TBC-604

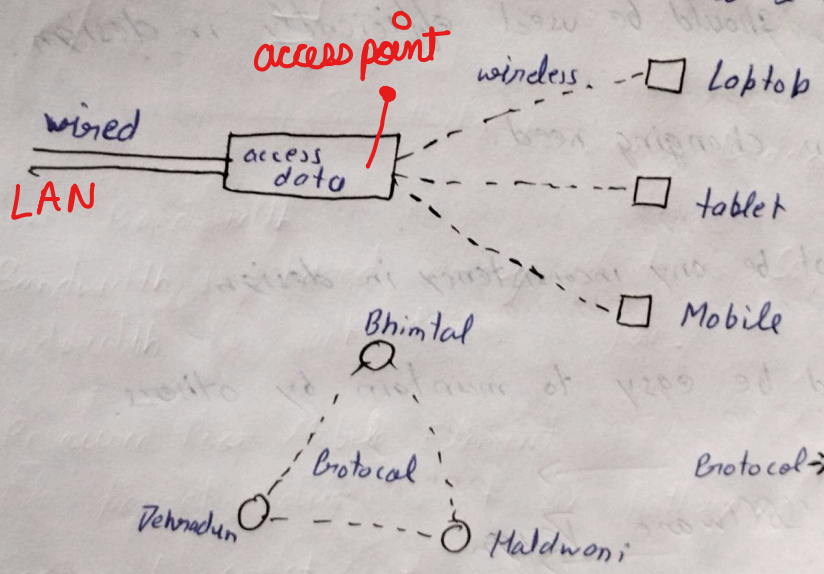
Mobile Computing

Mobile → movable

Computing → Processing + transformation + Storage.

Mobile Computing is the technology that uses computing devices (tables, mobile phone, ~~etc~~ I Pod, laptop, etc) and allows transmission of data (audio, video, text, picture) wirelessly any time, any where & everywhere.

Communication is spread over both wired & wireless medium.



Protocol → set of rules & regulation

Set of distributed computing system participate connect & synchronise through mobile communication protocol.

Concept of mobile computing divided into three parts:

Mobile Computing →
- Mobile Communication
- Mobile Hardware
- Mobile Software

Mobile Computing

Mobile → movable

Computing → Processing + transformation + Storage.

Mobile computing

- Mobile Hardware (device & components)
- Mobile Software (operating system)
- Mobile Communication (services for data transfer)

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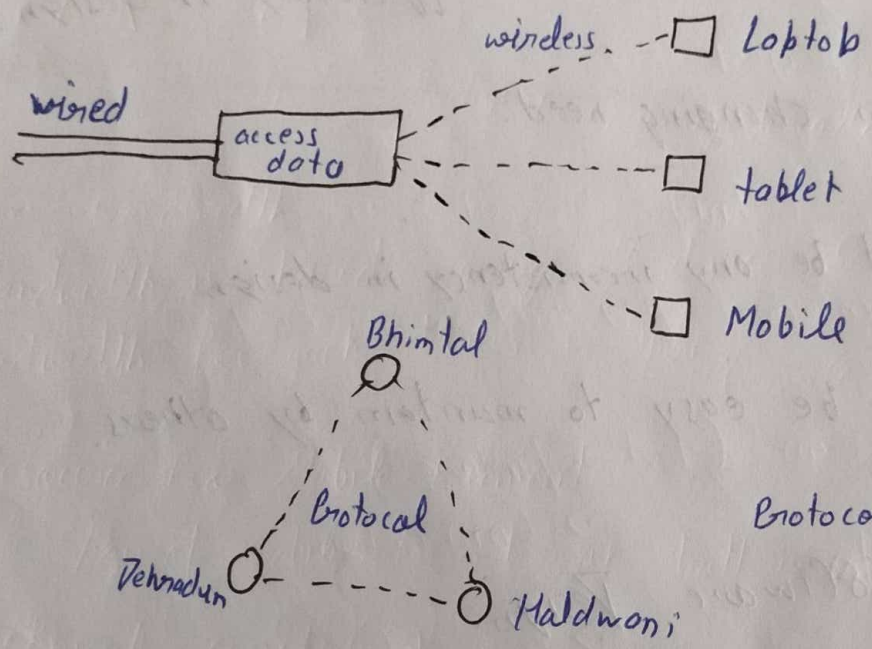

Protocol → set of rules & regulation

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Concept of mobile computing divided into three parts :-

Mobile Computing →
- Mobile Communication
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- Mobile Software

- Mobile Communication

Services that deals with the method of communicating data.

- Mobile Hardware

Devices/Components that can excess these services. These devices can send/receive data at the same time.

- Mobile Software

Deals with software/operating system used inside these devices. like window, linux etc.

★ Characteristic of Mobile Computing

1. Ubiquity

Provide the ability to user to perform compution from any where any time.

2 Location Awareness

Tracking current/present location of the hand held devices.
Example:- GPS, etc

3 Adaption

Adjusting bandwidth flextuation without user inconvense.

4 Broadcast

Signal is broadcasted by tower to get efficient delivery of data/information to many devices simultaneously.

5 Personalisation

As per user profile mobile services are customized.

★ Challenges In Mobile Computing

1 Disconnection

Frequent failure of network or disconnection of network due to mobile computing design.

2 Bandwidth Variation

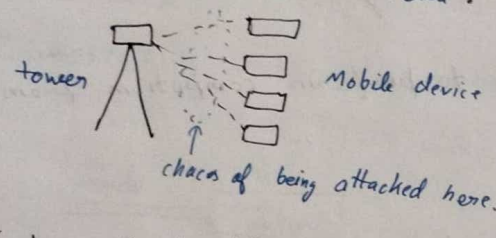
Flextuation in bandwidth / signal.
Example :- high or low signal.

3 Heterogeneous Network

Network con different topologies or different area network. (WAN, MAN, LAN, PAN).

4 Security Risk

In mobile environment, tower is broadcasted to serveral mobile devices and vice versa.



5 Low Bandwidth

Bandwidth is shared among all devices. So, very low bandwidth for each devices is there.

6. Resource Poor Mobile Element

Life Span of mobile element like battery.

7 Technical constraint

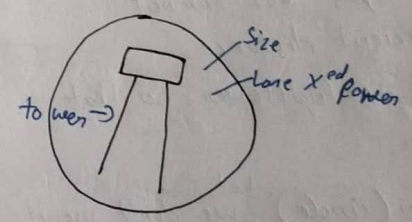
Limited Memory & Life.

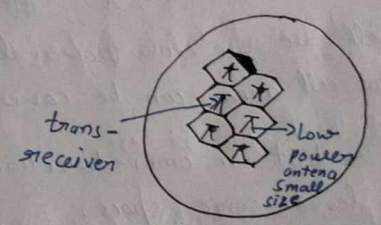
★ Application of Mobile Computing

1 Vehicles
2 Emergency
3 Business
4 Credit Card Verification
5 Replacement of wired network

★ Cellular Network / System

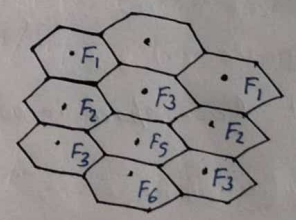
- It is a radio network, distributed over land area called cells each sub by at least one fixed location trans-receiver as cells side or Base Station.
- In cellular system, the service area / small geographical area is divided into cells.
- A transreceiver is design to serve as individual cell.
- The System seeks to make efficient use available ~~channel~~ channel by using low power transmitter to allowed frequency reuse at much smaller distance.





(.) each cell is contain a base station.

→ Frequency Reuse



Same frequency can be reuse in other cell which are to adjacent to each other.

Adjacent cell don't use same frequency because it cause interference.

★ Advantage / Characteristic of Mobile Computing

1 Large number of User.

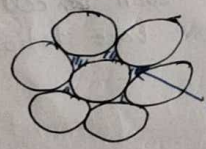
2 Large geographical area.

3 Reuse the radio frequency by the concept of cell.

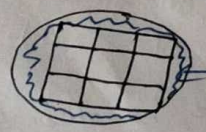
4 Reduce interference from other signal.

★ Why we use Hexagonal Structure for Cell ?

- We know that, each cell has a particular bandwidth.
- Co-channel has same set of frequencies but cannot interfere each other because of sufficient distance.
- In these cell we use low power & short-height tower so that the total cell area can be cover.
- Antena radiat in omni-direction (circle), but we don't use it because it leave some space.



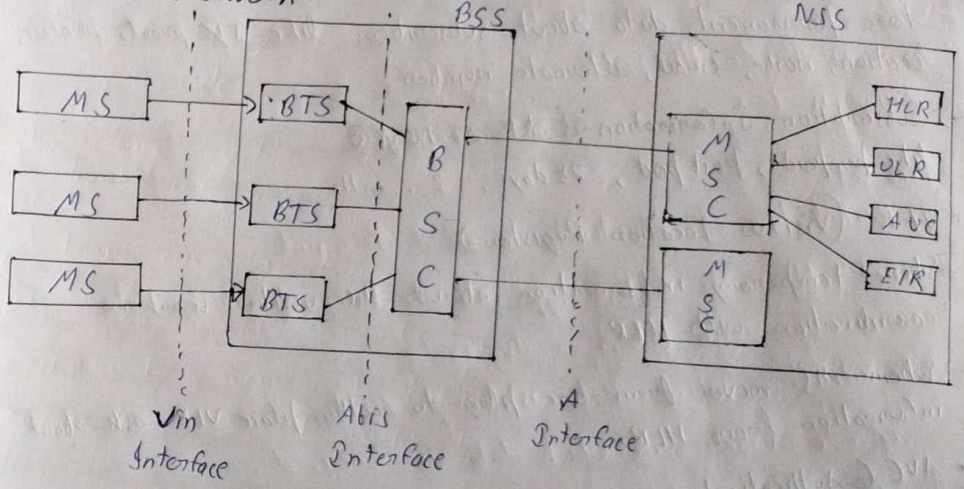
- We don't use square also because it leave space in outer part of geographical area.



- We don't use octagonal because it creat complexity.
- Hexagonal Structure is best approach available.

- Note:- If it theoritical approach use for calculation only & Extra. If it not purely hexagonal & identical.

★ Cellular Network Architecture



SIM
MS < eqt, sim

- Mobile Station (MS)
  - Mobile Equipment
  - Subscriber Indetity Module (SIM)
- Base Trans-receiver Station (BTS)
  - → It send & receives signal from mobile station.
  - → BTS facilitate wireless communication between user equipment & network
- BSC (Base Station Controller)
  - → It control BTS.
  - → When BTS is overloaded it handles the traffic & divert to another BTS
- Mobile Switching Center (MSC)
  - → It is associated with communication switching function such as call

setup, release & routing.

- HLR (Home Location Register)

→ Store permanent data about subscribers like ID proof, profile, location, name, email, alternate number.

→ Subscription Information

like prepaid, post paid, 28 days, 3 month.

- VLR (Visitor Location Register)

→ Store temporary information about the visitor work in coordination with HLR.

→ When MS move from one place to another place VLR ask about information from HLR.

- AUC (Authentication Center)

→ Protect from different type of frauds. Stores a copy of secrete key.

→ Used for authentication of MS.

- EIR (Equipment Indentity Register)

IMEI → used to identify each MS.

EIR is database that contain record of all of the mobile subscriber that are allowed or banned in the network.

- Base Station Sub-System (BSS)

Handle traffic & signaling in between a mobile phone & the network switching sub-system.

- Network Switching Sub-System (NSS)

It carried out call & mobility management function for mobile phone present in network.

★ Bluetooth Technology

- It is a low power wireless technology that uses a short range radio, that provides a way to connect nearby devices to each other based on mobile computing.
- Used in PAN (Personal Area Network).
- Open wireless technology standard used to send & receive data to connected devices.
- Known as IEEE 802.15 standard.
- Frequency bands is from 2.4 GHz to 2.485 GHz.
- Range upto 10 meters.
- Speed about 1 Mbps.
- Help to interconnect a set of devices with ambident computer that individual person might require.
- The developing unit of this technology is a group of five companies called special interest group which was formed in 1998.

→ Application of Bluetooth

Bluetooth Speakers
Bluetooth Headphone & Earphones.
Bluetooth Headset
Wireless mouse & keyboards
In personal vehicles.

→ Advantage of Bluetooth

- Wireless technology
- Cheap technology
- Low Energy Consumption.
- Free to use if the device is installed with bluetooth.
- Very simple to form a Piconet.

- Can pass through wall also.

→ Disadvantage of Bluetooth

- Low in Bandwidth.
- Range is Less.

→ Pico Net

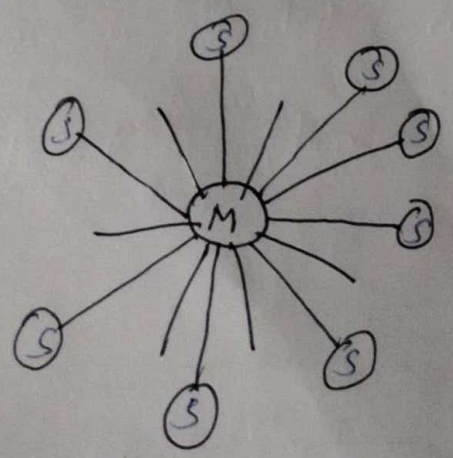
An architecture of Bluetooth is called Pico net.

- Piconet offers the technology with the help of which data transmission occurs based on its nodes.

i) Master Node → from which data is being send.

ii) Slave Node → nodes in which data is received.

- In Piconet, one primary nodes & seven active secondary nodes, So maximum number of nodes in Pico Net is 8.
- Maximum number of devices that can be paired is equal to 2^8-1 or 255.
- Pico Net is a combination code division multiple access (CDMA) & frequency hopping spread spectrum (FHPP).



active slave

only 7 node can connect at a time for data transfer.
but total number of node which can be connected as both active & waiting is 255.

Combination of piconet is scatter network

★ Wireless Multiple Access Control (WMAC)

- Used to allow many mobiles user to share simultaneously a finite amount of radio spectrum in the efficient manner.
- In a OSI model, function of DLL (Data-Link Layer) are divided into two parts.

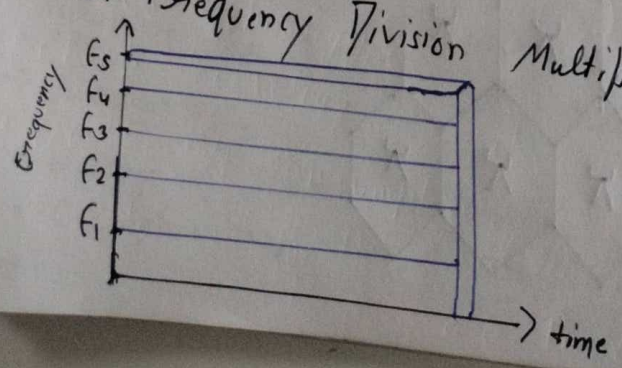
DLL → Data Link Control
DLL → MAC control.

Data Link Control:-
It is responsible for reliable transmission of messages over transmission channel by using techniques like, framing, error control & flow control

MAC Control:-
It is responsible for managing collision & cross-talk problem.

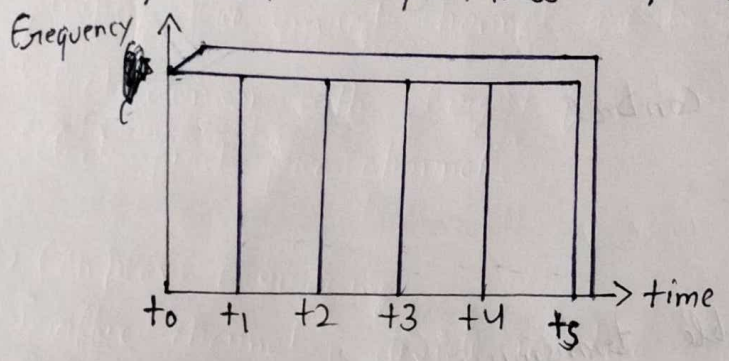
- In wireless communication, system subscriber is allow to send information simultaneously to the base station, while receiving information from the base station.
- We know that, the main aim of cellular system design is to able to increase the capacity of channel that is to handle as many call possible in a given bandwidth with a sufficient level of quality of service.
- TDMA, FDMA, CDMA are the three major multiple access techniques that are used to share available bandwidth in a wireless communication system.

1 Frequency Division Multiple Access (FDMA)



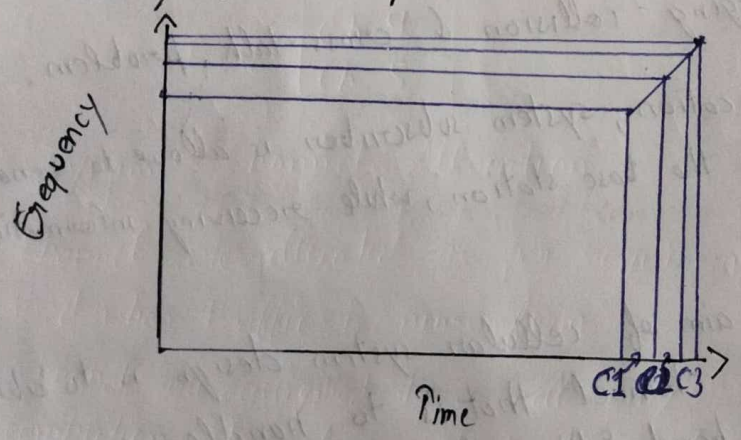
The available bandwidth is divided into frequency bands, each station/user is allocated a band/frequency to send data

2 Time Division Multiple Access (TDMA)



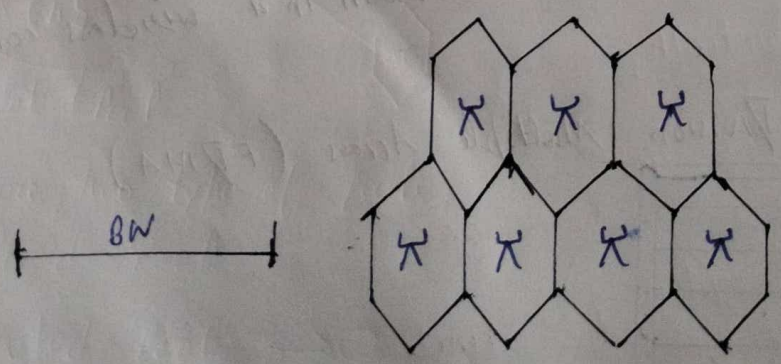
The available bandwidth is divided into time bands, each station/user is allocated a band to send data.

3. Code Division Multiple Access



The available bandwidth is divided into code and each station/user is allocated a code to send data

★ Channel Allocation in cellular network.



Channel Allocation is a process of allocating a channel to a cell in a network.

- For each cell a channel has to be allocated.
- Channel Allocation means focusing on selecting a channel frequency to each cell in other to avoid interference.
- The available bandwidth is divided into channel.

Channel Allocation
- Fixed Channel Allocation
- Dynamic Channel Allocation
- Hybrid Channel Allocation

1. Fixed Channel Allocation
- Also called static channel allocation / assignment.
- Fixed number of channel are allocated to each cell.
- Static hence can't be changed.
- Frequency reused is maximized.
- We have to find out the number of channel required to serve a coverage area this formulae:

$$N = \frac{D}{\sqrt{3}R}$$

$N = \frac{D}{\sqrt{3}R}$

$N \rightarrow$ Number of cell/channel, $R \rightarrow$ Radius of cell, $D \rightarrow$ Frequency reused distance

- Parmanently channels are allocated to a particular cell.
- Borrowing scheme is introduced in fixed channel allocation to minimize the blocking of cell.

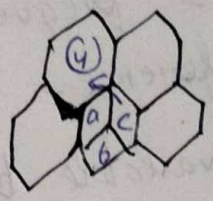
→ Disadvantage.
- Wastage of channel bandwidth.
- Conjuction may occur if traffic is not uniform.
  → congestion

→ Borrowing

When cells are allocated with fixed channel & traffic of any channel increases then free channel are borrowed from neighbouring cell.

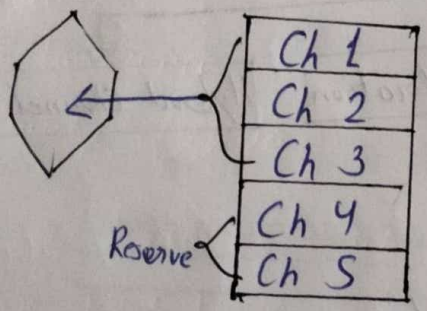
(i) Simple Borrowing.

- Simply free unused channel are borrowed.
- Select donor with largest free channel.
- Select first free channel.



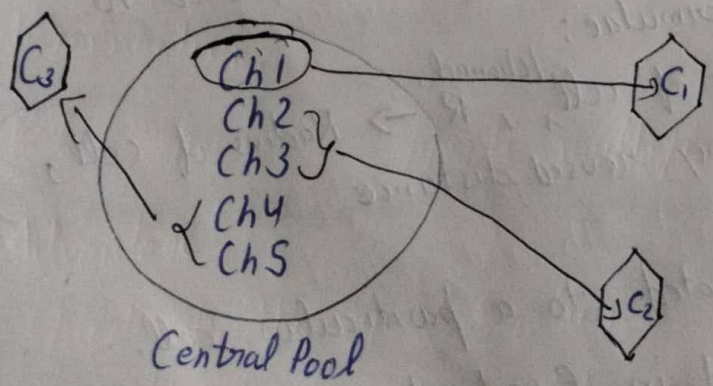
(ii) Complex Borrowing

- Traffic channel is divide in two group; one group is assigned to each cell & other group kept reserve as donor.



2 Dynamic Channel Allocation

- Channel are allocated as per requirement.
- Used when traffic is non-uniform
- Channel are assigned to a cell only when required & after the completion, channels are back to pool.



- There are two type of pools

(i) Centralised Pool

(ii) Distributed Pool →

Unit → 2

★ Data Management Issues

★ Mobile Database

- Allows application for hand held devices to access data stores given by on the move.
- Makes data from database application available all the time to all the mobile users
- Data Management is a pratice of collecting, organising, protecting and storing network data, so it can be analysed for processing & taking decision.

★ Features in Mobile Database

- Mobile Transition should be robust towards unexpected discussion due to mobility.
- Transmission Processing system also need to coop with restricted resources like low battery life, slower processor speed, limited memory.
- Mobile Application should react fast forward with frequent environment changes like location & narrow bandwidth.

→ There are various issues occur in data management

1 Mobile Database Design
2 Security
3 Data distribution & replication
4 Mobility Management
5 Wireless medium
6 Portability

★ Mobility

- It is the ability of a node to change its point of attachment while maintaining an existing communication using same IP address

- The location of mobile unit is an important parameter when locating a mobile station that may hold the require data & when selecting information specially location dependent information.

- Mobile unit has a home base station that keeps track of its location by receiving notification of its movement.

★ Data Replication & Its type

- Sharing of information to ensure data consistency between software & hardware resources connected via a internet to improve :-

→ Reliability
→ Availability
→ Fault Tolerence
→ Accessbility of Data.

- It is a process in which the data is copied at multiple location to improve the availability of data.

- A mobile host needs to have its own complete or partial copy of the relevent data from main database so it can process data locally.

- In mobile computing environment data relipcation is essential as it would allow user to contribute operating during temporary disconnection.

- Data replication supports multiple users & give high performance.

→ Advantage

- Speed up the query evolution.
- Efficient way to ensure data availability, integrity & fault tolerence
- Minimize the communication cost.

→ Disadvantage

- More storage space is needed as storing the replicas of same data at different sites or location.

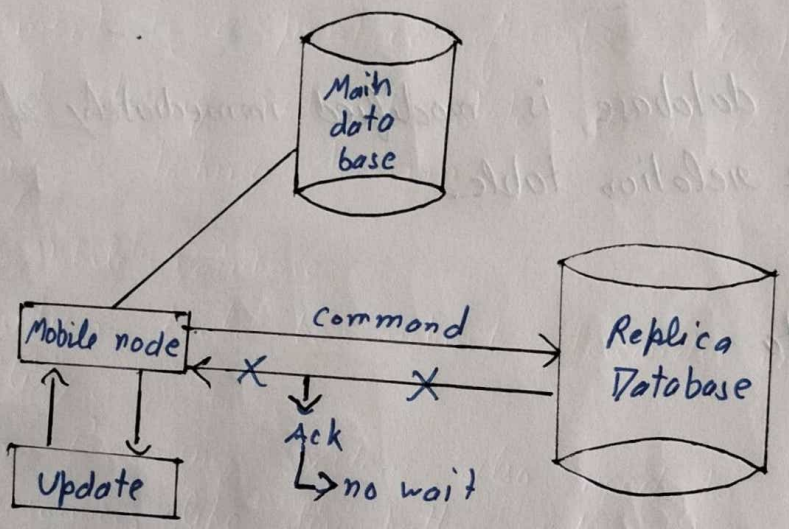
- Expensive
- Increase complexity of data update.
- High maintainance.

→ Methods of Replication

1 Asynchronous

2 Synchronous

1 Asynchronous Replication

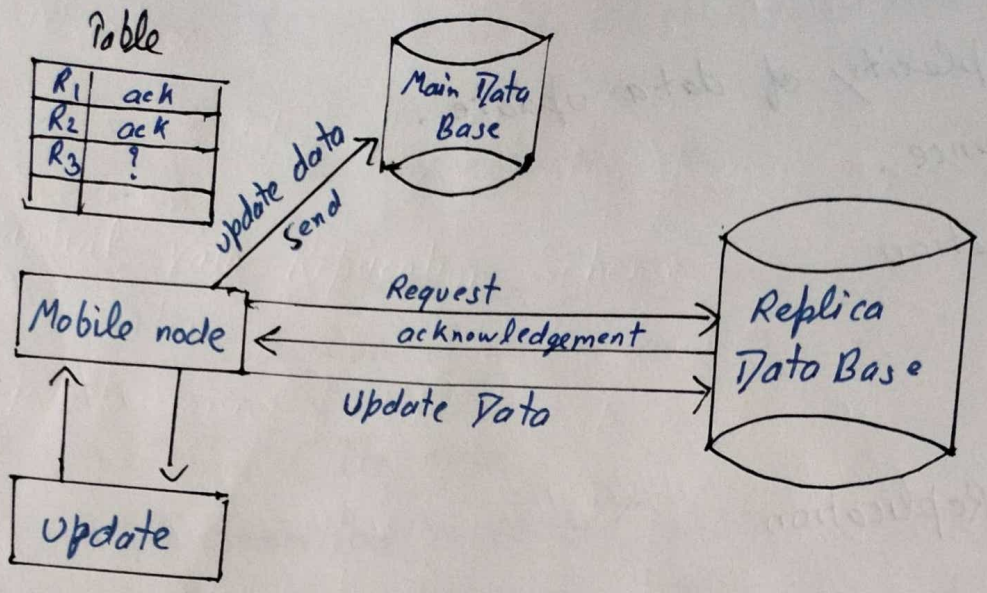


- Mobile node send comands to replicate data on remote / replicate database & doesn't wait for acknowledgement.
- The replica will be modified after commit action is fired on the database.

→ Advantage
- Fast
- Work as O.S label
- High Consistency

→ Disadvantage
- High Risk of Data Loss

2 Synchronous Replication.
- Mobile node send update request & wait for an acknowledgement from database being replicate.



- The replicat of database is modified immediately after changes are made in the relation table.

→ Advantage
- Security of Data
-
-

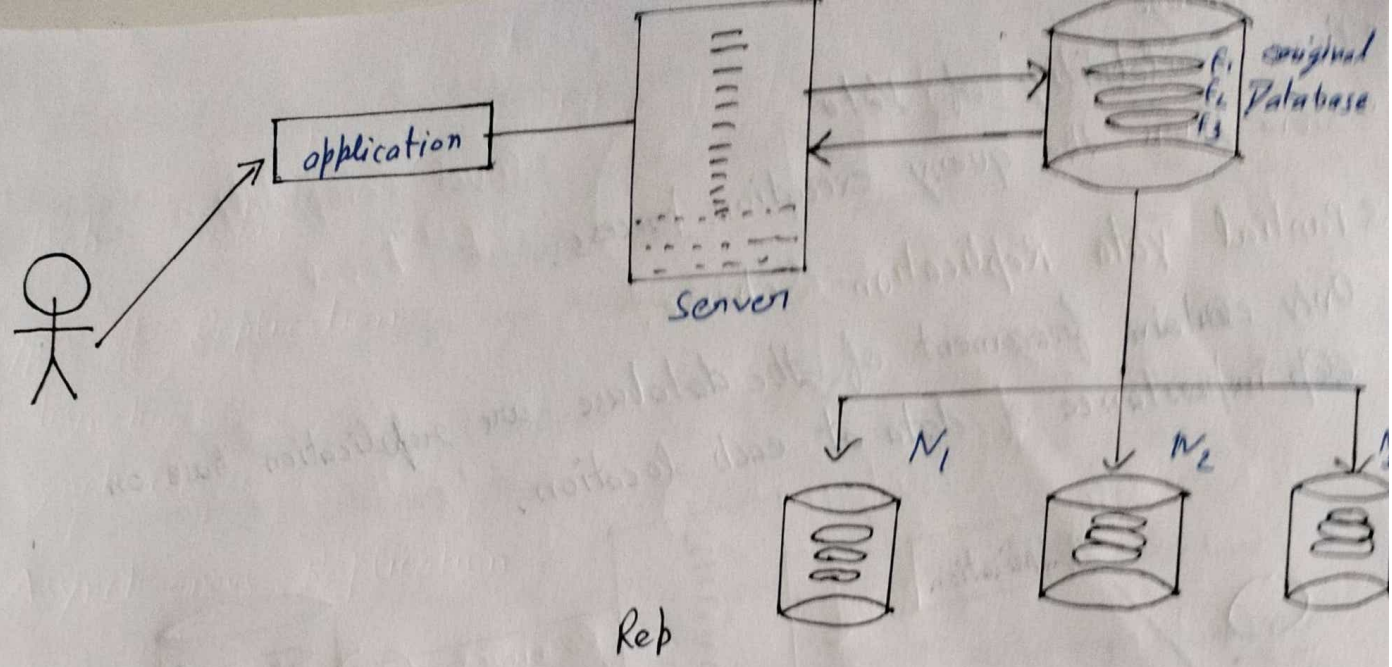
→ Disadvantage
- Slow
-
-

★ Replication Schemes

There a mainly three types of replication schemes :-

1 Full Replication Scheme
2 Low Replication Scheme
3 Partial Replication Scheme

1 Full Replication Scheme
- The database is available for almost every location or user in communication network.
- It contribute faster execution of global queries as the result can be obtained from any local server.



Rep

Advantage

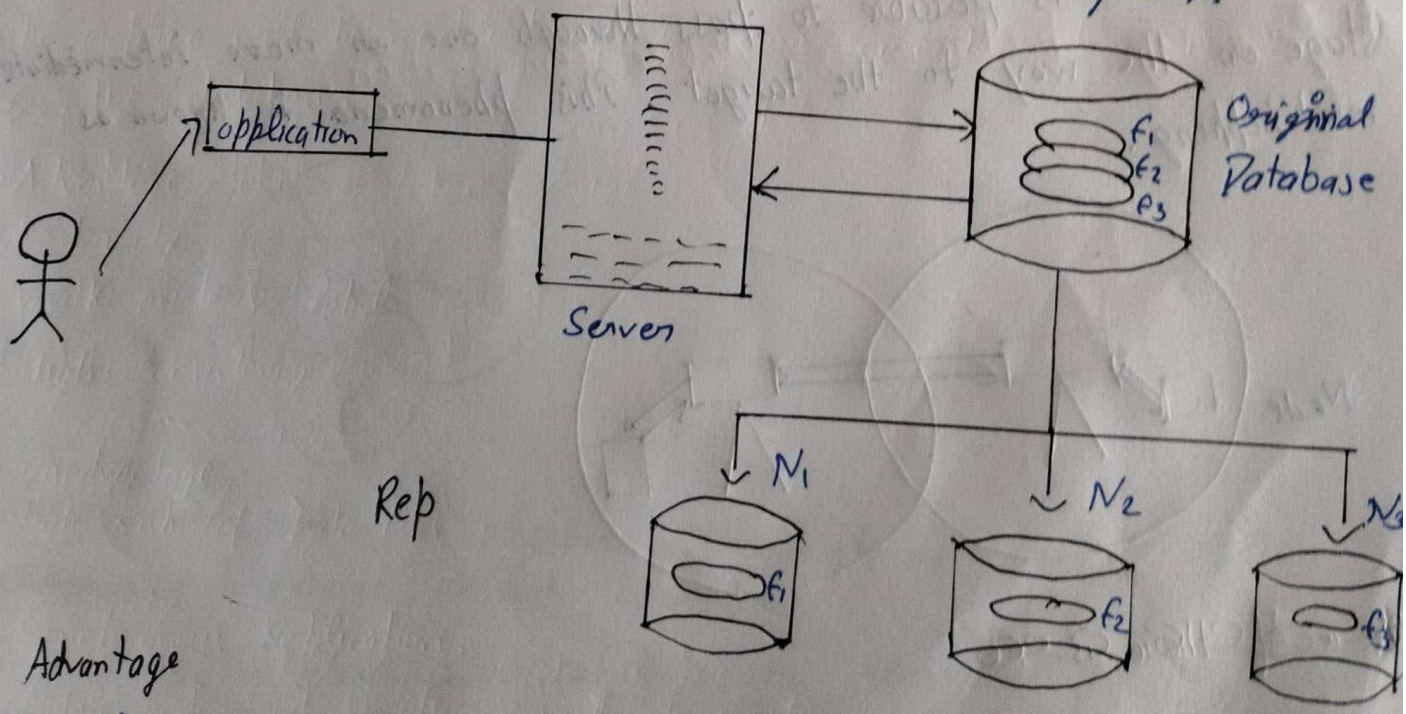
- High Availability of Data
- Faster Execution of queries

Disadvantage

- Control is difficult
- Update process is slower

2 Replication

- Only one fragment exist on each side of distribution system.



Rep

Advantage

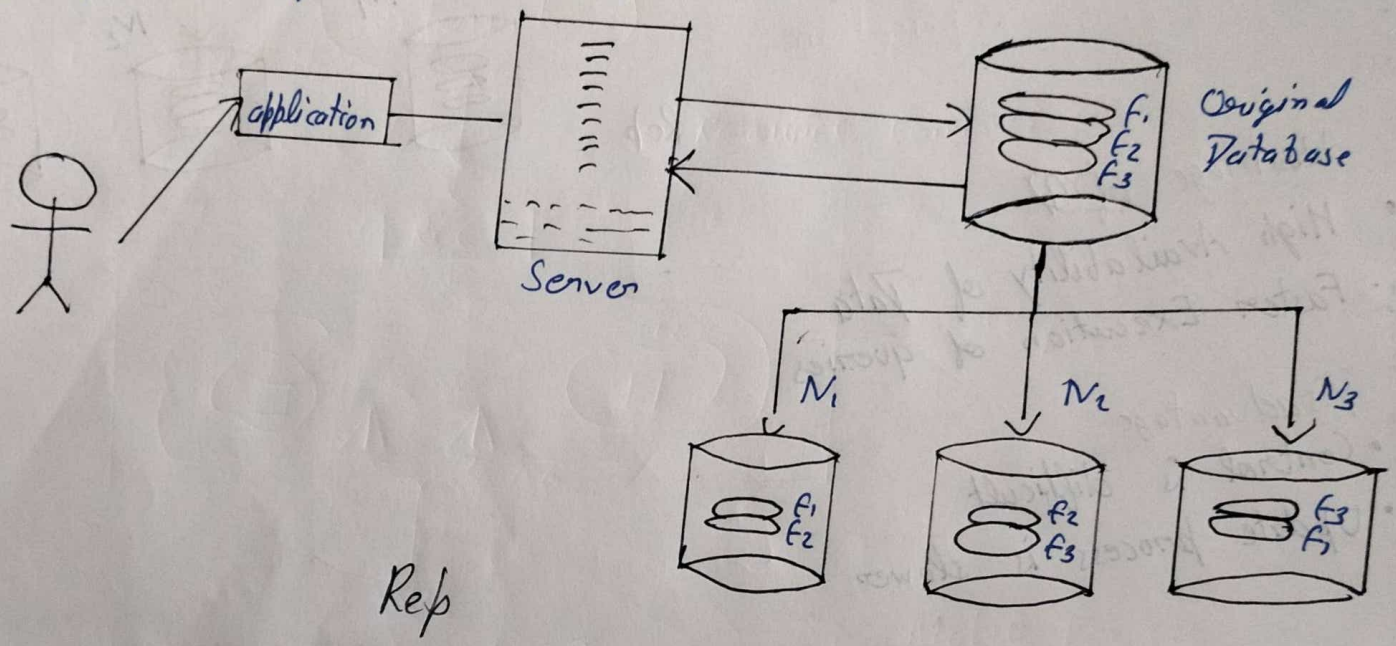
- Easy Recovery of Data
- Concurrency can be minimize.

Disadvantage

- Poor availability of Data
- Slow Down the query execution process.

3. Partial Data Replication Scheme.

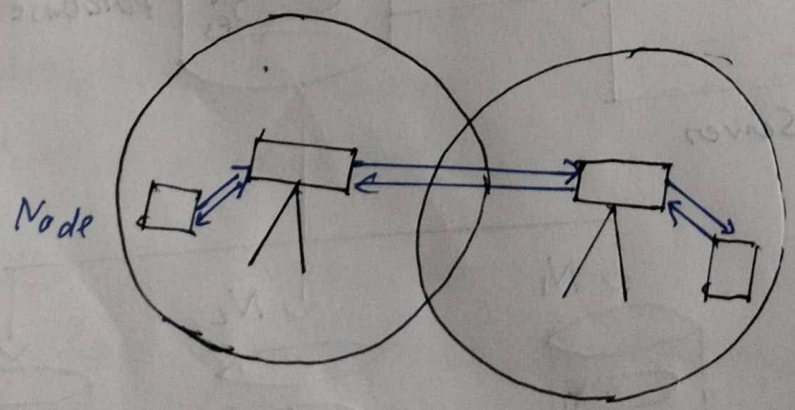
Only contain fragment of the database are replication base on ~~dep~~ importance of data at each location.



Rep

★ Multihoping

If there is no direct communication link between the source & destination it is possible to pass through one or more intermediate stage on the way to the target. This phenomena is known as multihopping.



~~• If there is no~~

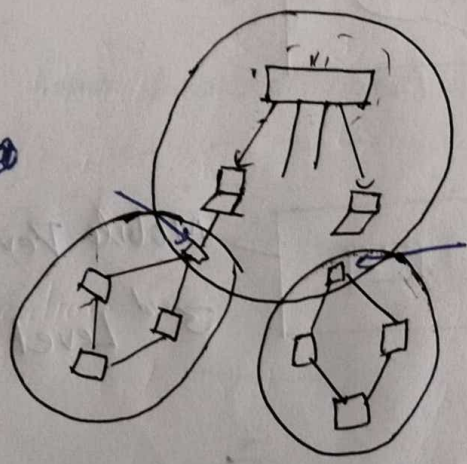
★ Multi-Cluster Architecture

Clustering → A cluster consists of a collection of interconnected stand alone computer or nodes working together as a single computing resource.

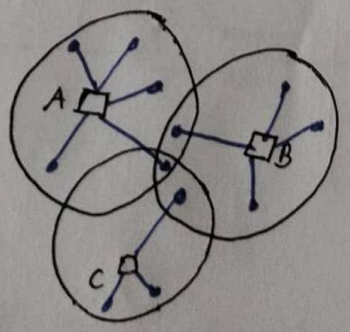
A Cluster is a subset of node which can communicate with a cluster head & possitively with each other.

Entire population of nodes are grouped into cluster.

Because of requirement of efficient resource control multimedia traffic support & scalability of computer or nodes, we select a distributed cluster approach that support virtual circuit & bandwidth allocation.



Cluster

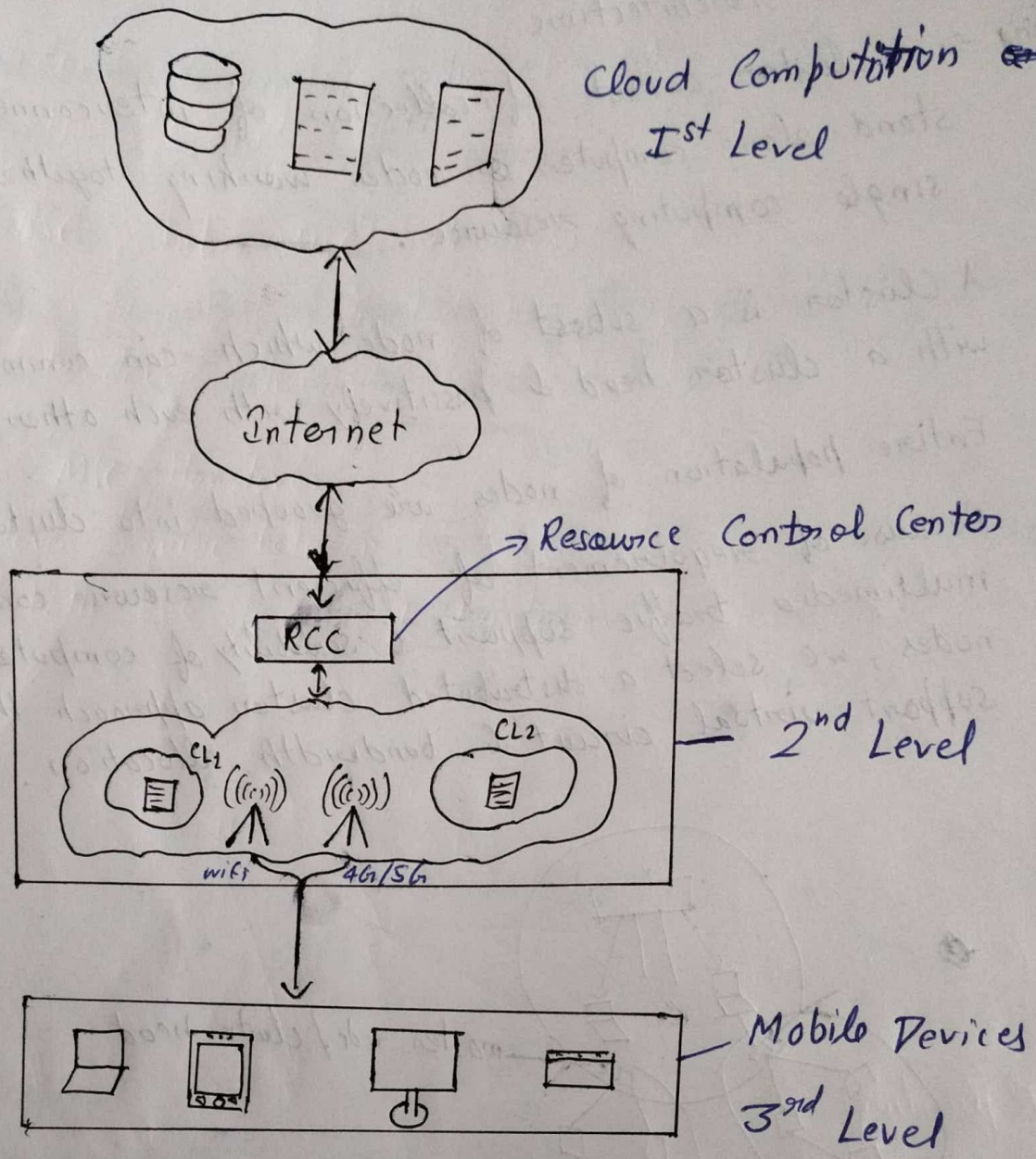


A, B, C are cluster heads

Each of them serve as a regional broadcast not & as a local coordinator to enhance channel throughput

To find a visible interconnected set of cluster, covering the entire node population, clustering algorithm is used for example, lowest ID algorithm & highest ~~connectivity algorithm~~ connectivity algorithm.

Architecture



★ Frequency Spectrum for Mobile Communication.

★ Handover

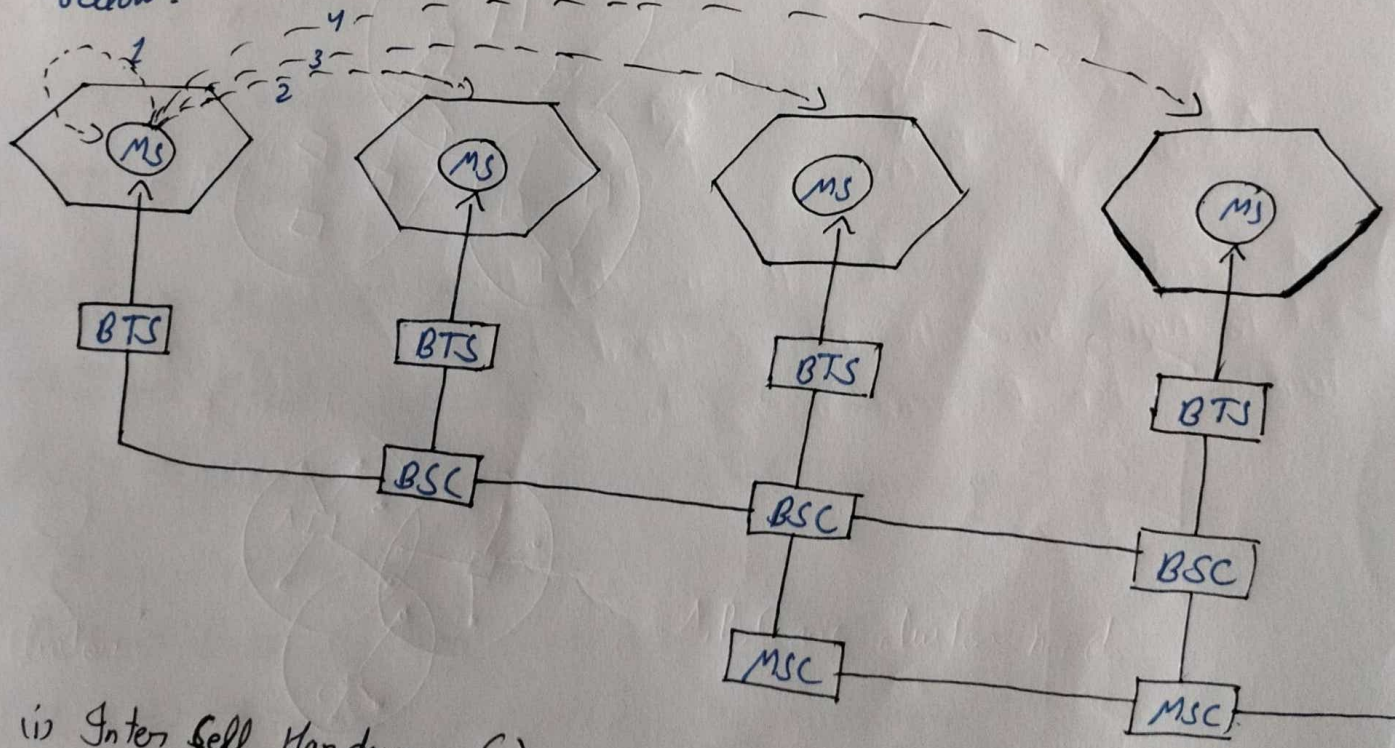
- A cellular system required a handover procedure as single cell do not cover the whole service area.
- A handover should not cause cut off or call drop.
- GSM aims to maximum handover duration 50 ms
- There are basically two reasons of handover:

(i) MS moves out of the range of the BTS it decrease signal strength & increase error rate. Hence, decrease quality of Radio link.

MS → ↓ Sign S → ↑ error rate → ↓ Quality of Radio link

(ii) Due to the load blancing.
when MS/BTS decide the traffic is too high in one cell & shift some MS to other cells with a lower load.

- There are four possible handover scenerios of GSM are as bellow:



(i) Inter Cell Handover (1)
within a cell narrow band interferrence could make transmission at a certain frequency impossible. The BSC could then decide to change the carrier bandwidth.

(ii) Inter Cell Intra BSC Handover
The mobile station moves from one cell to another but stayed

within the control of some BSC. The BSC then perform the handover a signal or radio channel in the new cell & release the old one.

iii) Inter BSC ; Intra MSC Handover

As a BSC only control a limited number of cells, GSM also has to perform handover between cells control by the MSC.

iv) Inter MSC Handover

A handover could be require between two cells belonging to different MSC & both MSC performed handover together.

Full Form

ISP -> Internet Service Provider
FDMA -> Frequency Division Multiple Access
TDMA -> Time Division Multiple Access
SIM -> Subscription Indentity Module
MS -> Mobile station
BSC -> Base Station Controller
BTS -> Base Trans-Receiver Station
MSC -> Mobile Switching Control
VLR -> Visitor Location Register
HLR -> Home Location Register
AUC -> Authentication Center
EIR -> Equipment Indentity Register
MT -> Mobile Terminal
MAC -> Multiple Access Control
MSI -> Mobile Subscription Indentification.
GSM -> Global System for Mobile Communication
RA -> Registration Area
BSS -> Base System Sub-System.
NSS -> Network Switching Sub-System

★★ Location Management

Mobility Issues

- Radio Resource Management
- Location Information Management
- Security
- Temporary loss of connectivity during movement.
- Resources, small device, low battery power, small CPU, less memory, light weight.
- React to sudden change due to bandwidth & other resource changed.

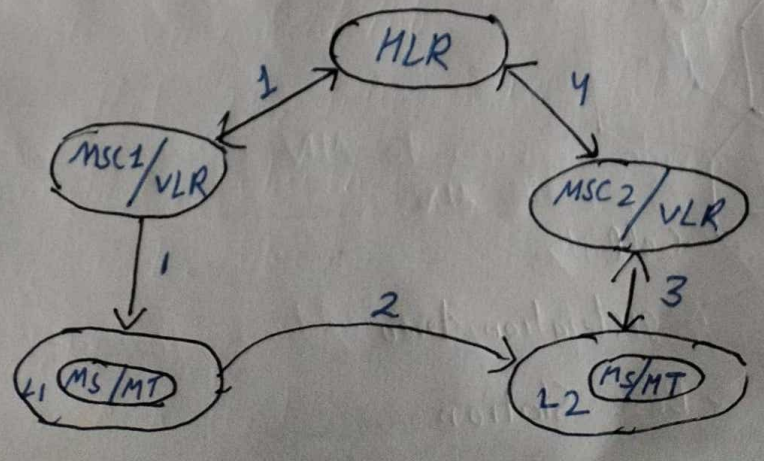
★ Location Management

How to keep track on an active mobile within a cellular network.

→ How to Manage & Update Location

- Based on search & update ~~location~~ operation.
- Tradition mobile communication application has voice, text, email or remote file downloaded. But now new video streaming, telemedicine, surveliance, etc are included, hence location management is very essential.

Search & Update Operation.



MT → Mobile Terminal

- The Location L_1 of a mobile node is maintain [illegible] of MSC 1 (where it last registers) permanentaly.
- For each mobile node, the HLR maintains a mobility table / binding, now if $L2$ is the latest cell of MS known to HLR.
- (MS, L) in HLR is updated as follows:

a) Location Management Scheme

This scheme is based on two label heirarchy :-

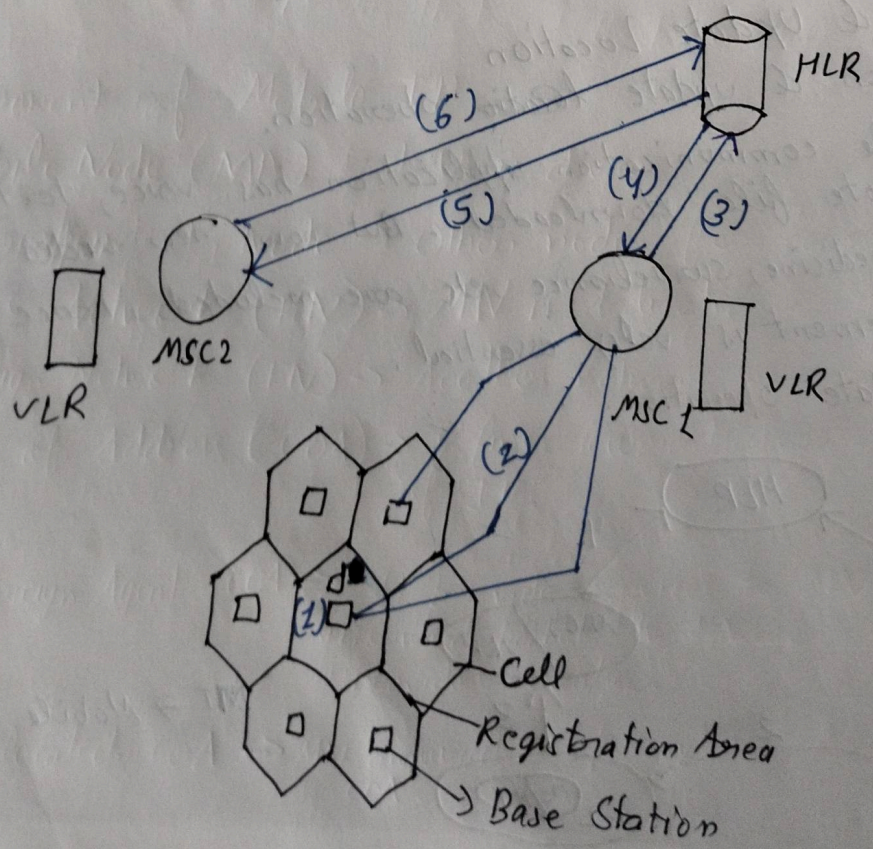
(i) Location Update / registration

(ii) Paging

i) Location Registration

Network coverage area is partition into registration area. All base station belonging to the same registration area belongs to the same MSC.

When a MS / MT moves to a new registration area.



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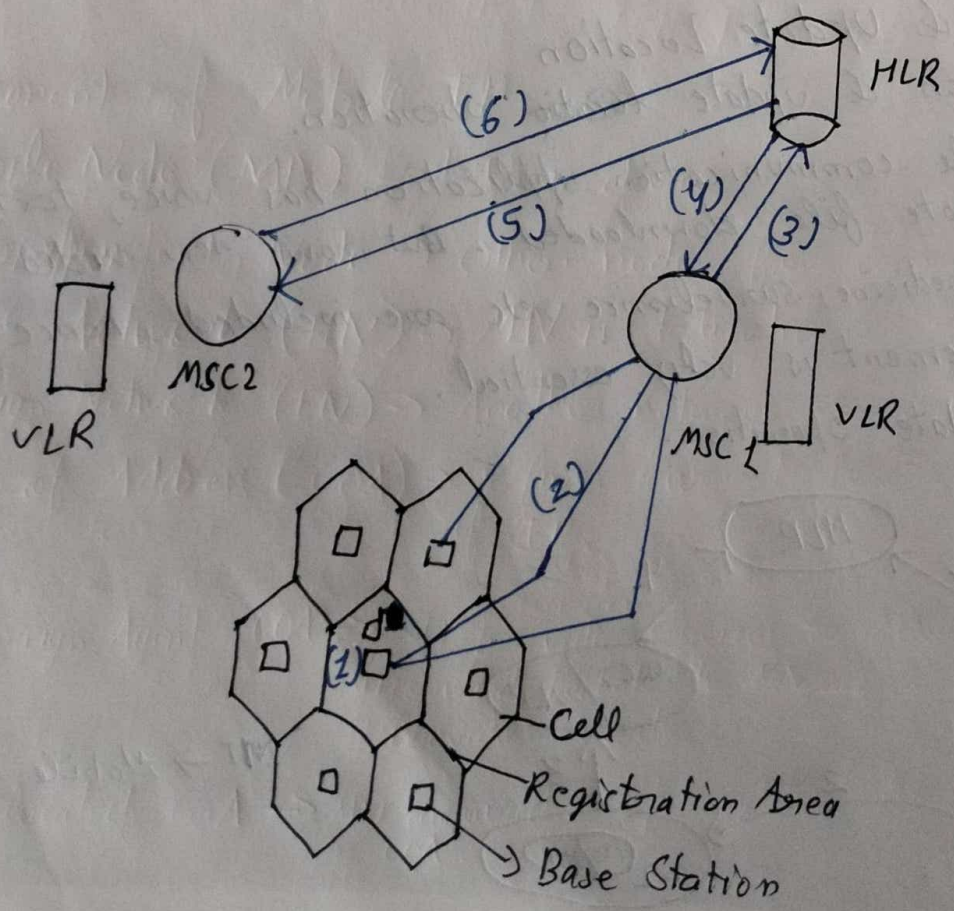


(1) MT enters a new RA (registration area) & transmit a location update messages to its new base station.

(2) The base station forward the location update message to the MSC through a wire link which launches a registration query to its associated VLR.

(3) VLR update its record on the location of MT.
If a new RA belongs to a different VLR, the new VLR determine the addresses of HLR of the MT to a lookup table & sends a location registration message in HLR.

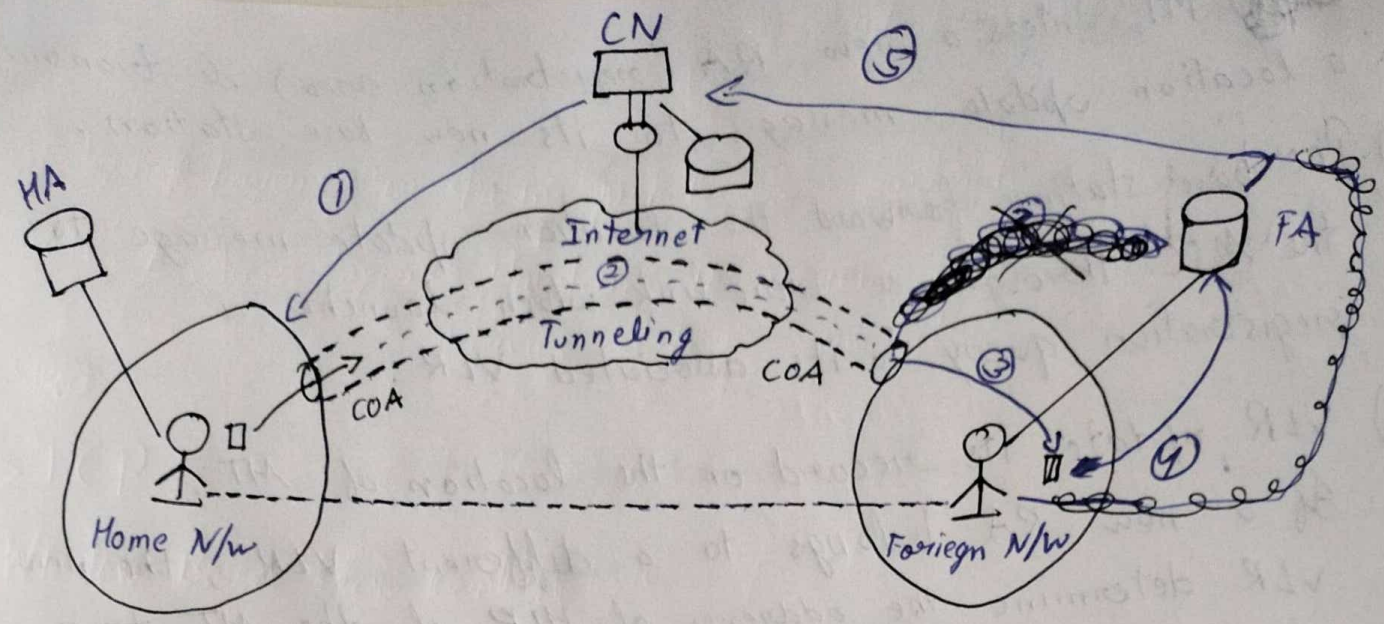
(4) The HLR records the ID of new serving VLR of the MT & sends a registration acknowledgement to the new VLR.

(5) The HLR then sends a registration cancellation message to the old VLR.

(6) The old VLR removes the record of the MT & return as acknowledgement to the HLR.

★ Mobile IP

- Mobile IP is an IETF (Internet Engineering Task Force) Standard communication protocol that is design to allow mobile device user to move from one network to another network without changing the IP address.
- Every device is provided an IP address. within a home network a device can used normal IP routing but as soon as it moves to visitor network it can't use a normal IP routing and due to this active session can be terminated.
- ∴ Solution is Mobile IP.
- The concept of COA (Care of Address) will help to register home agent to foreign agent.



- Main Component of Mobile IP

(i) Home Agent
(ii) Foreign Agent
(iii) Correspondent Node → It belongs to some third network who wants send data to mobile node who is now in foreign network.
(iv) COA (Care of Network)

↓

Tunneling :-
Encapsulation → Start point
Decapsulation → End point

→ Component of Mobile IP

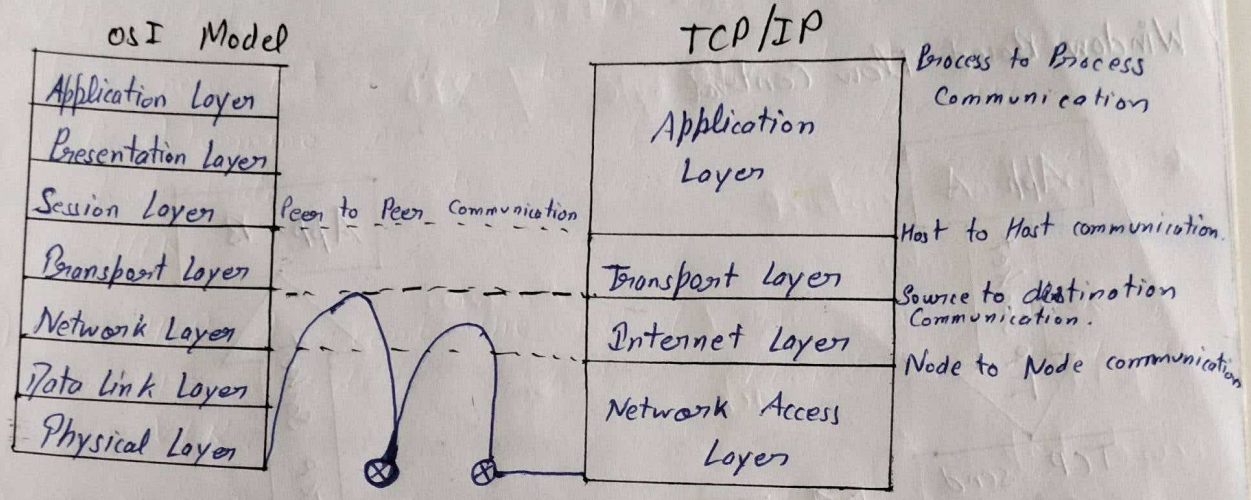
- Mobile Node (MN) End User devices
- Correspondent Node → Other node for communication.
- Home Network (HN) → MN is dedicated & registered to the network.
- Foreign Network (FN) → Another network where MN moves.
- Care of Address (COA) → Defines current location of MN in terms of IP.

→ Foreign Agent COA → It provide services to MN during its visit.
(i) Forward packet to MN
(ii) Provide Security.

→ Colocated COA → MN acquired temporary IP address. That address act as COA.

- Home Agent (HA) → Located in a home network
  - (i) Tunnel for packet,
    - forward towards MN, start at HA.
  - (ii) Has location registry.

★ TCP Over Wireless / TCP & Mobility



TCP → Transmission Control Protocol.

This model governs how data b/w two different devices are transmitted over a communication channel.

Responsibility of Layer

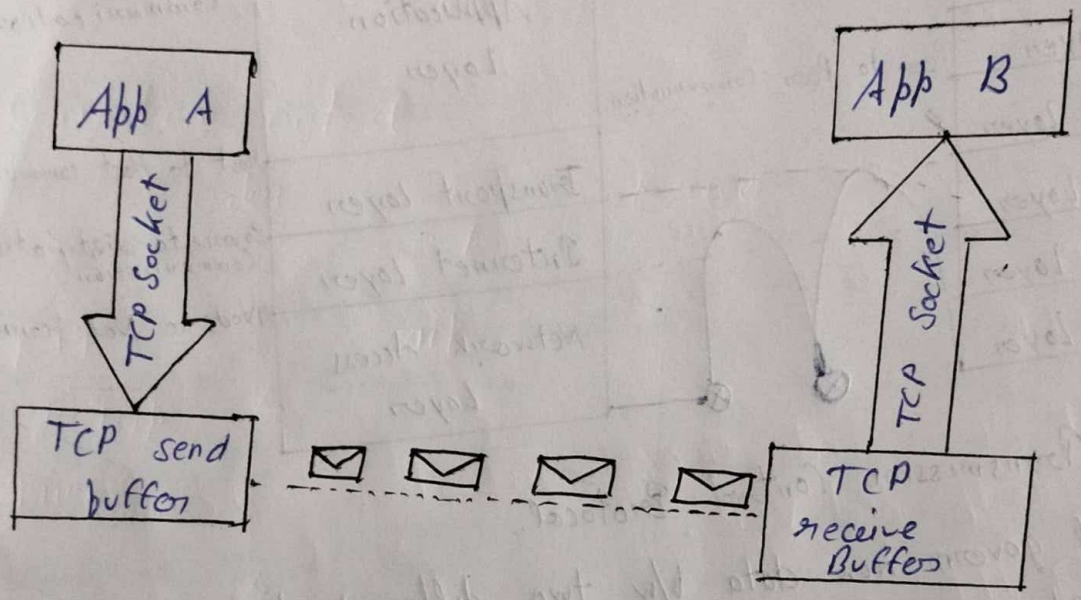
- Application Layer → Responsible for maintaining the protocols essential for interaction between user & application.
- Transport layer → Responsible for maintaining data flow between sender & receiver
  - (i) Reliable ordered delivery.
    - → Uses sequence number, acknowledgement, timeout & retransmission.
    - → End to end semantic acknowledgement after data received.
  - (ii) Provide Flow & conjuction control
    - → Using sliding window based buffer & feedback from receiver or network

to adjust Brains...

- Internet Layer -> For sharing packets from sender to receiver
- Network Access Layer -> Maintain the various task related to sending receiving data in raw bits.

-> TCP

Window Based Flow Control



- TCP flow Control means that, TCP will help to ensure that the sender is not overloaded the receiver by sending more packets that it can handle.
- TCP implements flow control by increasing / decreasing window size as required.
- Buffer is the capacity of receiving data at a time by a receiver.
- When buffer / receiver become overflow, there is a delay in data transmission a control mechanism needs to overcome this problem. ~~window~~ window
- Window is a mechanism in which the receiver tells the sender about the capacity of receiving data.
- Widowing System is used for reliable delivery.
- Receiver advertise its window size.

→

Received buffer size = 100 bytes
Last byte Received = 150 bytes
Last Read byte = 120 byte
bytes sends by sender = 180
Outstanding bytes = 110

I Maximum receiver buffer should be less than/equal to last byte Received minus last byte Read. { MSB <= LBR − LBRead }

II Advertize buffer/window sized = Maximum Received Buffer − (Last byte received − last byte read)

III Last Byte Send − Last Byte Acknowledge <= Advertising window.

I MSB <= 150 − 120 ⇒ 100 ≤ 30

II AWS = 100 − (150−120) ⇒ 100 − 30 = 70

III 180 − 150 ≤ 70 ⇒ 30 ≤ 70

IV Effect window (sender side window)

Effect window = Advertising window − (Last byte send − last byte acknowledge)

= 70 − (180 − 150)

= 70 − 30

= 40

V Maximum Window = Minimum of { Advertize window, conjestion window }

Advertize window ↓ initiate by receiver

conjestion window ↓ initiated by network.

~~VI Effective window = Maximum window − [illegible]~~

Q. On a TCP connection current congestion window size is 4 Kb, the window size advertize by the ~~send~~ receiver is 6 Kb. The last byte send by sender is 10240 & Last byte Acknowledge

by the receiver is 8192. What is the current window size of the sender.

Sol ~~Effective~~ max window = min (4kb, 6kb)

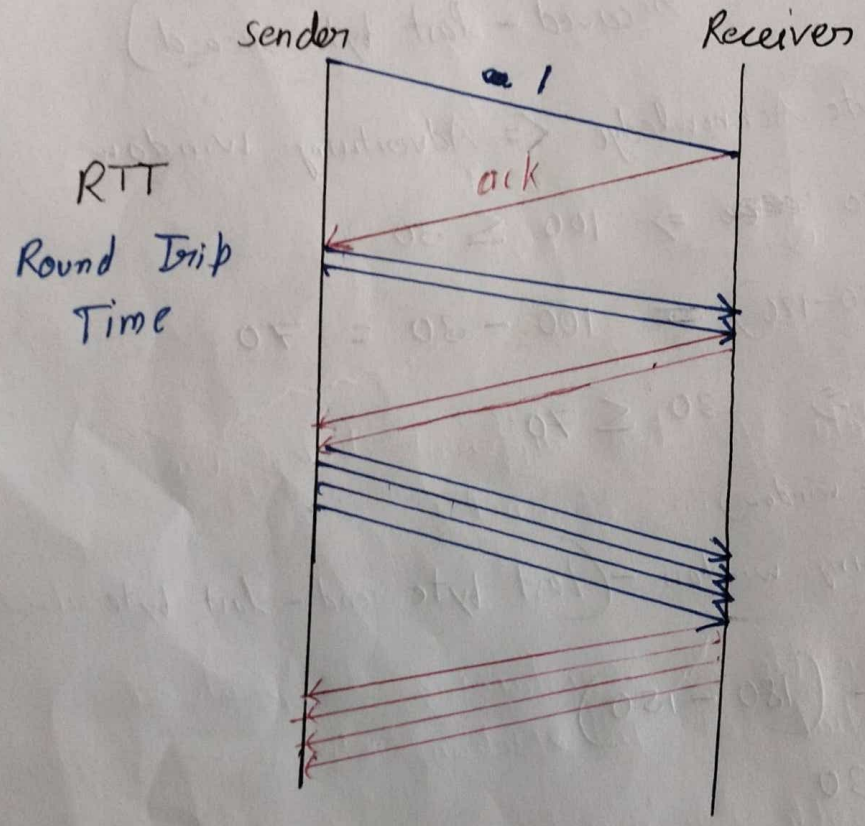
Effective Window = 4kb − (10240 − 8192)

= 4kb − 2048 b

= 4096b − 2048 b

= 2048 byte / 2kb

★ Congestion Control



It is slow start

It goes in a $2^0, 2^1, 2^2, 2^3$

$\frac{\text{Window size}}{2}$ = Threshold Window

Example

Let we have to send 50 packets. Packet size is 1kb. Lost Packet are 10, 25, 34 & 45.

RTT											
1	2^0	1									
2	2^1	2	3							exp↑	
3	2^2	4	5	6	7						
4	2^3	8	9	10	11	12	13	14	15	WS=8	$TW = \frac{WS}{2} = \frac{8}{2} = 4$
5	2^0	10									
6	2^1	11	12							expo↑	
7	2^2	13	14	15	16						
8		17	18	19	20	21				Linear	
9		22	23	24	25	26	27			WS=6	$TW = \frac{WS}{2} = \frac{6}{2} = 3$
10	2^0	25									
11	2^1	26	27							expo↑	
12		28	29	30							
13		31	32	33	34					Linear WS=4	$TW = \frac{WS}{2} = \frac{4}{2} = 2$
14	2^0	34									
15	2^1	35	36							exp↑	
16		37	38	39							
17		40	41	42	43					Linear	
18		44	45	46	47	48				WS=5	$TW = \frac{WS}{2} = \frac{5}{2} = 2.5$
19	2^0	45									
20	2^1	46	47							expo↑	
21		48	49								
22		50								Linear	

★ ~~Mobility & Wireless~~.

★ TCP & Wireless

TCP (Transmission Control Protocol)