Charactersstics of Mobile Devices / Ubiquitous / Nomadic

Nomadic means Portable
Mobile means on the way or moving
Ubiquitous means being or seeming to be everywhere

1. Limited Processing power
2. Limited (battery life
3. Limited N/W Connectivity
4. Poor availability ... they sleep a lot
5. Tedious data input
6. Not very expandable
7. Only devices traded for mobility can be used
8. Poor compatibility between devices
9. Functions is often duplicated
10. Limited Bandwidth.

Challenges in Mobile Computing :-

- Challenges in Mobile Computing directly related to the resource poor nature of the devices (Above all examples of characteristics can be discussed here as they all are resources)
- Mobile computing isn't a simple extension of distributed computing because of
  - (i) Hostile environment
  - (ii) Power-Poor
  - (iii) Poor network Bandwidth
  - (iv) Higher error rate
  - (V) Variable latency
  - (Vi) Frequent disconnections
- Can't be just "plug-in" like in classic distributed system theory
- Disconnection Means system crash

Batteries weigh more than any other component in most mobile devices.
(i) Smaller batteries, less power (ii) CPU speed reduced to converse power

→ Adaptability to Deal with varying conditions

(i) Transcoding Proxies - scale content (eg images) to match available bandwidth

(ii) Mobile proxies to convert content (eg Postscript → ASCII)

(iii) Agent systems for information Access

(iv) More clever ways of checking for data consistency

(v) Applications callbacks to monitor conditions (network, battery Power etc).

Cellular Architecture

Basic Introduction / Definition

The cellular mobile communications systems uses a large number of low-power wireless transmitters to create cells - the basic geographic service area of a wireless communications systems. Variable power levels allow cells to be sized according to the subscriber density and demand within a particular region. As mobile users travel from cell to cell, their conversation are "handed off" between cell in order to maintain seamless service. Channels (frequencies) used in one cell can be reused in another cell some distance away. Cell can be added to accomodate growth, creating new cells in unserved areas or overlaying cells in existing area.

MOBILE COMMUNICATION PRINCIPLES

- Each mobile uses a separate, temporary radio channel to talk to the cell site.
- The cell site talks to many mobiles at once
- Channels uses pair of frequencies for communication
  - (i) Forward link :- transmitting from the cell site
  - (ii) Reverse link :- for cell site to recieve call from the users.
- Radio energy dissipates over distance
- The basic structure of mobile n/ws includes the telephone systems and radio services

Mobile telephone System Architecture :→

Traditional mobile service was structured similar to television broadcasting : One very powerful transmitter located at the highest spot in an Area would broadcast in a radius of up to fifty Kms. The cellular concept structured the mobile telephone n/w in a different way. Instead of using one powerful transmitter, many ~~powerful~~ low-power transmitters were placed into the coverage area. Eg. By dividing a metropolitan region into one hundread different areas with low-power transmitters using ten conversions each the system capacity theoretically could be increase from ten conversions or voice channels using one powerful transmitter - to one thousand conversions (Channels) using one hundread low-power transmitter.

~~Mobile Telephone Cellular System using Cellular Concept~~

Interference problems caused by mobile units using the same channel in adjacent areas proved that all channels could not be reused in every cell. Areas had to be skipped before the same channel could be reused. Even though this affected the efficiency of the original concept, frequency reuse was still a viable solution to the problems of mobile telephony Systems.

By reducing the radius of an area by fifty percent, service providers could increase the number of potential customers in an area fourfold.

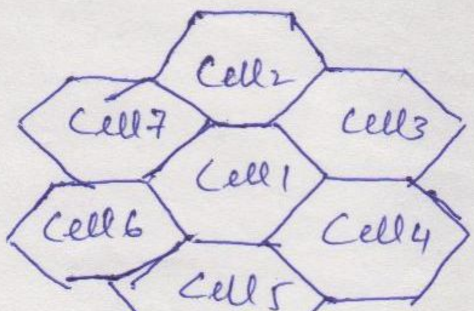
The cellular concept employs variable low-power levels, which allows cells to be sized according to the subscriber density and demand of a given area. Frequencies used in one cell cluster can be reused in other cells.

Cellular System Architecture:-

The cellular telephone system provides a wireless connection to the PSTN (Public switched tellphone Network). Deployment parameters such as amount of cell-spilitting and cell sizes, are determined by engineers experienced in cellular system Architecture. Provisioning for each region is planned according to an engineering plan that includes cells, clusters, frequency reuse, and handovers.

Cells:- The cell is the basic geographic unit of a cellular System. The term cellular comes from the honeycomb shape of the areas into which coverage region is divided. Cells are base stations transmitting over small geographic area that are represented as hexagons. Because of constraints imposed by natural terrian and man-made structures, the true shape of cells is not a perfect hexagon.

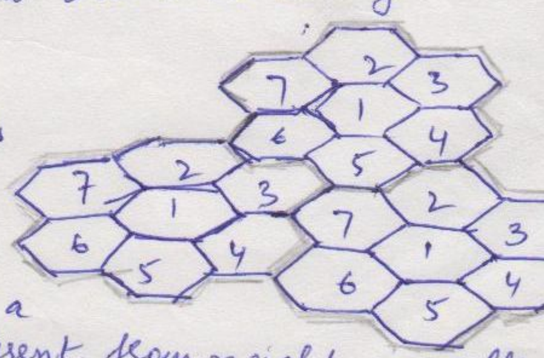
Clusters:- A cluster is a group of cells. No channels are reused with in a cluster. The given figure illustrates a seven cell cluster



Frequency Reuse

Because only a small number of radio channel frequencies were available for mobile Systems, engineers had to find a way to reuse radio channels in order to carry more than one conversion at a time.

The Concept of frequency reuse is based on assigning to each cell a group of radio channels used with in a small geographic area. Cells are assigned a group of channels that is completely different from neighboring cells. The cover area of the cells are called the footprint. This footprint is limited by a boundry so the same group of channels can be used in different cells that are far away so that their frequencies don't interfere.



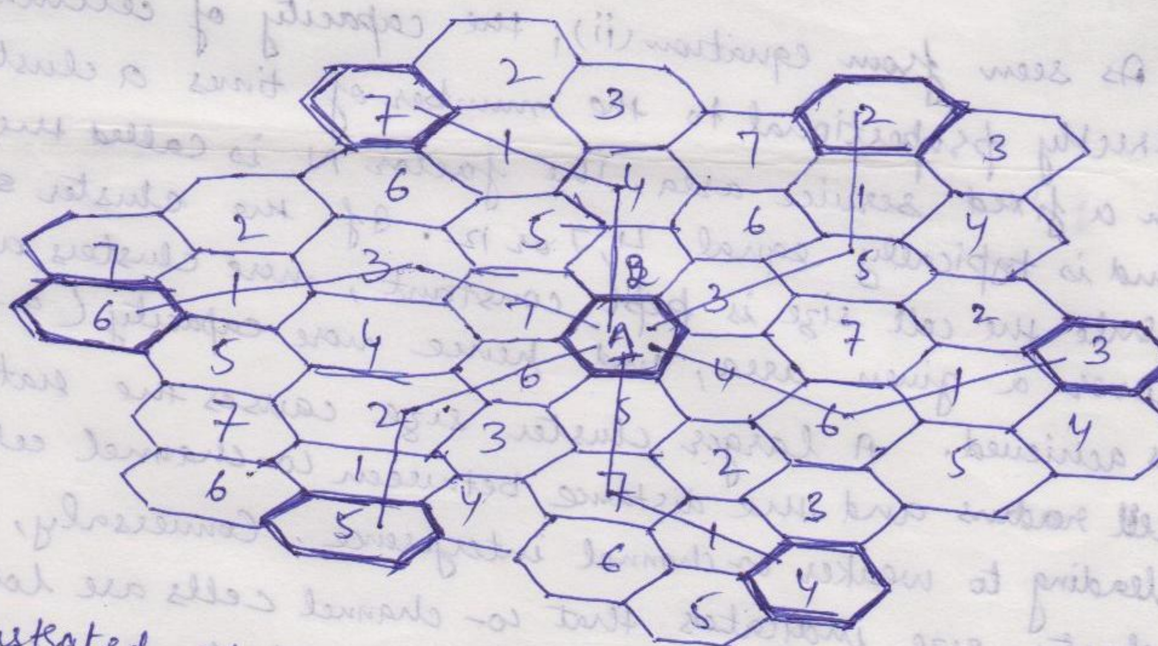
Cells with the same number have the same set of frequencies. Here ecause the number of available frequencies is 7, the frequency reuse factor is 1/7. That is each cell is using 1/7 of the available cellular channels.

ell splitting!- As the service area becomes full of users, this approach is used to split a single area into smaller ones. In this way, heavy traffic centers can be split into as many areas as necessary in order to provide acceptable service levels, while larger, less expensive cells can be used to cover low-traffic regions.

Handoff!-> When a mobile subscriber travelles from one cell to another during communication is going on, then the call must either be dropped or transferred from one radio channel to another because the adjacent areas do not use the same radio channels. Because dropping the communication is not acceptable, the process of handoff was created. Handoff occurs when a mobile telephone n/w automatically transfers a call from radio channel to radio channel as a mobile crosses adjacent cells.

Frequency Reuse :→

Each cellular Base Station is allocated a group of radio channels to be used within a small geographic area called a cell. Base stations in adjacent cells are assigned channel groups which contain completely different channels than neighboring cells. By limiting the coverage area to within the boundaries of a cell, the same group of channels may be used to cover different cells that are seprated from one another by distances large enough to keep interference levels within tolerable limits. The design process of selecting and allocating channel groups for all of the cellular base stations within a system is called frequency reuse or frequency planning.



The Figure illustrated ~~above~~ the concept of frequency reuse, where cells labeled with the same letter use the same group of channels. The actual radio coverage of a cell is known as the footprint. and is determined from field measurements or propagation prediction models.

To understand the frequency reuse concept, consider a cellular system which has a total of S duplex channels available for use. If each cell is allocated a group of K channels ($K < S$), and if the S channels are divided among N cells into unique and disjoint channel groups which each have the same number of channels, the total number of available radio channels can be expressed as

$$S = KN \quad \text{—— (i)}$$

The N cells which collectively use the complete set of available frequencies is called a <u>cluster</u>. If a cluster is replicated M times within the system, the total number of duplex channels, C can be used as a measure of capacity and is given by

$$C = MKN = MS \quad \text{—— (ii)}$$

As seen from equation (ii), the capacity of cellular systems is directly proportional to the number of times a cluster is replicated in a fixed service area. The factor N is called the cluster size and is typically equal 4, 7 or 12. If the cluster size N is reduced while the cell size is kept constant, more clusters are required to cover a given area, and hence more capacity (a larger value of C) is achieved. A larger cluster size causes the ratio between the cell radius and the distance between co-channel cells to decrease, leading to weaker co-channel interference. Conversely, a smaller cluster size indicates that co-channel cells are located much closer together. From the design viewpoint, the smallest possible value of N is desirable in order to maximize capacity over a given coverage area. The frequency reuse factor of a cellular system is given by 1/N, since each cell within the cluster is only assigned 1/N of the total available channels in the system

Due to the fact that the hexagonal geometry of cells, each cell has six equidistant neighbors and that the lines joining the centres of any cell and each of its neighbors are seprated by multiples of 60 degrees, there are only certain cluster sizes and cells layout which are possible. To connect cells without gap, the geometry of hexagon is such that the number of cells per cluster, N, can only have values which satisfy equ (iii)

$$N = i^2 + ij + j^2 \quad \text{(iii)}$$

where i & j are non negative numbers

To find the nearest co-channel neighbours of a particular cell, one must do the following

(a) move i cells along any chain of hexagons and then

(b) turn 60° degree counter - clockwise (anticlockwise) and move j cells.

This is illustrated in figure I for i = 2 & j = 2 (example N = 12.)

Channel Assignment Strategies:-

Channel Assignment strategies can be classified as either fixed or dynamic.

In fixed channel assignment strategy, each cell is allocated a predetermined set of channels. Any call attempt within the cell can only be served by the unused channels in that particular cell. If all the channels in that cell are occupied, the call is blocked and the subscriber does not receive service. A variation to this scheme called borrowing strategy exists, In this a cell is allowed to borrow channels from a neighboring cell if all of its channels are already occupied. The MSC supervices borrowing procedure and ensures that the borrowing of a channel does not disrupt or interfere with any of the call in progress in the donor cell.

In a dynamic channel assignment strategy, channels are not allocated to different cells permanently. Instead, each time a call request is made, the serving base station requests a channel from the MSC. The switch then allocates a channel to the requested cell following an algorithm that takes into account the likelihood of future blocking with in the cell, the reuse distance of frequency use of the candidate channel, the reuse distance of the channel, and other cost functions.

MSC - Mobile switching centre / MTSO → Mobile telephone switching office

BSC

CAI → Common air interface

- ↳ FVC → Forward voice channel
- ↳ RVC → Reverse voice channel
- ↳ FCC → Forward control channel
- ↳ RCC → Reverse control channel

Handoff Strategies

When a mobile moves into a different cell while a conversation is in progress, the MSC automatically transfers the call to a new channel belonging to the new base station. This handoff operation not only involves identifying a new base station, but also requires that the voice and control signals be allocated to channels associated with the new base station.

Handoffs must be performed successfully and as infrequently as possible, and be imperceptible to the users. In order to met these requirements, system designers must specify an optimum signal level at which to initiate a handoff. Once a particular signal level is specified as the minimum usable signal for acceptable voice quality at the base station receiver (normally taken as between −90 dBm and −100 dBm) a slightly stronger signal level is used as a threshold at which a handoff is made. The margain, given by $\Delta = P_{r\,handoff} - P_{r\,minimum\ usable}$, cannot be too large or too small. If Δ is too large, unnecessary handoff which burden the MSC may occur, and if Δ is too small, there may be insufficient time to complete a handoff before a call is lost due to weak signal conditions.

Drop call event can happen when there is an excessive delay by the MSC in assigning a handoff or when the threshold Δ is set too small for the handoff time in the system. Excessive delays may occur during high traffic conditions due to computational loading at the MSC or due to the fact that no channels are available on any of the near by base stations

In deciding when to handoff, it is important to ensure that the drop in the measured signal level is not due to momentary fading and that the mobile is actually moving away from the serving base station. In order to ensure this, the base station monitors he signal level for a certain period of time beforea handoff is initiated. This running average measurement of signal strength should be optimized so that unnecessary handoffs are avoided, while ensuring that necessary handoffs are completed before a call is terminated due to poor signal level. The time over which a call may be maintained within a cell, without handoff, is called the <u>dwell time</u>. The dwell time of a particular user is governed by number of factors, including propagation, interference, distance between the subscriber and the base station, and other time varying effects.

In first generation analog cellular systems, signal strength measurement are made by the base stations and supervised by the MSC. Each base station constantly monitors the signal strength of all of its reverse voice channels to determine the relative location of each mobile user with respect to the base station tower. Sometimes a spare reciever in each base station, called the <u>locator reciever</u>, is used to scan and determine signal strength of mobile user which are in neighboring cells. The locator reciever is controlled by the MSC and is used to monitor the signal strength of users in neighboring cell which appear to be in need of handoff and then MSC decides if handoff is necessary or not by listening to locator reciever.

In today's second generation systems, handoff decisions are <u>mobile assisted</u>. In <u>mobile assisted handoff</u> (MAHO), every mobile station measures the received power from surrounding base stations and continually reports the results of these measurements to serving base stations. A handoff is initiated when power received from base station of a neighboring cell begins to exceed the power received from the current base station by a certain level or for a certain period of time. Since handoff measurements are made by mobile, so MAHO methods provides much faster handoff rate and

Practical Handoff consideration :→

In practical cellular systems, several problems arise when attempting to design for a wide range of mobile velocities. High speed vehicles pass through the coverage area of cell within a matter of seconds, whereas pedestrian users may never need a handoff during a call. Although the cellular concept clearly provides additional capacity through the addition of cell sites, in practice it is difficult for cellular service providers to obtain new physical cell site locations in urban areas.

By using different antenna heights and "small" cells which are co-located at a single location. This technique is called the umbrella cell approach and is used to provide large coverage to high speed users while providing small area coverage to users travelling at low speeds. The umbrella cell approach tackles the ~~above~~ problem of fast moving users and pedestrian users very well. The speed of each user may be estimated by the base station or MSC by evaluating how rapidly the short-term average signal strength on the RVC (Reserve voice channel) changes over time.

Another practical handoff problem in microcell system is known as cell dragging. Cell dragging results from pedestrian users that provide very strong signal to the base station. As the user travels away from the base station at a very slow speed, the average signal strength does not decay rapidly. Even when the user has travelled well beyond the designed range of the cell, the recieved signal at the base station may be above the handoff threshold, thus a handoff may not be made. To solve the cell dragging problem, handoff thresholds and radio coverage must be adjusted carefully.

During the course of call, if a mobile moves from one cellular system to a different cellular system controlled by a different MSC, an intersystem handoff becomes necessary. MSC initiates handoff in intersystem handoff only when it cannot find another cell in its region to whom it can transfer the call. Some other issues are also need to be addressed

→ a local call may become longer-distance call and mobile may become roamer in neighboring system.

→ Compatibility between two MSCs must be determined before implementing intersystem handoff.

Prioritizing handoffs:

One methods of prioritizing handoff is called as guard channel concept, whereby a fraction of the total available channels in a cell is reserved exclusively for handoff requests from ongoing calls which may be handed off into the cell. This method has the disadvantage of reducing the total carried traffic, as fewer channels will be available for originating calls.

Queuing of handoff request is another method to decrease the probability of forced termination of a call due to lack of available channels. Queuing of handoff is possible due to the fact that there is a finite time interval between the time the received signal level drops below the handoff threshold and the time the call is terminated due to insufficient signal level. So this method can't guarantee a zero probability of forced termination. The delay time and size of the queue is determined from the traffic pattern of the particular service area.

In first generation analog cellular system, the typical time to make a handoff is about 10 seconds on signal to go below handoff threshold. This requires the Δ be on the order of 6dB to 12dB. In digital cellular system; the only time required is 1 or 2 seconds & Δ lies between 0dB to 6dB. Another feature of newer cellular system is the ability to make handoff decision based on a wide range of metrics other than signal strength. The co-channel and adjacent channel interference levels may be measured at the base station or the mobile, and this information may be used with conventional signal strength data to provide a multidimensional algorithm for determining when a handoff is needed.

Cellular IP

Cellular IP is a new lightweight and robust protocol that is optimized to support local mobility but efficiently interworks with Mobile IP to provide wide Area mobility support. It is used in environment where mobile hosts migrate frequ Cellular IP maintains distributed cache for location management and routing purposes. Distributed Paging Cache coarsely maintains the position of idle mobile hosts in a service area Distributed routing cache maintains the position of active mobile hosts in the service area and dynamically refreshes the routing state in response to the handoff of active mobile hosts

Primary Design Goals of Cellular IP

(i) Simplicity

(ii) Scalability :- Cheap passive connectivity Property

(iii) Performance transparency / location independent service

(iv) Performance scalability :-> ability to use the same protocol in distinct enviroments.

(v) Does not require new packet format or encapsulation or extra address space.

A Cellular IP n/w is fully distributed where :-> (i) nodes are unaware of n/w topology

(ii) no centralized database or other single points of failure exis

(iii) no element in the n/w must increase in complexity as th coverage area or no. of connected hosts increases.

Co-Channel Interference

Interference is the major limiting factor in the performance of cellular radio systems. Sources of the interference includes

→ Another mobile in the same cell,

→ A call in progress in a neighboring cell

→ other base station operating in the same frequency band, or

→ any non-cellular system which advertently leaks energy into cellular frequency band etc.

Interference has been recognized as a major bottleneck in increasing capacity and is often responsible for dropped calls. There are two major types of system-generated cellular interferences

(i) Co-channel Interfence

(ii) Adjacent channel Interfence

Interference resulting from signals which are adjacent in frequency to the desired signal is called adjacent channel Interference. Adjacent channel interference results from imperfect receiver filters which allow nearby frequencies to leak into the passband.

Frequency reuse implies that in a given coverage area there are several cells that use the same set of frequencies. These cells are called co-channel cells, and the inference between signals from these cells is called co-channel interfence. This interference can't be combated by simply increasing the carrier power of a transmitter because increase in carrier transmit power increases the interference to neigeboring co-channel cells.

When the size of each cell is approximately the same and base stations transmit the same power, the co-channel interference ratio is independent of the transmitted power and becomes a function of the radius of the cell (R) and the distance between the ratio of D/R, the spatial separation between co-channel cells relative to the coverage distance of a cell is increased. For a hexagonal geometry, the co-channel reuse ratio (Q) which is related to the cluster size is

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

A small value of Q provides larger capacity since the cluster size N is small; whereas a large value of Q improves the transmission quality, due to smaller level of co-channel interference.

Let i_0 be the number of co-channel interfering cells. Then signal-to-interference ratio (S/I or SIR) for a mobile receiver which monitors a forward channel be expressed as

$$\frac{S}{I} = \frac{S}{\sum_{i=1}^{i_0} I_i}$$

where S is the desired signal power from the desired base station and I_i is the interference power caused by the i^{th} interfering co-channel cell base station.

Propagation measurements in a mobile radio channel show the average received signal strength at any point decays as a power law of the distance of separation between a transmitter and receiver. The average received power P_r at a distance d from the transmitting antenna is approximated by

$$P_r = P_0 \left(\frac{d}{d_0}\right)^{-n}$$

where P_0 is the power received at a close-in reference point in the far field region of the antenna at a small distance d_0 from the transmitting antenna and n is the path loss exponent. The path loss exponent typically ranges between two and four in urban cellular systems.

Cell Splitting

As the number of subscribers increases within a given area, the number of channels allocated to a cell is no longer sufficient for supporting the subscriber demand. It then becomes necessary to allocate more channels to the area that is being covered by this cell. This can be done by splitting cells into smaller cells and allowing additional channels in the smaller cells

Consider the given figure of cellular architecture where a cluster size of seven is employed. When the traffic load increases, a smaller cell is introduced such that it has half the area of the larger cells. This will ultimately increases the capacity

fourfold (because area is proportional to the square of the radius). However, in practice, only a single cell will be introduced such that it is midway between two co-channel cells. In this case, these are the larger cells labeled A. It is logical to thus reuse the channels allocated to these cells in the smaller cell to minimize the interference.

This approach gives rise to some problems. Let us suppose that the radius of the smaller split cell (labeled a) is R/2. Let the transmit power of the base station of the small cell be the same as the transmit powers of the larger cells. As far as the smaller cell is concerned, the signal-to-interference ratio is maintained because the maximum distance the mobile can be from the base station in this cell is R/2. So though the distance between this cell and the co-channel cells A is also reduced to half, the value of S/I (S_r) remains the same.

On the other hand, this is not the case for the cells labeled A because the co-channel reuse ratio for these cells is now D/2R with respect to the smaller split cell. In order to maintain the same level of interference, the transmit power of the base station in the smaller cell should be reduced. But this will increase the interference observed by the mobiles in the smaller cell

The other alternative is to divide the channels allocated to cells labeled A into two parts: those used by 'a' and those not used by 'a'. The channel used by 'a' will be used in the larger cells only with in a radius of R/2 from the center of the cell so that the co-channel reuse ratio will be maintained as far as these channels are concerned. This is called the overlaid cell concept where a larger macrocell co exists with a smaller microcell.

The downside of this approach is that the capacity of the larger cells is reduced which will ultimately lead to introducing split cells in their area, until such time as a chain reaction will result in the entire area being served by cells of a smaller radius. Also the base station in cell labeled A will become more complex, and there will be a need for handoffs between the overlays.

Now consider the forward link where the desired signal is the serving base station and where the interference is due to the co-channel base stations. If D_i is the distance of the i^{th} interferer from the mobile, the received power at a given mobile due to the i^{th} interfering cell will be proportional to $(D_i)^{-n}$. When the transmit power of each base station is equal and path loss exponent is the same throughout the coverage area, S/I for a mobile can be appoximated as

$$\boxed{\frac{S}{I} = \frac{R^{-n}}{\sum_{i=1}^{i_0} (D_i)^{-n}}}$$

Considering only the first layer of interfering cells, if all the interfering base stations are equidistant from the desired base station and if this distance is equal to the distance D between cell centres, then above equation of signal to interference ration simplifies to

$$\frac{S}{I} = \frac{(D/R)^n}{i_0} = \frac{(\sqrt{3N})^n}{i_0} = \frac{(Q)^n}{i_0}$$

For the U.S. AMPS (Advanced Mobile Phone System) cellular system which uses FM and 30 KHz channels, subjecture tests indicate that sufficient voice quality is provided when S/I is greater than or equal to 18 dB.

MOBILE IP

In the broadest sense, the term mobile computing refers to a system that allows computers to move from one location to another in wireless fashion. The mobility should be in such a way that it should not affect IP configuration of system.

Because host's IP address includes a network prefix, moving the host to new n/w means either

*) The host's address must change

*) Routers must propagate a host-specific route across the entire n/w

Neither of the alternatives work well bcz in first the computer must reboot on changing IP and all connections should again be reconfigured. In second approach it requires space in routing tables so it does not scale well and will consume excessive bandwidth.

Mobile IP characteristics :→

→ Transparency :→ Mobility is transparent to applications & transport layer protocols as well as to routers

→ Interoperability with IPV4 :→ A host using mobile IP should have same addressing scheme as the other hosts in n/w which are not mobile

→ Scalability :→ The solution scales to larger internets. In particular it permits mobility across the global internet

Security :→ It should ensure that all messages are authenticated

Macro mobility :→ mobile IP focuses on the problem of long-duration moves instead of rapid n/w transitions.

Overview of Mobile IP operations :-

computer holds two addresses simultaneously.

- (i) Primary Address :- is permanent & fixed. Application & transport layer protocols use this address. Obtained by home n/w router
- (ii) Secondary Address :- Changes as computer moves and is valid only while computer visits a given location. It is obtained by foreign n/w agent / router. Secondary Address is sent to home agent for IP-in-IP encapsulation to tunnel each datagram to secondary Address. When mobile returns home it must contact the home agent to de-register.

Mobile Addressing Details :-

Secondary Address also known as care of Address is only used by IP s/w on mobile and agents on the foreign or home n/ws but is never used by applications. There are two types of C.O.A. The two types differ in method by which the address is obtained and in the entity responsible for forwarding

→ Co-located Care-of-address :- Requires mobile computer to handle all forwarding itself. Mobile host should have special s/w that uses two addresses; applications use the home address, while lower layer s/w uses the care-of-address to receive datagrams.

The Advantage of a CO-COA is that mobile host will manage all things without taking help of foreign agent.

The disadvantage of CO-COA arises from the burden of extra s/w to be carried by mobile host.

→ The second form, which is known as a foreign agent care of Address requires that mobile must first discover the Identity of an foreign agent and then contact it to obtain COA. In the the FA does not need to assign the mobile a unique address. Instead the agent can supply one of its IP addresses and agree to forward datagrams to the mobile. Its advantage is that the visiting mobile don't consume IP addresses

Foreign Agent Discovery :→ Each router in its n/w sends an ICMP (Internet control message protocol) router advertisement message and allows a host to send an ICMP router solicitation to prompt for an Advertisement. The additional information appended to each message is known as mobility agent extension which allow a foreign agent to advertise its presence or a mobile to solicit an advertisement. The extension format are

0	8	16	24 31
Type (16)	Length	Sequence Number	
Lifetime		CODE	Reserved
Care of Address			

→ The Length field specifies the size of extension message in Octets, excluding the type and length octets

→ The Lifetime field specifies the maximum amount of time in seconds that the agent is willing to accept registeration requests, with all 1's for infinity

→ Sequence number specification allow a recipient to determine when a message is lost.

→ Each bit in code Field defines specific features of the agent eg bit 0 means registeration with an agent is required; co-located CoA is not permitted, bit 1 means that the agent is busy and is not accepting registerations, bit 2 Agent functions as home agent, bit 3 agent fncs as foreign agent, 4 for minimal encapsulation, 5 for using GRE-style encapsulation, 6 for agent to support header compression while communicating with mobile and 7 is unused

Agent Registeration :→ The Registeration procedure allows a host to

→ Register with an agent on the foreign n/w

→ Register directly with its home agent to request forwarding

→ Renew a registration that is due to expire

→ Reregister after returning home

Registration Message format :→

All registration messages are sent via UDP. Agents listen to well-known port 434; request may be sent from any ~~source~~ port to destination port 434. An agent reverses the source and destination ports, so a reply is sent from source port 434 to ~~the port~~ which the requester used.

Each request is required to contain a mobile home authentication extension that allows the home agent to verify the mobile's identity

0 — 8	8 — 16	16 — 31
Type (1 or 3)	Flags	Lifetime
Home Address		
Home Agent		
Care of Address		
Identification		
Extension		

Type 1 → Registeration Request Type 3 → Registration Reply

Lifetime specifies the number of seconds registeration is valid

Identification field contains a 64-bit number generated by the mobile that is used to match requests with incoming replies and to prevent the mobile from accepting old messages

Flag is used to specify forwarding details.