01

Wireless Network :- Wireless networks are networks that use radio waves to connect devices, without the necessity of using cables. In radio and electronics, an antenna is an electrical devices which convert electric power into radio waves. Radio frequency (RF) range around 3KHz to 300GHz. As for example are- Cordless phone, TV Remote, GPS system etc.

Commonly used wireless networking devices are-

01. Sensor.
02. Phones.
03. Tablets
04. Bluetooth
05. Router.
06. Portable computer
07. Desktop "
08. hand held "
09. Personal digital assistant (PDA's)
10. cellular phone.
11. Pager.

(02) Explain briefly the propagation of Radio waves through space.

Ans:- Windless networks are networks that used radio waves to connect device without the necessity of using cables. The basis of windless system are radio waves, an implementation that take place at the physical level of network structure. Radio frequency (RF) is any of the electromagnetic wave frequencies that lie in the range extending from around 3KHz-300GHz. In Radio and electronic an antenna is an electrical device which converts electric power into radio waves.

Radio waves propagate through space as travelling electromagnetic waves. The energy of signals, exists in the form of electrical to magnetic fields. Both electrical and magnetic field vary sinusoidally with time.

The two fields always exists together because a change in electrical field and a change in magnetic field develops in electrical field. Thus is continuous flow of energy from one field to the other

Why Windless?

We need a new technology when we have such developed public telephone network.

- Windless network can be easily installed
- No running, media cables between Transceivers.
- Cost- Inexpensive.
- Ease of use- Use from anywhere.
- " " - Allow multiple device to simultaneously use the same windless connection
- Communicate with moving

Ans to the ques No-C (03) Roll-232133.

Q. Explain at least 3 limitation of wireless Network. Show 6 scenarios which present a specific challenge or problem that comes up when working with wireless equipments.

Ans:- Limitation of wireless network are —

1) Signal loss — the further they travel the more wireless signals to lose their strength. This equates to attenuation or signal loss (or weakening signals).

2) Interference — Radio transmission cannot be protected against interference with shielding

3) Absorption Wireless Network - Absorption occurs when the signal strength loses power as it passes through a medium. All materials will absorb the signal at different rates. Wood is an example.

P.T.O

Roll-23

04

Challenges or problem when work with wireless equipments: Wireless challenges that comes up when work with wireless equipments mention in below :—

1) Distance - Wireless signal lose power the further they travel, no matter the type of Antenna.
2) Line of sight - Wireless signal can encounter total barriers, preventing connection
3) Barriers - Windows signal lose signal strength through solid object
4) Interference - Router can be too loud, making it impossible for them to hear each other.
5) Weather - Weather condition can disrupt wireless signal.
6) Electrical power issues - Routers needs steady electricity to work correctly.

Ans. to the Qsn No - C.

(C) Ans: **Limitations of Wireless network**: There are some limitation of wireless network mention in below:—

i) Signal loss.
ii) Interference
iii) Multipath padding,
iv) Reflection Materials
v) Hidden node problems.
vi) Absorption Wireless Network.

Wireless challenges that comes up when working with wireless equipments:—

1. Distance - Wireless signal lose power the further they travel, no matter the type of Antenna.
2. Line of sight - Wireless signals can encounter total barriers, preventing connection.
3. Barriers - Wireless signal lose signal strength through solid object.
4. Interference - Router can be too loud, making it impossible for them to hear each other.
5. Weather - Weather conditions can disrupt wireless signals.
6. Electrical power issues - Routers needs steady electricity to work correctly.

	people etc.

Q.-04. Describe the Layers of Bluetooth networks

Ans. **Bluetooth** is a **network** technology that connects mobile devices wirelessly over a short range to form a personal area **network** (PAN)

Application Layer
L2CAL Layer
Baseband Layer
Radio Layer

Protocols in the Bluetooth Protocol Architecture

Physical Layer – *This includes Bluetooth radio and Baseband (also in the data link layer.*

Radio – This is a physical layer equivalent protocol that lays down the physical structure and specifications for transmission of radio waves. It defines air interface, frequency bands, frequency hopping specifications, and modulation techniques.

Baseband – This protocol takes the services of radio protocol. It defines the addressing scheme, packet frame format, timing, and power control algorithms.

Data Link Layer – This includes Baseband, Link Manager Protocol (LMP), and Logical Link Control and Adaptation Protocol (L2CAP).

Link Manager Protocol (LMP) – LMP establishes logical links between Bluetooth devices and maintains the links for enabling communications. The other main functions of LMP are device authentication, message encryption, and negotiation of packet sizes.

Logical Link Control and Adaptation Protocol (L2CAP) – L2CAP *provides adaption between upper layer frame and baseband layer frame format. L2CAP provides support for both connection-oriented as well as connectionless services.*

Middleware Layer – *This includes Radio Frequency Communications (RFComm) protocol, adopted protocols, SDP, and AT commands.*

RFComm – *It is short for Radio Frontend Component. It provides a serial interface with WAP.*

Adopted Protocols – These are the protocols that are adopted from standard models. The commonly adopted protocols used in Bluetooth are Point-to-Point Protocol (PPP), Internet Protocol (IP), User Datagram Protocol (UDP), Transmission Control Protocol (TCP), and Wireless Application Protocol (WAP).

Service Discovery Protocol (SDP)– SDP takes care of service-related queries like device information so as to establish a connection between contending Bluetooth devices.

AT Commands – ATtention command set.

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Ans to the ques No-

c) **IrDA:-** The infrared Data Association (IrDA) is intended for point-to-point links between two devices for simple data transfers and for synchronization. The IrDA specifies a complete set of infrared communications standard is IEEE 802.15.2. IrDA is low power, low cost, unidirectional (point-to-point), narrow angle (<30°) cone, ad hoc data transmission standard designed to operate over a distance of up to 1 meter and a speed of 9600bps to 4Mbps. 16Mbps under developed. Some of the devices that use IrDA are notebooks, PDAs, printers and cameras. The data transfer takes place between a laptop (computer) and a mobile when both come into vicinity and line-to-sight of IR receivers and detectors in each of them.

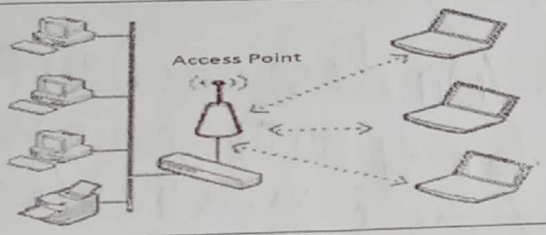
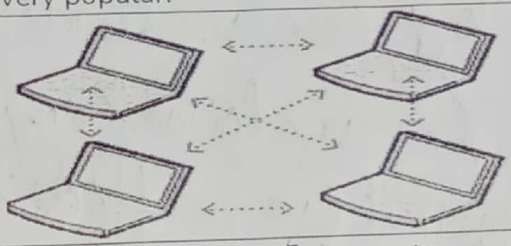
Zigbee:- Zigbee is designed for reliable wireless networked monitoring and control network. It is based on the IEEE 802.15.4. Zigbee is a low power, low data rate and closed proximity (i.e. personal area) wireless ad-hoc network targeted towards automation and remote control operation. The unlicensed bands including 2.4GHz, at a maximum transfer rate of 250Kbps. Typical application areas include

- Home automation
- Wireless sensor network.
- Industrial control system.
- Embedded sensing.
- Medical data collection
- Smoke and intruder warning.
- Home Automation
- Consumer appliance configuration.

Q. Wireless LANs can operate in one of two configurations, with a base station and without base station. Explain this statement.

Q.-04. Explain infrastructure mode in details by drawing mobile network

Ans. The major differences between Infrastructure and ad hoc mode are as follows –

Infrastructure mode	ad hoc mode
WLANs can operate in one of two configurations, with a base station is known as Infrastructure based wireless network.	WLANs can operate in one of two configurations, without a base station is known as ad hoc based wireless network.
The most popular mode used to connect clients like laptops and smartphones to another network such as company intranet or internet. This mode is shown below –	Collections of computers are associated so that they can directly send frames to each other. There is no Access Point in Ad hoc, because Internet access is the killer application for wireless. Ad hoc networks are not very popular.
	
In this mode, the transmitter and receivers are in direct range of the access point (AP).	In the ad hoc mode transmitter and receivers can communicate directly with each other.
In this mode AP handles all wireless nodes within the range.	In ad hoc mode there is no need for an access point in the range.
In this mode each client's security setting must be configured to match the security setting of the access point (AP).	Since in ad hoc mode there is no AP, the network users have to configure what are the correct security settings and it must have to match with each client's security settings in the network.
In this mode, a client or a system can only communicate with connected clients in managed mode.	Since ad hoc is peer to peer mode with no central access point, it also allows internet between any two connected clients.
More widely used. Generally used at airport lounge, hotel lobby, railway station etc.	Most of the IEEE 802.11 transmitter and receivers support the ad hoc mode. Generally used in the Military arena (for sharing information among soldiers),local area networks for communication among a fixed group of

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Wireless LANs can operate in one of two configurations
(i) With a base station is known as infrastructure based wireless network.
(ii) Without a base station is known as Ad-hoc networking.

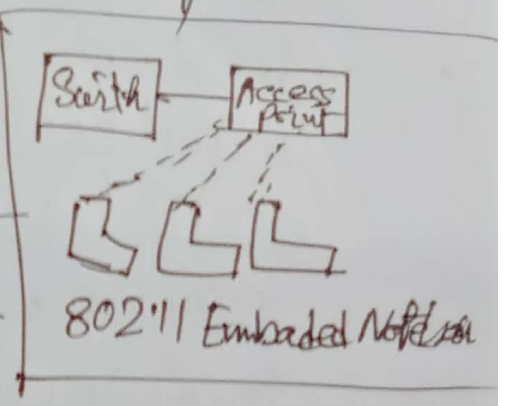
Ans. to the ques No-d. (3) Roll-232133.

3. Explain about IEEE802.15.4 standard.

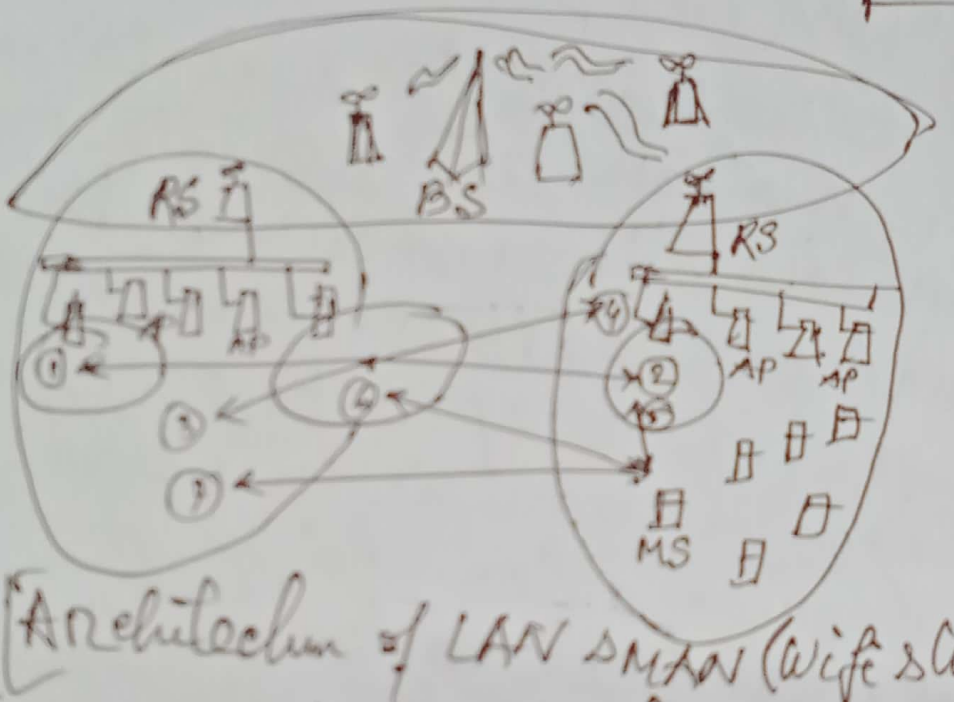
Ans:- Zigbee is a IEEE802.15.4 standard device. It is designed for reliable wireless networked monitoring and control network. It is based low power, low data rate and closely proximity (i.e. personal area) wireless ad hoc network targeted towards outer motion and remote control operation. The unlicensed band including 2.4 GHz at a maximum transfer rate of 250 Kbps. Typically application mentioned below:

i) Home automation
ii) Industrial control system
iii) Medical data collection
iv) Smoke detection survey.
v) Wireless sensor network
vi) Embedded sensing.
vii) Building automation
viii) Wireless microphone

DHCP (Dynamic Host Configuration Protocol) :- Dyna
Host Configuration Protocol (DHCP) is a protocol for assigni
dynamic IP addresses to device on a network. With dynamic
addressing a device can have a different IP address every
time it connects to the network



Architecture of the LAN and MAN (Wifi and WiMAX) integrated network.

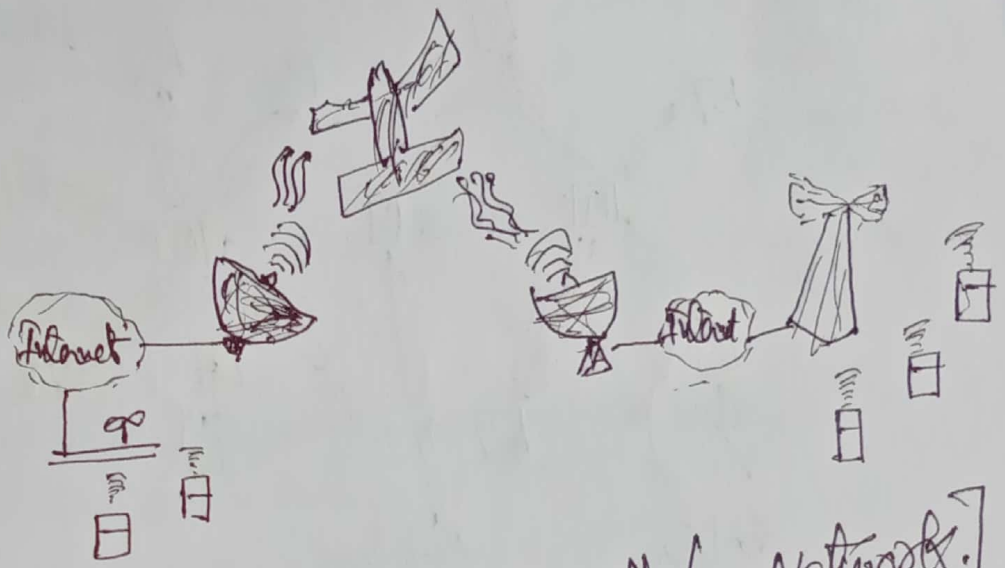


[Architecture of LAN & MAN (Wifi & WiMAX)]

- There may be several RS, (Relay station) in the coverage area of one WiMAX BS.
- Each RS can establish a communication link with its BS and can serve several MSs in its signal coverage.
- In addition, a RS can connect to multiple APs through wireless.
- Actual mode MS may connect to an AP or establish a communication link with a RS.

Draw and Describe the architecture of Satellite and cellular Network.

Ans:-

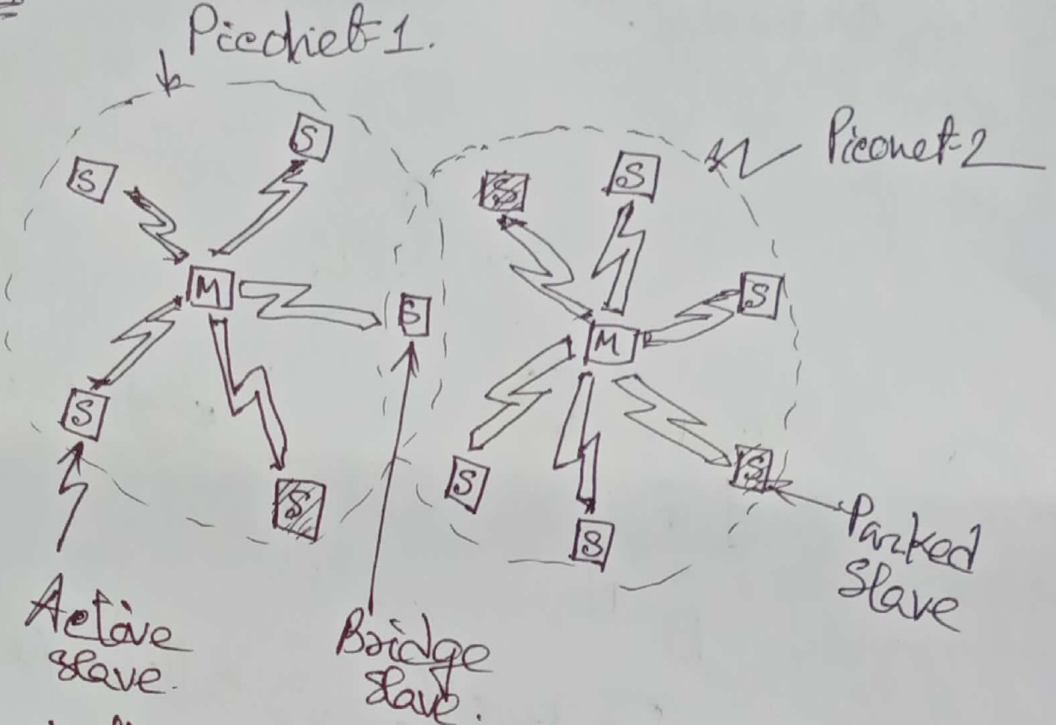


[Satellite and Cellular Network.]

> Satellite Wireless communication can also be developed via satelite.
> Due to its high altitude, satellite transmissions can cover a wide area over the surface of the earth.
> This can be very useful for users who are located in remote areas or islands where no submarine cables are service. In this case satellite telephones are needed.
> Each satellite is equipped with various transponders consisting of a transceiver and an antenna. They incoming signal is amplified and then rebroadcast on a different frequency.

Draw an describe scatternet & Piconet

Ans:-



Bluetooth ~~is a wireless LAN technology~~ defines two types of networks called: piconet and scatternet.

> A piconet can have upto eight stations, one of which is called primary station, the rest are called ~~secondary~~ secondaries. All secondary stations synchronize their clocks and hopping sequence with the primary. Bluetooth uses frequency hopping spread spectrum (FHSS) in the physical layer to avoid interference from other devices or network.

> Piconet can be combined to form scatternet where a secondary user of one piconet acts as bridge to another piconet. The bridge secondary/slave acts as a primary in receiving packet from the original first piconet then deliver the packet to secondaries of the second piconet.

> Although a piconet can have maximum 7 secondaries, additional secondaries can be ~~parked~~ parked state. A secondary parked state is synchronized with the primary but cannot take part in communication until it is removed from parked state to the active state.

8. Explain Infrared LANs. Mention some advantages and disadvantages.

Ans:- Each signal-covering cell in an infrared LAN is limited to one room. Coverage is small, since infrared rays cannot penetrate through wall and other opaque obstacles. The primary difference between infrared and radio wireless LANs is the frequency of the transmitted signal. 802.11a and 802.11b operate in the 2.4 & 5GHz bands respectively. But infrared systems use frequencies in the terahertz range.

Advantages:-

i) Bandwidth for infrared communication is large.
ii) Achieve high data rate.
iii) Infrared rays are reflected by lightly colored objects.
iv) It is possible to cover the entire area of the room using infrared.
v) Communication with infrared technology is more secure.
vi) Equipment is much cheaper than microwave communication.

Disadvantages:-

i) It cannot penetrate through walls & other opaque objects.
ii) It becomes very difficult for any adversary to carry out a passive attack.
iii) Background radiation from sunlight and indoor lighting can cause interference at the infrared receiver.

8. Explain the LEACH clustering protocol.

Ans:- The Low-Energy Adaptive Clustering Hierarchy (LEACH) is an application-specific protocol architecture that aims to prolong network lifetime by periodic re-clustering and change of the network topology.

LEACH is divided into rounds consisting of a clustering phase and a steady-state phase for data collection. At the start of each round, a sensor node randomly chooses a number between 0 and 1. and then compares this number to a calculated threshold called T(n). If T(n) is larger than the chosen number, the node becomes a cluster head for the current round. The value T(n) is calculated using the following formula:-

$$T(n) = \begin{cases} \dfrac{P}{1 - P(r \bmod (1/P))} & \text{for } n \in G \\ 0 & \text{otherwise} \end{cases}$$

where P is the ratio of the total number of cluster heads to the total number of nodes. r is the number of rounds, and G is a set of nodes that have not been chosen as cluster-heads for the last 1/P rounds.

Explain the packet Destination Sequenced Distance Vector (DSDV) packet process Algorithm with Example.

Ans: To distinguish stale update packets from valid ones, each update packet is tagged by the original node with a sequence number. The sequence number is monotonically increasing number which uniquely identifies each update packet from a given node.

> Consequently, if a node receives an update packet from another node, the sequence number must be equal to or greater than the sequence number already in the routing table.

> If the new address has a higher sequence number, the node chooses the route with the higher sequence number and discards the old sequence number.

> If the incoming sequence number is identical to the one belonging to the existing route, a route with the least cost metric is chosen.

(a)

Update pkt

Destination	3
Metric	6
Next hope	
sequence	18

+

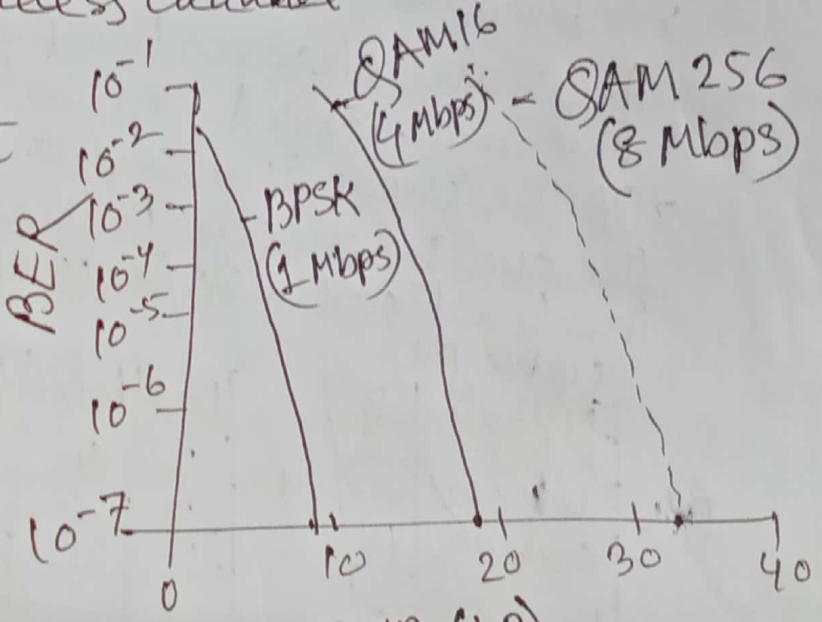
Dest.	Metric	Next Hope	Seq.
2	4	1	
3	5		19
7	1	7	

= update Ignored.

* Draw & Explain Multipath propagation?

8. "For a given SNR a modulation technique with a higher bit transmission rate will have a higher BER". Explain.

Ans: For a given signal to noise ratio (SNR) a modulation technique with a higher bit transmission rate will have a higher bit error rate (BER). The SNR is typically measured in unit of decibels (dB). Larger SNR - easier to extract signal from noise. Figure shows the BER - The probability that a transmitted bit is received in error rate at the receiver - versus the SNR for three different modulation technique for encoding information for transmission on an idealized wireless channel.



[BER, transmission rate & SNR]

For example, with an SNR of 10dB, BPSK modulation with transmission rate of 1 Mbps has a BER of less than 10^{-7}. While with QAM16 modulation with transmission rate of 4 Mbps, the BER is 10^{-1}, far too high. However, with an SNR of 20dB, QAM16 modulation has a transmission rate of 4 Mbps and a BER of 10^{-7}. While BPSK modulation has a transmission rate only of only 1 Mbps and a BER that is so low as to be "off the chart".

SRR (Signal to Noise Ratio):- The ratio of the electromagnetic signal that is a comparison of degraded form of the original signal transmitted by the sender degraded due to the attenuation and multipath propagation effect and background noise in the environment. The SNR is a definitive measure of the strength of the received signal and the noise.

Q: Differentiate between Cellular Vs Ad-Hoc network.

Ans:-

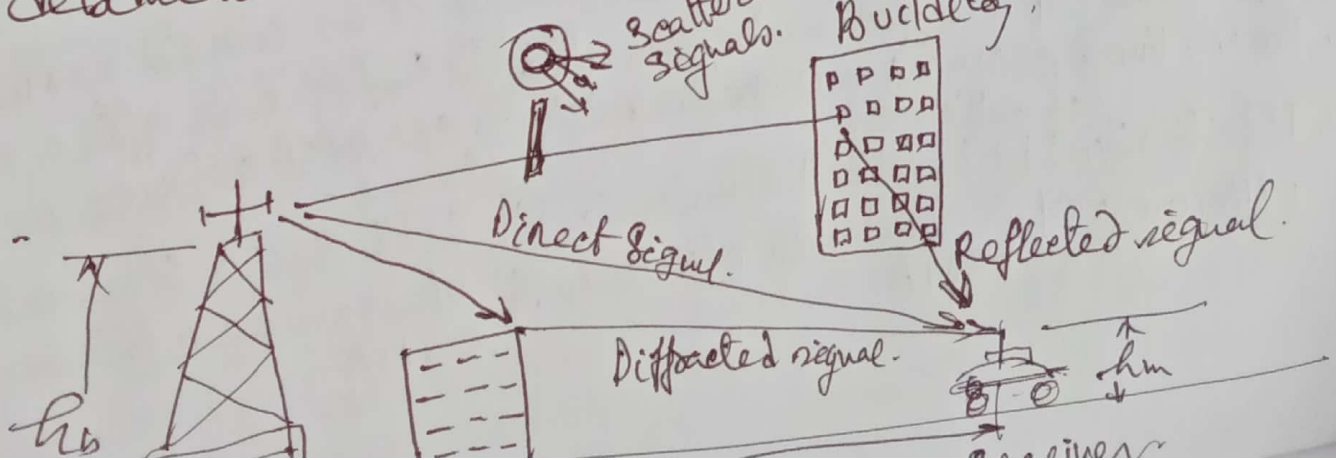
Cellular Network	Ad-Hoc Network
① Fixed infrastructure	① Infrastructure less
② Single-hop wireless link.	② Multi-hop wireless link.
③ Centralized Routing	③ Distributed Routing.
④ Base station: Single point of failure	④ Resilient
⑤ Seamless connectivity	⑥ Mobility ⇒ Frequent link breaks
⑥ High cost & long deployment time	⑦ Quick & cost effective.
⑦ Commercial sector	⑧ Defense, Emergency, Disaster
⑧ Simple Mobile, Complex Base	⑨ All complexity in Mobile.
⑨ Time Sync. ⇒ TDMA	Time Sync. difficult ⇒ CSMA

Q: Multipath Propagation. How does it cause harmful interference to signal

> In radio communication multipath propagation (multipath fading) due to presence of reflecting and refracting from water bodies and terrestrial objects such as mountains and buildings or even scatters hence cause multiple versions of the signal arrive at the received through two or more paths.

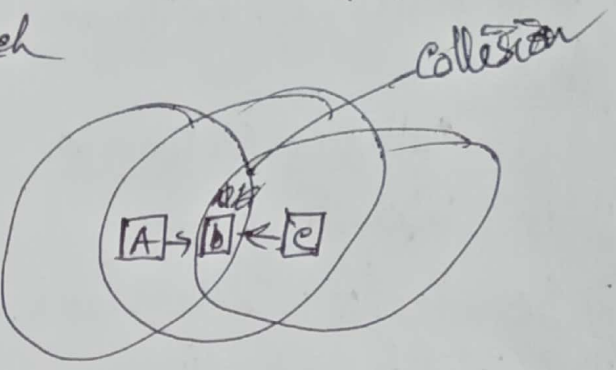
> Multipath propagation causes multipath interference, including constructive and destructive interference of the signal:

> Destructive interference causes fading. This may cause a radio signal to become too weak in certain areas to be received adequately, so multipath propagation can be detrimental in radio communication system



8. Define Hidden terminal Problem? How mitigate it?

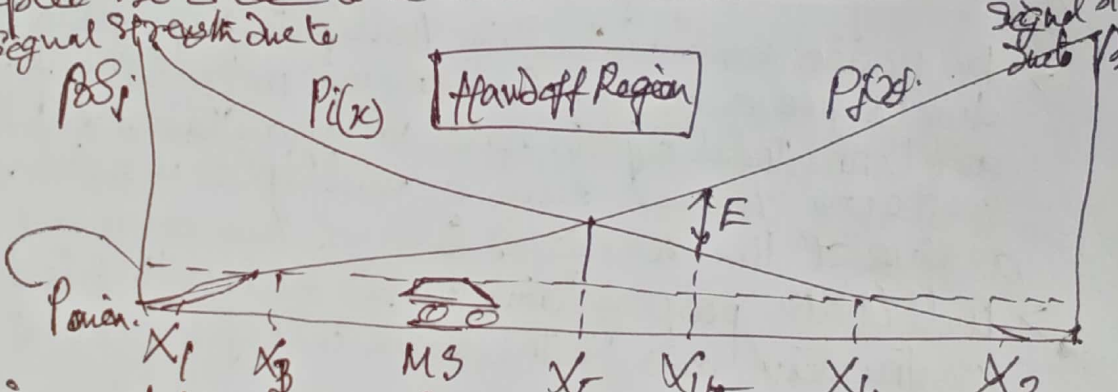
Ans:- A and B can hear each other, B and C can hear each other. But A and C cannot hear each other. The problem we mentioned here is called Hidden terminal problem.



Consider the effect of RTS/CTS:- RTS/CTS (Request to send/clear to send) is the optional mechanism used by the 802.11 wireless network protocol to reduce frame collisions introduce by the hidden node problem.

Handoff Region.

A well-implemented handoff is important for delivering uninterrupted service to a caller or data session user.



By Looking at the variation of signal strength from either base station, it is possible to decide on the optimum area where handoff can take place.

S.No	Key	CSMA/CA	CSMA/CD
1.	Network type	① It is generally used in wireless network.	① It is wired network.
2.	Effectiveness	② It is effective before a collision	② effective after a collision
3.	Recovery time	③ CSMA/CA minimize the risk of collision.	③ CSMA/CD reduce recovery time.
4.	IEEE standard	④ IEEE 802.11 standards	④ IEEE 802.3 standard.
5	Efficiency	⑤ It is similar in efficiency as CSMA	⑤ It is more efficient than CSMA.

FDMA waste bandwidth:- FDMA waste bandwidth, if an FDMA channel is not in use, then it sits idle and cannot be used by other users to increase or share capacity. FDMA system have higher cell site system cost compare to TDMA system because of the system need to use costly bandpass filters to eliminate spurious radiation at the base station

Weakness/Disadvantages of FDMA:- Due to simultaneous transmission of a large number of frequencies, there is a possibility of inter modulation distortion at the transponder. It is suitable only for analog signals

Advantages:- One of the main advantages of FDMA is that, it is simple and robust.

CDMA is the combination of FDMA & TDMA.

TDMA Technique:- Time division multiple access (TDMA) is a channel access method for shared-medium network. It allows several users to share the same frequency channel by dividing the signal into different time slots. The users transmit in rapid succession one after the other, each using its own time slot

Features	FDMA	TDMA	CDMA.
① Abbreviation	Frequency Devision Multiple Access	Time Devisio →	Code Devision
② Mode of operation	→ It distribute avail bandwidth among multiple station by deviding into sub channel.	→ It only share the time of transmission through the satellite not the channel.	→ It shares both time & bandwidth among multiple station by allocating a unique code to each slot.
③ Flexibility	→ It has a little flexib	moderate flexib	High flexible.
④ Codewords	→ Does not req. codewords	Does not req. cod →	Needs code words.
⑤ Rate of Data	Low data rate →	Medium data rate	High data rate.
⑥ Mode of Data Transfer	→ It uses continuous signal for data transmission	→ It uses signals in bursts for data transmission	→ It use digital signal for data transmission.
⑦ Synchro nization	→ Does not need any synchronization	Requires Synchro nization	→ Does not require any synchronization
⑧ Terminal	Every terminal has its own content frequency	Every terminal on the same frequency is active for just a short period of time	→ Every terminal may remain in operation of the same location without interruption
⑨ Cell Capacity	Limited cell capacity	Limited →	→ no capacity restriction
⑩ Cost →	High cost →	Low cost →	→ initial cost high, operation cost low
⑪ Guard time & band	needed guard band →	Needed guard time →	needed both
⑫ Fading mitigation	Does not req. equalizer →	needs an equalizer →	RAKE receiver may be used.
⑬ Advantages	It is very reliable well established and straight forward protocol	It is high flexible entirely digital well established	It is more flexible need less frequency planning offer a softer signal handover
⑭ Disadvantages	It is very flexible frequencies are limited	It requires guard space	extremely complicated complex power control method.

(6.2) In a first-generation AMP system, where there are 395 channel of 30 KHz each in a bandwidth of 12.5 MHz, what is the multiple access spectrum efficiency for FDMA?

Ans:- FDMA spectral efficiency $= \frac{\text{channel} \times \text{KHz}}{\text{Bandwidth}} = \frac{30 \times 395}{12.5 \times 1000} = 0.948$

(6.3) In the North American Narrowband TDMA cellular system the one way bandwidth of the system is 12.5 MHz. The channel spacing is 30 KHz and the total number of voice channel in the system is 395. The frame duration is 40 ms. with six time slot per frame. The system has an individual user data rate of 16.2 Kbps in which the speech with error protection has a rate of 13 Kbps. Calculate the multiple access spectral efficiency of the TDMA system.

Ans:-

The time slot duration that carries data, $\frac{6 \times 40 \times 10^{-3}}{13 \times 1000}$

$$\gamma = \left(\frac{13}{16.2}\right) \times \frac{40}{6} = 5.35 \text{ ms.}$$

$$\text{TDMA } \eta_d = \frac{5.95 \times 6}{40} \times \frac{30 \times 395}{12500} = 0.76$$

The overhead portion of the frame is

$= 1.0 - 0.76 = 24\%$

Where,
$T_f = 40$ ms. $M_f = 6$
$N_u = 395$, $B_c = 30$ KHz
$B_w = 12.5$ MHz.

(6.4) Calculate the capacity and spectral efficiency of a TDMA system where the following parameter: bandwidth efficiency factor $\eta_b = 0.9$, bit efficiency (with QPSK) $\mu = 2$, voice activity factor $\mu_f = 1.0$, one way system bandwidth $B_w = 12.5$ MHz. information bit rate $R = 16.2$ Kbps and frequency reuse factor $N = 19$.

Ans:-

$$N_u = \frac{\eta_b \times \mu}{V_f} \times \frac{B_w}{R \times N} = \frac{0.9 \times 2}{1.0} \times \frac{12.5 \times 10^6}{16.2 \times 10^3 \times 19} = 73.1 \approx 73 \text{ (say)}$$ mobile user per cell.

Spectral efficiency $\eta = \frac{N_u \times R}{B_w} = \frac{73 \times 16.2}{12.5 \times 1000} = 0.094$ bit/sec/Hz

Cell capacity:- The cell capacity is defined as the maximum number of users that can be supported simultaneously in each cell. The capacity of a TDMA system is given by

$N_u = \frac{\eta_b \mu}{} \times \frac{B_w}{RN}$, Spectral Efficiency. $\eta = \frac{N_u \times R}{B_w}$.

Q. 2B/Hz bandwidth for 8QAM and 8-PSK is BW = 2Rb/3. i) What is the bandwidth of 16QAM and 16-PSK? (ii) If a bit stream of 64 Kb/s is to be transmitted, how much bandwidth is required in each case (iii) How many symbols are represented (M) for 8QAM and 16QAM modulation (iv) How many bits per symbol are used (k) for 8PSK and 16PSK? (v) If the Band is 10,000 symbols/s. What is bit rate (Rb) for 8QAM and 16QAM? (vi) Draw the signal constellation for both 16QAM and 16-PSK.

Ans:-

i) Bandwidth of 16QAM and 16-PSK, $W = \frac{2Rb}{4} = \frac{Rb}{2}$

ii) Given that Rb = 64Kb/s, Each one bandwidth = $64/2 = 32$ KHz.

iii) Symbol for 8QAM = 8 symbol.

" " 16QAM = 16 "

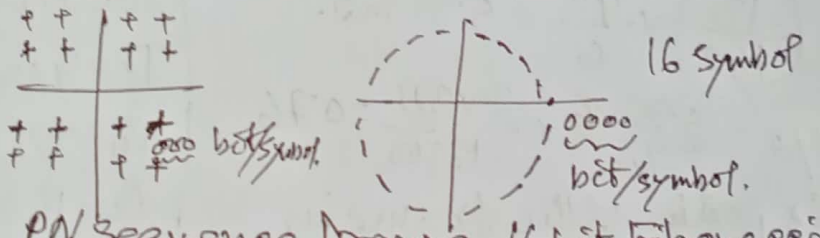
iv) Bit/symbol used for 8psk = 3 $(8 = 2^3)$

" " " " 16psk = 4 $(16 = 2^4)$

v) Rb for 8QAM = 10,000 × 3 = 30,000 bbps.

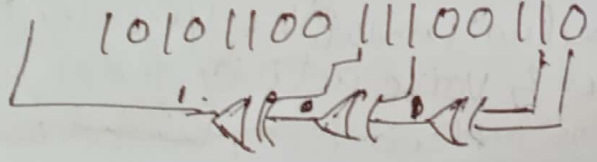
Rb " 16QAM = 10,000 × 4 = 40,000 bbps.

vi)



Q. Define PN sequence. Draw a 16 bit Fibonacci linear feedback shift register. If the seed is 1010110011100110. Find the PN sequence for four rounds.

Ans:-



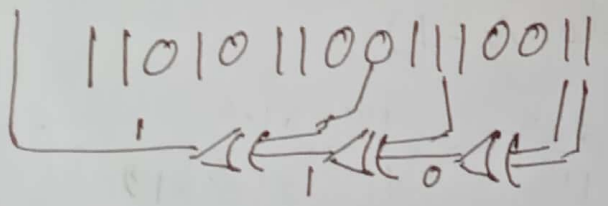
Round-1.

Given, 16 bit.

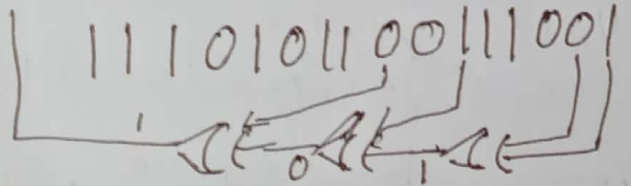
$16 = 2^4$

$= 4 - 1$

$= 3$



Round-2



Round-3.

1111010110011100

PN sequence.

- PN sequences are periodic but appear random within one period.
- PN sequences are very easy to generate using LFSR (Linear feedback shift reg)
- PN sequences are easy to regenerate and synchronize the receiver.
- PN sequence have good random properties.

8. We consider a cellular system in which total available voice channel to handle the traffic are 960. The area of each cell is 6 km^2 and the total coverage area of the system is 2000 km^2. Calculate (a) the system capacity if the cluster size N (reuse factor) is 4 and (b) the system capacity if the cluster size is 7. How many times would a cluster of size 4 have to be replicated to cover the entire cellular area? Does decreasing the reuse factor. N increase the system capacity. Explain.

Given that
Total available channel = 960
Cell Area = 6 km^2
Total Coverage Area = 2000 km^2
N = 4

Soln:- Area of cluster with reuse

N = 4 ∴ 4 × 6 = 24 km^2.

Number of cluster for covering total area with N = 4. = 2000/24 = 83.33 ≈ 83 (Say)

No. of channel/cell = 960/4 = 240

System capacity = 83 × 960 = 79,680 channel.

When, N = 7 ∴ 7 × 6 = 42 km^2.

No. of cluster = $\frac{2000}{42}$ = 47.62 ≈ 48 (Say) ∴

No. of channel/cell = 960/7 = 137.15 ≈ 137 (Say).

System capacity = 48 × 960 = 46,080 channels.

It is evident when we decrease the value of N from 7 to 4, we increase the system capacity 46,080 to 79,680 channel. Thus, decreasing the reuse factor increase the system capacity.

Near far problem?

Ans:- CDMA PN sequence use করার ফলে interference হয় না। যে user কাছে থাকে, সে signal বেশি পায়, যে দূরে থাকে সে signal পায় না। তখন Base station দূরের user এর থেকে signal ঠিকমতো পায় না। ফলে signal interference হয়। এ সমস্যা দূর করার জন্য কাছের/দূরের user এর ক্ষেত্রে power level সমান করে, এ সমস্যা দূর করা যায়।

Open loop- Base station থেকে mobile station এ কিরূপ আসছে signal observe করে। তারপর নিজেই mobile station নিজের signal strength কম বেশি করে।

Close loop- Mobile station নিজে Base station থেকে feedback নিয়ে signal strength বাড়ায়। এবং সে Feedback এর ভিত্তিতে নিজে signal strength ঠিক করে।

TDMA এর ক্ষেত্রে একটি cell কে ৮টি ভাগে ভাগ করা হয়। TDMA-তে একটি channel কে control channel হিসেবে ব্যবহার করা হয়।

Offer traffic = Call activate rate × holding time = $2 \times \frac{1.5}{60}$

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Cluster size না বাড়িয়ে signal strength বাড়ানোর জন্য (Interference কমিয়ে) omnidirectional Antena পরিবর্তন করে sectoring/splitting করা হয়। Directional Antena ব্যবহার করে cluster size বাড়িয়ে signal strength বাড়ানো হয় না। ফলে, splitting করা হয় cluster size কম থাকে, তাই capacity বাড়ানো যায়। splitting/sectoring দুইভাবে করা হয়। Splitting এর ক্ষেত্রে Antena অনেক বেশি Base station লাগে। Splitting এর মাধ্যমে capacity বাড়ানো যায়। Technique দুটো হলো splitting & sectoring।