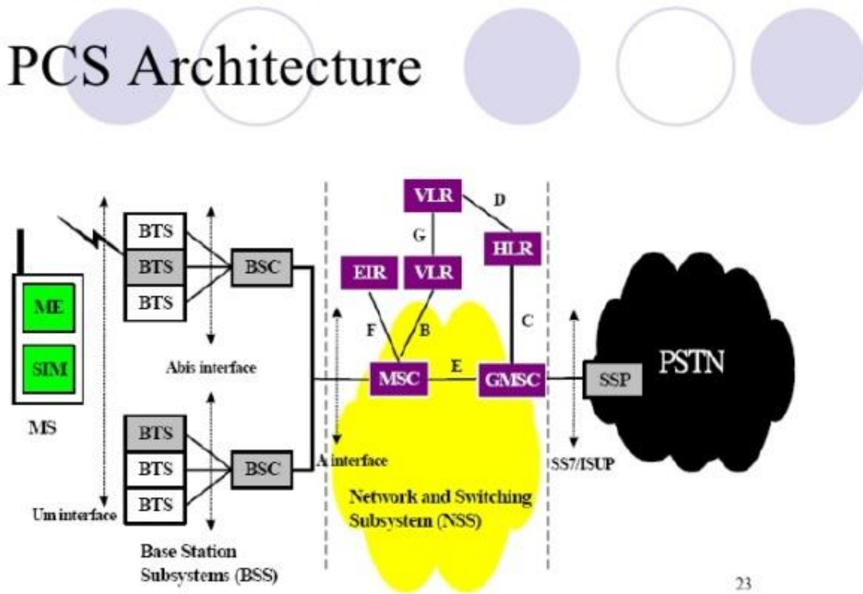
PCS(Personal communications services)

Personal communications services (PCS) refers to a wide variety of wireless access and personal mobility services provided through a small terminal, with the goal of enabling communications at any time, at any place, and in any form.

Broad range of voice and data telecommunications services that enable people to communicate via two-way radio phones based exclusively on digital technologies such as CDMA and GSM. Characteristics of PCS include personal numbers assigned to individuals rather than devices, near-wireline-call-transmission quality, low-power and lightweight mobile devices, enhanced call completion, call billing and call management services. PCS networks operate at 1,800MHz in the U.K. and at 1900MHz in North America.

PCS technologies have grown rapidly in the telecommunications industry.

Explain PCS architecture.



PCS architecture has mainly 3 types of Interfaces

- ***Um interface*** The "air" or radio interface standard that is used for exchanges between a mobile (ME) and a base station (BTS / BSC). For signalling, a modified version of the ISDN LAPD, known as LAPDm is used.
- ***Abis interface*** This is a BSS internal interface linking the BSC and a BTS, and it has not been totally standardised. The Abis interface allows control of the radio equipment and radio frequency allocation in the BTS.
- ***A interface*** The A interface is used to provide communication between the BSS and the MSC.

PCS architecture divides into to 3 subsystem i.e.Base Station Subsystem(BSS),Network Switching Subsystem (NSS) and Operation and Support Subsystem (OSS)

Mobile station

PCS use mobile stations (MSs) to communicate with the base stations (BSs) in a PCS network.

MS is also referred to as handset, mobile phone, subscriber unit, or portable.

Mobile stations (MS), mobile equipment (ME) or as they are most widely known, cell or mobile phones are the section of a GSM cellular network.

In recent years their size has fallen dramatically while the level of functionality has greatly increased.

There are a number of elements to the cell phone, although the two main elements are the main hardware and the SIM.

It contains a number known as the International Mobile Equipment Identity (IMEI). This is installed in the phone at manufacture and "cannot" be changed. It is accessed by the network during registration to check whether the equipment has been reported as stolen.

The SIM or Subscriber Identity Module contains the information that provides the identity of the user to the network. It contains are variety of information including a number known as the International Mobile Subscriber Identity (IMSI).

Base Station Subsystem (BSS)

The Base Station Subsystem (BSS) section of the GSM network architecture that is fundamentally associated with communicating with the mobiles on the network. It consists of two elements:

- ***Base Transceiver Station (BTS):*** The BTS used in a GSM network comprises the radio transmitter receivers, and their associated antennas that transmit and receive to directly communicate with the mobiles. The BTS is the defining element for each cell. The BTS communicates with the mobiles and the interface between the two is known as the Um interface with its associated protocols.
- ***Base Station Controller (BSC):*** The BSC forms the next stage back into the GSM network. It controls a group of BTSs, and is often co-located with one of the BTSs in its group. It manages the radio resources and controls items such as handover within the group of BTSs, allocates channels and the like. It communicates with the BTSs over what is termed the Abis interface.

Network Switching Subsystem (NSS)

The GSM system architecture contains a variety of different elements, and is often termed the core network. It provides the main control and interfacing for the whole mobile network. The major elements within the core network include:

- ***Mobile Services Switching Centre (MSC):*** The main element within the core network area of the overall GSM network architecture is the Mobile switching Services Centre (MSC). The MSC acts like a normal switching node within a PSTN or ISDN, but also provides additional functionality to enable the requirements of a mobile user to be supported. These include registration, authentication, call location, inter-MSC handovers and call routing to a mobile subscriber. It also provides an interface to the PSTN so that calls can be routed from the mobile network to a phone connected to a landline. Interfaces to other MSCs are provided to enable calls to be made to mobiles on different networks.
- ***Home Location Register (HLR):*** This database contains all the administrative information about each subscriber along with their last known location. In this way, the GSM network is able to route calls to the relevant base station for the MS. When a user switches on their phone, the phone registers with the network and from this it is possible to determine which BTS it communicates with so that incoming calls can be routed appropriately. Even when the phone is not active (but switched on) it re-registers periodically to ensure that the network (HLR) is aware of its latest position. There is one HLR per network, although it may be distributed across various sub-centres to for operational reasons.
- ***Visitor Location Register (VLR):*** This contains selected information from the HLR that enables the selected services for the individual subscriber to be provided. The VLR can be implemented as a separate entity, but it is commonly realised as an integral part of the MSC, rather than a separate entity. In this way access is made faster and more convenient.
- ***Equipment Identity Register (EIR):*** The EIR is the entity that decides whether a given mobile equipment may be allowed onto the network. Each mobile equipment has a number known as the International Mobile Equipment Identity. This number, as mentioned above, is installed in the equipment

and is checked by the network during registration. Dependent upon the information held in the EIR, the mobile may be allocated one of three states – allowed onto the network, barred access, or monitored in case its problems.

- ***Authentication Centre (AuC):*** The AuC is a protected database that contains the secret key also contained in the user's SIM card. It is used for authentication and for ciphering on the radio channel.
- ***Gateway Mobile Switching Centre (GMSC):*** The GMSC is the point to which a ME terminating call is initially routed, without any knowledge of the MS's location. The GMSC is thus in charge of obtaining the MSRN (Mobile Station Roaming Number) from the HLR based on the MSISDN (Mobile Station ISDN number, the "directory number" of a MS) and routing the call to the correct visited MSC. The "MSC" part of the term GMSC is misleading, since the gateway operation does not require any linking to an MSC.

Operation and Support Subsystem (OSS)

The OSS or operation support subsystem is an element within the overall GSM network architecture that is connected to components of the NSS and the BSC. It is used to control and monitor the overall GSM network and it is also used to control the traffic load of the BSS. It must be noted that as the number of BS increases with the scaling of the subscriber population some of the maintenance tasks are transferred to the BTS, allowing savings in the cost of ownership of the system.

HSCSD

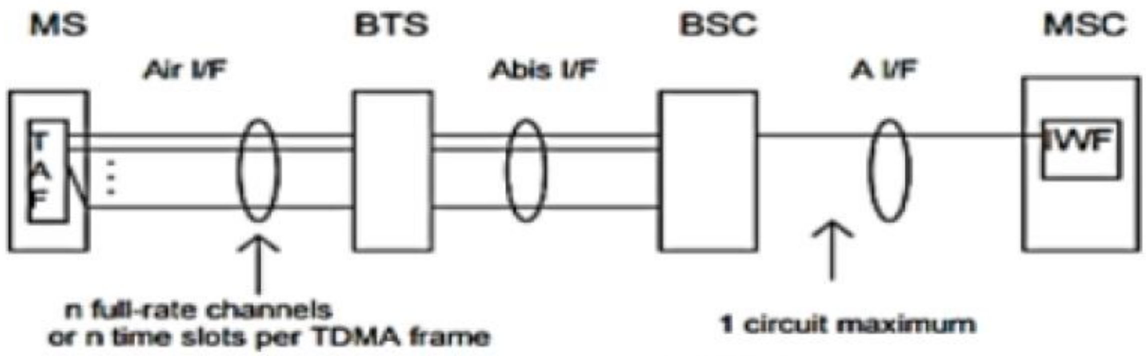
High Speed Circuit Switched Data (HSCSD)

High Speed Circuit Switched Data (HSCSD) is an enhancement in the data rate of circuit switched data in a GSM network. HSCSD uses two techniques to increase the data rate. First, HSCSD makes it possible to use more than one time slot. GSM uses time division multiple access (TDMA). Each radio channel is divided in eight time slots. Each time slot is allocated to a different user. This makes it possible to serve eight customers on one radio channel. HSCSD makes it possible to allocate more than one time slot to a user.

The second technique used by HSCSD is that the error correction can be adapted to the quality of the radio channel. A standard slot can carry 9.6 kbps. HSCSD makes it possible to increase this to 14.4 kbps. The quality of the radio channel must be good enough to do so.

The maximum data rate of a HSCSD configuration with 14.4-kbps channel coding is 115.2 kbps, if all eight time slots are allocated to the same user. In practice, is the number of time slots allocated to a user limited to three, limiting the data rate to 43.2 kbps. Another point is that the core network is based on circuit switched data with data channels of 64 kbps.

The main benefit of HSCSD compared to other data enhancements introduced later is that it is an inexpensive way to implement higher data rates in GSM networks. There modifications to be made are relatively small.



Network Architecture of HSCSD

A new functionality is introduced at the network and MS to provide the functions of combining and splitting the data into separate data streams which will then be transferred via n channels at the radio interface, where n = 1, 2, 3, ... 8. Once split, the data streams shall be carried by the n full rate traffic channels, called HSCSD channels, as if they were independent of each other, for the purpose of data relay and radio interface L1 error control, until to the point in the network where they are combined. However, logically the n full rate traffic channels at the radio interface belong to the same HSCSD configuration, and therefore they shall be controlled as one radio link by the network for the purpose of cellular operations, e.g. handover.

GPRS (General Packet Radio System)

General Packet Radio System is also known as **GPRS** is a third-generation step toward internet access. GPRS is also known as GSM-IP that is a Global-System Mobile Communications Internet Protocol as it keeps the users of this system online, allows to make voice calls, and access internet on-the-go. Even Time-Division Multiple Access (TDMA) users benefit from this system as it provides packet radio access.

GPRS also permits the network operators to execute an Internet Protocol (IP) based core architecture for integrated voice and data applications that will continue to be used and expanded for 3G services.

The GPRS specifications are written by the European Telecommunications Standard Institute (ETSI), the European counterpart of the American National Standard Institute (ANSI).

Key Features

Following three key features describe wireless packet data

- **The always online feature -** Removes the dial-up process, making applications only one click away.
- **An upgrade to existing systems -** Operators do not have to replace their equipment; rather, GPRS is added on top of the existing infrastructure.
- **An integral part of future 3G systems -** GPRS is the packet data core network for 3G systems EDGE and WCDMA.

Goals of GPRS

GPRS is the first step toward an end-to-end wireless infrastructure and has the following goals:

- Open architecture
- Consistent IP services
- Same infrastructure for different air interfaces
- Integrated telephony and Internet infrastructure

• Leverage industry investment in IP
• Service innovation independent of infrastructure

Benefits of GPRS

Higher Data Rate
GPRS benefits the users in many ways, one of which is higher data rates in turn of shorter access times. In the typical GSM mobile, setup alone is a lengthy process and equally, rates for data permission are restrained to 9.6 kbit/s. The session establishment time offered while GPRS is in practice is lower than one second and ISDN-line data rates are up to many 10 kbit/s.

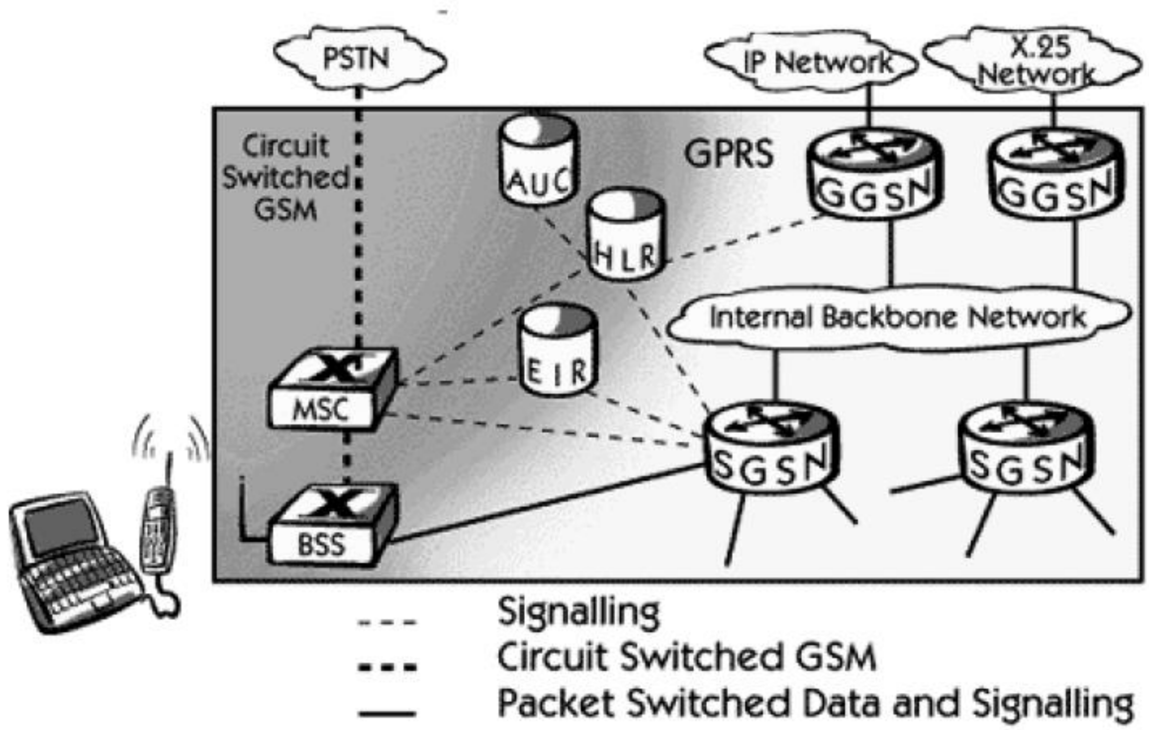
Easy Billing
GPRS packet transmission offers a more user-friendly billing than that offered by circuit switched services. In circuit switched services, billing is based on the duration of the connection. This is unsuitable for applications with bursty traffic. The user must pay for the entire airtime, even for idle periods when no packets are sent (e.g., when the user reads a Web page).
In contrast to this, with packet switched services, billing can be based on the amount of transmitted data. The advantage for the user is that he or she can be "online" over a long period of time but will be billed based on the transmitted data volume.

GPRS - Applications

- **Communications -** E-mail, fax, unified messaging and intranet/internet access, etc.
- **Value-added services -** Information services and games, etc.
- E-commerce - Retail, ticket purchasing, banking and financial trading, etc.
- **Location-based applications -** Navigation, traffic conditions, airline/rail schedules and location finder, etc.
- **Vertical applications -** Freight delivery, fleet management and sales-force automation.
- **Advertising -** Advertising may be location sensitive. For example, a user entering a mall can receive advertisements specific to the stores in that mall.

GPRS - Architecture

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.

GPRS Mobile Stations

New Mobile Stations (MS) are required to use GPRS services because existing GSM phones do not handle the enhanced air interface or packet data. A variety of MS can exist, including a high-speed version of current phones to support high-speed data access, a new PDA device with an embedded GSM phone, and PC cards for laptop computers. These mobile stations are backward compatible for making voice calls using GSM.

GPRS Base Station Subsystem

Each BSC requires the installation of one or more Packet Control Units (PCUs) and a software upgrade. The PCU provides a physical and logical data interface to the Base Station Subsystem (BSS) for packet data traffic. The BTS can also require a software upgrade but typically does not require hardware enhancements.
When either voice or data traffic is originated at the subscriber mobile, it is transported over the air interface to the BTS, and from the BTS to the BSC in the same way as a standard GSM call. However, at the output of the BSC, the traffic is separated; voice is sent to the Mobile Switching Center (MSC) per standard GSM, and data is sent to a new device called the SGSN via the PCU over a Frame Relay interface.

GPRS Support Nodes

Following two new components, called Gateway GPRS Support Nodes (GSNs) and, Serving GPRS Support Node (SGSN) are added:

Gateway GPRS Support Node (GGSN)

The Gateway GPRS Support Node acts as an interface and a router to external networks. It contains routing information for GPRS mobiles, which is used to tunnel packets through the IP based internal backbone to the correct Serving GPRS Support Node. The GGSN also collects charging information connected to the use of the external data networks and can act as a packet filter for incoming traffic.

Serving GPRS Support Node (SGSN)

The Serving GPRS Support Node is responsible for authentication of GPRS mobiles, registration of mobiles in the network, mobility management, and collecting information on charging for the use of the air interface.

Internal Backbone

The internal backbone is an IP based network used to carry packets between different GSNs. Tunnelling is used between SGSNs and GGSNs, so the internal backbone does not need any information about domains outside the GPRS network. Signaling from a GSN to a MSC, HLR or EIR is done using SS7.

Routing Area

GPRS introduces the concept of a Routing Area. This concept is similar to Location Area in GSM, except that it generally contains fewer cells. Because routing areas are smaller than location areas, less radio resources are used while broadcasting a page message.

GPRS - Quality of Service

The QoS is a vital feature of GPRS services as there are different QoS support requirements for assorted GPRS applications like realtime multimedia, web browsing, and e-mail transfer.

GPRS allows defining QoS profiles using the following parameters:

- Service Precedence
- Reliability
- Delay and
- Throughput

These parameters are described below:

Service Precedence

The preference given to a service when compared to another service is known as **Service Precedence**. This level of priority is classified into three levels called:

- high
- normal
- low

When there is network congestion, the packets of low priority are discarded as compared to high or normal priority packets.

Reliability

This parameter signifies the transmission characteristics required by an application. The reliability classes are defined which guarantee certain maximum values for the probability of loss, duplication, mis-sequencing, and corruption of packets.

EDGE (Enhanced Data Rate for GSM Evolution)

A higher bandwidth version of GPRS with speeds of up to 384Kbps, or twice that available from GPRS alone.

It has been evolved from GSM, which is the prevailing standard throughout Europe and the Asia Pacific region.

For GSM providers, this new technology will increase data rates of both circuit switching (HSCSD) and packet switching (GPRS) by a factor of 20 to 30 times.

Delay

The delay is defined as the end-to-end transfer time between two communicating mobile stations or between a mobile station and the GI interface to an external packet data network.

This includes all delays within the GPRS network, e.g., the delay for request and assignment of radio resources and the transit delay in the GPRS backbone network. Transfer delays outside the GPRS network, e.g., in external transit networks, are not taken into account.

Throughput

The throughput specifies the maximum/peak bit rate and the mean bit rate.

Using these QoS classes, QoS profiles can be negotiated between the mobile user and the network for each session, depending on the QoS demand and the available resources.

The billing of the service is then based on the transmitted data volume, the type of service, and the chosen QoS profile.

D-AMPS (Digital Advanced Mobile Phone System)

Digital Advanced Mobile Phone System (D-AMPS) is a digital version of Advanced Mobile Phone Systems (AMPS), the original analog standard for cellular phones. D-AMPS uses a combination of time division multiple access (TDMA) and frequency division multiple access (FDMA). It adds TDMA to get three channels per AMPS channel, thus tripling the number of calls on a channel.

Features

- They are standardised by IS-54 and IS-136.
- As in AMPS, D-AMPS also uses frequencies from 800 to 900MHz for transmission. Half of the spectrum is used for sending signals and the other half is used for receiving signals.
- The frequency band is divided into 30KHz sub-bands, called channels, by FDMA.
- The channels for uplink are called forward channels and the channels for downlink are called reverse channels.
- TDMA is applied to each channel thus tripling the number of available channels.
- Presently, all D-AMPS channels are replaced by GSM or CDMA technology.
- It is an analog system and is based upon initial electromagnetic spectrum allocation for cellular service by the federal communication commission.
- It uses **FDMA** (frequency division multiple) access for multiple simultaneous conversations.
- When the number of conversations is very high, it requires high bandwidth.
- It was the first to use hexagonal cells.
- Cells in AMPS are 10 km to 20 km across.
- Since it was analog technology, it suffers from noise and eavesdropping.

AMPS (Advanced Mobile Phone System) was invented by Bell Labs and first installed in the United States in 1982. In all mobile phone systems, a geographic region divides up into cells, which is why the devices are sometimes called cell phones.

In AMPS, cells are smaller and typically 10 to 20 km across digital systems. Each cell uses some set of frequencies, which are not used by any neighbors. The key idea that gives cellular systems far more capacity than previous systems is the use of relatively small cells and the reuse of transmission frequencies in nearby cells. Thus, the cellular design increases the system capacity by at least some order of magnitude. Smaller cells mean that less power is needed, which leads to smaller and cheaper transmitters and handsets.

Working of AMPS:

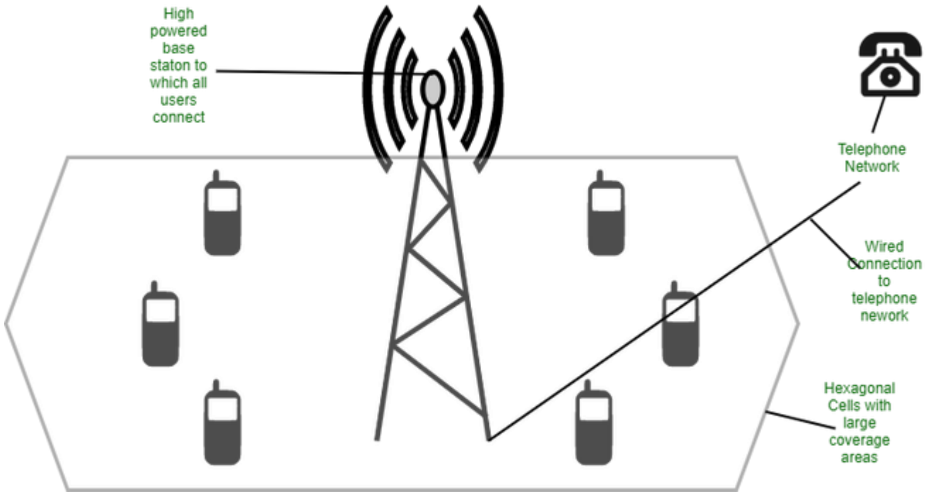
In an area where the number of users has grown to a point, where the system is overloaded, the power can be reduced and the overloaded cells split into small micro-cells to permit more frequency reuse. At the center of each cell, there is a base station to which all telephones in the cell transmit.

The base station consists of a computer and transmitter/receiver connected to the antenna. In a small system, all the base stations are connected to a single device called MSC (Mobile Switching Center) or MTSO(Mobile Telephone Switching Office).

The MSCs are essential for ending offices, as in telephonic systems, and are in fact connected to at least one telephone system’s end office.

At any instant mobile phone is logically in one specified cell and under the control of that cell’s base station. The mobile phone is then informed of its new boss (when the user leaves the current cell) and if a call is in progress, it is asked to switch to a new channel.

This process is called handoff, which takes about 300 msec. Channel assignment is done by the MSC, the nerve center of the system.



AMPS (Advanced Mobile Phone System):

Advanced mobile phone system (AMPS) was a standard for analog cellular phone system developed by Bell Labs and officially introduced by AT&T in 1983. It was officially introduced in the Americas on October 13, 1983,Israel in 1986, Australia in 1987, Singapore in 1988, and Pakistan in 1990.

AMPS is a **first-generation cellular** technology that uses separate frequencies, or "channels", for each conversation. It therefore required considerable bandwidth for a large number of users. In general terms, AMPS was very similar to the older "0G" Improved Mobile Telephone Service, but used considerably more computing power to select frequencies, hand off conversations to PSTN lines, and handle billing and call setup.

What really separated AMPS from older systems is the "back end" call setup functionality. In AMPS, the cell centres could flexibly assign channels to handsets based on signal strength, allowing the same frequency to be re-used in various locations without interference. This allowed a larger number of phones to be supported over a geographical area.

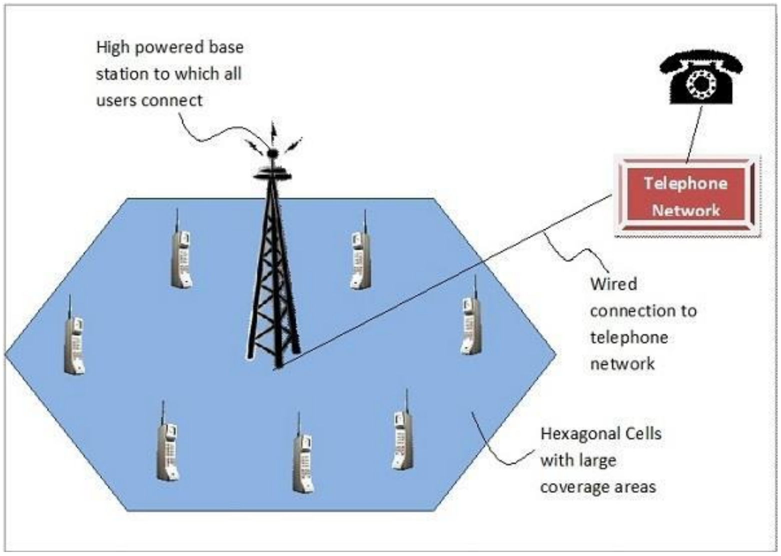
Features

- It is an Analog system based on the initial electromagnetic spectrum allocation for cellular service by the Federal Communications Commission.
- It uses frequency division multiple access (FDMA) for multiple simultaneous conversations.
- Frequency ranges within the **800 and 900 MHz** are allocated for cellular telephones in AMPS. Half of the signal is used for sending signals and half is used for receiving signals.
- It has a high bandwidth requirement particularly when the number of conversations is very high.
- **It was the first system to use hexagonal cells**. So, the pioneers of AMPS had coined the term coined cellular.
- **The cells in AMPS are 10km to 20 km across.**
- RF bandwidth 30khz. The band can accommodate 832 duplex Channels, among which 21 are reserved for call set up, and the rest for voice communication.

• Frequency allocated by FCC(**Federal Communications Commission**) on 824-849MHz for downlink and 869-894MHz for Uplink traffic.

• Since, it was an Analog technology, it suffered from noise and **Eavesdropping**

(Eavesdropping is as an electronic attack where digital communications are intercepted by an individual whom they are not intended. This is done in two main ways: Directly listening to digital or analog voice communication or the interception or sniffing of data relating to any form of communication.)

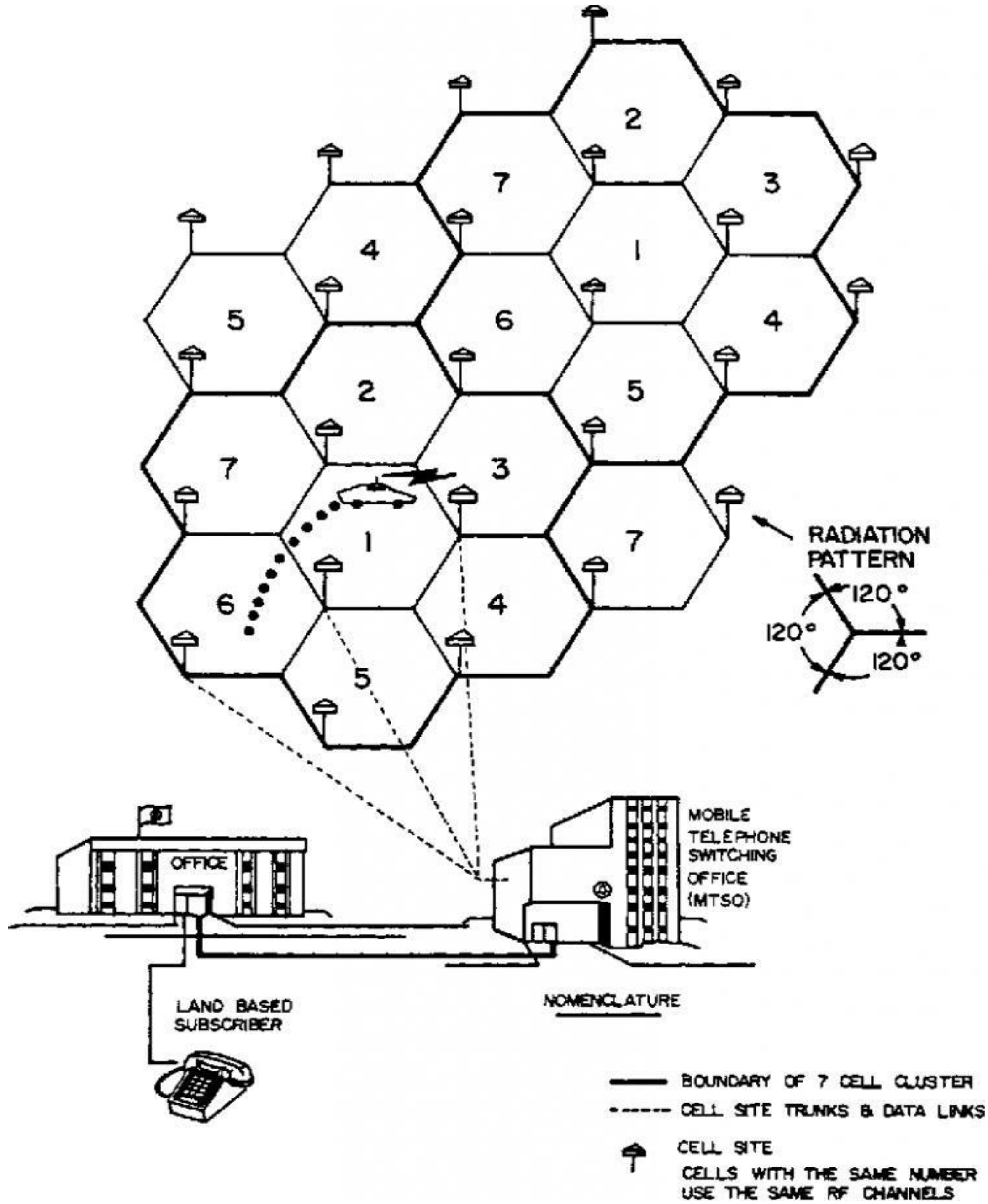


The analog service of AMPS has been updated with digital cellular service by adding to FDMA a further subdivision of each channel using time division multiple access (TDMA). This service is known as digital AMPS (D-AMPS)

AMPS and D-AMPS have now been phased out in favour of either CDMA2000 or GSM, which allow for higher capacity data transfers for services such as WAP, Multimedia Messaging System (MMS), and wireless Internet access. There are some phones capable of supporting AMPS, D-AMPS and GSM all in one phone (using the GAIT standard).

AMPS System Components:

1. Public Switch Telephone Network (PSTN)
2. Mobile Telephone Switching Office (MTSO)
3. Cell site with Antenna
4. Mobile Subscriber Unit



How Advanced Mobile Phone Service works:

The First AMPS cellular system used large cells and omni directional base station antennas to minimize the Initial equipment needs. The AMPS system Uses a seven-cell reuse pattern with provisions for sectoring and cell splitting to increase capacity when needed.

AMPS was designed as a voice only System.

AMPS use frequencies in the 800-MHz to 900-MHz range of the radio spectrum. It modulates a 3-kHz voice channel onto 30-kHz FM carrier signals using Frequency Division Multiple Access (FDMA) to create a series of 30-kHz channels. Separate channels are used for base station to mobile transmission (forward channels) and mobile station to base transmission (backward channels). The resulting allocation of bandwidth for each channel results in a maximum of approximately 800 simultaneous phone conversations per operator.

Because the population of most cities would suggest that 800 simultaneous phone conversations is far from enough, the idea was developed to partition the coverage of cities into several small areas called “cells.”

Each base station uses a limited-power transmitter with a **directional antenna** to provide coverage for a small geographical cell (from which the term "cellular communication" arose). **A typical cell ranges from .5 kilometre to 20 kilometres in size**, depending on whether the coverage is in a densely populated urban area or a sparsely populated rural one. Mobile users' phones also have limited transmission power, meaning that communication is usually limited to the immediate cell the user is in. As a user moves from one cell to another, the signal is smoothly picked up from the new cell. Adjacent cells use different frequencies, which prevents interference.

In communication with the network the mobile provides two identifiers for registration, call control and validation. The first of these identifiers is the MOBILE IDENTIFICATION NUMBER (MIN), which is programmed handset phone number used to call the subscriber.

The second identifier is the ELECTRONIC SERIAL NUMBER (ESN), which is a manufactured characteristic of the mobile unit. This identifier is permanent and associated with the physical equipment. It is 32bits is length, with the first 8 bits identifying the manufacturer.

CDMA ONE

IS-95. cdmaOne was the first cellular standard to implement the CDMA multiple access scheme, also known as IS-95. Individual channels can be distinguished from one another by means of unique orthogonal codes. Within this standard, all services – including speech and data – are circuit-switched with a maximum data rate of either 9.6 kbit/s or 14.4 kbit/s on each channel. With the IS-95-B technology extension, many operators also offer 64 kbit/s packet-switched data, in addition to voice services. A bandwidth of 1.25 MHz results in up to 61 channels under optimal channel conditions. cdmaOne is included as a subset in all cdma2000® standards up to the latest 1xEV-DO Rev. B standard.

CDMA is an American Standard that was developed by Qualcomm.

It was originally developed for the battlefield because it is very hard if not impossible to intercept due to their spread spectrum nature.

CDMA is now defined by a number of standards, some of which are IS-95, J-STD-008 (PCS) and CDMA 2000.

A unique code is assigned to all digital speech bits and the signals spread across the broad spectrum of the RF. Each CDMA base station can use the same 1.25 MHz carrier at the same time.

There are a maximum of 64 Walsh noise codes per 1.25MHz in a CDMAOne system.

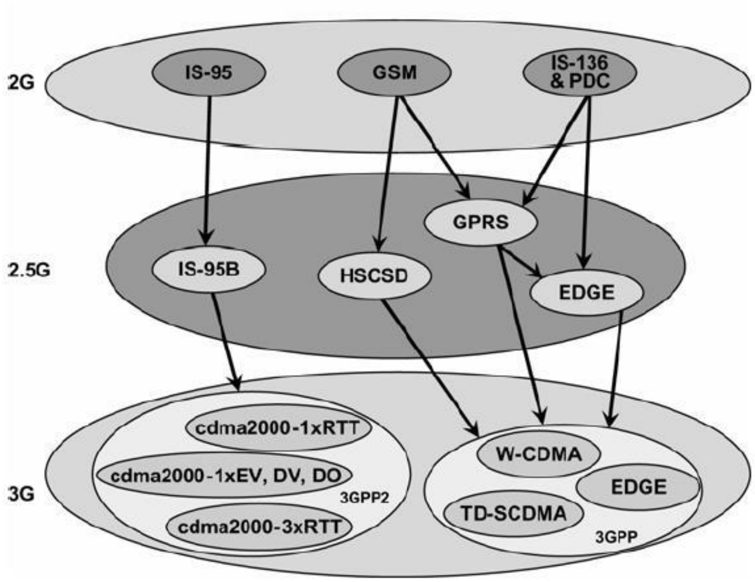
CDMA networks have pilot channels which carry no data but are used by the subscriber's mobile unit to acquire the system and assist in the soft handoff process. A separate pilot channel is transmitted for each sector of a cell site and is uniquely identified by it's own PN code, just like other users

CDMA refers collectively to three CDMA standards that were the first formal specifications assigned to the technology;

1. IS-95A
2. IS-95B
3. J-STD-008

CDMAOne standards have evolved in the complexity and effectiveness. Earlier versions (IS-95A&B) had issues with voice quality, data throughput and were limited in the methods in which they transmitted data.

IS-95B and J-STD-008 allowed for Integrated Service Digital Network or ISDN to be used. More advanced calling features were accessible CDMA 2000 falls under the specification known as IS-2000 as is backward compatible with earlier versions. CDMA2000 is a 3G specification, which allows for multidata platform usage.

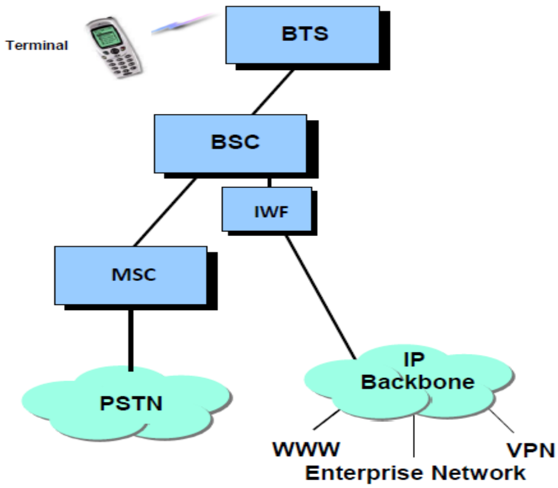


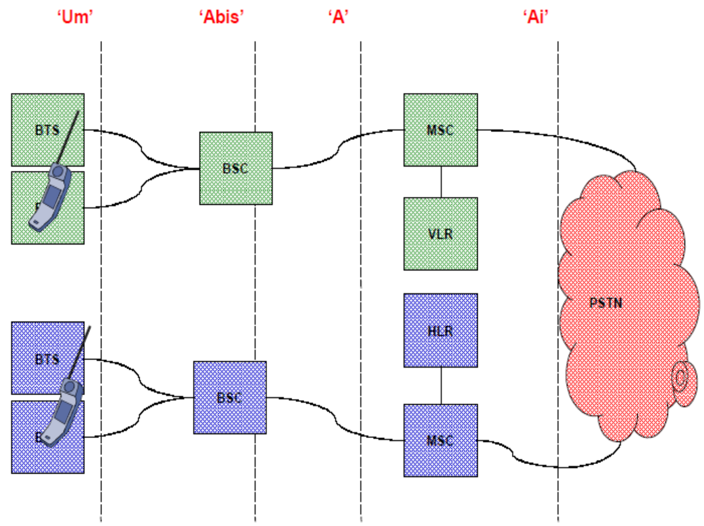
Interim Standard 95 (IS-95)

- •Also known as cdmaOne
- •64 users in a 1.25 MHz channel.
- •Can be used in 800 MHz and 1900 MHz bands.
- •Sprint and Verizon in the U.S.
- •Spectrum bandwidth:
- •1850 to 1910 MHz Mobile to Base
- •1930 to 1990 MHz Base to Mobile
- •Channels are 1.25 MHz
- •3.75 MHz in CDMA 2000, 5 MHZ in UMTS
- •Results in approximately only 48 forward/reverse channel pairs in IS-95.
- •Adjacent cell phone towers use the exact same channels as all other towers.
- •This is a major difference.
- •Allows for much better frequency reuse and makes setting up a cellular network much easier.

Upgrade path from IS-95A to IS-95B for 2.5G CDMA

- •Only one upgrade path for IS-95
- •Users can use up to 8 CDMA codes simultaneously.
- •14.4 kpbs* 8 = 115.2 kbps
- •Practical throughput is 64 kbps that can actually be achieved.
- •Also changes the method of handoff between base stations.





Network Interconnects

- Airlink: "Um" Interface
- BTS-to-BSC: "A" Base Station Interface (bis)
- BSC-to-MSC: "A" Interface
- MSC-to-MSC: "Ai" Interface

Packet Data System

Packet Data Systems was formed in 1991 to supply European telecommunication test products to a market dominated by high value American products. The capabilities of the European products were identical and in some cases better but the cost was much lower so the market responded with great enthusiasm.

The most powerful product we had was our **Clarinet protocol test system** comprising of a range of physical interfaces which connect to a laptop PC host running an application to simulate many telecom protocols including **DASS2, DPNSS, ISDN, Q-SIG, V5.1, V5.2, SS#7, H.323, SIP** and **SIPi** which were used by all the major telecom operators, the government, ministry of defence and many companies manufacturing and testing PBX or Switch harware. Many thousands of **Clarinet** systems have been sold with full support and product training offered by **PDS** internationally.

PDS also soon became a manuafacturer of our own range of **ISDN network simulators** which could be used to demonstrate two ISDN basic rate video conferencing terminals, two ISDN telephones or two ISDN data terminals working back-to-back. You can find information leaflets for our **B-Link** unit which had two ISDN basic rate S-T or 2B1Q U interfaces, and our **Simline 6** which has six ISDN basic rate S-T interfaces and one optional ISDN primary rate E1 interface on this web page and they can sometimes be purchsed on eBay. These became very popular and we were asked by the government to build products based on our design to fill more complex applications resulting in the sale of hundreds of these products all over the world.

In 2015 a number of companies got together and decided to share the development of their own products in order to avoid spending too much money. One of the first products they produced was called **Wireshark** which is an excellent protocol analyser but when they finished, they decided to put it on to the internet and let anyone download it free-of-charge so the market was destroyed damaging **PDS** and many of our competitors.

We still had protocol simulators to sell but fewer people were using this approach, and soon another product called **SIPp** was released. **SIPp** is a protocol simulator for the session initiation protocol and this too was put on to the internet free-of-charge. The only prodcuts we had left now were **Protocol Conformance Testers** which could be used to automatically generate messages to all connected devices and check their responses, a correct responce would result in a **'PASS'** verdict and a wrong response would result in a **'FAIL'** verdict. These systems offered a perfect way to point fingers at devices which were not in full compliance of the protocol but were very expensive so therefore the market was too small.