20IT701/PE3A

Hall Ticket Number:

IV/IV B.Tech (Regular/Supplementary) DEGREE EXAMINATION

December, 2024 **IT**

VII Semester **Wireless Networks**

Time: Three Hours **Maximum:** 70 Marks

Answer question 1 compulsorily. **(14X1 = 14 Marks)**

Answer one question from each unit. **(4X14=56Marks)**

			CO	BL	M
1	a)	State examples for Mobile Wired and Wireless Networks?	**CO1**	**1**	**1M**
	b)	Define Constellation Diagram?	**CO1**	**1**	**1M**
	c)	Construct the radiation pattern for Hertzian Dipole.	**CO1**	**5**	**1M**
	d)	Outline the Functions of Physical Layer?	**CO1**	**2**	**1M**
	e)	List any two satellites launched in the year of 2020	**CO2**	**1**	**1M**
	f)	Describe Van Allen Radiation Belts?	**CO2**	**2**	**1M**
	g)	Define Gateway Handover of Satellite Systems.	**CO2**	**1**	**1M**
	h)	Who developed LTE systems?	**CO3**	**1**	**1M**
	i)	Identify DFW MAC DCF	**CO3**	**2**	**1M**
	j)	What is the use of NAV in DFWMAC-DCF with RTS/CTS.	**CO3**	**2**	**1M**
	k)	Define Encapsulation	**CO3**	**1**	**1M**
	l)	State any two examples for Proactive algorithms	**CO3**	**1**	**1M**
	m)	Identify where do we use X2 Interface in LTE-Advanced?	**CO4**	**2**	**1M**
	n)	State any two softwarization methods used in 5G?	**CO4**	**1**	**1M**
		Unit-I			
2	a)	Describe simplified reference model of communication systems.	**CO1**	**2**	**7M**
	b)	What is Antenna and explain different types of Antennas with their Radiation Patterns.	**CO1**	**2**	**7M**
		(OR)			
3	a)	What is the multiplexing? Differentiate various types of multiplexing techniques.	**CO1**	**4**	**7M**
	b)	Describe various applications of wireless networks.	**CO1**	**2**	**7M**
		Unit-II			
4	a)	What are the possibilities of Calling? Explain Mobile Terminated Calls with the help of neat diagram.	**CO2**	**2**	**7M**
	b)	What is Hand over? Explain different Handover Mechanisms in Satellite Systems.	**CO2**	**2**	**7M**
		(OR)			
5	a)	Draw and explain the System Architecture of DECT system	**CO2**	**2**	**7M**
	b)	Explain different types of Orbits of Satellite Systems.	**CO2**	**2**	**7M**
		Unit-III			
6	a)	Describe basic DFWMAC-DCF using CSMA/CA.	**CO3**	**2**	**7M**
	b)	Explain the Destination Sequenced Distance Vector (DSDV) routing protocol.	**CO3**	**2**	**7M**
		(OR)			
7	a)	Discuss about agent discovery in Mobile IP.	**CO3**	**2**	**7M**
	b)	Explain in detail about DHCP.	**CO3**	**2**	**7M**
		Unit-IV			
8	a)	Draw the 4G Architecture of LTE-Advanced and explain about Femtocells.	**CO4**	**2**	**7M**
	b)	Discuss the softwarization approaches used in 5G NGMN Model.	**CO4**	**2**	**7M**
		(OR)			
9	a)	Discuss Carrier Aggregation and Evolved Packet Core.	**CO4**	**2**	**7M**
	b)	Draw and explain overall Next Generation Radio Access Network Architecture.	**CO4**	**2**	**7M**

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SCHEME OF VALUATION

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VII Semester **Wireless Networks**

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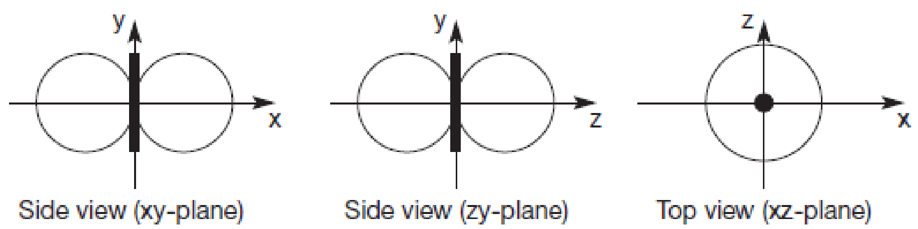
Answer question 1 compulsorily. **(14X1 = 14 Marks)**

Answer one question from each unit. **(4X14=56Marks)**

			CO	BL	M
1	**a)**	**State examples for Mobile Wired and Wireless Networks?**	**CO1**	**1**	**1M**
		Mobile Wired :***Ex: Laptops***Mobile Wireless : ***Ex: GSM Mobiles***			
	b)	**Define Constellation Diagram?**	**CO1**	**1**	**1M**
		This representation, also called phase state or signal **constellation diagram**, shows the amplitude M of a signal and its phase *φ in polar* coordinates.			
	c)	**Construct the radiation pattern for Hertzian Dipole.**	**CO1**	**5**	**1M**
		 **ANY ONE**			
	d)	**Outline the Functions of Physical Layer?**	**CO1**	**2**	**1M**
		• frequency selection, • generation of the carrier frequency, • signal detection • modulation of data onto a carrier frequency • (depending on the transmission scheme) encryption. **ANY TWO**			
	e)	**List any two satellites launched in the year of 2020**	**CO2**	**1**	**1M**
		SpaceX's Starlink, Telesat's Light speed, and Amazon's Kuiper.			
	f)	**Describe Van Allen Radiation Belts?**	**CO2**	**2**	**1M**
		The Van Allen radiation belts, belts consisting of ionized particles, at heights of about 2,000–6,000 km (inner Van Allen belt) and about 15,000–30,000 km (outer Van Allen belt) respectively make satellite communication very difficult in these orbits.			
	g)	**Define Gateway Handover of Satellite Systems.**	**CO2**	**1**	**1M**
		Gateway handover: While the mobile user and satellite might still have good contact, the satellite might move away from the current gateway. The satellite has to connect to another gateway.			
	h)	**Who developed LTE systems?**	**CO3**	**1**	**1M**
		3GPP			
	i)	**Identify DFW MAC DCF**	**CO3**	**2**	**1M**
		DFW :Distributed Foundation Wireless MAC: Medium Access Control DCF: Distributed Co-ordination Function			
	j)	**What is the use of NAV in DFWMAC-DCF with RTS/CTS.**	**CO3**	**2**	**1M**
		NAV resolves the hidden terminal problem.			
	k)	**Define Encapsulation**	**CO3**	**1**	**1M**
		Encapsulation: Encapsulation is the mechanism of attaching a new header to the existing packet.			
	l)	**State any two examples for Proactive algorithms**	**CO3**	**1**	**1M**
		Destination Sequenced Distance Vector (DSDV), Wireless Routing Algorithm (WRP), Global State Routing (GSR), Source-tree Adaptive Routing (STAR), Cluster-Head Gateway Switch Routing (CGSR), Topology Broadcast Reverse Path Forwarding			

		(TBRPF), Optimized Link State Routing (OLSR).			
	m)	**Identify where do we use X2 Interface in LTE-Advanced?**	**CO4**	**2**	**1M**
		The X2 interface is used for eNodeBs to interact with each other			
	n)	**State any two softwarization methods used in 5G?**	**CO4**	**1**	**1M**
		1.Software-Defined Networking (SDN) 2.Network Functions Virtualization (NFV) 3.Edge Computing 4.Cloud-Edge Computing			

<u>Unit-I</u>

2	a)	**Describe simplified reference model of communication systems.**	**CO1**	**2**	**7M**

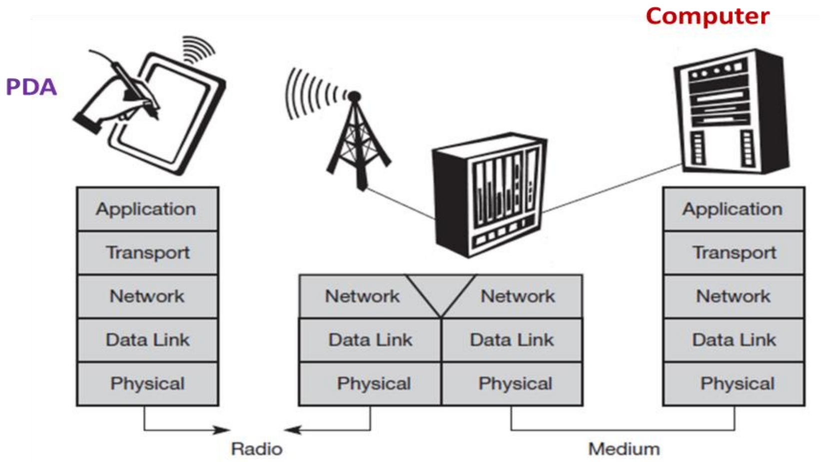


Figure 1.6 Simple network and reference model used in this book

- Figure 1.6 shows a Personal Digital Assistant (PDA) which provides an example for a wireless and portable device.
- This PDA communicates with a base station in the middle of the picture. The Base Station consists of a radio transceiver (sender and receiver) and an interworking unit connecting the wireless link with the fixed link.
- The communication partner of the PDA, a conventional Computer, is shown on the right-hand side.

Physical layer:

- This is the lowest layer in a communication system and is responsible for the conversion of a stream of bits into signals that can be transmitted on the sender side.
- The physical layer of the receiver then transforms the signals back into a bit stream.
- For wireless communication, the physical layer is responsible for
- ❖ frequency selection,
- ❖ generation of the carrier frequency,
- ❖ signal detection
- ❖ modulation of data onto a carrier frequency
- ❖ and (depending on the transmission scheme) encryption.

Data link layer:

- The main tasks of this layer include
- ➢ accessing the medium,
- ➢ multiplexing of different data streams,
- ➢ correction of transmission errors,
- ➢ and synchronization (i.e., detection of a data frame).
- Altogether, the data link layer is responsible for a reliable point-to point connection between two devices or a point-to-multipoint connection between one sender and several receivers.

Network layer:

This third layer is responsible for

- ➢ routing packets through a network or
- ➢ establishing a connection between two entities over many other intermediate systems.
- ➢ Important topics are addressing, routing, device location,
- ➢ and handover between different networks.

Transport layer:

This layer is used in the reference model to establish an end-to-end connection.

- Topics like
- ➢ Quality of Service,
- ➢ flow and congestion
- ➢ control are relevant,
- ➢ especially if the transport protocols known from the Internet, TCP and UDP, are to be used over a wireless link.

Application layer:

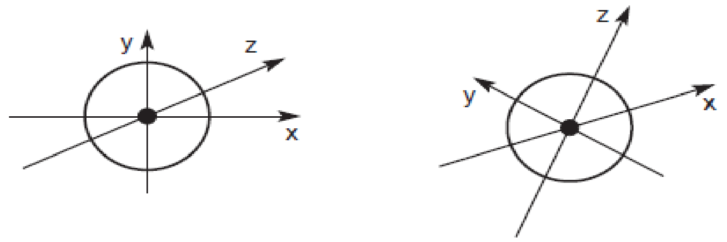
- Finally, the applications (complemented by additional layers that can support applications) are situated on top of all transmission oriented layers.
- Topics of interest in this context are
- ➢ Service Location,
- ➢ support for multimedia applications,
- ➢ adaptive applications that can handle the large variations in transmission characteristics, and

- wireless access to the world wide web using a portable device.

Very demanding applications are video (high data rate) and interactive gaming (low jitter, low latency).

b)	**What is Antenna and explain different types of Antennas with their Radiation Patterns.**	**CO1**	**2**	**7M**

- Antennas couple the energy from the transmitter to the outside world and, in reverse, from the outside world to the receiver.
- Antennas couple electromagnetic energy to and from space to and from a wire or coaxial cable (or any other appropriate conductor).
- A theoretical reference antenna is the isotropic radiator, a point in space radiating equal power in all directions, i.e., all points with equal power are located on a sphere with the antenna as its center.
- The radiation pattern is symmetric in all directions (see Figure 2.5, a two dimensional cross-section of the real three-dimensional pattern).



- However, such an antenna does not exist in reality.
- Real antennas all exhibit directive effects, i.e., the intensity of radiation is not the same in all directions from the antenna.
- The simplest real antenna is a thin, center-fed dipole, also called Hertzian dipole, as shown in Figure 2.6 (right-hand side). The dipole consists of two collinear conductors of equal length, separated by a small feeding gap.
- The length of the dipole is not arbitrary, but, for example, half the wavelength λ *of the signal* to transmit results in a very efficient radiation of the energy.
- If mounted on the roof of a car, the length of $\lambda/4$ *is efficient. This is also known as* Marconi antenna.
- A $\lambda/2$ *dipole has a uniform or omni-directional radiation pattern in one plane* and a figure eight pattern in the other two planes as shown in Figure 2.7.
- This type of antenna can only overcome environmental challenges by boosting the power level of the signal. Challenges could be mountains, valleys, buildings etc.

Figure 2.6 Simple Antennas

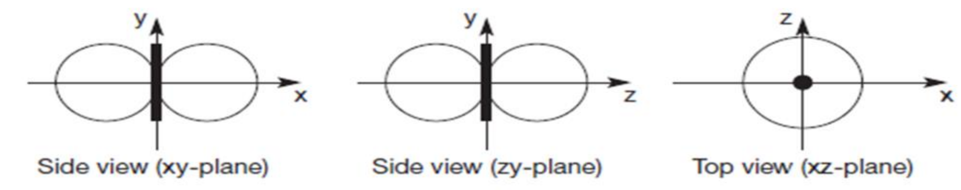


Figure 2.7 Radiation pattern of a simple dipole

- If an antenna is positioned, e.g., in a valley or between buildings, an omnidirectional radiation pattern is not very useful.
- In this case, Directional antennas with certain fixed preferential transmission and reception directions can be used.
- Figure 2.8 shows the radiation pattern of a directional antenna with the main lobe in the direction of the x-axis.

A special example of directional antennas is constituted by satellite dishes

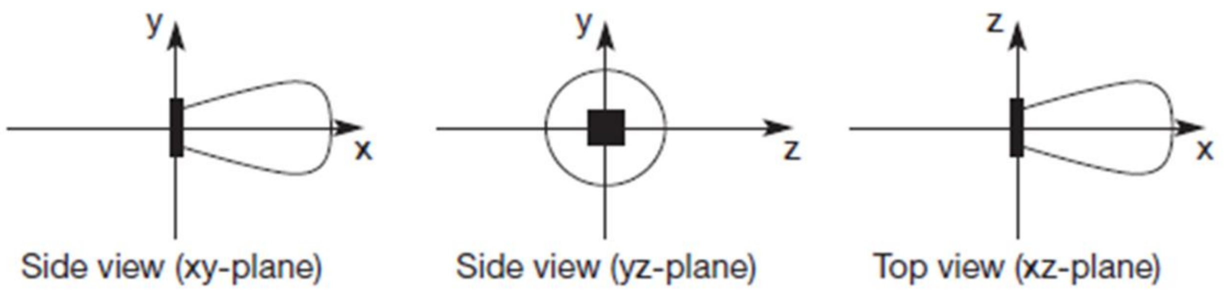


Figure 2.8 Radiation pattern of a directed antenna

- Several directed antennas can be combined on a single pole to construct a Sectorized antenna.
- A cell can be Sectorized into, for example, three or six sectors, thus enabling frequency reuse.
- Figure 2.9 shows the radiation patterns of these Sectorized antennas.

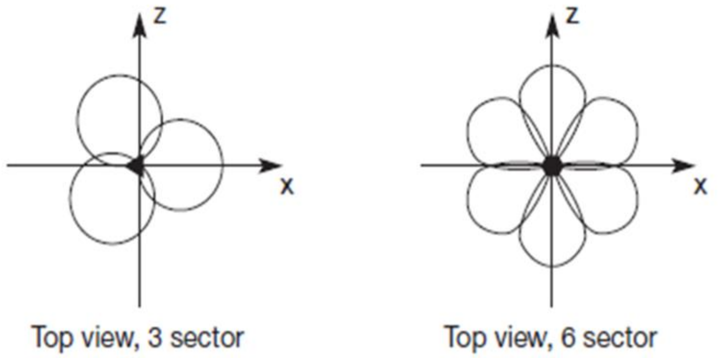
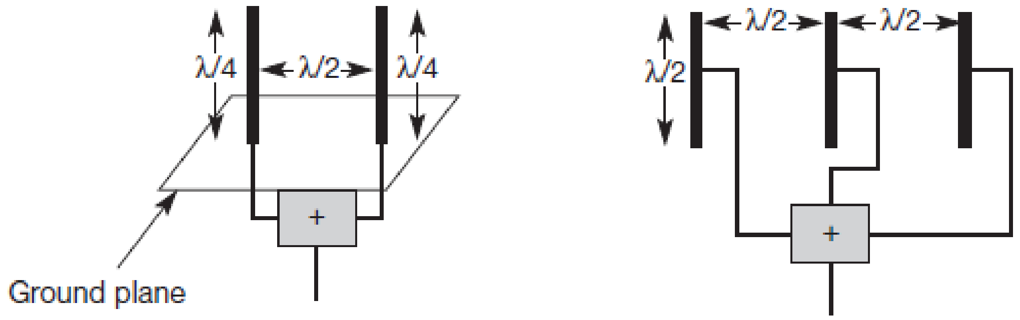


Figure 2.9 Radiation patterns of Sectorized Antennas

- Two or more antennas can also be combined to improve reception by counteracting the negative effects of multi-path propagation.
- These antennas, also called multi-element antenna arrays, allow different diversity schemes.
- One such scheme is switched diversity or selection diversity, where the receiver always uses the antenna element with the largest output.
- Diversity combining constitutes a combination of the power of all signals to produce gain.
- The phase is first corrected (cophasing) to avoid cancellation.
- As shown in Figure 2.10, different schemes are possible.
- On the left, two λ/4 antennas are combined with a distance of λ/2 between them on top of a ground plane.
- On the right, three standard λ/2 dipoles are combined with a distance of λ/2 between them.
- Spacing could also be in multiples of λ/2.



- A more advanced solution is provided by Smart Antennas which combine multiple antenna elements (also called antenna array) with signal processing to optimize the radiation/reception pattern in response to the signal environment.
- These antennas can adapt to changes in reception power, transmission conditions and many signal propagation effects.
- Antenna arrays can also be used for beam forming. This would be an extreme case of a directed antenna which can follow a single user thus using Space Division Multiplexing .
- It would not just be base stations that could follow users with an individual beam.
- Wireless devices, too, could direct their electromagnetic radiation, e.g., away from the human body towards a base station. This would help in reducing the absorbed radiation.
- Today's handset antennas are omni-directional as the integration of smart antennas into mobiles is difficult and has not yet been realized.

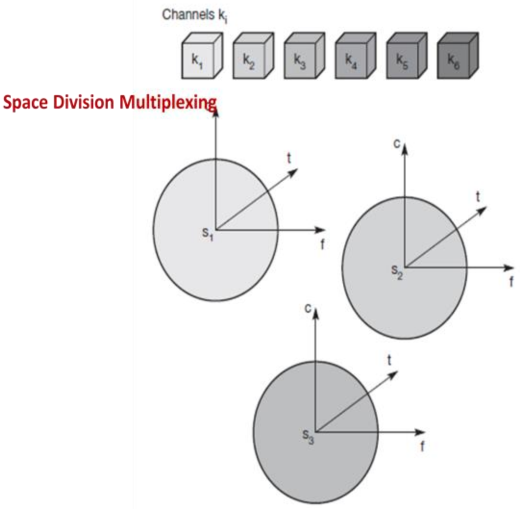
(OR)

3	a)	**What is the multiplexing? Differentiate various types of multiplexing techniques.**	**CO1**	**4**	**7M**

- Multiplexing describes how several users can share a medium with minimum or no interference.
- One example, is highways with several lanes. Many users (car drivers) use the same medium (the highways) with hopefully no interference (i.e., accidents). This is possible due to the provision of several lanes (space division multiplexing) separating the traffic.
- In addition, different cars use the same medium (i.e., the same lane) at different points in time (time division multiplexing).
- For wireless communication, multiplexing can be carried out in four dimensions: space, time, frequency, and code.
- Depending on this there are four types of Multiplexing

✓ **Space Division Multiplexing**
✓ **Frequency Division multiplexing**
✓ **Time Division Multiplexing**

✓ **Code Division Multiplexing**



Space Division Multiplexing

- For this first type of multiplexing, **Space Division Multiplexing (SDM), the (three dimensional) space s_i is also shown. Here space is represented** via circles indicating the interference range.
- How is the separation of the different channels achieved? The channels k_1 to k_3 can be mapped onto the three 'spaces' s_1 to s_3 which clearly separate the channels and prevent the interference ranges from overlapping.
- The space between the interference ranges is sometimes called **guard space**. **Such a guard space is needed in** all four multiplexing schemes presented.
- For the **remaining channels (k_4 to k_6) three additional spaces would be needed.**
- In our highway example this would imply that each driver had his or her own lane.

Frequency Division Multiplexing (FDM) describes schemes to subdivide the frequency dimension into several non-overlapping frequency bands as shown in Figure 2.17.

- Each channel k_i is now allotted its own frequency band as indicated.

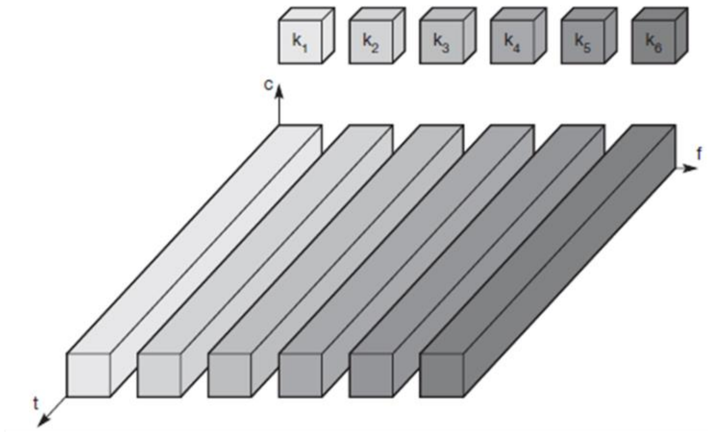
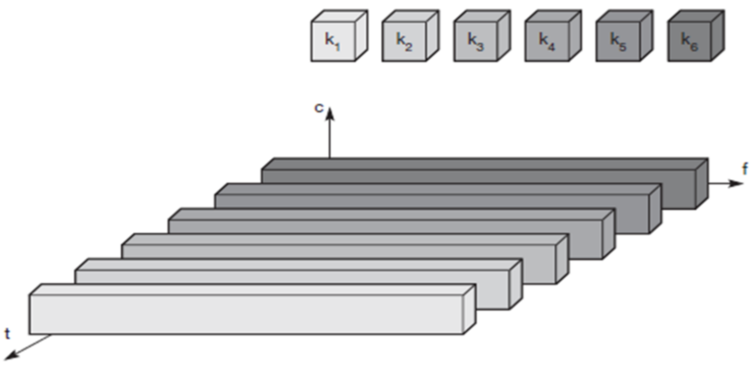


Figure 2.17 Frequency Division Multiplexing (FDM)

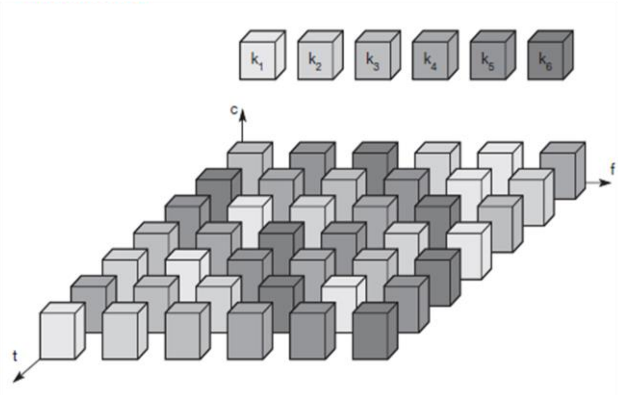
- Senders using a certain frequency band can use this band continuously.
- Again, Guard spaces are needed to avoid frequency band overlapping (also called adjacent channel interference).
- This scheme is used for radio stations within the same region, where each radio station has its own frequency.
- This very simple multiplexing scheme does not need complex coordination between sender and receiver: the receiver only has to tune in to the specific sender.
- However, this scheme also has disadvantages. While radio stations broadcast 24 hours a day, mobile communication typically takes place for only a few minutes at a time.
- Assigning a separate frequency for each possible communication scenario would be a tremendous waste of (scarce) frequency resources.
- Additionally, the fixed assignment of a frequency to a sender makes the scheme very inflexible and limits the number of senders.

- **Time Division Multiplexing**



- Here a channel ki is given the whole bandwidth for a certain amount of time, i.e., all senders use the same frequency but at different points in time (see Figure 2.18).
- Again, guard spaces, which now represent time gaps, have to separate the different periods when the senders use the medium.
- In our highway example, this would refer to the gap between two cars.
- If two transmissions overlap in time, this is called co-channel interference.
- In the highway example, interference between two cars results in an accident.
- To avoid this type of interference, precise synchronization between different senders is necessary. This is clearly a disadvantage, as all senders need precise clocks or, alternatively, a way has to be found to distribute a synchronization signal to all senders.

- **Frequency and time division multiplexing can be combined**



Code Division Multiplexing

- Figure 2.20 shows how all channels ki use the same frequency at the same time for transmission. Separation is now achieved by assigning each channel its own 'code', **guard spaces are realized** by using codes with the necessary 'distance' in code space, e.g., **orthogonal codes. CDM is Viterbi**

The typical everyday example of CDM is a party with many participants from different countries around the world who establish communication channels, i.e., they talk to each other, using the same frequency range (approx. 300–6000 Hz depending on a person's voice) at the same time.

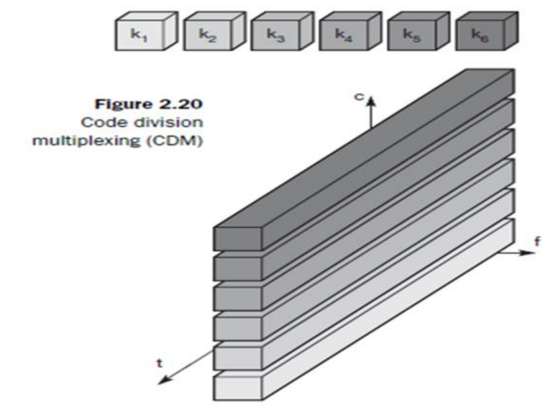


Figure 2.20 Code division multiplexing (CDM)

	b)	**Describe various applications of wireless networks.**	**CO1**	**2**	**7M**

- **Vehicles**
- **Emergencies**
- **Business**
- **Replacement of wired networks**
- **Infotainment and more**
- **Location dependent services**
- **Mobile and wireless devices**

- **Vehicles-DAB, UMTS, GPS, GSM**

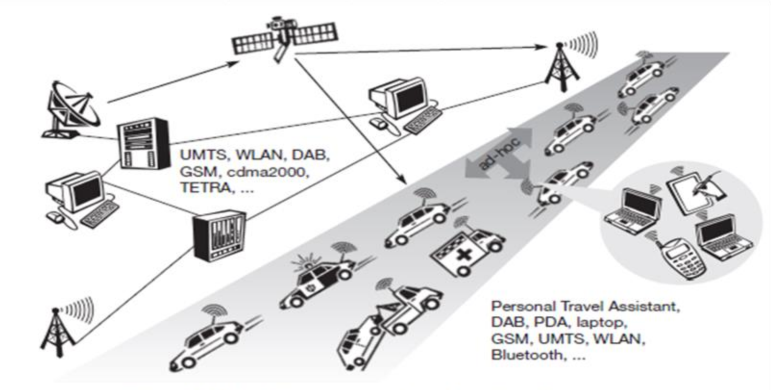


Figure 1.1 A typical application of mobile communications: road traffic

- **Emergencies –**
  - ➢ Ambulance with a high-quality wireless connection to a hospital.
  - ➢ Wireless networks are the only means of communication in the case of natural disasters such as hurricanes or earthquakes.

- **Business** - A **travelling salesman** today **needs instant access** to the company's database: to ensure that files on his or her laptop reflect the current situation, to enable the company to keep track of all activities of their travelling employees, to keep databases consistent etc.

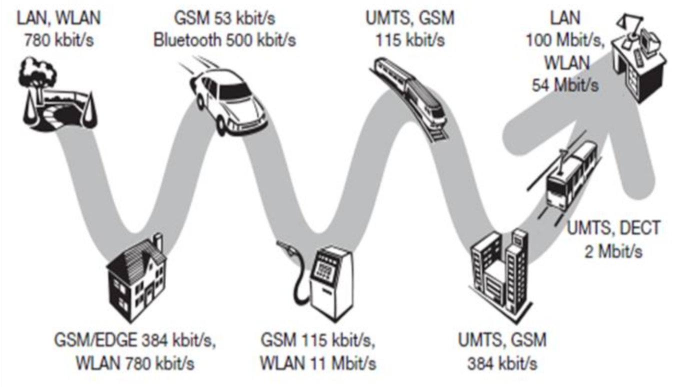


Figure 1.2 Mobile and wireless services – always best connected

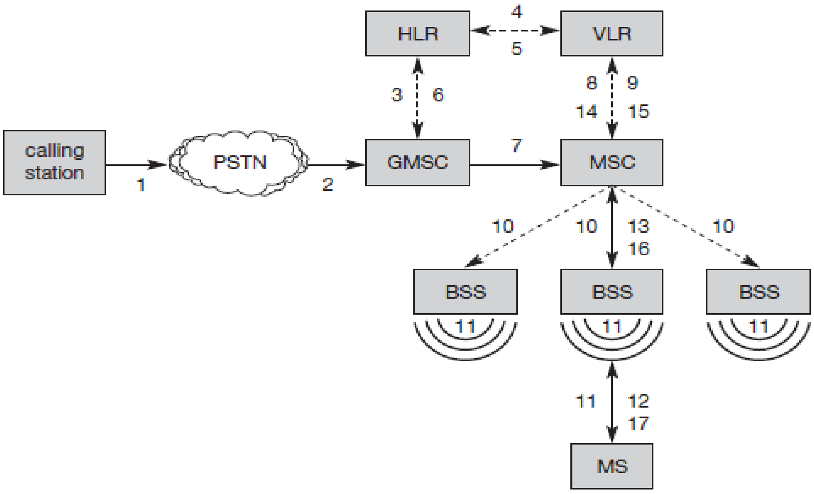
- **Replacement of wired networks**
  - ➢ In some cases, wireless networks can also be used to replace wired networks, e.g., remote sensors, for tradeshows, or in historic buildings.
  - ➢ Due to economic reasons, it is often impossible to wire remote sensors for weather forecasts, earthquake detection, or to provide environmental information.
  - ➢ Wireless connections, e.g., via satellite, can help in this situation.
  - ➢ Tradeshows need a highly dynamic infrastructure, but cabling takes a long time and frequently proves to be too inflexible.
- **Infotainment and more**
  - ➢ Imagine a travel guide for a city. Static information might be loaded via CD-ROM, DVD, or even at home via the Internet.
  - ➢ But wireless networks can provide up-to-date information at any appropriate location. The travel guide might tell you something about the history of a building (knowing via GPS, contact to a local base station, or triangulation where you are) downloading information about a concert in the building at the same evening via a local wireless network.
  - ➢ You may choose a seat, pay via electronic cash, and send this information to a service provider (Cheverst, 2000).
  - ➢ Another growing field of wireless network applications lies in entertainment and games to enable, e.g., ad-hoc gaming networks as soon as people meet to play together.
- **Location dependent services**
  - ➢ Follow-on services
  - ➢ Location aware services
  - ➢ Privacy
  - ➢ Information services
  - ➢ Support services
- **Mobile and Wireless devices**
  - ➢ Sensor : Automatic Door Openers
  - ➢ Embedded Controllers : TV, Washing Machines
  - ➢ Pager: Displays short text message.
  - ➢ Mobile phones
  - ➢ Personal Digital Assistant
  - ➢ Pocket Computer
  - ➢ E-Notebook/Laptop

Unit-II

4	a)	**What are the possibilities of Calling? Explain Mobile Terminated Calls with the help of neat diagram.**	CO2	2	7M

- **The calling function is used to make a call to a mobile (or) a landline.**
- **Two possibilities are**

1.Mobile Terminated Calls
2.Mobile Originated Calls



Step 1: The user dials a GSM subscriber phone number.
Step 2: The PSTN identifies that the number dialed belongs to GSM network and forwards the call to Gateway MSC(GMSC).
Step 3: The gateway MSC identifies the HLR of the subscriber and signals the call setup to the HLR.
Step 4: The HLR checks whether the number exists and the services are permitted services and requests MSRN from the current VLR.
Step 5: The HLR receives the (Mobile Subscriber Roaming Number) MSRN.
Step 6: The HLR determines the MSC responsible for the MS forwards the information to the GMSC.
Step 7: The GMSC forwards the call setup request to the MSC indicated.
Step 8: The MSC is responsible for the steps from here after.
Step 9: The MSC requests the VLR to provide the current status of the MS. The MSC resends the request.
Step 10: If the MS is available the MSC initiates paging in all cells responsible for.
Step 11: The BTS of all the BSS transmit the paging signal.
Step 12 & 13: If the MS answers the VLR performs security check.
Step 14: The MSC response is transmitted to VLR.
Step 15 to 17: The VLR asks the MSC to setup a connection to communicate.

	b)	**What is Hand over? Explain different Handover Mechanisms in Satellite Systems.**	**CO2**	**2**	**7M**

Handover, also known as handoff, is the process of transferring a connection from one base station or channel to another. Different Handover Mechanisms in Satellite Systems are

- **Intra-satellite handover**
- **Inter-satellite handover**
- **Gateway handover**
- **Inter-system handover**

Intra-satellite handover: A user might move from one spot beam of a satellite to another spot beam of the same satellite. Using special antennas, a satellite can create several spot beams within its footprint. The same effect might be caused by the movement of the satellite.

Inter-satellite handover: If a user leaves the footprint of a satellite or if the satellite moves away, a handover to the next satellite takes place. This might be a hard handover switching at one moment or a soft handover using both satellites (or even more) at the same time (as this is possible with CDMA systems). Inter-satellite handover can also take place between satellites if they support ISLs. The satellite system can trade high transmission quality for handover frequency.

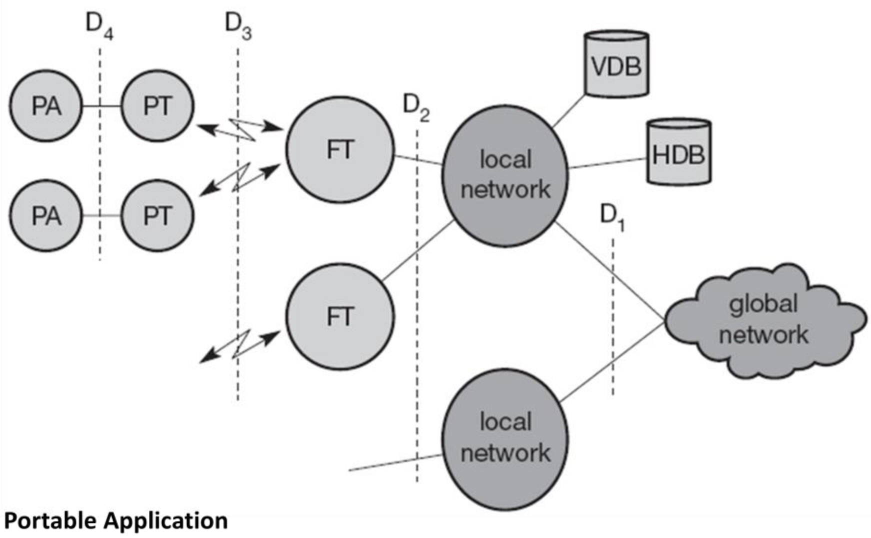
Gateway handover: While the mobile user and satellite might still have good contact, the satellite might move away from the current gateway. The satellite has to connect to another gateway.

Inter-system handover: Typically, satellite systems are used in remote areas if no other network is available. As soon as traditional cellular networks are available, users might switch to this type usually because it is cheaper and offers lower latency. Current systems allow for the use of dual-mode (or even more) mobile phones but unfortunately, seamless handover between satellite systems and terrestrial systems or vice versa has not been possible up to now.

(OR)

5	a)	**Draw and explain the System Architecture of DECT system**	**CO2**	**2**	**7M**

DECT stands for Digital Enhanced Cardless Telecommunication.. DECT is used in offices, trade shows, home etc. Digital Cellular networking specialized by ETSI in 2002. A normal DECT slot is 417 microseconds long and contains 420 bits. Most of the DECT product on the market today use Gaussian filtered FSK (GFSK).DECT uses Dynamic Channel Allocation. Most of the DECT product on the market today use Gaussian filtered FSK (GFSK) as their modulation scheme.



PA: Portable Application
PT: Portable Radio Termination
FT: Fixed Radio Termination

Global Networks:

- connects the local structure to the outside world, offer services via interface *D1, External Network.*
- Global Network can be ISDN/PSTN.
- The services offered can be transportation of data, translation of address and routing of data between networks.

Local Network:

- The local networks in DECT offer local Communication Services (e.g.) call forwarding, address translation. This is the core of the DECT system.
- All the network functions needs to be integrated in with local or global network.
- The local network has Home Data Base (HDB) and Visitor Data Base (VDB).
- These data bases support mobility. They are similar to HLR and VLR.
- Incoming calls are automatically forwarded to the current subsystem responsible for the DECT user and the VDB informs the HDB about change in location.

Fixed Radio Termination(FT) and Portable Radio Termination(PT)

- They form the (FT & PT) core of DECT network.
- They provide multiplexing.
- They form layer 1 to 3 in both fixed network and mobile network.

b)	**Explain different types of Orbits of Satellite Systems.**	**CO2**	**2**	**7M**

Four different types of orbits can be identified as shown in Figure 5.6:

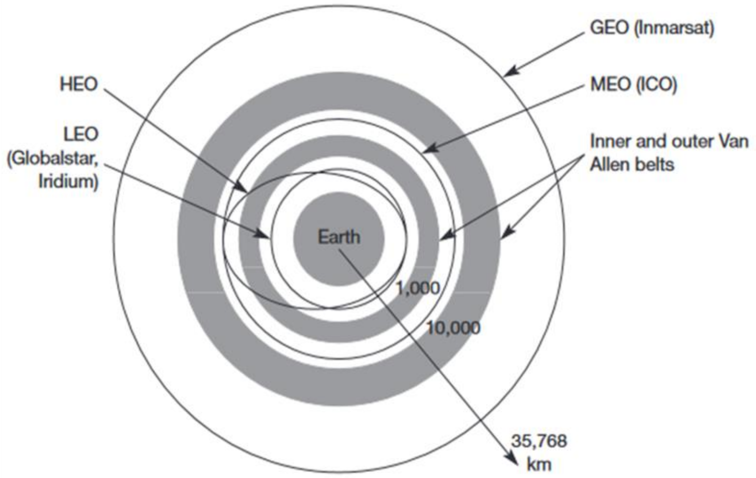


Figure 5.6 Different types of satellite orbits

● **Geostationary (or geosynchronous) earth orbit (GEO):** GEO satellites have a distance of almost 36,000 km to the earth. Examples are almost all TV and radio broadcast satellites, many weather satellites and satellites operating as backbones for the telephone network.

● **Medium earth orbit (MEO):** MEOs operate at a distance of about 5,000–12,000 km. Up to now there have not been many satellites in this class, but some upcoming systems (e.g., ICO) use this class for various reasons .

● **Low Earth Orbit (LEO):** While some time ago LEO satellites were mainly used for espionage, several of the new satellite systems now rely on this class using altitudes of 500–1,500 km.

● **Highly Elliptical Orbit (HEO):** This class comprises all satellites with noncircular orbits. Currently, only a few commercial communication systems using satellites with elliptical orbits are planned. These systems have their perigee over large cities to improve communication quality.

Unit-III

6	a)	Describe basic DFWMAC-DCF using CSMA/CA.	CO3	2	7M

- **To access the medium three methods are available.**
  - **DFWMAC-DCF CSMA/CA(mandatory)**
  - **DFWMAC-DCF W/RTS/CTS (optional)**
  - **DFW MAC-PCF (optional)**

DFW: Distributed Foundation Wireless
MAC: Medium Access Control
DCF: Distributed Co-ordination Function
PCF: Point Co-ordination Function
DFWMAC-DCF using CSMA/CA

- This method is used to check whether the medium is idle or busy. This is the mandatory access method. This method is based on CSMA/CA.

Concept:

- When the device is ready to send it starts sensing the medium. Carrier sense based on Clear Channel Assessment(CCA).
- If the medium is free for the duration of Inter Frame space(IFS), the station can start sending. The IFS depends upon the service type.
- If the medium is busy the station has to wait for a free IFS. When more than one node compete after IFS they entering the contention phase.
- During the contention phase, each node chooses a random back off time within the contention window.
- The Nodes delays the medium sense for chosen random amount of time.
- After the random amount of time the node senses the medium, two scenario's exist.

(a) Medium is idle, the node can access the medium.
(b) The medium is busy, the cycle is lost and the node has to wait once again for on DIFS the idle medium.

- The additional waiting time is measured in multiple of the slots.
- The advantage of randomness is that it avoids collision.
- The disadvantage is that this method is not fair because irrespective of the waiting time all the nodes have chance of transmitting data in the next cycle.
- To have fairness 802.11 adds back off timer.

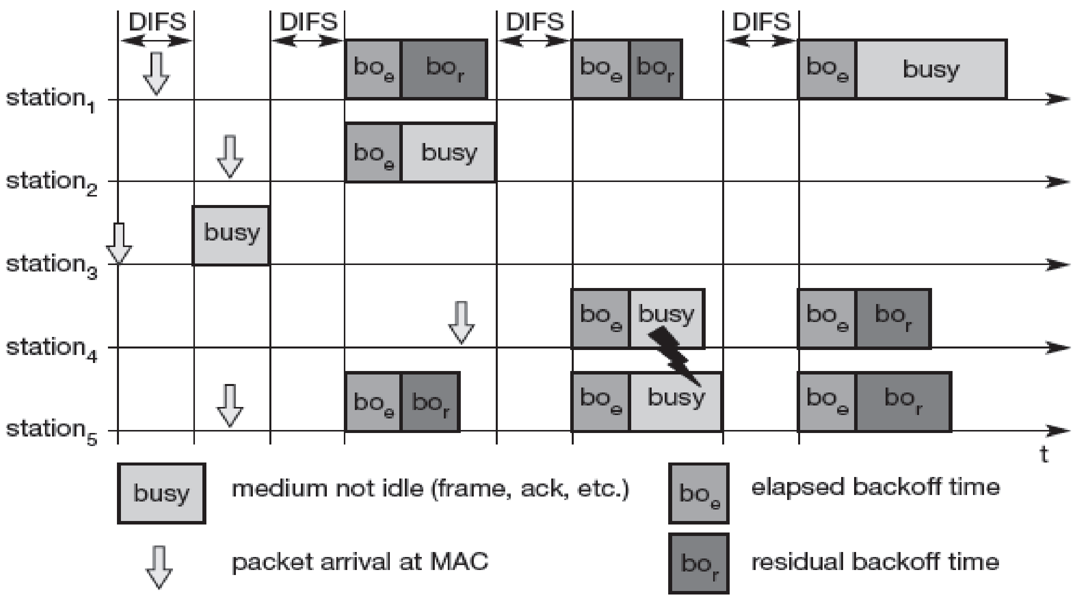
Concept of Back off timer:

- All the nodes need to wait for IFS (Free). Then each nodes selects a random waiting time within the contention window.
- If the station does not get the access to the medium, it stops the back off timer. Waits for the channel to be free for I DIFS and starts the counter again.
- As soon as the counter expires the nodes access the medium.
- The states that the deferred station do not choose the back off timer again but counts down.

Advantage:

- Station waiting for a longer time has an edge over the nodes that have just entered, because
- it has to wait only for the remainder of the back off timer from the previous cycles.

To illustrate the concept consider 5 stations STA1 to STA5 are trying to send a packet at some point of timer.



- From the figure station 3 has the first request to send a packet. The station 3 senses the medium, finds the waits for medium is idle 1 DIFS and finds that the medium is idle throughout and sends the packet.
- Station1, Station2, Station5 need to wait for 1 DIFS after station 3 window and starts coming down their timer. The stations need to choose back off times because more stations compete.

  Back off time=BOe + BOr
- The back off timer for station 2 is very low. Hence it accesses the medium.
- The station 1 , and station 5 stops the clock and store their residual back off timer. Now station 4 wants to send a packet. It waits for 1 DIFS. Three stations try to get access the medium. Accidentally two stations can have the same back off time. Station 4 and Station 5-

- This results in collision and need to wait. Hence station 1 gets access to the medium. Due to the collision station 4 and 5 need to select a new back off timer.
- The problem in this method is the selection of contention window size. If the window size is large causes unnecessary delay over the other hand when it is small results in unnecessary collisions.
- The system tries to select the value based upon the number of stations trying to send. The size of the contention window follows exponential back off.
  (e.g.) Starts with CW=7.
- When collision occurs, CW size doubles CW=49 and goes on until maximum of CW, 255.
- The above scenario is for heavy load. Under light load, it starts decreasing until CW=7.

	b)	**Explain the Destination Sequenced Distance Vector (DSDV) routing protocol.**	**CO3**	**2**	**7M**

Destination Sequence Distance Vector

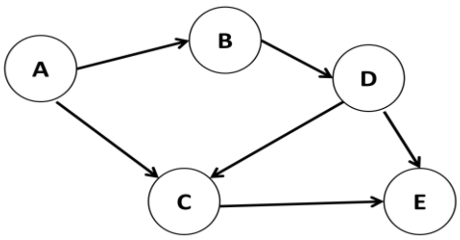
- This DSDV is an enhancement to Distance Vector Routing.
- Distance vector routing is used as Routing Information Protocol (RIP) in wired networks.
- Distance Vector Concept: Each node exchanges with its neighbor , the adjacency in formation (i.e.) hop count changes at one node in the network
- To the existing also DSDV adds two concepts:

1. Sequence Number: Each routing advertisement s come s with a sequence number. The advertisement travel in many paths. The sequence number is used to see the order of advertisements.

2. Damping Advantage: Avoid loops ; when the topology remains the same**.**

- DSDV adds the concept of sequence numbers to the distance vector algorithm.
- Each routing advertisement comes with a sequence number.
- Within ad-hoc networks, advertisements may propagate along many paths.
- Sequence numbers help to apply the advertisements in correct order.
- This avoids the loops that are likely with the unchanged distance vector algorithm.
- Each node maintains a routing table which stores next hop, cost metric towards each destination and a sequence number that is created by the destination itself.
- Each node periodically forwards routing table to neighbors.
- Each node increments and appends its sequence number when sending its local routing table.
- Each route is tagged with a sequence number; routes with unique sequence numbers are preferred.
- Each node advertises a monotonically increasing even sequence number for itself.
- When a node decides that a route is broken, it increments the sequence number of the route and advertises it with infinite metric.
- Destination advertises new sequence number.
- In this, each node keeps the record of route information in the form of Routing Table.
- Each node exchanges its updated routing table with each other.
- The Routing table consists of Destination ID, Next Node, Distance(no.of hops) and Sequence number.
- Route Broadcast message consists of Destination node, next hop, recent sequence number, distance.
- Updates about the routing are two types: Full Dump and Incremental update.

- Each node receives the route information
- Node looks at its routing table in order to determine shortest path to reach all the destinations.
- Each node constructs another routing table based on shortest path information.
- New routing table will be broadcast to its neighboring nodes.
- Neighbor nodes updates its routing Table.
- If path broken, then sequence number updated to infinity



Routing Table for Node A

Destination	Next Node	Distance	Sequence Number
B	B	1	31
C	C	1	32
D	B	2	33
E	C	2	34

(OR)

7	a)	**Discuss about agent discovery in Mobile IP.**	**CO3**	**2**	**7M**

Agent discovery

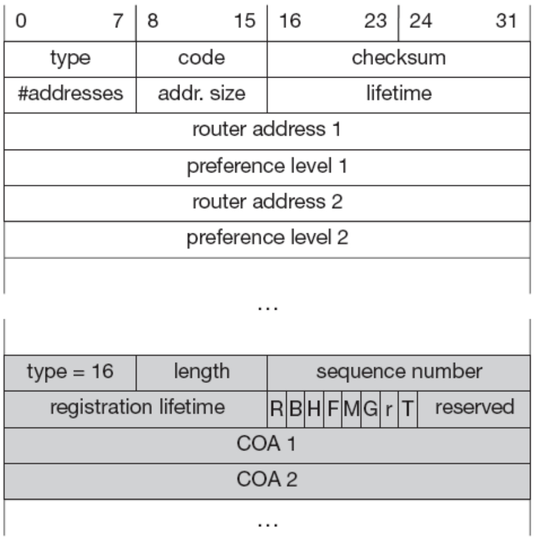
- When the MN moves to a Foreign Network it needs the support of Foreign Agent. To identify the FA, mobile IP suggests two methods.

1. Agent Advertisement.

2. Agent Solicitation.

Agent Advertisement

- In this method the **HA and Foreign Agent advertise periodically** the "Agent advertisement messages". These messages are sent as **beacon broadcast to the subnet.**
- **To advertise, ICMP (Internet Control Message Protocol) are used.**
- The agent advertisement packet follows RFC 1256(Request For Comments) standard plus mobility extension.
- The packets have the following structure in Figure 4.3.
- The **upper part represents the ICMP packet**, the **lower part is the extension needed for mobility.**
- The TTL field of IP packet is =1 for all advertisements to avoid forwarding.
- IP destination address for advertisement is **224.0.0.1** the multicast address (or**) 255.255.255.255** the broadcast address



Agent Solicitation (collection)

- If no agent advertisements are present (or) Inter Arrival time is too high, and mobile Node has not received a COA by any other means, the **Mobile Node must send "agent Solicitation**".
- The Solicitations are based on RFC 1256.
- Care should be taken to ensure that solicitation messages should not flood the network.
- But the **Mobile Node can search for an FA endlessly sending out solicitation messages.**
- **A mobile Node can send out 3 solicitations, One-per second, as soon as it enters new networks.**
- In highly dynamic networks, the Mobile Node's are moving, and the application receives continuous packets in one second interval between solicitation will be too long.
- Before the **Mobile Node gets ends new address many packets will be lost.** If the node does not receive an answer it must decrease the rate of solicitation exponentially to avoid flooding.

b)	**Explain in detail about DHCP.**	**CO3**	**2**	**7M**

1) The aim of DHCP is to simplify the installation and maintenance of network computer.
2) When a new computer is added to the network, DHCP can provide with all necessary information for integration.
3) DHCP provides IP address.

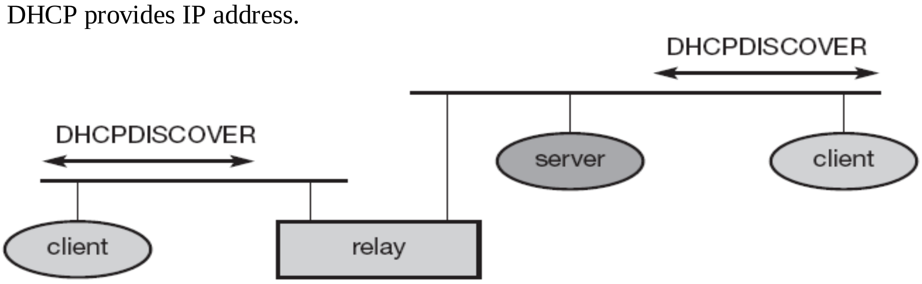


Fig 4.17: Basic DHCP configuration

- DHCP is based on client server model.
- DHCP client sends a request to the server using DHCP Discover, which is broadcasted.
- The server responds.
- The relay is needed to forward across the interworking units to a server.

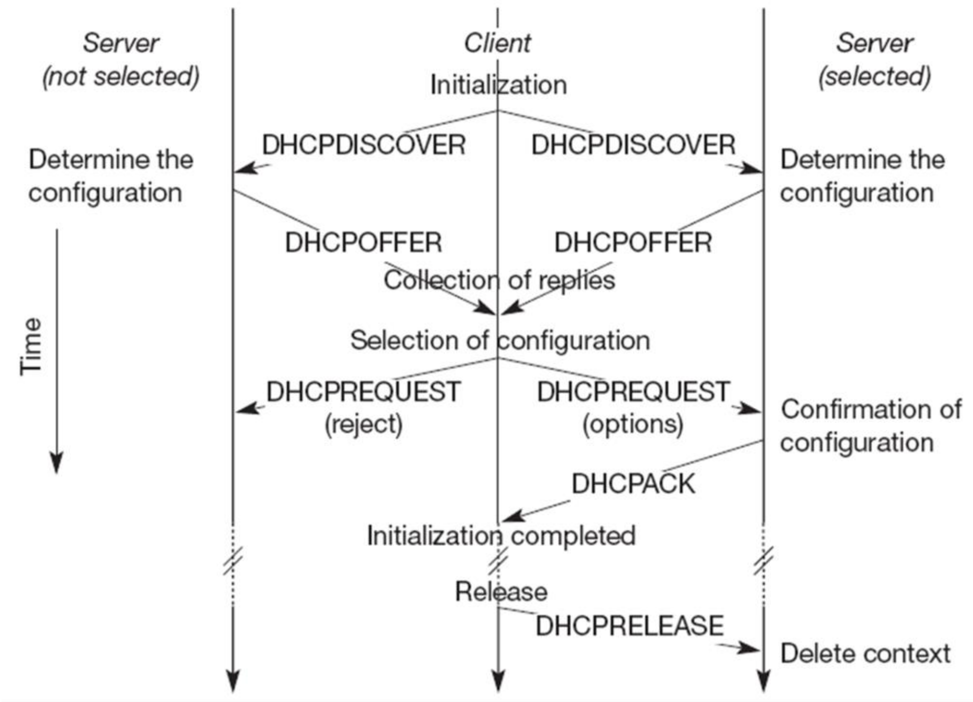


Fig 4.18: Client initialization via DHCP

Initialization phase:

- The client broadcasts a DHCPDISCOVER to the subnet. There may be a relay to forward this broadcast.
- In the above figure two servers receive this broadcast and determine the configuration they can offer to the client.
- Server‟s reply to the client‟s request with DHCPOFFER and offers a list of configuration parameters.
- The client can choose one of the configurations offered.
- The client replies to the servers either accepting or rejecting using DHCPREQUEST for rejection the client sends DHCP REQUEST with a reject.
- The rejected server releases the reserved configuration.
- The accepted server sends back DHCPACK acknowledgement.

This completes the initialization phase.

Release:

- When the client leaves the subnet it should release the configuration received from the server.
- It does using the DHCPRELEASE.
- The period of service is fixed.
- If the client does not reconfirm within that duration the server will free the configuration.
- Thus the DHCP supports the acquisition of COA for the mobile modes.

DHCP is a good candidate for supporting the acquisition of Care-Of Addresses for mobile nodes. The same holds for all other parameters needed, such as addresses of the Default Router, DNS servers, the Time Server etc. A DHCP server should be located in the subnet of the Access Point of the mobile node, or at least a DHCP relay should provide forwarding of the messages. RFC 3118 specifies authentication for DHCP messages which is needed to protect mobile nodes from malicious DHCP servers. Without Authentication, the mobile node cannot trust a DHCP server, and the DHCP server cannot trust the mobile node.

Unit-IV

8	a)	**Draw the 4G Architecture of LTE-Advanced and explain about Femtocells.**	**CO4**	**2**	**7M**

- Figure 1.11 illustrates the principal elements in an LTE- Advanced network.
- The two main components are

1. **The radio access network, called Evolved Universal Terrestrial Radio Access Network (E-UTRAN), and**
2. **The core network, called Evolved Packet Core (EPC).**

- E-UTRAN involves eNodeB,X2 Interface, Relay Nodes, Femtocells, Carrier Aggregation.
- Evolved Packet Core (EPC) involves Mobility management entity(MME), Serving gateway (SGW), Packet data network gateway (PGW) and Home subscriber server (HSS) with S1 interfaces

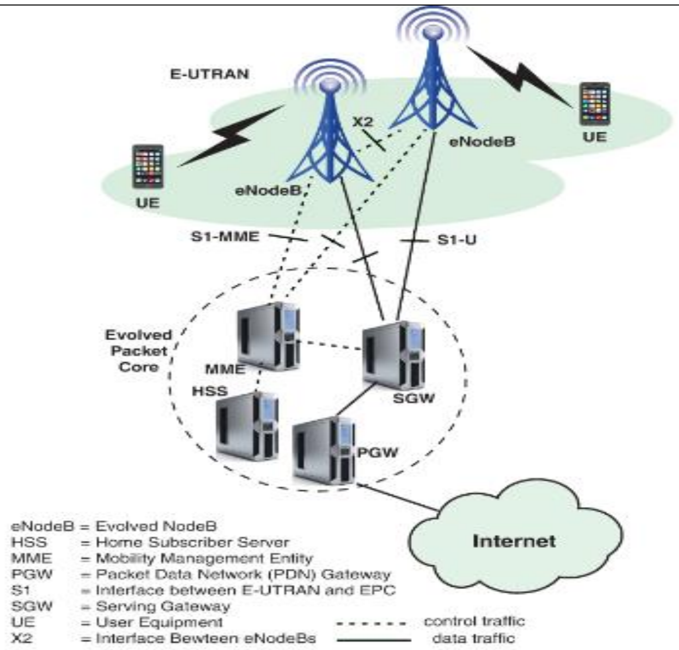


FIGURE 1.11 4G Architecture: LTE-Advanced

- The heart of the E-UTRAN is the base station, designated evolved NodeB (eNodeB). In UMTS, the base station is referred to as NodeB.

Femtocells

- The industry responded to the increasing data transmission demands from smartphones, tablets, and similar devices by introducing 3G and 4G cellular networks.
- As demand continues to increase, it becomes increasingly difficult to satisfy the demand, particularly in densely populated areas and remote rural areas.
- An essential component of the 4G strategy for satisfying demand is the use of femtocells.
- A femtocell is a low-power, short-range, self-contained base station.

Initially used to describe consumer units intended for residential homes, the term has expanded to encompass higher-capacity units for enterprise, rural, and metropolitan areas.

- Key attributes include IP backhaul, self- optimization, low power consumption, and ease of deployment.
- Femtocells are by far the most numerous type of small cells.
- The term small cell is an umbrella term for low-powered radio access nodes that operate in licensed and unlicensed spectrum that have a range of 10 m to several hundred meters indoors or outdoors.
- These contrast with a typical mobile macrocell, which might have a range of up to several tens of kilometers.
- Macrocells would best be used for highly mobile users and small cells for low-speed or stationary users.
- Small cells now outnumber macrocells, and the proportion of small cells in 4G networks has risen dramatically.
- Deployment of these cells is called network densification, and the result is a heterogeneous network of large and small cells called a HetNet.
- Figure 1.12 shows the typical elements in a network that uses femtocells.
- The femtocell access point is a small base station, much like a Wi-Fi hotspot base station, placed in a residential, business, or public setting.
- It operates in the same frequency band and with the same protocols as an ordinary cellular network base station.
- Thus, a 4G smartphone or tablet can connect wirelessly with a 4G femtocell with no change.
- The femtocell connects to the Internet, typically over a DSL, fiber, or cable landline.
- Packetized traffic to and from the femtocell connects to the cellular operator's core packet network via a femtocell gateway.

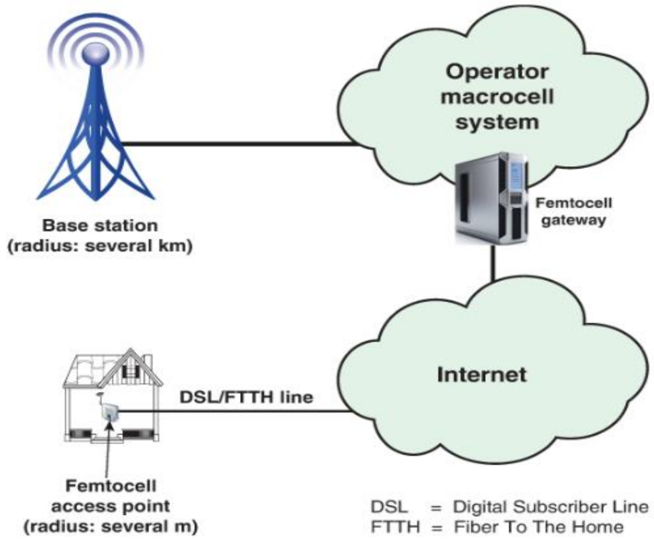


FIGURE 1.12 The Role of Femtocells

	b)	**Discuss the softwarization approaches used in 5G NGMN Model.**	CO4	2	7M

Four approaches to softwarization are important in 5G networks and reflected in the NGMN model: They are

1.Software-Defined Networking (SDN)
2.Network Functions Virtualization (NFV)
3.Edge Computing
4.Cloud-Edge Computing

1. Software-defined networking (SDN): An approach to designing, building, and operating large-scale networks based on programming the forwarding decisions in routers and switches via software from a central server. SDN differs from traditional networking, which requires configuration of each device separately and relies on protocols that cannot be altered.

2.Network Functions Virtualization (NFV): The virtualization of compute, storage, and network functions by implementing these functions in software and running them on virtual machines.

3.Edge computing: A distributed information technology (IT) architecture in which client data is processed at the periphery of the network, as close to the originating source as possible.

4.Cloud-Edge computing : A form of edge computing that offers application developers and service providers cloud computing capabilities as well as an IT service environment at the edge of a network. The aim is to deliver compute, storage, and bandwidth much closer to data inputs and/or end users.

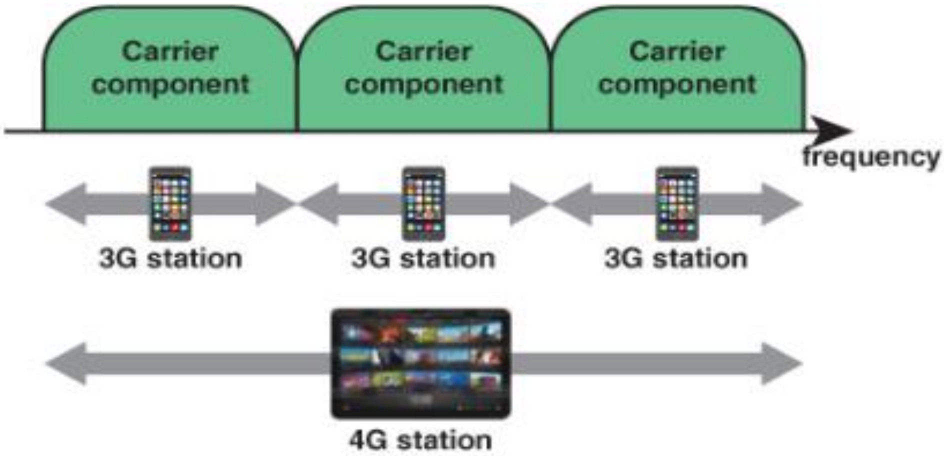
(OR)

9	a)	**Discuss Carrier Aggregation and Evolved Packet Core.**	CO4	2	7M

Carrier Aggregation

- Carrier aggregation is used in LTE-Advanced in order to increase the bandwidth and thereby increase the bitrates.
- Because it is important to maintain backward compatibility with LTE, the aggregation is of LTE carriers.
- Carrier aggregation can be used for both FDD and TDD.
- Each aggregated carrier is referred to as a component carrier (CC).
- The component carrier can have a bandwidth of 1.4, 3, 5, 10, 15, or 20 MHz, and a maximum of five component carriers can be aggregated; hence, the maximum aggregated bandwidth is 100 MHz.
- In FDD, the number of aggregated carriers can be different in the DL and the UL. However, the number of UL component carriers is always equal to or lower than the number of DL component carriers.
- The individual component carriers can also be of different bandwidths.
- When TDD is used, the number of CCs and the bandwidth of each CC are the same for the DL and the UL.

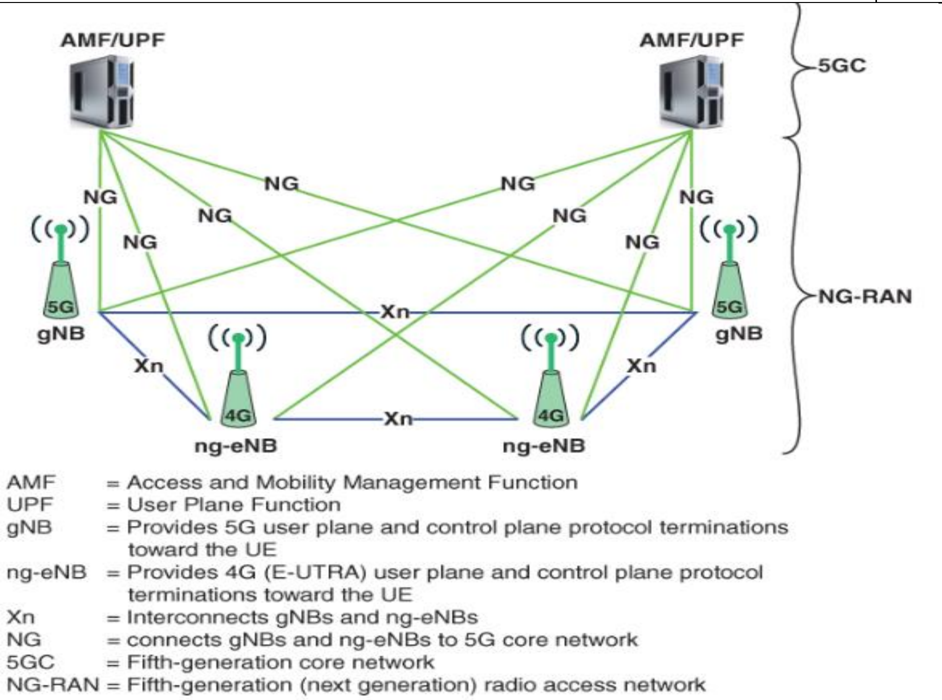
Figure 1.14a illustrates how three carriers, each of which is suitable for a 3G station, are aggregated to form a wider bandwidth suitable for a 4G station.



(a) Logical view of carrier aggregation

- The operator, or carrier, network that interconnects all of the base stations of the carrier is referred to as the **evolved packet core (EPC).**
- Traditionally, the core cellular network was circuit switched, but for 4G, the core is entirely packet switched.
- It is based on IP and supports voice connections using **voice over IP (VoIP).**
- The essential components of the EPC: **Mobility management entity(MME), Serving gateway (SGW), Packet data network gateway (PGW) and Home subscriber server (HSS)**
- **Mobility management entity (MME):** The MME deals with control signaling related to mobility and security. The MME is responsible for the tracking and paging of UE in idle mode.
- **Serving gateway (SGW):** The SGW deals with user data transmitted and received by UEs in packet form, using IP. The SGW is the point of interconnect between the radio side and the EPC. As its name indicates, this gateway serves the UE by routing the incoming and outgoing IP packets. It is the anchor point for the intra-LTE mobility (i.e., in the case of handover between eNodeBs). Thus packets can be routed from an eNodeB to an eNodeB in another area via the SGW and can also be routed to external networks such as the Internet (via the PGW).
- **Packet data network gateway (PGW):** The PGW is the point of interconnection between the EPC and external IP networks such as the Internet. The PGW routes packets to and from the external networks. It also performs various functions, such as IP address/IP prefix allocation and policy control and charging.
- **Home subscriber server (HSS):** the HSS maintains a database that contains user-related and subscriber-related information. It also provides support functions in mobility management, call and session setup, user authentication, and access authorization.

	b)	**Draw and explain overall Next Generation Radio Access Network Architecture.**	**CO4**	**2**	**7M**



- Figure 3.8, from TS 38.300, depicts the overall RAN architecture.
- There are two types of base stations, called NG-RAN nodes:
  - gNB: Provides 5G user plane and control plane protocol terminations toward the UE.
  - ng-eNB: Provides 4G (E-UTRA) user plane and control plane protocol terminations toward the UE and connects via the NG interface to the 5G core. This enables 5G networks to support UE that use the 4G air interface. However, the UE must still implement the 5G protocols to interact with the 5G core network.
- The gNBs and ng-eNBs are interconnected with each other by means of the Xn interface.
- The gNBs and ng-eNBs are also connected by means of the NG interfaces to the core network (5GC)—specifically, to the AMF (Access and Mobility management Function) by means of the NG-C interface and to the UPF (user plane function) by means of the NG-U interface.

Functional Split b/w NG-RAN and Core Network

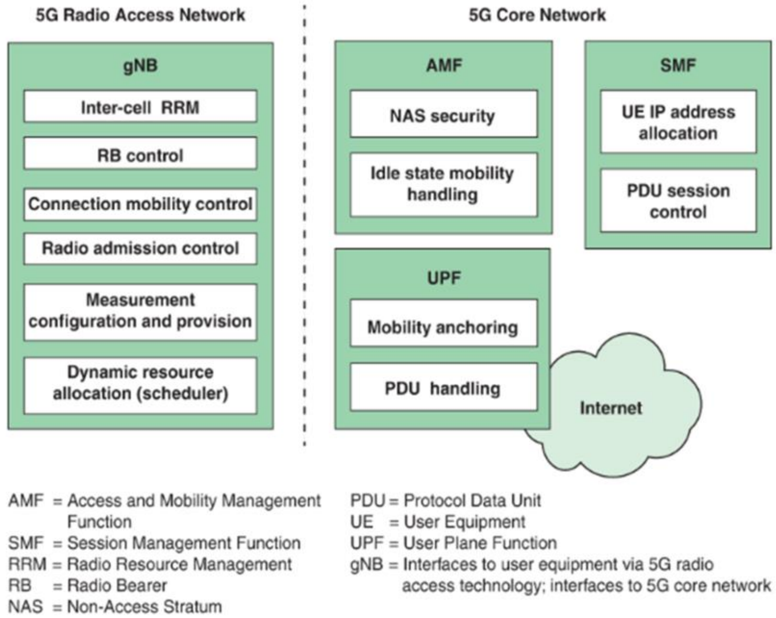


FIGURE 3.9 Functional Split Between NG-RAN and 5G Core Network

- Figure 3.9, from TS 38.300, shows the major functional elements performed by the RAN, together with functions within the core network that specifically relate to the RAN.
- The outer shaded boxes depict the logical nodes, and the inner white boxes depict the main functions at each node.
- TS 38.300 also includes a more comprehensive list of functions for the four logical nodes.
- **RAN Functional Areas:** The following key functional areas in the NG-RAN are
  - **Inter-cell Radio Resource Management:** Allows the UE to detect neighbor cells, query about the best serving cell, and support the network during handover decisions by providing measurement feedback.
  - **Radio Bearer Control (RBC):**Consists of the procedure for configuration (such as security), establishment, and maintenance of the radio bearer (RB) on both the uplink and downlink with different quality of service (QoS). The term radio bearer refers to an information transmission path of defined capacity, delay, bit error rate, and other

parameters.

- **Connection Mobility Control (CMC):**Functions both in UE idle mode and connected mode.
  - In idle mode, UE is switched on but does not have an established connection.
  - In connected mode, UE is switched on and has an established connection.
  - In idle mode, CMC performs cell selection and reselection. The connected mode involves handover procedures triggered on the basis of the outcome of CMC algorithms.
- **Radio Admission Control (RAC):** Decides whether a new radio bearer admission request is admitted or rejected.
  - The objective is to optimize radio resource usage while maintaining the QoS of existing user connections.
  - Note that RAC decides on admission or rejection for a new radio bearer, while RBC takes care of bearer maintenance and bearer release operations.
- **Measurement Configuration and provision:** Consists of provisioning the configuration of the UE for radio resource management procedures such as cell selection and reselection and for requesting measurement reports to improve scheduling.
- **Dynamic Resource allocation (scheduler):** Consists of scheduling RF resources according to their availability on the uplink and downlink for multiple pieces of UE, according to the QoS profiles of a radio bearer.

Core Network

- On the core network side, the NG-RAN nodes interact with three functions: **the Access and Mobility management(AMF), Session Management(SMF), and User Plane Functions(UPF).**
- **Access and Mobility Management:** The AMF provides UE authentication, authorization, and mobility management services.
  - The two main functions for AMF are **NAS security** and **idle state mobility handling.**
    - **The Non-Access Stratum (NAS)** is the highest protocol layer of the control plane between UE and the access and mobility management function (AMF) in the core network.
    - The main functions of the protocols that are part of the NAS are the support of mobility of the UE and the support of session management procedures to establish and maintain IP connectivity between the UE and user plane function (UPF). It is used to maintain continuous communications with the UE as it moves.
    - In contrast, the access stratum is responsible for carrying information just over the wireless portion of a connection.
    - NAS security involves IP header compression, encryption, and integrity protection of data based on the NAS security keys derived during the registration and authentication procedure.
  - **Idle state mobility** handling deals with cell selection and reselection while the UE is in idle mode, as well as reachability determination.
- **Session Management Function**: The two main functions for SMF are UE IP address allocation and PDU session control.
  - UE IP address allocation assigns an IP address to the UE at the time of session establishment. This ensures the ability to route data packets within the 5G system and also supports data reception and forwarding to outside networks and provides interconnectivity to external packet data networks (PDNs).
  - In cooperation with the UPF, the SMF establishes, maintains, and releases a PDU session for user data transfer, which is defined as an association between the UE and a data network that provides PDU connectivity.
- **User Plane Function(UPF):** The two main functions for UPF are UE IP mobility anchoring and PDU handling.
  - UE mobility handling deals with ensuring that there is no data loss when there is a connection transfer due to handover that involves changing anchor points.
  - Once a session is established, the UPF has a responsibility for PDU handling. This includes the basic functions of packet routing, forwarding, and QoS handling.

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