

Mobile Computing

Unit-1

④ Mobile Computing :- It is a technology that allows transmission of data, voice and video via a computer or any other wireless enabled device without having to be connected to a fixed physical link.

The main concept involves → Mobile communication
→ Mobile hardware
→ Mobile software.

Reviews of Generation of Mobile Services

1G Technology

- Analog Signals used,
- Early 1980s.
- Speed upto 2.4 kbps
- Poor voice quality
- Large phone with limited battery life
- No data security

2G Technology

- Digital Signals used,
- Early 1991
- Speed upto 64 kbps
- Text & multimedia messaging possible
- better quality than 1G

3G Technology

- speed of 144 kbps to 2 Mbps
- High speed web browsing
- 3D gaming
- fast & easy transfer of audio & video files.
- possibility of running of web-based apps.

④ 4G Technology

- early 2011
- speed of 100 Mbps to 1 Gbps
- Mobile web access
- IP telephony
- cloud computing

Parameters	1G	2G	3G	4G
Introduced	1980	1993	2001	2011
Speeds	upto 2.4 kbps	upto 64 kbps	upto 2 Mbps	upto 1 Gbps
Bandwidth	Analog	25 MHz	25 MHz	100 MHz
Switching	Circuit	Ckt & Pkt	Packet	All Packet
Multiplexing	FDMA	TDMA/CDMA	CDMA	CDMA
Band type	Narrowband	Narrow	Wide	Ultra-wide
Carrier frequency	30 kHz	200 kHz	5 MHz	15 MHz
Internet services	No Internet	Narrow band	Broadband	Ultra broadband

⑤ Overview of Wireless Telephony

Wireless Telephony is the technology that operates by transmission of information through space ; there is no physical or fixed connection in b/w sender and receiver device. By using the wireless telephony, people can be transceivers the info from airplane, driving car, etc.

It comes in two basic varieties ! -

- ① cordless phone (sometimes called portable telephone)
- ② mobile phone (sometimes called cell phones)

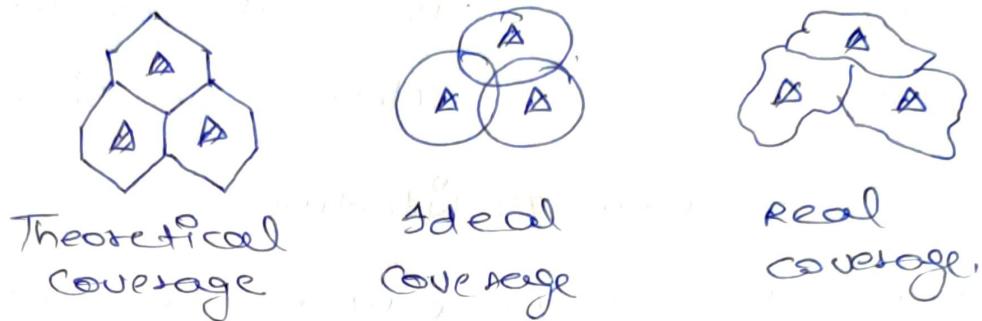
Basically, in cordless phone, consisting of a base station and a handset, base station attached to telephone nw the same way a corded telephone does.

mobile phones connect to a base station & satellite phones are connected to orbiting satellite. Both now are interconnected to PSTN so that any phone in the world can be dialed.

④ The cellular concept

Cell:- The coverage area of mobile base station.
So, for every cell, there is a base station.

Cell fundamentals :



Frequency Reuse Concept: frequency reuse distance is maintained b/w two same frequencies of clusters

Clusters may be made up of 3, 4, 7, 9, 12, 13, 16, etc cells. but most commonly used are 7-cell & 4-cell clusters to cover an area.

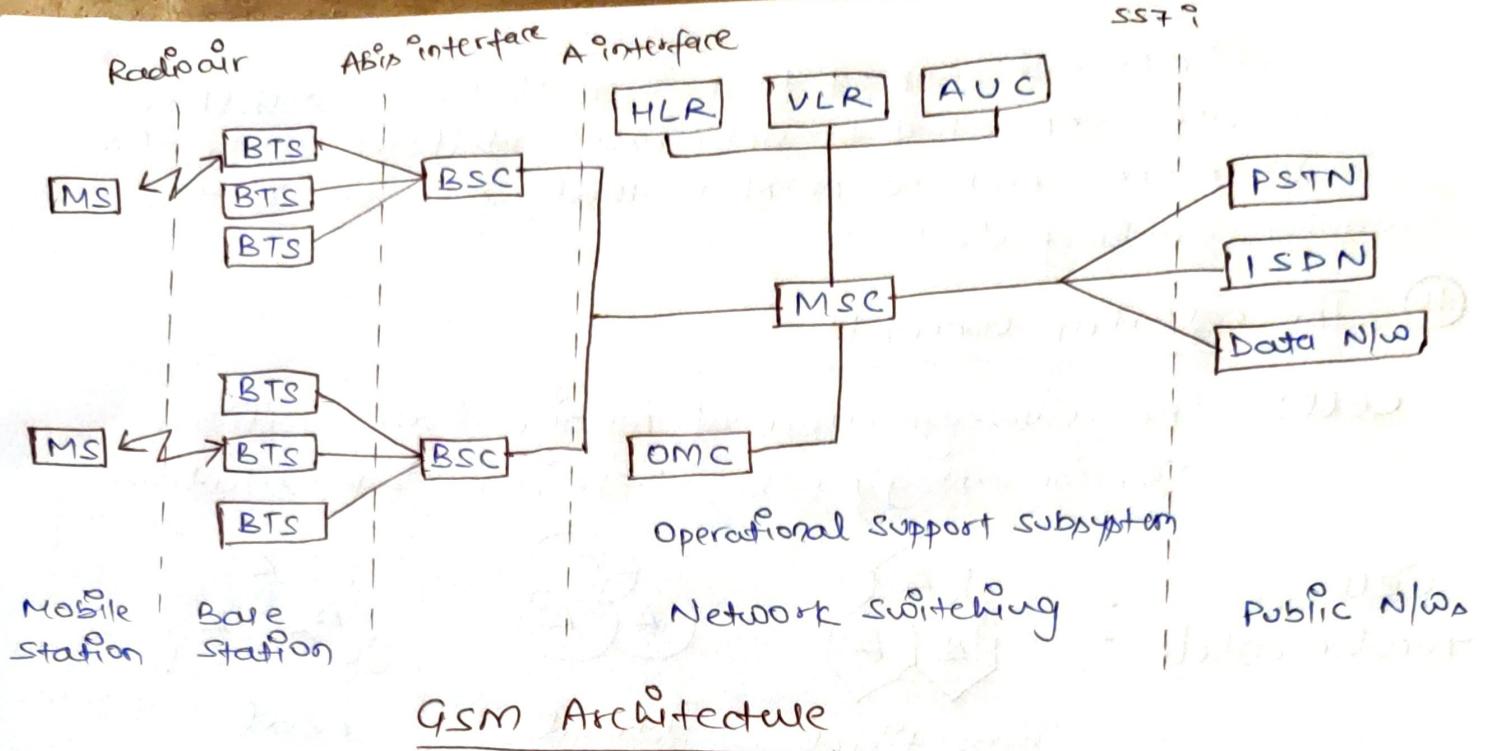
In simpler words, frequency reuse implied, that in a given coverage area, there are several cells that use same set of frequencies.

These channels are also called co-channel cells and interference b/w signals from these channels is called co-channel interference.

⑤ GSM Architecture

It consists of three major interconnected subsystems that interact with themselves with users through certain network interface. The subsystems are :-

- ① Base Station Subsystem (BSS)
- ② Network Switching Subsystem (NSS)
- ③ Operational Support Subsystem (OSS)



GSM Architecture

① Mobile Station is made up of two entities.

- Mobile equipment (ME)
- Subscriber Identity Module (SIM)

② Base station subsystem is also known as radio subsystem, provides & manages radio transmission path b/w MS and MSC. It consists of two parts:-

* Base Transceiver Station (BTS)

- It encodes, encrypts, multiplexes, modulates and feeds the RF signal to the antenna.
- It communicates with MS via radio air interface and also communicates with BSC via Abis interface.

* Base Station Controller (BSC)

- It manages radio resources for BTS. It assigns frequency & time slots for all MS in its area.
- It handles call setup, transcoding and adaptation functionality handover for each MS radio power control.
- It communicates with MSC via A interface and also with BTS.

Network Switching Subsystem (NSS)

It manages the switching function of the system and allows MSC to communicate with other networks such as PSTN and ISDN. It consists of :-

Mobile Switching Centre (MSC)

- It is a heart of the network. It manages communication b/w GSM and other networks.
- It manages call set up function, routing and basic switching.
- It provides billing information.

Home Location Registers (HLR)

- It is a permanent database about mobile subscriber in a large service area.
- Its database contains IMSI, IMEI, MSISDN, prepaid/post-paid, roaming restrictions, supplementary services.

Visitor Location Registers (VLR)

- It is a temporary database which updates whenever new MS enters its area by HLR database.
- It controls mobile roaming in its area.
- It reduces no. of queries to HLR.
- Its database contains IMSI, TMSI, IMEI, MSRN, location, area authentication key.

Authentication Centre (AUC)

- It provides protection against intruders in air interface.
- It maintains authentication keys and algorithms and provides security triplets (RAND, SRES, Ki).

Equipment Identity Registry (EIR)

- It is a database that is used to track handset using IMEI no.
- It is made up of 3 sub classes - the white list, the black list and the gray list.

④ Operational Support Subsystem (OSS)

- It supports the operations & maintenance of GSM.
- To maintain all telecommunication hardware and network operations with a particular market.
- To manage all charging and billing procedures.
- To manage all mobile equipment in the system.

⑤ Air Interface: It is the interface b/w MS and the fixed infrastructure. It is one of the most important interfaces of the GSM system.

One of the main objectives of GSM is roaming. Therefore, in order to obtain a complete compatibility b/w MS and networks of different manufacturers and operators, the radio/air interface must be completely defined. GSM utilizes a combination of FDMA & TDMA on Air interface that results in 2D structure.

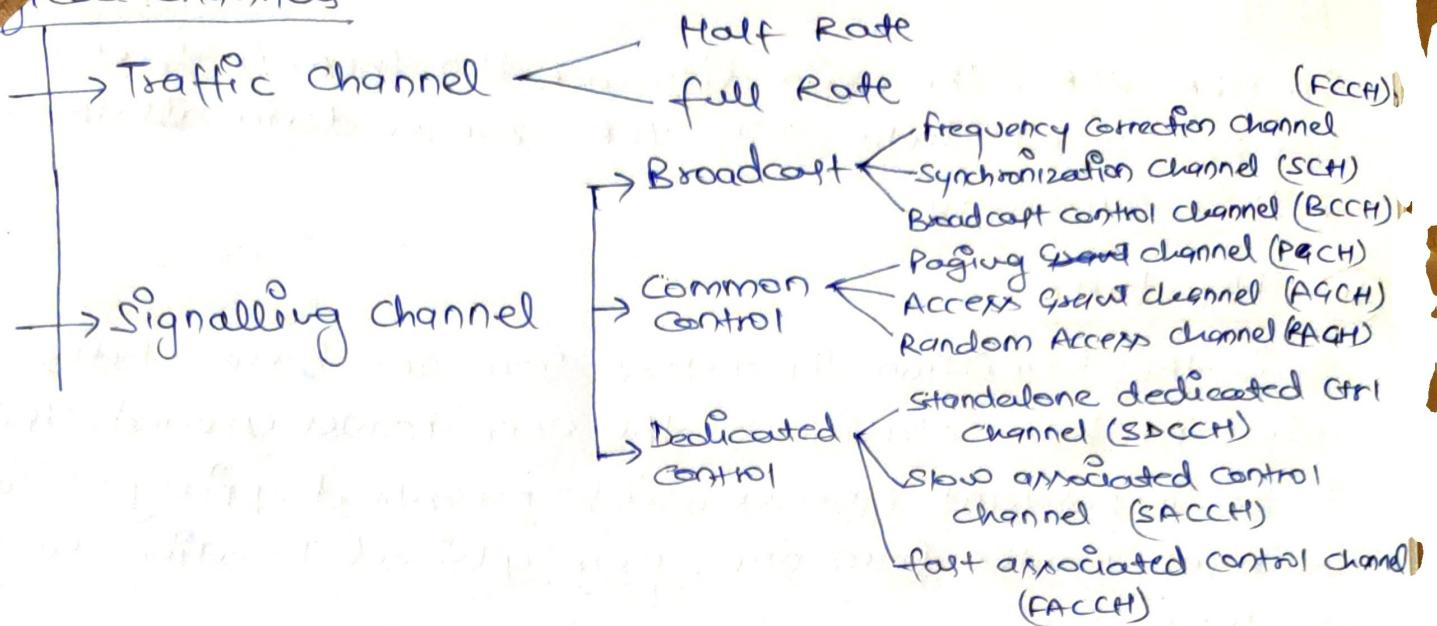
⑥ Channel Structure

- * Physical Channel → medium over which information is carried.
- * Logical Channel → consist of info carried over physical channel.

Basically, when MS & BTS communicate, they do so on RF carriers within a given time slot. This combination of time slot & carrier frequency forms physical channel.

Logical channel transports user data or signalling information for MS or BS.

Physical Channels



Location Management (Mobility Management)

- Location Management will be an important issue in these situations where because wireless devices can change the location while connected to a wireless network.
- The main task of location management is to keep track of a user's location all the time while operating and on the move, so that incoming messages, calls can be routed to the intended recipient.
- It is one of the major functions of GSM and that allows mobile phone to work.
LM consists mainly of :-
- Location Tracking & Updating! - A process in which an end-point initiates a change in the location database according to its new location. This procedure allows the main system to keep track of a user's location.
- Location finding (Paging)! - The process of which the network initiates a query for an end point's location. This process is implemented by the system sending beacons to all cells so that one of the cells could locate the user. This might also result in an update to the location register.

NOTE!

In HLR, VLR, the main difference b/w them is that HLR has permanent data while VLR changes data all the time & it is temporary.

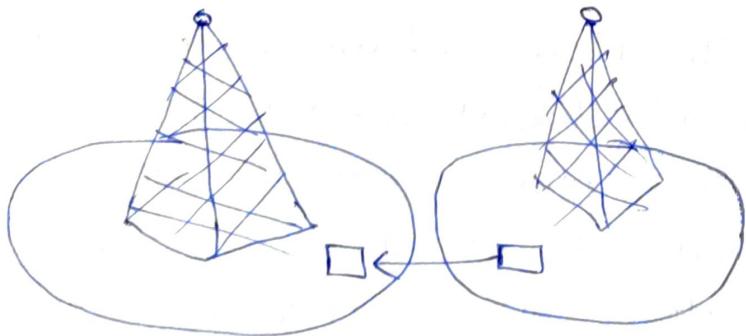
Handoffs

It is the transition for a user from one base station to adjacent base station as the user moves around. This is an important process which prevents dropping of call as user moves from one geographical location to another.

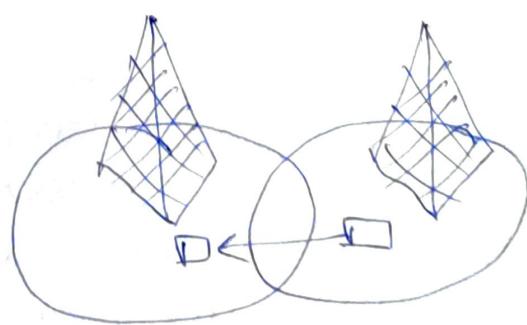
Types of Handoffs

- * **Hard handoff**:- In this, an actual break in the connection occurs while switching from one cell to another. The radio link from the MS to the existing cell is broken before establishing a link with the next cell. It is a "break before make" policy.
- * **Soft handoff**:- In this, at least one of the links is kept when radio links are added and removed to the mobile station. This ensures that during the handoff, no break occurs. It is a "make-before-break" policy.

Hard Handoffs



soft handoffs



Types of GSM handover

- * **Intera-BTS handover!:-** This occurs if it is required to change the frequency or slot being used by a mobile because of interference, or other reasons. In this, the mobile remains attached to the same base station transceiver, but changes the channel or slot.
- * **Inter-BTS Intera BSC-handover!:-** It occurs when the mobile moves out of the coverage area of one BTS but into another controlled by the same BSC. In this instance, the BSC is able to perform the handover and it assigns a new channel and slots to the mobile before releasing the old BTS from communicating with mobile.
- * **Inter-BSC handover!:-** When the mobile moves out of the range of cells controlled by one BSC, a more involved form of handover has to be performed, handing over not only from one BTS to another but one BSC to another. It is controlled by the MSC.
- * **Inter- MSC handover!:-** It occurs when changing b/w networks. The two MSCs involved negotiate to control the handover.

| # **Channel Allocation!:-** It deals with the allocation of channels to calls in cellular networks. Types are!:-

- ① **Fixed Channel Allocation!:-** It allocates specific channel to specific cell. It is static & can't be changed. It allocates channel in a way which maximizes frequency use.
- ② **Dynamic Channel Allocation!:-** In this, there is no relationship b/w channels & cells. Whenever a channel is needed by a cell, the channel is allocated such that frequency reuse requirements cannot be violated.

③ Hybrid Channel Allocation:- If includes all systems are hybrids of fixed & dynamic channel allocation scheme.

④ CDMA (Code Division Multiple Access)

- CDMA is a sort of multiplexing that facilitates various signals to occupy a single transmission channel.
- It optimizes the use of available bandwidth.
- CDMA uses spread spectrum technique.
- It provides channel access to multiple users simultaneously.
- Each bit in signal is replaced by code to create high bandwidth signal. Codes are different for different users.

Advantages:- * Dropouts in CDMA occur only if MS is atleast twice or far from the base station.
* Transmission burst - reduces interference.

Disadvantages:- * Time synchronization is required.
* Gradual transfer increases the use of radio resources and may reduce capacity.

⑤ GPRS (General Packet Radio System)

- GPRS is packet based wireless communication service that provides high data rate.
- It is based on GSM communication as it implements packet switch network domain alongwith circuit switch domain of GSM.
- It costs user less than circuit switched service.
- It supports WAP, SMS, MMS etc.
- GPRS reuses GSM network nodes such as MSC/VLR, HLR & BSS.

- end network nodes for packet data are ! -
- * Serving GPRS Support Node (SGSN) is responsible for authentication of GPRS mobile, registration of mobile in network, mobility management.
- * Gateway GPRS support node (GGSN) acts as interface & router to external networks. It contains routing information for GPRS mobile.

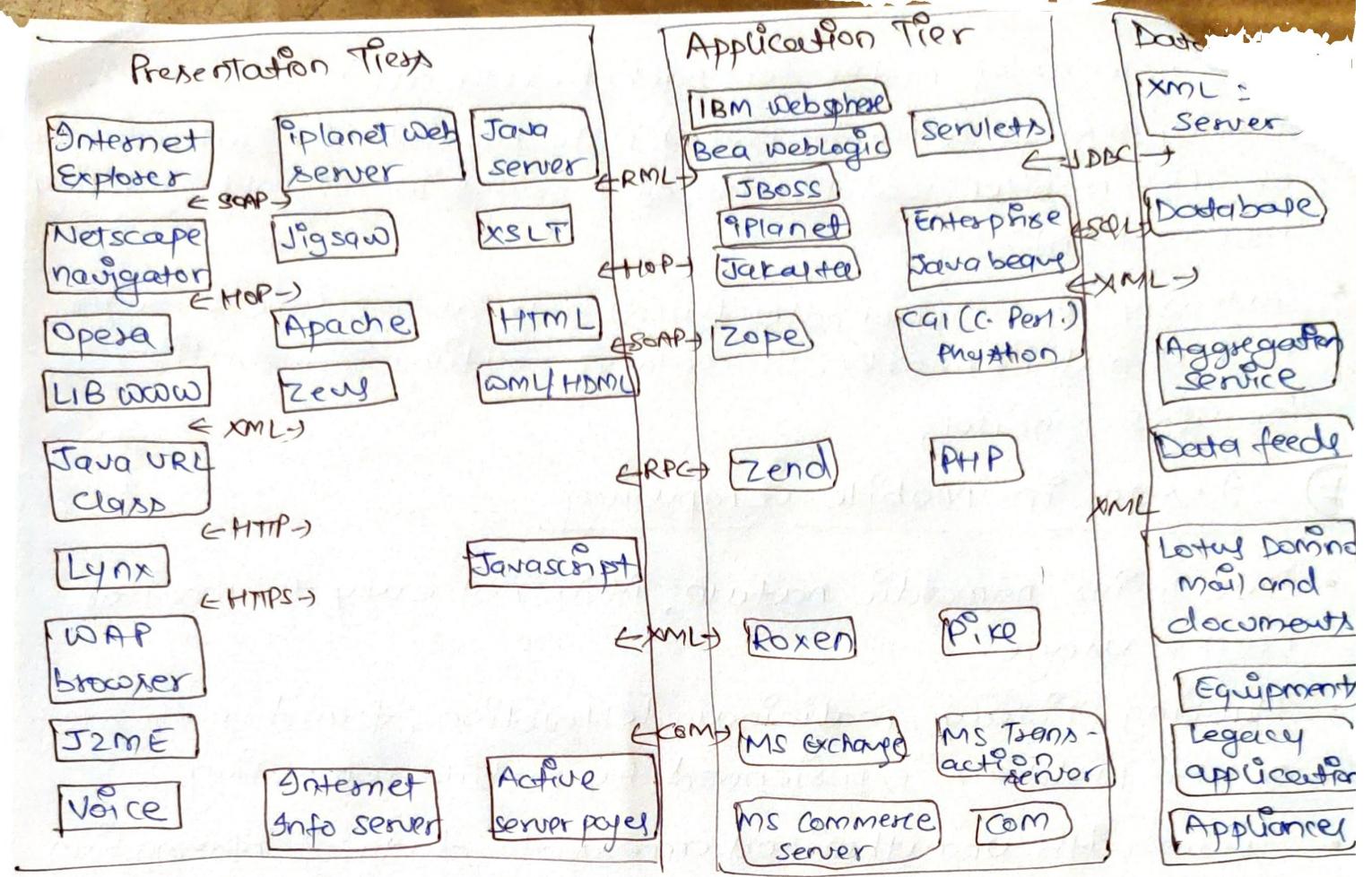
Issues in Mobile Computing

- Due to its nomadic nature, it is not easy to monitor proper usage.
- Hacking, piracy, malicious destruction, fraud are some of the problems experienced by mobile computing.
- Issues with unauthorized access to data & information by hackers.
- The problem of identity theft is very difficult to eradicate.
- Credential verification is also a big problem in mobile computing.

Three tier architecture for mobile computing

* Presentation (Tier-1)

- This is the user facing system in first tier.
- These applications run on client device & offer user interface.
- This tier is responsible for presenting information to the end user.
- It includes web browser, WAP browser and customized client programs.



* Application (Tier-2)

- It performs the business logic of processing user input, obtaining data, and making decision.
- This layer transcode data for rendering in presentation tier.
- These functions are implemented using middleware software which is in b/w OS & user facing software.
- It includes JAVA, JSP, .Net, PHP etc.

* Data (Tier-3)

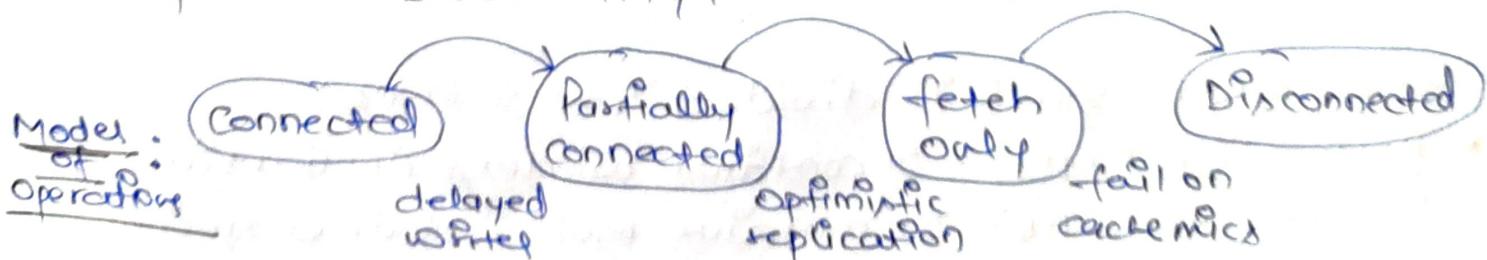
- It is used to store data needed by application & act as depository for both temporary & permanent data.
- Data can be stored in any form of database.
- Database middleware run b/w application program & database.

Design Considerations for Mobile Computing

- Decide if you will build a rich client, a thin web client or rich internet application (RIA)
- Determine the device types you will support
- Design considering occasionally connected, limited-bandwidth scenarios when reqd.
- Design a UI appropriate for mobile devices, taking into account platform constraints.
- Design a layered architecture for mobile devices that improves reuse and maintainability.
- Battery
- Cloud
- Storage
- Memory usage
- Graphics, etc.

④ Mobile file systems

- It allows mobile users to run applications that access shared files over a mobile net.
- Applications behave same regardless where user is located.
- Adaptability
- It provides location transparency.
- It provides cache consistency.
- It provides scalability.



Coda Distributed file System is used in which files are grouped into volumes which are replicated on Coda servers.

Mobile Database

- It is a database that is transportable, portable and physically detached from corporate database server but has capability to communicate with those servers from remote sites allowing sharing of data.
- With mobile database, users can access corporate data on their laptop, Personal Digital Assistant (PDA) at remote sites.
- Corporate database servers & DBMS in mobile database environments deal with storing corporate data and providing corporate applications.
- Two main issues with mobile database are management of mobile database & communication b/w mobile & corporate database.

Example:- SQL Server Express (Microsoft),
DB2 Everywhere (Oracle).

WAP: Architecture & Protocol Stack

- Stands for Wireless Application Protocol.
- It is the set of rules governing the transmission and reception of data by computer applications on or via wireless devices like mobile phone.
- It allows wireless device to view specifically designed pages from the Internet using only plain text and very simple black and white pictures.

WAP protocol stack is divided into 5 layers:-

- * Application Layer:- It contains Wireless Application Environment (WAE). It contains mobile device specifications and content development programming languages like WML, WML scripts.

Session Layer! - It contains Wireless Session Protocol (WSP). It provides fast connection suspensions & reconnections.

- * Transaction Layer! - It contains Wireless Transaction Protocol (WTP). It runs on top of UDP and is a part of TCP/IP and offers transaction support.
- * Security Layer! - It contains Wireless Transaction Layer Security (WTLS). It offers data integrity, privacy and authentication.
- * Transport Layer! - It contains Wireless Datagram Protocol (WDP). It presents consistent data format to higher layer of WAP protocol stack.

Application Layer (WAE)

Session Layer (WSP)

Transaction Layer (WTP)

Security Layer (WTLS)

Transport Layer (WDP)

Datagram Protocol

- It defines the movement of information b/w source & destination over wireless IP network.
- It provides interface to upper layers of protocol stack.
- It performs 3 basic tasks :- Port addressing, segmentation of datagrams & reassembly of packets at receiving end.
- It does not confirm datagram delivery, resend lost packets or correct errors during transmission.

Wireless Transport Layer Security

- It is a security protocol which is a part of protocol stack.
- It is based on industry standard transport layer security (TLS).
- It provides transport layer security b/w a WAP client and WAP gateway/proxy.
- It is used to encrypt the connection.
- Goals are data integrity, privacy & authentication.

Wireless Transaction Protocol

- It is a standard used in mobile telephony.
- It is a layer of WAP that is intended to bring Internet access to mobile phones.
- It runs on top of UDP & performs many of the same tasks as TCP optimized for wireless devices.
- Each transaction has unique identifiers, acknowledgements, duplicate removal & retransmission.
- It has no security mechanisms.

Types of classes in WTP

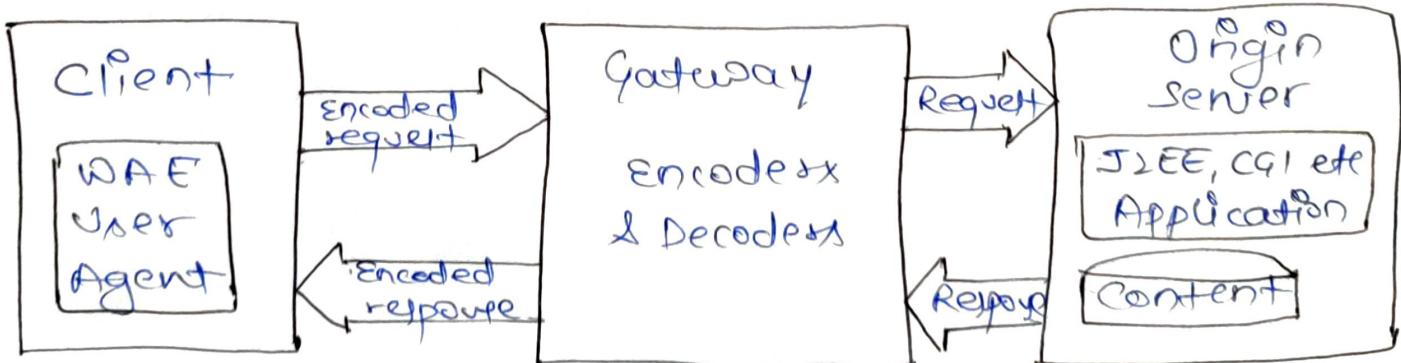
- * **WTP class 0:-** It provides unreliable message transfer without any result message. They are stateless & can't be aborted.
- * **WTP class 1:-** It offers reliable transaction service but without a result message.
- * **WTP class 2:-** It provides reliable request/response transaction.

Wireless Session Protocol

- It is an open standard for maintaining high level session.
- Wireless session is normal web browsing session that starts when user connects to one URL and ends when user leaves that URL.
- It provides shared state b/w client & server used to optimize content transfer.
- There are 2 types of WSP:-
 - * **Connection less WSP (cl-WSP)** :- Offers unreliable transport of WSP primitive.
 - * **Connection oriented WSP (co-WSP)** :- enhances HTTP 1.1 performance larger data transfer and reliable data transport.

Wireless Application Environment

- The main idea is to create a general purpose application environment based mainly on existing technologies.
- goal is to minimize over-the-air traffic and resource consumption on the handheld device.
- It allows all content & services to be hosted on standard web servers.



④ Applications of WAP

- Accessing the Internet from mobile device.
- Games can be played from mobile device over wireless device.
- Online banking via mobile phone.
- Email, voicemail on mobile device.
- Providing weather & traffic alerts.