UNIT - II

DECT: System architecture, Protocol architecture.

2.1 GSM

GSM Stands for Global System for Mobile communication. It is a digital mobile network that is widely used by mobile phone users in Europe and other parts of the world.

The idea of GSM was developed at Bell Laboratories in 1970. It is widely used mobile communication system in the world. GSM used for transmitting mobile voice and data services operates at the 850MHZ, 900MHZ, 1800MHZ and 1900MHZ frequency bands.

GSM is a globally accepted standard for digital cellular communications. GSM uses narrowband Time Division Multiple Access (TDMA) for providing voice and text based services over mobile phone networks.

GSM is the most successful digital mobile telecommunication system in the world today. It is used by over 800 million people in more than 190 countries. GSM permits the integration of different voice and data services and the interworking with existing networks. Services make a network interesting for customers.

There are five different cell sizes in a GSM network

- Macro (range from 1 to 20km)
- Micro (range from 400m to 2 km)
- Pico (range from 4 to 200m)
- Femto (10m)
- Umbrella cells (2m)

The coverage area of each cell varies according to the implementation environment.

Time Division Multiple Access

TDMA technique relies on assigning different time slots to each user on the same frequency. It can easily adapt to data transmission and voice communication and carry 64kbps to 120Mbps of data rate.

GSM Architecture

A GSM network consists of the following components.

1. A mobile Station

It is the mobile phone which consists of the transceiver, the display and the processor and is controlled by a SIM card operating over the network.
2. Base Station Subsystem
It acts as an interface between the mobile station and the network subsystem. It consists of the
a) **Base Transceiver Station** contains the radio transceiver and handles the protocols for communication with mobiles.

b) **Base Station Controller** which controls the Base Transceiver Station and acts as an interface between the mobile station and mobile switching center.

3. Network Subsystem
It provides the basic network connection to the mobile stations. The basic part of the Network Subsystem is the
a) **Mobile Service Switching Centre** which provides access to different networks.

b) **Home Location Register and the Visitor Location Register** which provides the call routing and roaming capabilities of GSM.

c) **Equipment Identity Register** which maintains an account of all the mobile equipments wherein each mobile is identified by its own IMEI(International Mobile Equipment Identity) number.

d) **The authentication center(AuC)**
It is a key component of a GSM home location register(HLR). The AuC validates any security information management(SIM) card attempting network connection when a phone has a live network signal. The AuC provides security to ensure that third parties are unable to use network subscriber services. Each network SIM card is assigned an individual authentication key. A matching key is contained in the AuC. The SIM and AuC store the key in an unreadable format. The key even remains hidden from the SIM card owner to protect network operators from fraud.

**Features of GSM**
1. Improved spectrum efficiency
2. International roaming
3. Compatibility with integrated services digital network (ISDN)
4. Support for new services
5. SIM phonebook management
6. Fixed dialing number (FDN)
7. Real time clock with alarm management
8. High-quality speech
9. Short message services (SMS)
10. Uses encryption to make phone calls more secure
<table>
<thead>
<tr>
<th>GSM</th>
<th>CDMA</th>
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</thead>
<tbody>
<tr>
<td>The GSM is based on wedge spectrum called carrier</td>
<td>The CDMA is based on spread spectrum technology</td>
</tr>
<tr>
<td>This carrier is divided into time slots, and each user is assigned a different time slot. Thus, until the ongoing call is finished, no other user can access the same slot</td>
<td>This technology allows each user to transmit over the entire frequency spectrum all the time.</td>
</tr>
<tr>
<td>Less security compared to CDMA technology</td>
<td>More security is provided in CDMA technology</td>
</tr>
<tr>
<td>No built-in encryption</td>
<td>It has built-in encryption</td>
</tr>
<tr>
<td>The GSM network operates in the frequency spectrum of 850MHZ and 1900MHZ</td>
<td>The CDMA network operates in the frequency spectrum of 850MHZ and 1900MHZ</td>
</tr>
<tr>
<td>GSM is used over 80% of the world's mobile network</td>
<td>CDMA is exclusively used in the United States, Canada and Japan</td>
</tr>
<tr>
<td>A SIM card is required for the working of GSM device</td>
<td>CDMA phones do not have these pulses</td>
</tr>
<tr>
<td>A GSM is more flexible than CDMA (SIM can be replaced with other GSM devices)</td>
<td>A CDMA is not flexible</td>
</tr>
<tr>
<td>GSM phone emits 28 times more radiations on an average as compared to CDMA</td>
<td>Very less radiation</td>
</tr>
</tbody>
</table>
2.1.1 Mobile Services

GSM permits the integration of different voice and data services and the interworking with existing networks. GSM has defined three different categories of services:

a) Bearer Services (Data Services)

b) Tele Services

c) Supplementary Services

b) Tele Services

The abilities of a Bearer Service are used by a Teleservice to transport data. These services are further transited in the following ways:

Voice Calls

The most basic Teleservice supported by GSM is telephony. This includes full-rate speech at 13 kbps and emergency calls, where the nearest emergency-service provider is notified by dialing three digits.

Videotext and Facsmile(Fax)

Another group of teleservices includes Videotext access, Teletex transmission, Facsmile alternate speech and Facsmile Group 3, Automatic Facsmile Group, 3 etc. (Scanned printed material (both text and images)

Short Text Messages

Short Messaging Service (SMS) service is a text messaging service that allows sending and receiving text messages on your GSM mobile phone. In addition to simple text messages, other text data including news, sports, financial, language, and location-based data can also be transmitted.

a) Bearer Services (Data Services)

Data services or Bearer Services are used through a GSM phone. To receive and send data is the essential building block leading to widespread mobile Internet access and mobile data transfer.

c) Supplementary Services

Supplementary services are additional services that are provided in addition to teleservices and bearer services. These services include caller identification, call forwarding, call waiting, multi-party conversations (Conferencing), and barring of outgoing (international) calls, among others.
2.1.2 System Architecture

A GSM system consists of three subsystems,

a) Radio Sub System (RSS) or Mobile Stations (MS)

b) Operating Subsystem (OSS)

c) Network and Switching Subsystem (NSS)

The wireless link interface between the MS and the Base Transceiver Station (BTS), which is a part of BSS. Many BTSs are controlled by a Base Station Controller (BSC). BSC is connected to the Mobile Switching Center (MSC), which is a part of NSS. Figure shows the key functional elements in the GSM network architecture.

a) Radio Sub System (RSS) or Mobile Stations (MS)

A mobile station communicates across the air interface with a base station transceiver in the same cell in which the mobile subscriber unit is located. The MS communicates the information with the user and modifies it to the transmission protocols if the air-interface to communicate with the BSS. The user’s voice information is interfaced with the MS through a microphone and speaker for the speech, keypad, and display for short messaging, and the cable connection for other data terminals.

The MS has two elements. The Mobile Equipment (ME) refers to the physical device, which comprises of transceiver, digital signal processors, and the antenna. The second element of the MS is the GSM is the Subscriber Identity Module (SIM). The SIM card is unique to the GSM system. It has a memory of 32 KB.

b) Operating Subsystem (OSS) or Base Station Subsystem (BSS)

A base station subsystem consists of a base station controller and one or more base transceiver station. Each Base Transceiver Station defines a single cell. A cell can have a radius of between 100m to 35km, depending on the environment. A Base Station Controller may be connected with a BTS. It may control multiple BTS units and hence multiple cells.
There are two main architectural elements in the BSS – the **Base Transceiver Subsystem** (BTS) and the **Base Station Controller** (BSC). The interface that connects a BTS to a BSC is called the **A-bis interface**. The interface between the BSC and the MSC is called the **A interface**, which is standardized within GSM.

c) **Network and Switching Subsystem (NSS)**

The NSS is responsible for the network operation. It provides the link between the cellular network and the Public switched telecommunicates Networks (PSTN or ISDN or Data Networks). The NSS controls handoffs between cells in different BSSs, authenticates user and validates their accounts, and includes functions for enabling worldwide roaming of mobile subscribers. In particular the switching subsystem consists of:

- Mobile switch center (MSC)
- Home location register (HLR)
- Visitor location Register (VLR)
- Authentications center (Auc)
- Equipment Identity Register (EIR)
- Interworking Functions (IWF)

**Mobile switch center (MSC)**

It connects fix networks like ISDN, PSTN etc.

Following are the functions of MSC

1. Call setup, supervision and relies
2. **COLLECTION OF BILLING INFORMATION**
3. Call handling / routing
4. Management of signaling protocol
5. Record of VLR and HLR

**Home location register (HLR)**

Call roaming and call routing capabilities of GSM are handled. It stores all the administrative information of subscriber registered in the networks. IT maintained unique international mobile subscriber identity (IMSI).

**Visitor location Register (VLR)**

It is a temporary data base. It stores the IMSC number and customer information for each roaming customer visiting specific MSC.

**Authentications center (Auc)**

It is protected database. It maintained authentication keys and algorithms. It contains a register called as **Equipment Identity Register**.

Maintains an account of all the mobile equipments wherein each mobile is identified by its own IMEI (International Mobile Equipment Identity) number.
**Interworking Functions (IWF)**

1) UM Interface – Used to communicate between BTS with MS
2) Abis Interface— Used to communicate BSC TO BTS
3) A Interface-- Used to communicate BSC and MSC
4) Singling protocol (SS 7)- Used to communicate MSC with other network.

![Fig 2 GSM network Interfaces](image)

PSDN: Public Switched Telephone Network

⇒**2.1.3 Radio Interface**

The most interesting interface in a GSM system is $U_m$. The radio interface, used for media access. The "air" or radio interface standard that is used for exchanges between a mobile (ME) and a base station (BTS / BSC).

Currently, there are several types of networks in the world using the GSM standard, but at different frequencies.

The GSM-900 is the most common in Europe and the rest of the world. Its extension is E-GSM.

The DCS-1800 operates in the 1,800-MHz band and is used mainly in Europe, usually to cover urban areas. It was also introduced to avoid saturation problems with the GSM-900.

The PCS-1900 is used primarily in North America.

The GSM-850 is under development in America.

The GSM-400 is intended for deployment in Scandinavian countries.

The system is based on **frequency-division duplex** (FDD), which means that the uplink (radio link from the mobile to the network—that is, mobile transmit, base receive), and downlink (from the network to the mobile—that is, base transmit, mobile receive) are transmitted on different frequency bands.
There are different ways of sharing the physical resource among all the users in a radio system, and this is called the **multiple-access method**. The multiple-access scheme defines **how simultaneous communications share the GSM radio spectrum**.

The various multiple-access techniques in use in radio systems are **frequency-division multiple access (FDMA)**, **TDMA**, and **code-division multiple access (CDMA)**. GSM is based on both **FDMA** and **TDMA** techniques.

![Diagram of multiple-access techniques](image)

### Table 1.1: GSM System Frequency Bands

<table>
<thead>
<tr>
<th></th>
<th>Uplink Band</th>
<th>Downlink Band</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSM-900</td>
<td>890-915 MHz</td>
<td>935-960 MHz</td>
</tr>
<tr>
<td>E-GSM-900</td>
<td>880-915 MHz</td>
<td>925-960 MHz</td>
</tr>
<tr>
<td>DCS-1800</td>
<td>1,710-1,785 MHz</td>
<td>1,805-1,880 MHz</td>
</tr>
<tr>
<td>PCS-1900</td>
<td>1,850-1,910 MHz</td>
<td>1,930-1,990 MHz</td>
</tr>
<tr>
<td>GSM-400</td>
<td>GSM-450</td>
<td>450.4-457.6 MHz</td>
</tr>
<tr>
<td></td>
<td>GSM-480</td>
<td>478.8-486 MHz</td>
</tr>
<tr>
<td>GSM-850</td>
<td></td>
<td>824-849 MHz</td>
</tr>
</tbody>
</table>

2.1.3.1 Logical channels and Frame Hierarchy

In telecommunications a channel, refers either to a **physical** transmission medium such as wire, or to a **logical** connection over a multiplexed medium such as **radio channel**.

The channel used in the air interface is divided into two types

**a) Physical channel**: It is the medium over which the information is carried.

**b) Logical channel**: It consists of information carried over a physical channel.
Traffic Channels (TCH)
GSM uses a TCH to transmit user data. Two basic categories of TCHs have been defined
a) Full-rate TCH (TCH/F)
b) Half-rate TCH (TCH/H)

<table>
<thead>
<tr>
<th>Full-rate TCH (TCH/F)</th>
<th>Half-rate TCH (TCH/H)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A TCH/F has a data rate of 22.8 kbit/S (13 Kbit/s for voice 9.6 Kbit/s for data)</td>
<td>Whereas TCH/H only has 11.4 kbit/S (6.5 kbit/s for voice 4.8 kbit/s for data)</td>
</tr>
</tbody>
</table>
Both can be used to carry signaling information

Control Channels (CCH)
Control channels carry signaling information between an MS and a BTS. There are several forms of control channels in GSM, and they can generally be divided into three categories according to the manner in which they are supported on the radio interface and the type of signaling information they carry.
a) Broadcast control channel
b) Common control channel
c) Dedicated control channel
a) Broadcast control channel (BCCH)
Broadcast control channels are transmitted in downlink direction only i.e. only transmitted by BTS. A broadcast channel is used to broadcast synchronization and general network information to all the MSs within a cell (A BTS uses this channel to signal information to all MSs within a cell). Such as Location Area Identity (LAI) and maximum output power.
It has three types
1. FCCH frequency correction channel
2. SCH synchronization channel
3. BCCH Broadcast control channel

b) Common control channel
The common control channels are used by an MS during the paging and access procedures. Common control channels are of following types.
1. Random Access Control Channel (RACH)
2. Paging Channel (PCH)
3. Access Grant Control Channel (AGCH)
4. Cell Broadcast Channel (CBCH)

c) Dedicated control channel
Signaling information is carried between an MS and a BTS using associated and dedicated control channels during or not during a call. Dedicated control channel are the following types.
1. Standalone dedicated control channel (SDCCH)
2. Associated Control Channel (ACCH)
3. Slow Associated Control Channel (SACCH)
4. Fast Associated Control Channel (FACCH)

2.1.4 Protocols
GSM architecture is a layered model that is designed to allow communications between two different systems. The lower layers assure the services of the upper-layer protocols. Each layer passes suitable notifications to ensure the transmitted data has been formatted, transmitted, and received accurately. The GMS protocol stacks diagram is shown below
Radio Resource Management  
Mobility Management  
Connection Management  
Mobile Application Part (MAP)  
BTS Management  

In GSM, there are different types of protocols used in different layers. These layers protocols function are describe bellow:

**Mobility Management (MM)**
The MM layer is in charge of maintaining the location data, in addition to the authentication and ciphering procedures.

**Communication Management (CM)**
The CM layer consists of setting up call at the users request. Its functions are: call control, which manages the supplementary services configuration, short message services which provides point-to-point short message services.

**Radio Resource (RR)**
The RR management layer is in charge of establishing and maintaining a stable uninterrupted communication path between the MSC and MS over which signaling and user data can be covered. Most of the functions are controlled by the BSC, BTS and MS though some are performed by the MSC.

**Base Transceiver Station Management (BTSM)**
The BTSM is responsible for transferring the RR information to the BSC.

**Link access protocol for the ISDN D-channel (LAPD)**
This is the ISDN LAPD protocol providing error-free transmission between the BSC and MSC.

**Base station system application part (BSSAP)**
The BSSAP is split into two parts the Base station System management application part (BSSMAP) and the Direct transfer application part (DTAP). The message exchanges are handled by SS7.
Signaling connection control part (SCCP)

The SCCP from SS7.

Message Transport Part (MTP)

The MTP of SS7.

What is SS7

Signaling system No. 7 (SS7) is used for signaling between and MSC and a BSC. This protocol also transfer all management information between MSCs, HLR,VLR, AUc, EIR and MOC.

→2.1.5 Localization and Calling

The fundamental feature of the GSM system is the automatic, worldwide localization of users for which, the system performs periodic location updates. The HLR always contains information about the current location and the VLR currently responsible for the MS informs the HLR about the location changes. Changing VLRs with uninterrupted availability is called roaming.

Roaming can take place within a network of one provider, between two providers in a country and also between different providers in different countries. To locate and address an MS, several numbers are needed:

**Mobile station international ISDN number (MSISDN):** The only important number for a user of GSM is the phone number. This number consists of the country code (CC), the national destination code (NDC) and the subscriber number (SN).

**International mobile subscriber identity (IMSI):** GSM uses the IMSI for internal unique identification of a subscriber. IMSI consists of a mobile country code (MCC), the mobile network code (MNC), and finally the mobile subscriber identification number (MSIN).

**Temporary mobile subscriber identity (TMSI):** To hide the IMSI, which would give away the exact identity of the user signaling over the air interface, GSM uses the 4 byte TMSI for local subscriber identification.

**Mobile station roaming number (MSRN):** Another temporary address that hides the identity and location of a subscriber is MSRN. The VLR generates this address on request from the MSC, and the address is also stored in the HLR. MSRN contains the current visitor country code (VCC), the visitor national destination code (VNDC), the identification of the current MSC together with the subscriber number. The MSRN helps the HLR to find a subscriber for an incoming call.

For a **mobile terminated call (MTC),** the following figure shows the different steps that take place:
**Step 1:** User dials the phone number of a GSM subscriber.

**Step 2:** The fixed network (PSTN) identifies the number belongs to a user in GSM network and forwards the call setup to the Gateway MSC (GMSC).

**Step 3:** The GMSC identifies the HLR for the subscriber and signals the call setup to HLR

**Step 4:** The HLR checks for number existence and its subscribed services and requests an MSRN from the current VLR.

**Step 5:** VLR sends the MSRN to HLR

**Step 6:** Upon receiving MSRN, the HLR determines the MSC responsible for MS and forwards the information to the GMSC

**Step 7:** The GMSC can now forward the call setup request to the MSC indicated

**Step 8:** The MSC requests the VLR for the current status of the MS

**Step 9:** VLR sends the requested information

**Step 10:** If MS is available, the MSC initiates paging in all cells it is responsible for.

**Step 11:** The BTSs of all BSSs transmit the paging signal to the MS

**Step 12:** If MS answers, VLR performs security checks

**Step 13:** Then the VLR signals to the MSC to setup a connection to the MS

For a **mobile originated call (MOC)**, the following steps take place:
Step 1: The MS transmits a request for a new connection

Step 2: The BSS forwards this request to the MSC

Step 3: Step 4: The MSC then checks if this user is allowed to set up a call with the requested and checks the availability of resources through the GSM network and into the PSTN. If all resources are available, the MSC sets up a connection between the MS and the fixed network.

In addition to the steps mentioned above, other messages are exchanged between an MS and BTS during connection setup (in either direction).

2.1.6 Handover
Cellular systems require handover procedures, as single cells do not cover the whole service area. 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:

1. The mobile station moves out of the range of a BTS, decreasing the received signal level increasing the error rate thereby diminishing the quality of the radio link.
2. Handover may be due to load balancing, when an MSC/BSC decides the traffic is too high in one cell and shifts some MS to other cells with a lower load.

The four possible handover scenarios of GSM are shown below:

**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).

**Inter MSC handover:** A handover could be required between two cells belonging to different MSCs. Now both MSCs perform the handover together (scenario 4).

To provide all the necessary information for a handover due to a weak link, MS and BTS both perform periodic measurements of the downlink and uplink quality respectively. Measurement reports are sent by the MS about every half-second and contain the quality of the current link used for transmission as well as the quality of certain channels in neighboring cells (the BCCHs).
More sophisticated handover mechanisms are needed for seamless handovers between different systems.
2.1.7 Security

GSM offers several security services using confidential information stored in the AuC and in the individual SIM. The SIM stores personal, secret data and is protected with a PIN against unauthorized use. Three algorithms have been specified to provide security services in GSM. Algorithm A3 is used for authentication, A5 for encryption, and A8 for the generation of a cipher key.

The various security services offered by GSM are:

Access control and authentication: The first step includes the authentication of a valid user for the SIM. The user needs a secret PIN to access the SIM. The next step is the subscriber authentication. This step is based on a challenge-response scheme as shown below:

Authentication is based on the SIM, which stores the individual authentication key Ki, the user identification IMSI, and the algorithm used for authentication A3. The AuC performs the basic generation of random values RAND, signed responses SRES, and cipher keys Kc for each IMSI, and then forwards this information to the HLR. The current VLR requests the appropriate values for RAND, SRES, and Kc from the HLR. For authentication, the VLR sends the random value RAND to the SIM. Both sides, network and subscriber module, perform the same operation with RAND and the key Ki, called A3. The MS sends back the SRES generated by the SIM; the VLR can now compare both values. If they are the same, the VLR accepts the subscriber, otherwise the subscriber is rejected.
**Confidentiality:** All user-related data is encrypted. After authentication, BTS and MS apply encryption to voice, data, and signaling as shown below.

To ensure privacy, all messages containing user-related information are encrypted in GSM over the air interface. After authentication, MS and BSS can start using encryption by applying the cipher key Kc, which is generated using the individual key Ki and a random value by applying the algorithm A8. Note that the SIM in the MS and the network both calculate the same Kc based on the random value RAND. The key Kc itself is not transmitted over the air interface. MS and BTS can now encrypt and decrypt data using the algorithm A5 and the cipher key Kc.

**Anonymity:** To provide user anonymity, all data is encrypted before transmission, and user identifiers are not used over the air. Instead, GSM transmits a temporary identifier (TMSI), which is newly assigned by the VLR after each location update. Additionally, the VLR can change the TMSI at any time.
2.1.8 New Data Services

The standard bandwidth of 9.6 kbit/s (14.4 kbit/s with some providers) available for data transmission is not sufficient for the requirements of today’s computers. When GSM was developed, not many people anticipated the tremendous growth of data communication compared to voice communication.

At that time, 9.6 kbit/s was a lot, or at least enough for standard group 3 fax machines. But with the requirements of, e.g., web browsing, file download, or even intensive e-mail exchange with attachments, this is not enough.

To enhance the data transmission capabilities of GSM, two basic approaches are possible. As the basic GSM is based on connection-oriented traffic channels, e.g., with 9.6 kbit/s each, several channels could be combined to increase bandwidth. This system is called HSCSD (High Speed Circuit Switched Data).

A more progressive step is the introduction of packet oriented traffic in GSM, i.e., shifting the paradigm from connections/telephone thinking to packets/internet thinking. The system is called GPRS (General Packet Radio Service).

a) HSCSD

A straightforward improvement of GSM’s data transmission capabilities is high speed circuit switched data (HSCSD) in which higher data rates are achieved by bundling several TCHs. An MS requests one or more TCHs from the GSM network, i.e., it allocates several TDMA slots within a TDMA frame.

Advantages

- Ready to use
- Constant quality
- Simple

Provides GSM users with a bandwidth up to 57.6 Kbps.

Does not require a hardware upgrade within BSS or core network, but different MS are needed.

Disadvantage

- It still uses the connection-oriented mechanisms of GSM, which is not efficient for computer data traffic.
- Channels blocked for voice transmission.

b) GPRS

The next step toward more flexible and powerful data transmission avoids the problems of HSCSD by being fully packet-oriented. GPRS offers bandwidth up to 160 kbps. For the new GPRS radio channels, the GSM system can allocate between one and eight time slots within a TDMA frame. Time slots are not allocated in a fixed, pre-determined manner but on demand. All time slots can be shared by the active users; up- and downlink are allocated separately. GPRS includes several security services such as authentication, access control, user identity confidentiality, and user information confidentiality.
2.2 DECT (Digital Enhanced Cordless Telecommunications)

Digital enhanced cordless telecommunications (DECT) is a digital wireless technology for telephony that is used both for home and business. Unlike analog cordless phones, which have a very limited range, DECT phones can operate on a longer range.

The DECT standard was created by the European Telecommunications Standards Institute (ETSI) in the late 1980s. The standard was created to offer a more economical alternative to the existing wireless and cordless solutions through a secure digital protocol.

The DECT system accesses a fixed network using radio waves. It uses time division multiple access (TDMA) and time division duplex technologies, which typically use 10 radio frequency channels between 1880 to 1930 MHz.

DECT may also provide more than voice communications as it can be used to transmit data using DECT packet radio service (DPRS) and multimedia access profile (MMAP). This allows the system to be used as a wireless LAN and for wireless Internet access. Furthermore, DECT's services are compatible with the Global System for Wireless Communications (GSM) and the Integrated Services Digital Network (ISDN).

Characteristics of DECT

- Frequency: 1880-1900 MHz
- Channels: 120 full duplex
- Duplex mechanism: TDD (Time Division Duplex) with 10 ms frame length
- Multiplexing scheme: FDMA with 10 carrier frequencies, TDMA with 2x 12 slots
- Modulation: digital, Gaussian Minimum Shift Key (GMSK)
- Power: 10 mW average (max. 250 mW)
- Range: approx. 50 m in buildings, 300 m open space

Applications of DECT

a) Cordless Private Branch Exchange (PBX)
b) Wireless Local Loop (WLL)
c) Cordless Terminal Mobility
d) Home Cordless Phones
e) GSM/DECT internetworking

**Usage in Society**

a) Used for residential and business purposes  
b) DECT is used in many countries such as the US, Italy and the UK  
c) IN 2002 Bluetooth was created  
d) Bluetooth uses short range wireless data applications

**DECT Solutions**

**a) Home Solutions**

Residential areas are the largest application area

Fax, PC, Telephones as well as PC and telephone wireless devices are connected by fixed access unit.  
PTSN—Public Switched Telephone Network.  
PSTN access allows 6-10 handsets to be used externally and for intercom access.

**b) Office Solutions**

DECT capacity is high and supports more than 10,000 Erlanger per floor square kilometer.
Main application area for DECT is seamless handover.

No separate base station controller.

DECT is cost efficient

c) Enterprise Solutions

Typical data services are paging, group calls, automatic alarms, and many others.

DECT provides laptop PC wireless access to LAN.

Provides cordless solutions for system integrators.

d) Public Solutions

DECT provides high capacity WLL services.

- cluster of DECT transceivers and antennas
- high-gain antennas for range
- diversity for quality and redundancy
- synchronization

WLL supports voice telephony, ISDN and Internet user data.

This provides user access data upto a few hundred of Kbps.
e) Industrial Solutions

DECT applications provide supervision and control needs in a variety of ways.

**Authenticating** - Base station and handset handshake using specific rules and calculations.

**Encryption** - The digital data is encrypted and then is decrypted when it is received by the intended receiver.

⇒2.2.1 System architecture

Shown in Fig. A **global network** connects the local communication structure to the outside world and offers its services via the interface D1. Global networks could be integrated services digital networks (ISDN), public switched telephone networks (PSTN), public land mobile networks (PLMN), e.g., GSM, or packet switched public data network (PSPDN). The services offered by these networks include transportation of data and the translation of addresses and routing of data between the local networks.

Local networks in the DECT context offer local telecommunication services that can include everything from simple switching to intelligent call forwarding, address translation etc. Examples for such networks are analog or digital private branch exchanges (PBXs) or LANs, e.g., those following the IEEE 802.x family of LANs.
Home data base (HDB) and visitor data base (VDB)

Both databases support mobility with functions that are similar to those in the HLR and VLR in GSM systems. Incoming calls are automatically forwarded to the current subsystem responsible for the DECT user, and the current VDB informs the HDB about changes in location.

The DECT core network consists of the fixed radio termination (FT) and the portable radio termination (PT) and basically only provides a multiplexing service. FT and PT cover layers one to three at the fixed network side and mobile network side respectively. Additionally, several portable applications (PA) can be implemented on a device.

2.2.2 Protocol architecture

The DECT protocol reference architecture follows the OSI reference model. Figure shows the layers covered by the standard: the physical layer, medium access control, and data link control for both the control plane (C-Plane) and the user plane (U-Plane). An additional network layer has been specified for the C-Plane, so that user data from layer two is directly forwarded to the U-Plane. A management plane vertically covers all lower layers of a DECT system.

Physical layer As in all wireless networks, the physical layer comprises all functions for modulation/demodulation, incoming signal detection, sender/receiver synchronization, and collection of status information for the management plane.
Modulation/demodulation
Generation of the physical channel structure with a guaranteed throughput
Controlling of radio transmission
Channel assignment on request of the MAC layer
Detection of incoming signals
Sender/receiver synchronization
Collecting status information for the management plane

Management Plane
Monitoring and configuration services to, all layers of the network stack and other parts of the system.

Control Plane
The control plane is the part of a network that carries signaling traffic and is responsible for routing.

User Plane (Data plane or forwarding plane, carrier plane or bearer plane)
It carries the network user traffic.

DECT is based on Time Division Duplex (TDD) and Time Division Multiple Access (TDMA) with 10 carriers in the 1880 - 1900MHz band. It has a TDD/TDMA frame structure. The complete frame is 10ms in duration with 24 time slots. The first 12 slots are allocated for the transmission from base station to handsets, and the other 12 slots are for the transmission from handsets to base station.

In the picture above the yellow squares represent occupied time slots. A connection always uses a pair of time slots separated by one half TDMA frame. DECT uses Dynamic Channel Allocation (DCA). This means that slots and frequencies are not pre assigned, but each connection automatically selects the channel with the best quality. Since this can change over time, connections may be transferred to another channel which may or may not be with the same base station (handover).
A normal DECT slot is 417 microseconds long and contains 420 bits.

It is made up of the following fields:
- **Preamble (16 bits)** — alert receiver (yellow)
- **Sync (16 bits)** — Enable receiver to synchronize on beginning of time slot (blue)
- **A filed (64 bits)** — used for network control (red).
- **B field (324 bits)** — This contains the actual information: voice of data (green).

**b) Medium access control layer**

The medium access control (MAC) layer establishes, maintains, and releases channels for higher layers by activating and deactivating physical channels. Additional services offered include segmentation/reassembly of packets and error control/error correction.

**It supports three services**

- Broadcast
- Connection oriented
- Connectionless

**c) Data link control layer**

The data link control (DLC) layer creates and maintains reliable connections between the mobile terminal and the base station.

**d) Network layer**

The network layer of DECT is similar to those in ISDN and GSM and only exists for the C-Plane. This layer provides services to request, check, reserve, control, and release resources at the fixed station and the mobile terminal.

The **mobility management** (MM) within the network layer is responsible for identity management, authentication, and the management of the location data bases.

**Call Control** (CC) handles connection setup, release, and negotiation. **Two message services**, the **connection oriented message service** (COMS) and the **connectionless message service** (CLMS) transfer data to and from the interworking unit that connects the DECT system with the outside world.