→ The GPRS system bring some new network elements to an existing GSM n/w.

→ PCU (Packet control unit)
→ SGSN (Service GPRS support node)
→ GGSN (Gateway GPRS support node)
→ BG (Border gateway)
→ CG (charging gateway)

1. Packet control unit:

→ The PCU separates the circuit switched and packet switch traffic from the user and sends them to the GSM and GPRS network respectively.
→ It also perform most of the radio resource management function of the GPRS network.
→ PCU can be either located on the BTS, BSC or some other point btw MS and MSC.
→ There will be atleast one PCU that served a cell in which GPRS service will be available.
→ Frame Relay technology is being used at present to interconnect the PCU to the GPRS core.

2. Service GPRS support node:

→ SGSN is the most important element of the GPRS network
→ SGSN of the GPRS is equivalent to GSM or MSC
→ There must be atleast on SGSN in a GPRS n/w.
→ one coverage area is associated with every SGSN. As the network expands and the number of subscriber increases, there must be more than one SGSN in a network
→ The SGSN has the following function
  → protocol conversion
  → ciphering of GPRS data btw MS and SGSN
  → Data compression is used to minimize the size of transmitted data unit
  → Authentication of GPRS user
  → Mobility management as the subscriber move from one area to another and possibly one SGSN to another

- Routing of data to the relevent GGSN when a connection to an external network is required.
→ Interaction with the NSS (i.e MSC/VLR, HLR, EIR) via the SS7 network in order to retrieve subscription information.
→ Collection of charging data pertaining to the use of GPRS users
→ Traffic statistics collection of network management purpose

3. Gateway GPRS support Node (GGSN):
→ GGSN is the gateway to external networks. Every connection to a fixed external data network has to go through a GGSN.
→ GGSN acts as the anchor point in a GPRS data connection even when the subscribers moves to another SGSN during roaming.
→ GGSN may accept connection request from SGSN that is another PLMN. Hence the concept of coverage area does not apply to GGSN.
→ The area usually two or more GGSNs in a network for redundancy purpose and they backup each other up in case of failures.
→ The function of GGSN are
  → Routing mobile destined packet coming from external network to the relevent SGSN.
  → Routing packet originating from a mobile to the correct external network
  → Interface to external IP network and deal with security issues
  → Allocates dynamic or static IP address to mobile either by itself or with the help of a DHCP
  → Involved in the establishment of tunnel with the SGSN.
→ GGSN is a simple a router to an IP subnetwork
→ When the GGSN receives data address to a specific user in the mobile network, it first check if the address is active.

4. Bonder gateway:

→ The BG is a router that can provide a direct GPRS tunnel betn different operator GPRS network. This is called inter-PLMN data network

→ It is more secure to transfer data between two operator PLMN networks through a direct connection, rather than via the public Internet

→ The Bonder gateway will commence operation once the GPRS Roaming agreement between various operator have been signed

→ It will essentially allow a roaming subscriber to connect to company intranet through the home GGSN via the visiting PLMN network

5. Charging gateway:

→ GPRS users have to be charged for the use of the network

→ In GSM network charging is based on the destination, duration and time of call

→ GPRS offer connectionless service to user, so it is not possible to charge subscriber on the connection duration

→ Charging has to be based on the volume, destination, QoS and other parameter of a connectionless data transfer.

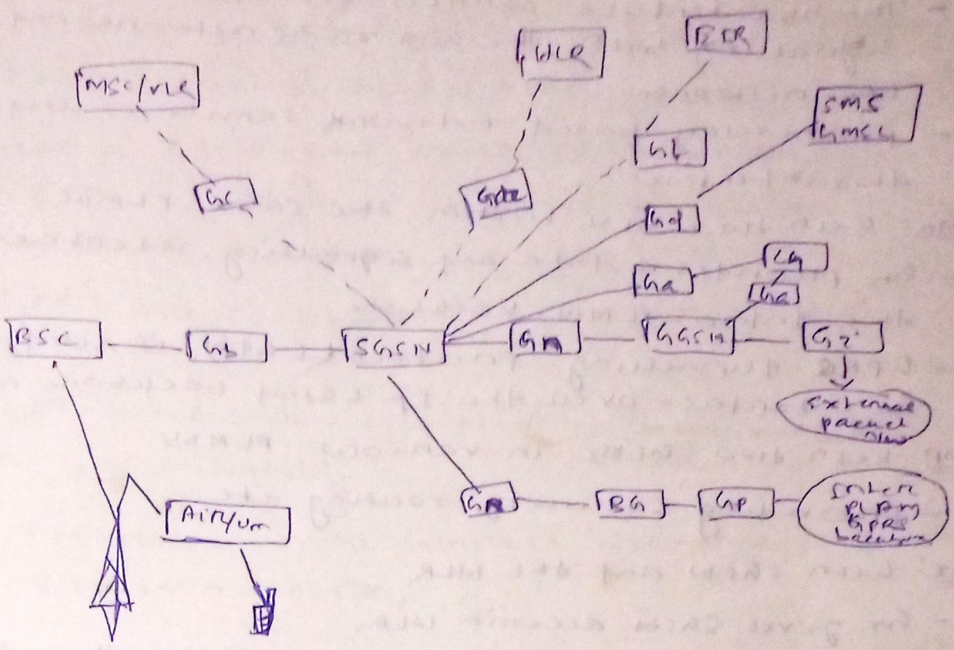
→ GPRS charging data are generated by all the SGSN and GGSN in the network. The data is called charging Data Records.

→ On data session may generate a no. of CDRs which need to be collected and processed

→ The CG collects all of those Record, sort them process it and pass it on to Billing system.

→ Here the GPRS subscriber is billed for the data transaction

GPRS Interface:



- Signalling and data
- ---- Signalling
- GPRS system introduces new interface to the GSM network
- Connection from the GPRS system to the NSS part of the GSM network are implemented through the SS7 network.
- GPRS element interfacing with the NSS is SGSN the important interface to the NSS are SGSN - HLR (Gr), SGSN - EIR (Gf), and SGSN - MSC/VLR
- The other interface are implemented through the Intra-PLMN backbone network (Gn), the inter-PLMN backbone network (Gp) or the external network (Gi)

→ The interface used by the GPRS system are

Um: between an MS and GPRS fixed network part.

- Um is the access interface the MS uses to access the GPRS network
- The radio interface to the BTS is the same as used by the existing GSM network with some GPRS specific changes

Gb: between a SGSN and a BSS
- The Gb interface carries the GPRS traffic and signaling between the GSM radio network and the GPRS network
- Frame relay based network service is used for this interface

Gn: between two GSN within the same PLMN
- Gn provides a data and signaling interface in the Intra-PLMN backbone
- GPRS Tunneling Protocol (GTP) is used on the Gn interface over the IP based backbone network

Gp between two GSNs in various PLMNs
- Providing security, routing etc.

Gr: between SGSN and the HLR
- Gr gives SGSN access to HLR.
- HLR can be located in a diff. PLMN, than the SGSN (MAP)

Ga: between ~~GSNs~~ GSNs and CG inside the same PLMN
- Ga provides a data and signalling interface
- used for sending the charging data records generated by GSNs to the CG.

Gs: between SGSN and a MSC
- SGSN can send location data to the MSC or receiving paging request from the MSC via this optional interface.
- improve the effectiveness of the radio and network resources.

Gd: between the SMS-GMSC and an SGSN and between SMS-IWMSC and an SGSN
- used for more efficient use of the SMS service (MAP)

Gf: between SGSN and EIR
- used for equipment information.

Ge: between the GGSN and HLR.
- this interface is used if the GGSN needs to forward packet to an MS that is not reachable

There are two reference points in the GPRS network.

→ Gi is GPRS specific but R is common this with the circuit switched GSM network

→ Gi between a GGSN and external network

- The GPRS network is connected to an external data network via the interface.
- The GPRS not a standard interface but merely a reference point.
- R between terminal equipment and mobile ~~proto~~ termination.
- This reference point connect terminal equipment to mobile termination,

WIRELESS LAN:

→ It is a LAN without wires

→ Goal: is to replace obtrusive cabling to enable quicker access to internet and to high flexibility communication

→ WLAN Application:

→ WLAN is best suited for dynamic environment the application are.

1. cross building Interconnect:
   → used to connect LAN in nearby building using a point-to-point wireless LAN
   → using bridges and router devices.

2. Nomadic access:
   → is a wireless link between LAN hub and a mobile data terminal equipped with an antenna such as laptop or notepad.
   → useful in extended environment.

3. Adhoc networking:
   → is a peer-to-peer network setup temporarily to some immediate need.
   → e.g a group of employees, each with a laptop computer, may convene in a conference room for business
   → Link for network is done for the duration of the meeting.

WLAN requirement:

→ Throughput: MAC protocol should make as efficient use as possible of wireless medium to maximum throughput

→ No. of nodes: need to support no. of nodes across multiple cells

→ connection to backbone LAN:

→ Service area:

→ License free operation

→ Handoff/roaming

→ Dynamic configuration

→ Battery power consumption

WLAN Advantage:

→ mobility
→ Low implementation cost
→ Installation speed
→ Network expansion
→ Reliability
→ Scalability
→ Usage of ISM band.

WLAN Technology:

1. Infrared LAN:

→ Limited to a single room, as IR light does not penetrate wall

→ 3 transmission techniques are used

(1) Direct beam IR to create point-to-point link

(2) Omnidirectional configuration

(3) diffused configuration.

2. Spread Spectrum LAN:

→ make use of a multiple cell arrangement.

1. Hub technology: hub is mounted on the ceiling and connected to backbone wired LAN.

2. Peer-to-peer technology: No hub is there MAC algorithm such as CSMA is used to control access

3. Narrowband microwave:

WLAN operate at microwave frequencies but do not use spread spectrum.

Types of WLAN:

1. IEEE 802.11

→ In 1997 IEEE finalized the initial specifications for WLAN

→ Specification 2.4 GHz frequency band data rate of 2 Mbps

2. Hyperlan:

→ Began in Europe in 1996 by ETSI (Europ Telecom standard institute)

→ 5 GHz frequency band 24 Mbps bandwidth

3. Bluetooth:

→ Promoted by big industry leader like IBM, Ericsson, Nokia

→ Was named after Harold Bluetooth

→ 1 Mbps data rate 2.2 GHz band

→ Also known as PAN.

4. MANET:

→ It is a working group to investigate and develop the standard for MANET

IEEE 802.11

→ It specifies the most known family of WLANs in which many products are available.
i.e. no. in the standard indicates it belonging to the group of 802.x LAN standard.

→ Primary goal: the specification of a simple and robust WLAN which obtains some bounded and asynchronous services

Architecture:

→ BSS (Basic service set) is the smallest building block of WLAN, which consists of some no. of station executing the same MAC protocol

→ BSS may be isolated or it may be connected to a backbone distribution system (DS) through an access point

→ The AP function as a bridge and a relay point.

→ If one station in BSS wants to communicate with another station in the same BSS, the MAC frame is first sent from originating station to the AP and from AP to destination station.

→ IBSS

→ When all the station in the BSS are mobile stations with no connection to other BSS, the BSS is called an independent (IBSS)

→ IBSS is an adhoc network

ESS (Extended service set)

→ An ESS consists of two or more basic services set interconnected by a distribution system.

→ DS is a wired backbone LAN but can be any communication network. The ESS appears as a single logical LAN to the logical link control level.

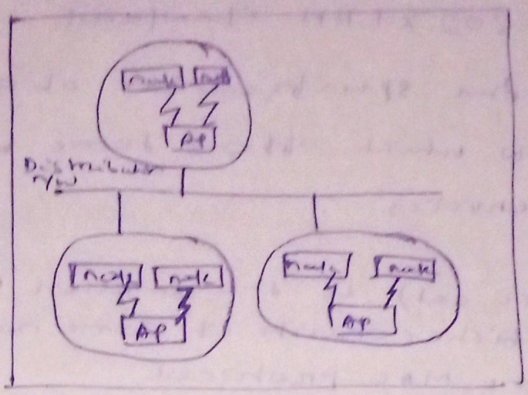
AP (Access point)

→ AP is implemented as part of a station

→ AP is the logic within a station that provides access to DS by providing DS service in addition to acting as a station.

-> WLAN come in 2 types

1. Infrastructure mode
2. Adhoc mode



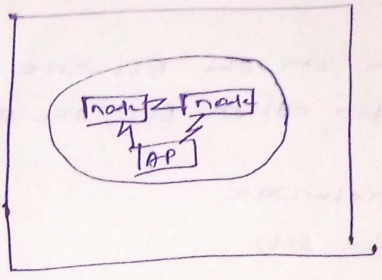
WLAN in infrastructure mode.

-> Here MSC are connected with BS or access point

-> This is similar to star network communication takes place between wireless node and access point but not directly between wireless device.

-> Here access point acts as a bridge to other network

Adhoc mode:



- In adhoc mode there is no access point

-> A no. of MS connect can communicate directly with each other

-> nodes can communicate directly with each other physically i.e they are given each other radio range

Protocol Architecture:

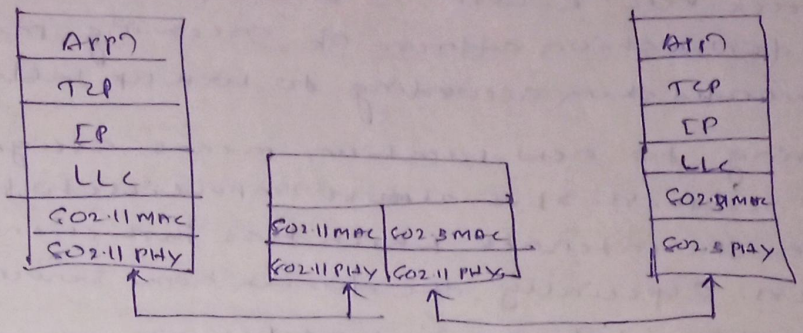
-> 802.11 bits into other 802-X standard for wired LAN

-> WLAN is connected to switched IEEE 802.3 ethernet via bridge.

→ Appn should not notice many any difference apart from lower bandwidth and higher access time from the wireless LAN

→ Appn layer TCP, IP are same both from the upper layer of data link control (DLC)

→ The logical link control covers the difference of the medium access control layer needed for diff. media



→ IEEE 802.11 standard only covers physical and medium access layer

→ The physical layer is subdivided into physical layer convergence protocol (PLCP) and physical medium dependent (PMD)

→ MAC layer performs medium access fragmentation and encryption.

→ PLCP provides carrier sense signal called as CSA (clear channel assessment) and provides common PHY service to access point (SAP)

→ PMD handle the modulation and encoding, decoding.

→ Physical layer support 3 different transmission (infrared and two radio transmission)

→ MAC management support association and reassociation of station to an access point and roaming between diff. access point

→ It also control authentication, encryption and synchronization of a station with regard to an access point

Mobile IP

→ It support the mobility of host in internet.
→ Support mobility is a diff. task.

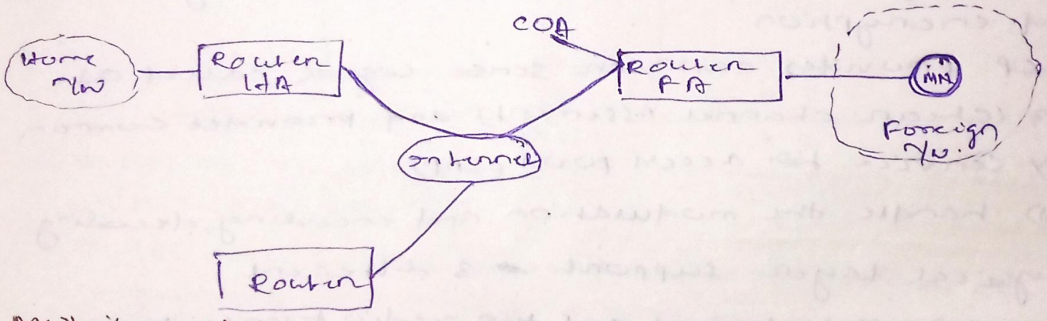
(1) A host send an IP packet with header containing a destination address and other field. The destination address not only determines the receiver of the packet but also physical subnet of the receiver. Router in the internet look at the destination address of incoming packets and forwarded them according to look up table.

(2) Moving to new location means assigning of new address. It is almost impossible to keep a host on the internet which has just changed its address. Especially the domain name server needs sometime before it updates its internal tables.

(3) Router are built for extremely fast forwarding but not for fast update of routing table.

Example of mobile IP:

The following defines several entities and terms need to understand mobile IP.



Mobile node:

→ A mobile node is an end system or Router that can change its point of attachment to the internet using mobile IP.
→ The MN keeps its IP address and can continously communicate with any other system on the internet as long as the link layer connectivity is given
→ MNs are not necessarily small devices such as Laptop with antenna or mobile phone.

Corresponding node:

At least one partner is needed for communication. Here CN represent that partner for MN. The CN can be a fixed or mobile node.

Home network:

- The network is the subnet the MN belongs to with its IP address
- No mobile IP support is needed within the home network.

Foreign network:

- It is the current subnet the MN visits and which is not the home network

Foreign Agent:

- FA can provides several services to the MN during its visit to the foreign network.
- FA can have the COA acting as tunnel endpoint and forwarding packets to MN
- FA can be the default router for the MN
- FA can also provide security services because they belong to the foreign network as opposed to the MN which is only visiting
- FA mobile IP functioning, FA are not necessarily needed. Typically an FA is implemented on a router for the subnet the MN attached to.

Care of address (COA)

→ It defines the current location of the MN from an IP point of view.

→ All IP packet sent to the MN are delivered to the COA not directly to the IP address of the MN.

→ Packet delivery towards the MN is done using a tunnel.

→ COA marks the tunnel endpoint, i.e the address where packet exit the tunnel

→ There are diff. possibilities for the location of the COA

1. Foreign agent COA:

-) The COA could be located at the FA i.e the COA is an IP address of the FA

-) The FA is the tunnel end point and forwarded packet to the MN. Many MN using the FA can share this COA as common COA

2. Co-located COA:

-) COA is located at the MN temporarily acquire an additional IP address which acts as COA.

-) This address is now topologically correct and the tunnel endpoint is at the MH.

-) Co-located addresses can be acquired using services such as DHCP.

-) Problem associated is: need for additional addresses if MNs request a COA

Home agent:

-) HA provides several service for the MN and is located in the home network

-) Tunnel for packet towards the MN starts at the HA

-) HA maintains a location register i.e it is informed of the MN location by the current COA

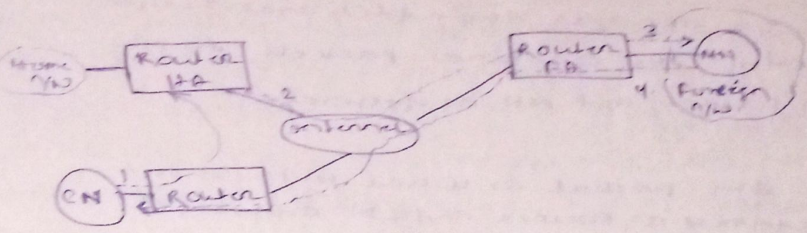
-) Three alternatives for the implementation of an HA exists.

1. HA can be implemented on a router that is responsible for the home network

2. HA can also be implemented on an arbitrary node in the subnet. One disadvantage of this solution is the double crossing of the router by the packet if MN is in a foreign network

3. HA could be a giant on the router but this time only acting as a manager for MN. belonging to a virtual home network

Ip packet delivery:



A mobile node is an end system or router that can change its point of attachment to internet using mobile IP

- The partner to MN for communication is called correspondent node
- The home network is the subnet to which the MN belongs to with respect to its IP address.
- Foreign network is the current network to the MN visits

packet delivery steps:

Step-1: A CN want to send an IP packet to the MN. Mobile IP has to support hiding the mobility of the MN.

→ So CN doesn't has to know anything about MN's location. It sends the packet as usual to the IP address.

Step-2: The packet router routes the packet to the router responsible for the home network of MN.

- The HA gets the information that MN is not present in its home network
- Then the packet is not forwarded into the subnet as usual
- An extra header is added to the packet containing the address of new network. The process is called encapsulation
- Then the packet moves to the foreign network showing; the COA as new destination.

Step-3: the foreign agent now decapsulates the packet i.e removes the additional header and forwarded the original packet to MN with CN as source and MN as destination

Step-4:

- MN sends the packet as usual with its own fixed IP address as source and CN address as destination
- the router with the FA acts as default router and forwards the packet in the same way as it would do for any other node in the foreign nw.