FCCH (1), SCH (1), PAGCH (8), FCCH (1), SCH(1), PAGCH (8), FCCH (1), SCH (1), PAGCH (8), FCCH (1), SCH (1), PAGCH (8).

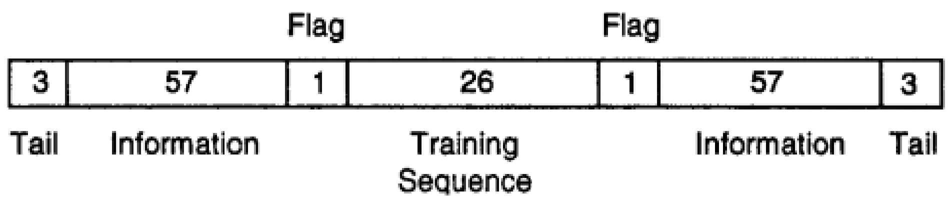


The symbol PAGCH (4) means that the PAGCH channel information appears in consecutive ones of every 8 BP cycle 4 times. Each of the remaining seven TNs (TN1 to TN7) is assigned to one TACH/F channel.

Bursts and Training Sequences: In TDMA, the signal transmits in bursts. The time interval of the burst brings the amplitude of a transmitted signal up from a starting value of 0 to its normal value. Then a packet of bits is transmitted by a modulated signal. Afterward, the amplitude decreases to zero. These bursts occur only at the mobile station transmission or at the base station if the adjacent burst is not transmitted. There are tail bits and training sequence bits within a burst. The tail bits are three 0 bits added at the beginning and at the end of each burst which provide the guard time. The training sequence is a sequence known by the receiver that trains an equalizer, a device that reduces inter symbol interference. The training sequence bits are inserted in the middle of a time slot sometimes called a midamble, for the same purpose as a preamble, so that the equalizer can minimize its maximum distance with any useful bit. There are eight different training sequences, with little correlation between any two sequences to distinguish the received signal from the interference signal.

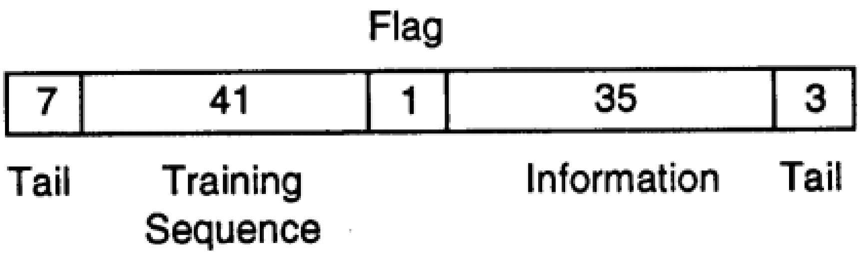
There are several kinds of bursts:

1. The normal burst used in TCH:

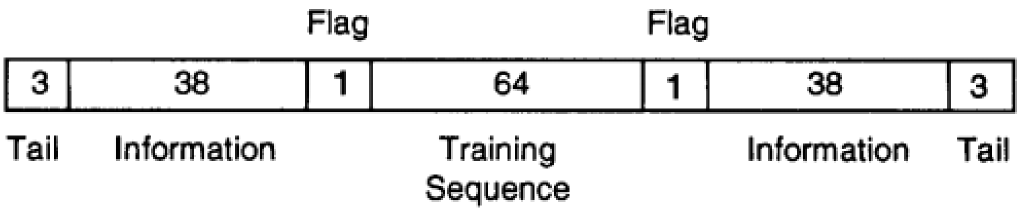


The 1-bit binary information indicating data or signaling is called the stealing flag.

2. The access burst used on the RACH in the uplink direction:



3. The F and S bursts. The F burst is used on the FCCH and has the simplest format. All of the 148 bits are zero, producing a pure sine wave. Five S bursts in each 51 × 8 BP cycle are used on the SCH. One S burst is shown below:



5. Explain the architecture of TDMA?

NA-TDMA architecture:

The NA-TDMA architecture is similar to GSM architecture. The only difference is that in NA-TDMA, there is only one common interface, which is the radio interface as shown in Fig. 5. The NA-TDMA uses the intelligent network. All the components such as HLR, VLR, AUC, and EIR are the same as used in GSM. In developing the NA-TDMA system, there were two phases:

First phase: To commonly share the 21 set-up channels that are used for the analog system. The first-phase system is only for voice transmission. Both modes, AMPS and digital, are built in the same unit. The handoff procedure has to take care of the following four features:

1. AMPS cell to AMPS cell

2. TDMA cell to TDMA cell

3. AMPS cell to TDMA cell

4. TDMA cell to AMPS cell

Second phase: (1) generate new digital set-up channels (they were in the voice band) to access to TDMA voice channels so that a digital stand-alone unit can be provided and (2) specify a data-service signal protocol for transmitting data.

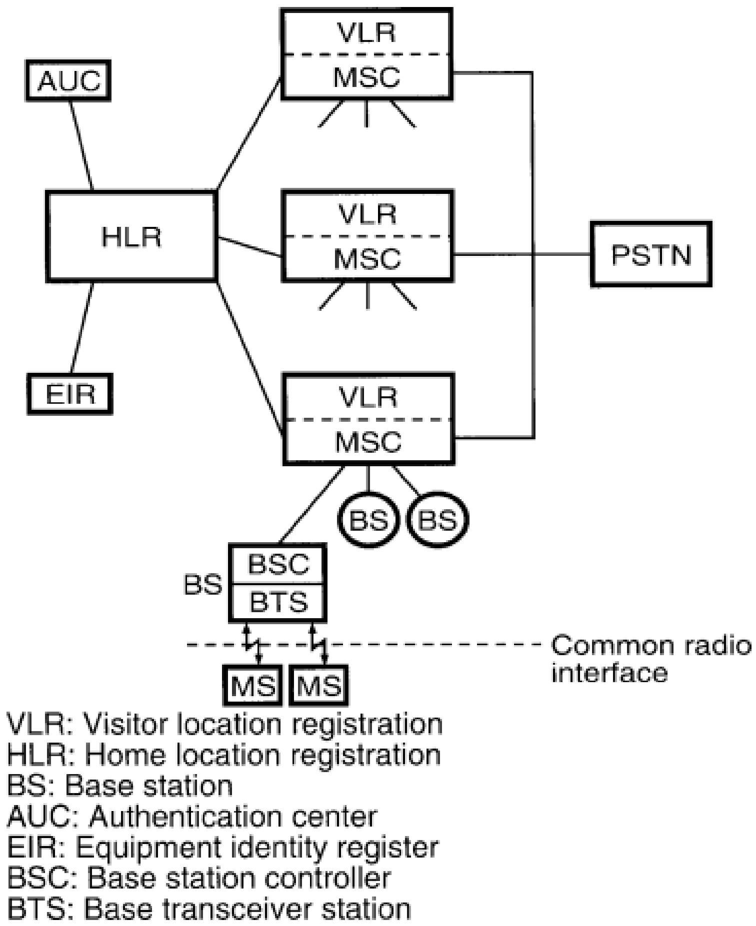


Fig.5. NA-TDMA system architecture

6. Write about the signaling format and message structure in TDMA.

Signaling Format in Different Channels: A reverse digital traffic channel (RDTC) is used to transport user information and signaling. A forward digital traffic channel (FDTC) has same format as the RDTC (reverse digital traffic channel). Two control channels are used: the FACCH is a blank and burst channel, the SACCH is a continuous channel, and interleaving is on the SACCH. The signaling formats of these two channels are shown in Fig.6.

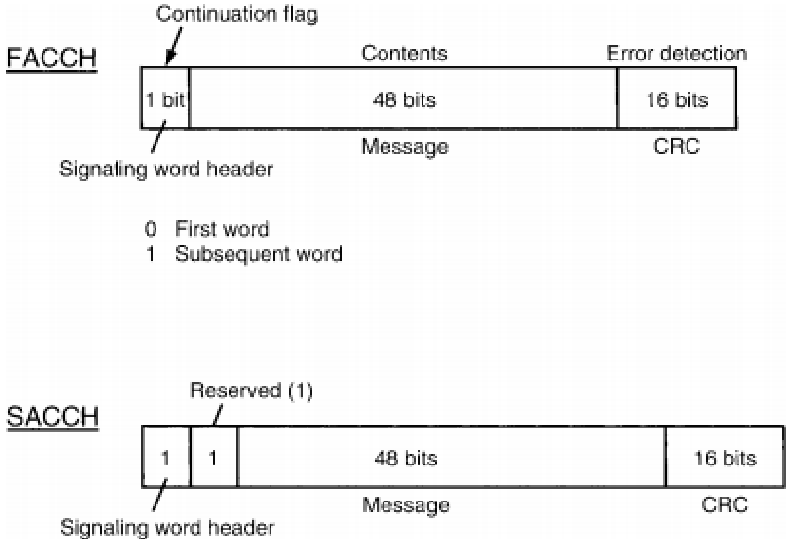


Fig.6.Signaling formats of FACCH and SACCH

Message Structure:

All messages contain:

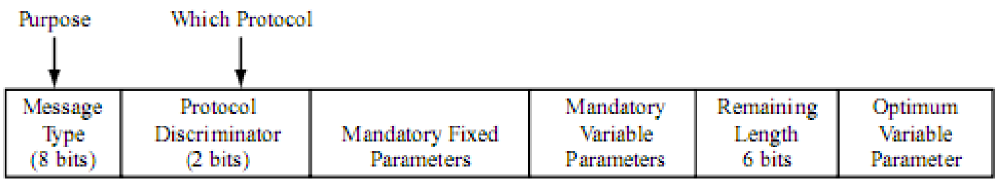
1. An application message header

2. Mandatory fixed parameters

3. Mandatory variable parameters

4. Remaining length

5. Optional variable parameters



7. Write short notes on,

(a) TDMA structure

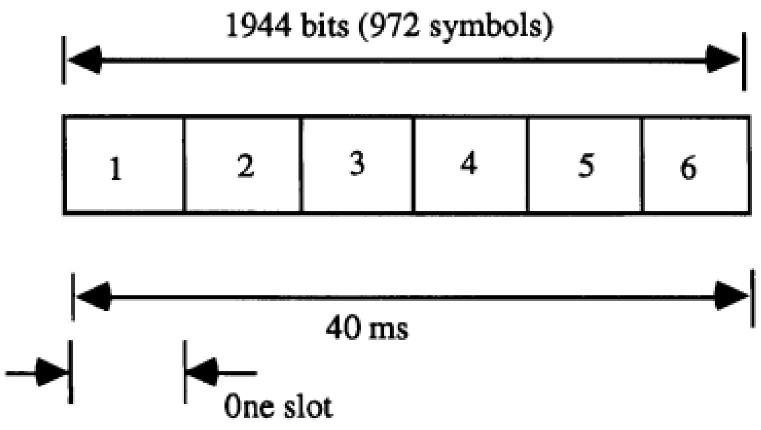
(b) Frame length

(c) Frame offset

(d) Modulation timing.

(a) TDMA Structure (Digital Channels):

In NA-TDMA, the set-up channels are analog channels shared with the AMPS system. One digital channel (a 30-kHz TDMA channel) contains 25 frames per second. Each frame is 40-ms long and has 6 time slots. Each time slot is 6.66-ms long. One frame contains 1944 bits (972 symbols), as shown in Fig. 7. Each slot contains 324 bits (162 symbols) and the duration between bits is 20.57 μs. Therefore, one radio channel is transmitted at 48.6 kbps but only 24,000 symbols per second over the radio path. Each frame consists of 6 time slots. The maximum effect on the signal for a forward time slot is one-half full symbol period and for a reverse time slot is 6 symbol periods (Fig. 7b).



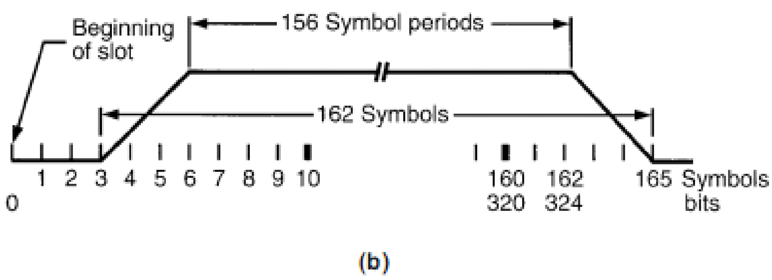


Fig.7. TDMA frame and slot (a) TDMA frame structure; (b) overall length in each slot

Frame Length: There are two frame lengths, full rate and half rate. Each full-rate traffic channel shall use two equally spaced time slots of the frame. The overall length in each slot is shown in Fig. 7b.

Channel 1 uses time slots 1 and 4

Channel 2 uses time slots 2 and 5

Channel 3 uses time slots 3 and 6

Each half-rate traffic channel shall use one time slot of the frame:

Channel 1 uses time slot 1

Channel 2 uses time slot 2

Channel 3 uses time slot 3

Channel 4 uses time slot 4

Channel 5 uses time slot 5

Channel 6 uses time slot 6

Frame Offset: At the mobile station, the offset between the reverse and forward frame timing (without time advanced applied), is

Forward frame = reverse frame + (1 time slot + 44 symbols)

= reverse frame + 206 symbols

The time slot (TS) 1 of frame N (in forward link) occurs 206 symbol periods after TS 1 of frame N in the reverse link.

Modulation Timing:

Modulation timing within a forward time slot: The first modulated symbol (the first symbol of the sync word) used by the mobile unit shall have maximum effect on the signal (156 symbols) transmitted from the base antenna, one-half symbol (1 bit) period after beginning the time slot.

Modulation timing within a reverse time slot: The first modulated symbol has a maximum effect on the signal transmitted at the mobile unit 6 symbol periods after the beginning of the reverse time slot.

8. Explain about TDMA channels.

NA-TDMA Channels:

In NA-TDMA, there are no common channels such as those used in GSM. The digital call set-up uses the 21 set-up channels which are shared with the analog system.

Supervision of the Digital Voice Channel: The supervision channels in NADC are similar to those in GSM:

(i) Fast Associated Control Channel FACCH is a blank and burst channel equivalent to a signaling channel for the transmission of control and supervision messages between the base station and the mobile station. It consists of 260 bits. Mostly FACCH is used for handoff messages.

(ii)Slot Associated Control Channel SACCH is a signaling channel including twelve code bits present in every time slot transmitted over the traffic channel whether these contain voice or FACCH information.

Mobile-Assisted Handoffs (MAHO): The mobile station performs signal quality measurements on two types of channels:

1. Measures the RSSI (received signal strength indicator) and the BER (bit error rate) information of the current forward traffic channel during a call.

2. Measures the RSSI of any RF channel which is identified from the measurement order message from the base station.

MAHO consists of three messages:

1. Start measurement order:

Measurement order message—sent from the base station to the mobile station.

Measurement order acknowledge message—sent from the mobile station to the base station.

2. Stop measurement order:

Stop measurement order—sent from the base station to the mobile station.

Mobile acknowledges—sent from the mobile station to the base station.

3. Channel quality message (mobile to base only)

The mobile transmits the signal quality information over either the SACCH or FACCH.

In the case of discontinuous transmission (DTX):

(a) Whenever the mobile is in the DTX high state, the mobile transmits channel quality information over the SACCH

(b) When the mobile is in the DTX low state, the mobile transmits the channel quality information over the FACCH

Handoff Action: When a handoff order is received, the mobile station is at DTX high state and stays at that state. If the mobile station is at DTX low state it must enter the DTX high state and wait for 200 ms before taking the handoff action. Handoff to a digital traffic channel is described as follows:

1. Turn on signaling tone for 50 ms, turn off signaling tone, turn off transmitter which was operating on the old frequency.

2. Adjust power, tune to new channel, set stored DVCCs to the DVCC field of the received message.

3. Set the transmitter and receiver to digital mode, set the transmit and receive rate based on the message-type field.

4. Set time slot based on the message-type field.

5. Set the time alignment offset to the value based on the TA field.

6. Once the transmitter is synchronized, enter the conversation task of the digital traffic channel.

9. Explain the some of the important terms of CDMA digital cellular systems.

CDMA development started in early 1989 after the NA-TDMA standard (IS-54) was established. A CDMA demonstration to test its feasibility for digital cellular systems was held in November 1989. The CDMA "Mobile Station-Base Station Compatibility Standard for Dual Mode Wideband Spread Spectrum Cellular System" was issued as IS-95 (PN-3118, Dec. 9, 1992). CDMA uses the idea of tolerating interference by spread-spectrum modulation. The power control scheme in a CDMA system is a requirement for digital cellular application. However, it was a challenging task and has been solved. Before describing the structure of the system, we list the key terms of CDMA systems.

Terms of CDMA Systems:

Active set: The set of pilots associated with the CDMA channels containing forward traffic channels assigned to a particular mobile station (MS).

CDMA channel number: An 11-bit number corresponding to the center of the CDMA frequency assignment.

Code channel: A sub channel of a forward CDMA channel. A forward CDMA channel contains 64 code channels. Certain code channels are assigned to different logic channels.

Code channel zero**:** Pilot channel.

Code channels 1 through 7: Either paging channels or traffic channels.

Code channel 32: A sync channel or a traffic channel.

The remaining code channels are traffic channels.

Code symbol: The output of an error-correcting encoder.

Dim-and-burst: A frame in which the primary traffic is multiplexed with either secondary traffic or signal traffic. It is equivalent to the blank-and-burst function in AMPS.

Forward CDMA channel: Contains one or more code channels.

Frame: A basic timing interval in the system. For the access channel, paging channel, and traffic channel, a frame is 20-ms long. For the sync channel, a frame is 26.666-ms long.

Frame offset: A time skewing of traffic channel frames from system time in integer multiples of 1.25ms. The maximum frame offset is 18.75ms.

GPS (Global Position System): System used for providing location and time information to the CDMA system.

Handoff (HO): The act of transferring communication with a mobile station from one base station to another.

Hard HO: Occurs when (1) the MS is transferred between disjoint active sets, (2) the CDMA frequency assignment changes, (3) the frame offset changes, and (4) the MS is directed from a CDMA traffic channel to an analog voice channel but not vice versa.

Soft HO: HO from CDMA cell to CDMA cell at the same CDMA frequency.

Idle HO: Occurs when the paging channel is transferred from one base station (BS) to another.

Layering: A method of organization for communication protocols. A layer is defined in terms of its communication protocol to a peer layer.

Layer 1: Physical layer presents a frame by the multiplex sub layer and transforms it an over-the-air waveform.

Layer 2: Provides for the correct transmission and reception of signaling messages.

Layer 3: Provides the control of the cellular telephone system. The signaling messages originate and terminate at layer 3.

Long code: A PN (pseudo noise) sequence with period $2^{42}-1$ using a tapped n-bit shift register.

Modulation symbol: The output of the data modulator before spreading. There are 64 modulation symbols on the reverse traffic channel, 64-ary orthogonal modulation is used, and six code symbols are associated with one modulation symbol. On the forward traffic channel, each code symbol (data rate is 9600 bps) or each repeated code symbol (data rate is less than 9600 bps) is 1 modulation symbol.

$$\text{Reverse}: \overbrace{110101}^{53}\ \overbrace{101110}^{48} \longrightarrow (\overbrace{\text{Walsh function 53}}^{64\text{ bits}})(\overbrace{\text{Walsh function 48}}^{64\text{ bits}})$$

$$6 \text{ code symbols} \longrightarrow 1 \text{modulation symbol}$$

$$\text{Forward: } 1 \text{ code symbol} = 1 \text{ modulation symbol}$$

Multiplex option: The ability of the multiplex sub layer and lower layers to be tailored to provide special capabilities. A multiplex option defines the frame format and the rate decision rules.

Multiplex sublayer: One of the conceptual layers of the system that multiplexes and demultiplexes primary traffic, secondary traffic, and signaling traffic.

Nonslotted mode: An operating mode of an MS in which the MS continuously monitors the paging channel.

Null traffic data: A frame of sixteen 1's followed by eight 0's sent at the 1200 bps rate. Null traffic channel data serve to maintain the connectivity between MS and BS when no service is active and no signaling message is being sent.

Paging channel: A code channel in a forward CDMA channel used for transmission of (1) control information and (2) pages from BS to MS. The paging channel slot has a 200-ms interval.

Power control bit: A bit sent in every 1.25 ms interval on the forward traffic channel to the MS that increases or decreases its transmit power.

Primary CDMA channel: A pre assigned frequency used by the mobile station for initial acquisition.

Primary paging channel: The default code channel (code channel 1) assigned for paging.

Primary traffic: The main traffic stream between MS and BS on the traffic channel.

Reverse traffic channel: Used to transport user and signaling traffic from a single MS to one or more BSs.

Shared Secret Data (SSD): A 128-bit pattern stored in the MS.

SSD is a concatenation of two 64-bit subsets.

SSD-A is used to support the authentication.

SSD-B serves as one of the inputs to generate the encryption mask and private long code.

Secondary CDMA channel: A pre assigned frequency (one of two) used by the mobile station for initial acquisition.

Secondary traffic: An additional traffic stream carried between the MS and the BS on the traffic channel.

Slotted mode: An operation mode of MS in which the MS monitors only selected slots on the paging channel.

Sync channel: Code channel 32 in the forward CDMA channel which transports the synchronization message to the MS.

Pilot channel: An un modulated, direct-sequence (DS) signal transmitted continuously by each CDMA BS. The pilot channel allows a mobile station to acquire the timing of the forward CDMA channel, provides a phase reference for coherent demodulation, and provides a means for signal strength comparisons between base stations for determining when to hand off.

System time: The time reference used by the system. System time is synchronous to universal time coordination (UTC) time and uses the same time origin as GPS time. All BSs use the same system time. MSs use the same system time, offset by the propagation delay from the BS to the MS.

Time reference: A reference established by the MS that is synchronous with the earliest arriving multipath component that is used for demodulation. The time reference establishes transmit time and the location of zero in PN space.

Walsh chip: The shortest identifiable component of a 64-walsh function. On the forward CDMA channel, one chip equals 1/1.2288 MHz or 813.802 ns. On the reverse CDMA channel, one chip equals 4/1.2288 MHz or 3255 ns.