Q1.a) What is the reason for a handoff in cellular networks?Explain the various type os handoff and the strategies used for handoff.

Ans:

Cellular systems require handover procedures, as single cells do not cover the whole service area, but, e.g., only up to 35 km around each antenna on the countryside and some hundred meters in cities. The smaller the cell size and the faster the movement of a mobile station through the cells (up to 250 km/h for GSM), the more handovers of ongoing calls are required. However, a handover should not cause a cut-off, also called call drop. GSM aims at maximum handover duration of 60 ms.

There are two basic reasons for a handover (about 40 have been identified in the standard):

● The mobile station moves out of the range of a BTS or a certain antenna of a BTS respectively. The received signal level decreases continuously until it falls below the minimal requirements for communication. The error rate may grow due to interference, the distance to the BTS may be too high (max. 35 km) etc. – all these effects may diminish the quality of the radio link and make radio transmission impossible in the near future.

● The wired infrastructure (MSC, BSC) may decide that the traffic in one cell is too high and shift ome MS to other cells with a lower load (if possible). Handover may be due to load balancing.

Figure 4.11 shows four possible handover scenarios in GSM:

● Intra-cell handover: Within a cell, narrow-band interference could make transmission at a certain frequency impossible. The BSC could then decide to change the carrier frequency (scenario 1).

● Inter-cell, intra-BSC handover: This is a typical handover scenario. The mobile station moves from one cell to another, but stays within the control of the same BSC. The BSC then performs a handover, assigns a new radio channel in the new cell and releases the old one (scenario 2).

● Inter-BSC, intra-MSC handover: As a BSC only controls a limited number of cells; GSM also has to perform handovers between cells controlled by different

BSCs. This handover then has to be controlled by the MSC (scenario 3). This situation is also shown in Figure 4.13.

● **Inter MSC handover:** A handover could be required between two cells belonging to different MSCs. Now both MSCs perform the handover together the typical signal flow during an inter-BSC, intra-MSC handover. The MS sends its periodic measurements reports, the BTSold forwards these reports to the BSCold together with its own measurements. Based on these values and, e.g., on current traffic conditions, the BSCold may decide to perform a handover and sends the message HO_required to the MSC. The task of the MSC then comprises the request of the resources needed for the handover from the new BSC, BSCnew. This BSC checks if enough resources (typically frequencies or time slots) are available and activates a physical channel at the BTSnew to prepare for the arrival of the MS. The BTSnew acknowledges the successful channel activation, BSCnew acknowledges the handover request. The MSC then issues a handover command that is forwarded to the MS. The MS now breaks its old radio link and accesses the new BTS. The next steps include the establishment of the link (this includes layer two link establishment and handover complete messages from the MS).

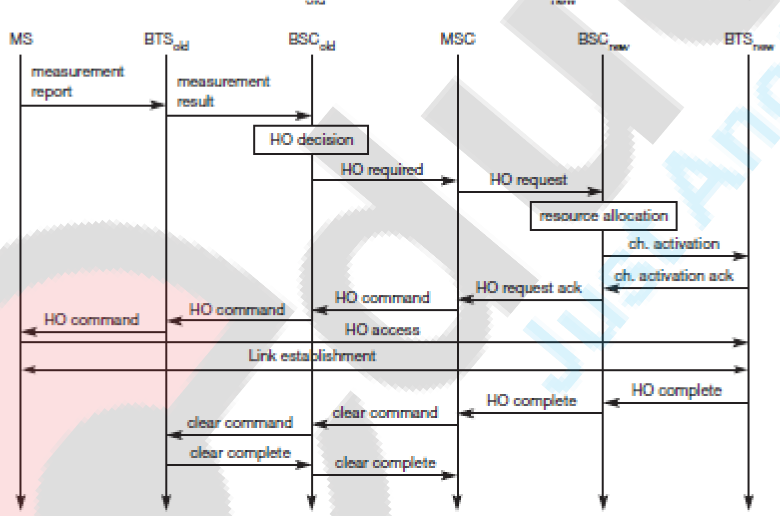


Figure 4.13
Intra-MSC handover

Basically, the MS has then finished the handover, but it is important to release the resources at the old BSC and BTS and to signal the successful handover using the handover and clear complete messages as shown. More sophisticated handover mechanisms are needed for seamless handovers between different systems. For example, future 3G networks will not cover whole countries but focus on cities and highways. Handover from, e.g., UMTS to GSM without service interruption must be possible. Even more challenging is the seamless handover between wireless LANs (see chapter 7) and 2G/3G networks. This can be done using multimode mobile stations and a more sophisticated roaming infrastructure. However, it is still not obvious how these systems may scale for a large number of users and many handovers, and what handover quality guarantees they can give.

Q.1 b)Discuss the various modulation techniques used in wireless transmission.

Ans: **Frequency shift keying:**

A modulation scheme often used for wireless transmission is **frequency shift keying (FSK)**. The simplest form of FSK, also called **binary FSK (BFSK)**, assigns one frequency f1 to the binary 1 and another frequency f2 to the binary 0.
A very simple way to implement FSK is to switch between two oscillators, one with the frequency f1 and the other with f2, depending on the input. To avoid sudden changes in phase, special frequency modulators with **continuous phase modulation**, **(CPM)** can be used. Sudden changes in phase cause high frequencies, which is an undesired side-effect. A simple way to implement demodulation is by using two bandpass filters, one for f1 the other for f2. A comparator can then compare the signal levels of
the filter outputs to decide which of them is stronger. FSK needs a larger bandwidth compared to ASK but is much less susceptible to errors. 2.6.3 Phase shift keying

phase shift keying (PSK) uses shifts in the phase of a signal to represent data. Figure 2.25 shows a
phase shift of 180° or π as the 0 follows the 1 (the same happens as the 1 follows the 0). This simple scheme, shifting the phase by 180° each time the value of data changes, is also called **binary PSK (BPSK)**. A simpleimplementation of a BPSK modulator could multiply a frequency f with +1 if the binary data is 1 and with –1 if the binary data is 0. To receive the signal correctly, the receiver must synchronize in frequency and phase with the transmitter. This can be done using a **phase lock loop (PLL)**.
Compared to FSK, PSK is more resistant to interference, but receiver and transmitter are also more complex. 2.6.4 Advanced frequency shift keying .

A famous FSK scheme used in many wireless systems is **minimum shift keying (MSK)**. MSK is basically BFSK without abrupt phase changes, i.e., it belongs to CPM schemes. Figure 2.26 shows an example for the implementation of MSK. In a first step, data bits are separated into even and odd bits, the duration of each bit being doubled. The scheme also uses two frequencies: f1, the lower frequency, and f2, the higher frequency, with f2 = 2f1.

Advanced phase shift keying

The simple PSK scheme can be improved in many ways. The basic BPSK scheme only uses one possible phase shift of 180°. The left side of Figure 2.27 shows BPSK in the phase domain (which is typically the better representation compared to the time domain in Figure 2.25). The right side of Figure 2.27 shows **quadrature PSK (QPSK)**, one of the most common PSK schemes (sometimes also called quaternary PSK). Here, higher bit rates can be achieved for the same bandwidth by coding two bits into one phase shift. Alternatively, one can reduce the bandwidth and still achieve the same bit rates as for BPSK. QPSK (and other PSK schemes) can be realized in two variants. The
phase shift can always be relative to a **reference signal** (with the same frequency). If this scheme is used, a phase shift of 0 means that the signal is in phase with the reference signal. A QPSK signal will then exhibit a phase shift of 45° for the data 11, 135° for 10, 225° for 00, and 315° for 01 – with all phase shifts being relative to the reference signal. The transmitter 'selects' parts of the signal as shown in Figure 2.28 and concatenates them. To reconstruct data, the receiver has to compare the incoming signal with the reference signal. One problem of this scheme involves producing a reference signal at the receiver. Transmitter and receiver have to be synchronized very often, e.g., by using special synchronization patterns before user data arrives or via a pilot frequency as reference.

Multi-carrier modulation

Special modulation schemes that stand somewhat apart from the others are **multi-carrier modulation (MCM)**, **orthogonal frequency division multiplexing (OFDM)** or **coded OFDM (COFDM)** that are used in the context of the European digital radio system DAB (see section 6.3) and the WLAN standards IEEE 802.11a and HiperLAN2 (see chapter 7). The main attraction of MCM is its good ISI mitigation property. As explained in section 2.4.3, higher bit rates are more vulnerable to ISI. MCM splits the high bit rate stream into many lower bit rate

streams (see Figure 2.30), each stream being sent using an independent carrier frequency. If, for example, n symbols/s have to be transmitted, each subcarrier transmits n/c symbols/s with c being the number of subcarriers. One symbol could, for example represent 2 bit as in QPSK. DAB, for example, uses
between 192 and 1,536 of these subcarriers. The physical layer of HiperLAN2 and IEEE 802.11a uses 48 subcarriers for data.

Q2 A) List three benefits of using spread spectrum. Describe Direct Sequence Spread Spectrum(DSSS) technique.

Spread spectrum techniques involve spreading the bandwidth needed to transmit data – which does not make sense at first sight.

There are many benefits to spread spectrum technology. Some are:

1) **Resistance to Interference and Antijamming Effects:** Resistance to Interference is the most important advantage. Intentional or unintentional interference and jamming signals are rejected because they do not contain the spread spectrum key. Only the desired signal, which has the key, will be seen at the receiver when the dispreading operation is exercised.

2) **Resistance to Interception:** Resistance to interference is the second advantage provided by spread spectrum techniques. Because non-authorized listeners do not have the key used to spread the original signal, those listeners cannot decode it. Without the right key, the spread spectrum signal appears as noise or as an interferer. Even better, signal levels can be below the noise floor, because the spreading operation reduces the spectral density. The message is made invisible, an effect that is particularly strong with the direct-sequence spread spectrum technique. Other receivers cannot “see” the transmission; they only register a slight increase in the overall noise level.

3) **Resistance to Fading (Multipath Effects):** Wireless channels often include multiple path propagation in which the signal has more than one path from the transmitter to the receiver. Such multiple paths can be caused by atmospheric reflection or refraction and by reflection from the ground or from objects such as buildings. The reflected path (R) can interfere with the direct path (D) in a phenomenon called fading. Because the dispreading process synchronizes to signal D, signal R is rejected even though it contains the same key. Methods are available to use the reflected path signals by dispreading them and adding the extracted results to the main one.

DSSS Technique:

In telecommunications, direct-sequence spread spectrum (DSSS) is a modulation technique. As with other spread spectrum technologies, the transmitted signal takes up more bandwidth than the information signal that modulates the carrier or broadcast frequency. The name 'spread spectrum' comes from the fact that the carrier signals occur over the full bandwidth (spectrum) of a device's transmitting frequency. Certain IEEE 802.11 standards use DSSS signaling.

Features:

DSSS phase-shifts a sine wave pseudorandomly with a continuous string each of which has a much shorter duration than an information bit. That is, each information bit is modulated by a sequence of much faster chips. Therefore, the chip rate is much higher than the information signal bit rate.

DSSS uses a signal structure in which the sequence of chips produced by the transmitter is already known by the receiver. The receiver can then use the same *PN sequence* to counteract the effect of the PN sequence on the received signal in order to reconstruct the information signal.

Benefits:

Resistance to intended or unintended jamming

Sharing of a single channel among multiple users

Reduced signal/background-noise level hampers interception

Determination of relative timing between transmitter and receiver

Q2b.)Explain CDMA with suitable example.

Many codes with certain characteristics can be applied to the transmission to enable the use of **code division multiplexing (CDM)**. **Code division multiple access (CDMA)** systems use exactly these codes to separate different users in code space and to enable access to a shared medium without interference. The main problem is how to find “good” codes and how to separate the signal from noise generated by other signals and the environment.

The example explains the basic function of CDMA before it is applied to signals:

● Two senders, A and B, want to send data. CDMA assigns the following unique and orthogonal key sequences: key Ak = 010011 for sender A, key BK = 110101 for sender B. Sender A wants to send the bit Ad = 1, sender B sends Bd = 0. To illustrate this example, let us assume that we code a binary 0 as –1, a binary 1 as +1. We can then apply the standard addition and multiplication rules.

● Both senders spread their signal using their key as chipping sequence (the term 'spreading' here refers to the simple multiplication of the data bit with the whole chipping sequence). In reality, parts of a much longer chipping sequence are applied to single bits for spreading. Sender A then sends the signal As = Ad*Ak = +1*(–1, +1, –1, –1, +1, +1) = (–1, +1, –1, –1, +1, +1). Sender B does the same with its data to spread the signal with the code: Bs = Bd*Bk = –1*(+1, +1, –1, +1, –1, +1) = (–1, –1, +1, –1, +1, –1).

● Both signals are then transmitted at the same time using the same frequency, so, the signals superimpose in space (analog modulation is neglected in this example). Discounting interference from other senders and environmental noise from this simple example, and assuming that the signals have the same strength at the receiver, the following signal C is received at a receiver: C = As + Bs = (–2, 0, 0, –2, +2, 0).

● The receiver now wants to receive data from sender A and, therefore, tunes in to the code of A, i.e., applies A's code for despreading: C*Ak = (–2, 0, 0, –2, +2, 0)*(–1, +1, –1, –1, +1, +1) = 2 + 0 + 0 + 2 + 2 + 0 = 6. As the result is much larger than 0, the receiver detects a binary 1. Tuning in to sender B, i.e., applying B's code gives C*Bk = (–2, 0, 0, –2, +2, 0)* (+1, +1, –1, +1, –1, +1) = –2 + 0 + 0 – 2 – 2 + 0 = –6. The result is negative, so a 0 has been detected.

Q5 A) Explain Bluetooth protocol architecture

Ans:

Architecture

Like IEEE 802.11b, Bluetooth operates in the 2.4 GHz ISM band. However, MAC, physical layer and the offered services are completely different. After presenting the overall architecture of Bluetooth and its specialty, the piconets, the following sections explain all protocol layers and components in more detail.

7.5.2.1 Networking

To understand the networking of Bluetooth devices a quick introduction to its key features is necessary. Bluetooth operates on 79 channels in the 2.4 GHz band with 1 MHz carrier spacing. Each device performs frequency hopping with 1,600 hops/s in a pseudo random fashion. Bluetooth applies FHSS for interference mitigation (and FH-CDMA for separation of networks).

A very important term in the context of Bluetooth is a **piconet**. A piconet is a collection of Bluetooth devices which are synchronized to the same hopping sequence. Figure 7.41 shows a collection of devices with different roles. One device in the piconet can act as **master** (M).

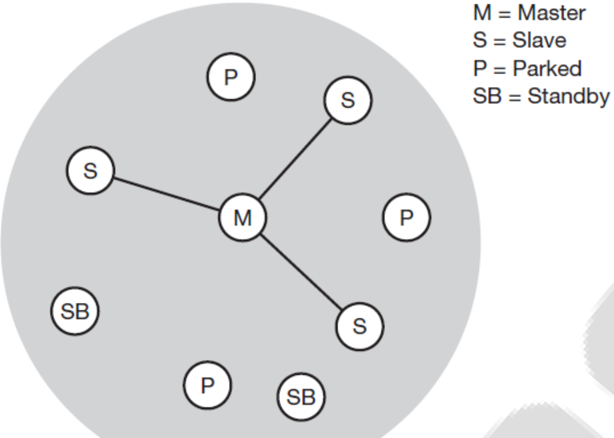


Figure 7.41
Simple Bluetooth piconet

master must act as **slaves** (S). The master determines the hopping pattern in the piconet and the slaves have to synchronize to this pattern. Each piconet has a unique hopping pattern. If a device wants to participate it has to synchronize to this. Two additional types of devices are shown: parked devices (P) can not actively participate in the piconet (i.e., they do not have a connection), but are known and can be reactivated within some milliseconds.
Devices in stand-by (SB) do not participate in the piconet. Each piconet has exactly one master and up to seven simultaneous slaves. More than 200 devices can be parked. The reason for the upper limit of eight active devices, is the 3-bit address used in Bluetooth. If a parked device wants to communicate and there are already seven active slaves, one slave has to switch to park mode to allow the parked device to switch to active mode.

Q5 b.)Why do u require spreading the spectrum?Explain the various methods of spreading the data and spectrum in a wireless environment..

Ans:

Spread spectrum

As the name implies, **spread spectrum** techniques involve spreading the bandwidth needed to transmit.Spreading the bandwidth has several advantages. The main advantage is the resistance to **narrowband interference**. In Figure 2.32,

diagram i) shows an idealized narrowband signal from a sender of user data (here power density dP/df versus frequency f). The sender now spreads the signal in step ii), i.e., converts the narrowband signal into a broadband signal. The energy needed to transmit the signal (the area shown in the diagram) is the same, but it is now spread over a larger frequency range. The power level of the spread signal can be much lower than that of the original narrowband signal without losing data. Depending on the generation and reception of the spread signal, the power level of the user signal can even be as low as the background noise. This makes it difficult to distinguish the user signal from the background noise and thus hard to detect.
Spreading the spectrum can be achieved in two different ways:

Direct sequence spread spectrum (DSSS) systems take a user bit stream and perform an (XOR) with a so-called **chipping sequence** as shown in Figure 2.35. The example shows that the result is either the sequence 0110101 (if the user bit equals 0) or its complement 1001010 (if the user bit equals 1). While each user bit has a duration tb, the chipping sequence consists of smaller pulses, called **chips**, with a duration tc. If the chipping sequence is generated properly it appears as random noise: this sequence is also sometimes called **pseudo-noise** sequence. The **spreading factor** s = tb/tc determines the bandwidth of the resulting signal. If the original signal needs a bandwidth w, the reslting signal needs s·w after spreading. While the spreading factor of the very simple example is only 7 (and the chipping sequence 0110101 is not very random), civil applications use spreading factors between 10 and 100, military applications use factors of up to 10,000. Wireless LANs complying with the standard IEEE 802.11 (see section 7.3) use, for example, the sequence 10110111000, a so-called Barker code, if implemented using DSSS. Barker codes exhibit a good robustness against interference and insensitivity to multi-path propagation. Other known Barker codes are 11, 110, 1110, 11101, 1110010, and 1111100110101 Up to now only the spreading has been explained. However, transmitters and receivers using DSSS need additional components as shown in the simplified block diagrams in Figure 2.36 and Figure 2.37. The first step in a DSSS transmitter, Figure 2.36 is the spreading of the user data with the chipping sequence (**digital modulation**). The spread signal is then modulated with a radio carrier.
Assuming for example a user signal with a bandwidth of 1 MHz. Spreading with the above 11-chip Barker code would result in a signal with 11 MHz bandwidth. The radio carrier then shifts this signal to the carrier frequency (e.g., 2.4 GHz in the ISM band). This signal is then transmitted. Frequency hopping spread

spectrum. For **frequency hopping spread spectrum (FHSS)** systems, the total available bandwidth is split into many channels of smaller bandwidth plus guard spaces between the channels. Transmitter and receiver stay on one of these channels for a certain time and then hop to another channel. This system implements FDM and TDM. The pattern of channel usage is called the **hopping sequence**, the time spend on a channel with a certain frequency is called the **dwell time**.FHSS comes in two variants, slow and fast hopping. In **slow hopping**, the transmitter uses one frequency for several bit periods.3 Figure 2.38 shows five user bits with a bit period tb. Performing slow hopping, the transmitter uses the frequency f2 for transmitting the first three bits during the dwell time td. Then, the transmitter hops to the next frequency f3. Slow hopping systems are typically cheaper and have relaxed tolerances, but they are not as immune to narrowband interference as fast hopping systems.

For **fast hopping** systems, the transmitter changes the frequency several times during the transmission of a single bit. The transmitter hops three times during a bit period. Fast hopping systems are more complex to implement because the transmitter and receiver have to stay synchronized within smaller tolerances to perform hopping at more or less the same points in time. However, these systems are much better at overcoming the effects of narrowband interference and frequency selective fading as they only stick to one frequency for a very short time.

Q6a.)Explain the difference between GSM and GPRS.explain the architechture of GPRS.

Ans:

- In **GPRS** multiple timeslots are allocated to one UE while in GSM one timeslot is allocated

- In **GSM** signaling and traffic follow different multi frame structure. 51 frame MF is used for signaling and 26 frame MF is used for traffic. In GPRS signaling and traffic both follow common one multi frame structure i.e. 52 frame MF structure. Here 52 Multiframe composed of total 12 radio blocks, two idle slots and two slots are for PTCCH used fo timing advance purpose. Each Radio Block spans over 4 consecutive TDMA frames of one time slot.

- In GPRS Synchronization is done using BCCH and hence FCCH/SCH of GSM is not needed. There is optional channel PBCCH, which carry GPRS specific SIs, may or may not be used by GSMBaseStations.

- Common Control channels are similar in both GSM and GPRS,PRACH to RACH, PAGCH to AGCH and PPCH to PCH of GSM is available here.

- GSM is used for circuit switched traffic (mainly voice) and GPRS is used for packet switched traffic (mainly internet/MMS). Due to this in GPRS PDTCH(Packet Data Traffic Channel) is allocated on demand unlike static nature of TCH in GSM.

- There is no direct relevance to SACCH and FACCH of GSM in GPRS. In GPRS, PTCCH(Packet Timing Advance Control Channel) is used for timing advance purposes. For other signalling stuff, PACCH(Packet Associated Control Channel) is used. • Unlike GSM, in GPRS same time slot can be used by multiple UEs at different times, each will have unique identifiers both in downlink (called TFI) and uplink (called USF). In GSM time slots are dedicatedly reserved for particular UEs till they are released.

- In GSM time slot is allocated both in uplink and downlink hence in GSM radio resource allocation is called symmetric allocation. While in GPRS it is asymmetric, for example it is possible to allocate time slot only in downlink and not in uplink when user is only downloading some file.

- In GSM location area concept is used while in GPRS routing area concept is used.

- In GSM Mobile or UE will be in two states i.e. IDLE and READY while in GPRS UE will be in three states i.e. IDLE, STANDBY and READY.

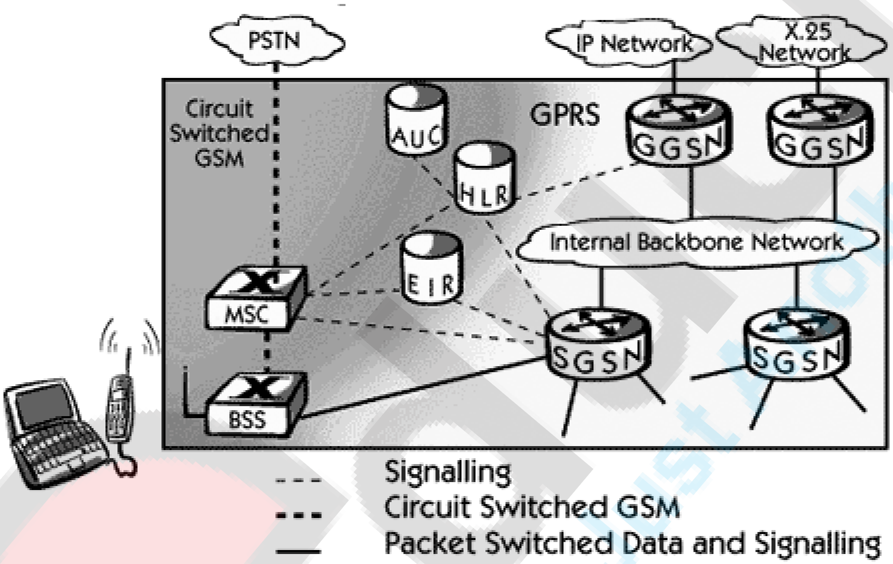
- Paging channel is required to be transmitted frequently in GPRS as traffic is bursty compare to GSM.

- In network architecture PCU, SGSN and GGSN is added to normal GSM architecture components to support packet traffic. In addition, channel coding units are upgraded at BTS to support various GPRS rates.

GPRS architechture:

GPRS architecture works on the same procedure like GSM network, but, has additional entities that allow packet data transmission. This data network overlaps a second-generation GSM network providing packet data transport at the rates from 9.6 to 171 kbps. Along with the packet data transport the GSM network accommodates multiple users to share the same air interface resources concurrently.

Following is the GPRS Architecture diagram:



GPRS attempts to reuse the existing GSM network elements as much as possible, but to effectively build a packet-based mobile cellular network, some new network elements, interfaces, and protocols for handling packet traffic are required.

Therefore, GPRS requires modifications to numerous GSM network elements as summarized below:

GSM Network Element	**Modification or Upgrade Required for GPRS.**
Mobile Station (MS)	New Mobile Station is required to access GPRS services. These new terminals will be backward compatible with GSM for voice calls.
BTS	A software upgrade is required in the existing Base Transceiver Station(BTS).
BSC	The Base Station Controller (BSC) requires a software upgrade and the installation of new hardware called the packet control unit (PCU). The PCU directs the data traffic to the GPRS network and can be a separate hardware element associated with the BSC.
GPRS Support Nodes (GSNs)	The deployment of GPRS requires the installation of new core network elements called the serving GPRS support node (SGSN) and gateway GPRS support node (GGSN).
Databases (HLR, VLR, etc.)	All the databases involved in the network will require software upgrades to handle the new call models and functions introduced by GPRS.

Q6b.)Discuss the MAC layer of IEEE802.11

Ans:
Medium access control layer

The MAC layer has to fulfill several tasks. First of all, it has to control medium access, but it can also offer support for roaming, authentication, and power conservation. The basic services provided by the MAC layer are the mandatory **asynchronous data service** and an optional **time-bounded service**. While 802.11 only offers the asynchronous service in ad-hoc network mode, both service types can be offered using an infrastructure-based network together with the access point coordinating medium access. The asynchronous service supports broadcast and multi-cast packets, and packet exchange is based on a 'best effort' model, i.e., no delay bounds can be given for transmission.

The following three basic access mechanisms have been defined for IEEE 802.11: the mandatory basic method based on a version of CSMA/CA, an optional method avoiding the hidden terminal problem, and finally a contention- free polling method for time-bounded service. The first two methods are also summarized as **distributed coordination function (DCF)**, the third method is called **point coordination function (PCF**). DCF only offers asynchronous service, while PCF offers both asynchronous and time-bounded service but needs an access point to control medium access and to avoid contention. The MAC mechanisms are also called **distributed foundation wireless medium access control (DFWMAC)**.

For all access methods, several parameters for controlling the waiting time before medium access are important. Figure 7.9 shows the three different parameters that define the priorities of medium access. The values of the parameters depend on the PHY and are defined in relation to a **slot** time. Slot time is derived from the medium propagation delay, transmitter delay, and other PHY dependent parameters. Slot time is 50 μs for FHSS and 20 μs for DSSS.

The medium, as shown, can be busy or idle (which is detected by the CCA). If the medium is busy this can be due to data frames or other control frames. During a contention phase several nodes try to access the medium.

Short inter-frame spacing (SIFS): The shortest waiting time for medium access (so the highest priority) is defined for short control messages, such as acknowledgements of data packets or polling responses. For DSSS SIFS is 10 μs and for FHSS it is 28 μs. The use of this parameter will be explained in sections 7.3.4.1 through 7.3.4.3.

● **PCF inter-frame spacing (PIFS):** A waiting time between DIFS and SIFS (and thus a medium priority) is used for a time-bounded service. An access point polling other nodes only has to wait PIFS for medium access (see section 7.3.4.3). PIFS is defined as SIFS plus one slot time.● **DCF inter-frame spacing (DIFS):** This parameter denotes the longest waiting time and has the lowest priority for medium access. This waiting time Is used for asynchronous data service within a contention period (this parameter and the basic access method are explained in section 7.3.4.1). DIFS is defined as SIFS plus two slot times.

Q7. Write short notes on:

a)Antennas:

As the name wireless already indicates, this communication mode involves 'getting rid' of wires and transmitting signals through space without guidance. We do not need any 'medium' (such as an ether) for the transport of electromagnetic waves. Somehow, we have to couple the energy from the transmitter to the out-side world and, in reverse, from the outside world to the receiver. This is exactly what **antennas** do. Antennas couple electromagnetic energy to and from space to and from a wire or coaxial cable (or any other appropriate conductor). A theoretical reference antenna is the **isotropic radiator**, a point in space radiating equal power in all directions, i.e., all points with equal power are located on a sphere with the antenna as its center. The **radiation pattern** is symmetric in all direction. However, such an antenna does not exist in reality. Real antennas all
exhibit **directive effects**, i.e., the intensity of radiation is not the same in all directions from the antenna. The simplest real antenna is a thin, center-fed **dipole**, also called Hertzian dipole, as shown in Figure 2.6 (right-hand side). The dipole consists of two collinear conductors of equal length, separated by a small feeding gap. The length of the dipole is not arbitrary, but, for example, half the wavelength λ of the signal to transmit results in a very efficient radiation of the energy. If mounted on the roof of a car, the length of
$\lambda/4$ is efficient. This is also known as Marconi antenna. A $\lambda/2$ dipole has a uniform or **omni-directional** radiation pattern in one plane and a figure eight pattern in the other two planes as shown in Figure 2.7. This type of antenna can only overcome environmental challenges by boosting the power level of the signal. Challenges could be mountains, valleys, buildings etc. If an antenna is positioned, e.g., in a valley or between buildings, an omnidirectional
radiation pattern is not very useful. In this case, **directional antennas** with certain fixed preferential transmission and reception directions can be used. Figure 2.8 shows the radiation pattern of a directional antenna with the main lobe in the direction of the x-axis. A special example of directional antennas is constituted by satellite dishes. Directed antennas are typically applied in cellular systems as

presented in section 2.8. Several directed antennas can be combined on a single pole to construct a **sectorized antenna**. A cell can be sectorized into, for example, three or six sectors, thus enabling frequency reuse as explained in section 2.8. Figure 2.9 shows the radiation patterns of these sectorized antennas. Two or more antennas can also be combined to improve reception by counteracting the negative effects of multi-path propagation (see section 2.4.3). These antennas, also called **multi-element antenna arrays**, allow different diversity schemes. One such scheme is **switched diversity** or **selection diversity**, where the receiver always uses the antenna element with the largest output. **Diversity combining** constitutes a combination of the power of all signals to produce gain. The phase is first corrected (cophasing) to avoid cancellation. As shown in Figure 2.10, different schemes are possible. On the left, two $\lambda/4$ antennas are combined with a distance of $\lambda/2$ between them on top of a ground plane. On the right, three standard $\lambda/2$ dipoles are combined with a distance of $\lambda/2$ between them. Spacing could also be in multiples of $\lambda/2$.

Q7.B) XHTML

XHTML is the
extensible hypertext mark-up language developed by the W3C (2002) to replace and enhance the currently used HTML. WAP 2.0 uses the **composite capabilities/preference profiles (CC/PP)** framework for describing user preferences and device capabilities. CC/PP provides the technical basis for the UAProf device profile function.

Several properties make XHTML an attractive choice for wireless application development. Some of the advantages of using XHTML for wireless devices are:

- **Easier development and maintenance:** Since XHTML uses HTML v4.1 tags, you don’t have to learn new language tags and you can employ the same tools you use for PC Web development. This means lower development costs as well as lower maintenance costs (no need to maintain different versions of content).
- **Better performance:** HTML allows for ambiguous code, whereas XHTML, being an XML application, enforces strict syntax. To handle HTML's

ambiguities, HTML browsers are typically complex and large—not an option for small mobile devices with limited memory capabilities. XHTML puts relatively simpler requirements on memory footprint and processing power and as a result offers greater performance.

- **Consistent look and feel:** Many types of wireless devices exist, each with its own display, memory, and processing capabilities. Use of strict XML syntax rules (well-formed document) ensures that content looks consistent on different device types. Also, each document is associated with a Document Type Definition (DTD), which essentially specifies what each tag means and how it should be treated.
- **Converging wireless and Web development:** According to W3C, XHTML is now the official Web markup standard, replacing HTML. Wireless development so far has been more or less going on in parallel to the Web development. This has had a significant impact on the growth of wireless Internet.

Q7 C) Impairment in Wireless Transmission.

1. Network Transmission Impairments

2. Transmission Impairment

- Signal received may differ from signal transmitted
- Analog - degradation of signal quality
- Digital - bit errors
- Caused by – Attenuation and attenuation distortion – Delay distortion – Noise

3. Attenuation

- Signal strength falls off with distance
- Depends on medium•

Received signal strength: – must be enough to be detected – must be sufficiently higher than noise to be received without error

- Attenuation is an increasing function of frequency

4. Delay Distortion

- Only in guided media
- Propagation velocity varies with frequency

5. NOISE

- Additional signals inserted between transmitter and receiver
- Thermal – Due to thermal agitation of electrons – Uniformly distributed – White noise
- Inter modulation – Signals that are the sum and difference of original frequencies sharing a medium
- Crosstalk – A signal from one line is picked up by another
- Impulse – Irregular pulses or spikes – e.g. External electromagnetic interference – Short duration – High amplitude