1.How can we design adhoc and sensor networks that operate solely on harvested energy from the environment?

Ans:

Wireless energy harvesting techniques can be categorized into two main categories: RF energy harvesting and resonant energy harvesting. RF energy harvesting is the process of converting electromagnetic waves into electricity by a rectifying antenna, or rectenna.

2. Imagine you're designing a communication system for a satellite link that operates in the X-band frequency range (8-12 GHz). The system experiences a signal-to-noise ratio (SNR) of 25 dB. The channel bandwidth is 500 MHz. Calculate the maximum achievable data transmission rate using Shannon's Theorem.

Ans:

$C = B \cdot \log_2(1+\text{SNR})$

Where:

- C is the channel capacity (maximum achievable data transmission rate),
- B is the channel bandwidth,
- SNRSNR is the signal-to-noise ratio.

Given the values:

- Channel bandwidth (B): 500 MHz (which can be converted to Hz by multiplying with 106106),
- Signal-to-noise ratio (SNRSNR): 25 dB (which can be converted to a linear ratio by taking the antilogarithm, i.e., 1025/101025/10).

Let's perform the calculations:

SNR (linear)=1025/10≈31.62SNR (linear)=1025/10≈31.62

B=500 MHz=500×106 HzB=500MHz=500×106Hz

Now plug these values into the formula:

C=500×106×log$f_0$2(1+31.62)C=500×106×log2(1+31.62)

Calculating the logarithm and multiplying:

C≈500×106×log$f_0$2(32.62)≈500×106×5=2.5×109 bpsC≈500×106×log2(32.62)≈500×106×5=2.5×109bps

So, the maximum achievable data transmission rate is approximately 2.52.5 Gbps (gigabits per second) using Shannon's theorem.

3.A police car with a siren is moving at a speed of 30 m/s towards a stationary observer. The siren emits a sound wave at a frequency of 800 Hz. Given the speed of sound in air as 343 m/s, calculate the frequency heard by the observer.Using the above scenario Apply Doppler shift.

Ans:

The Doppler effect describes the change in frequency or wavelength of a wave in relation to an observer moving relative to the source of the wave. When the source of the wave (in this case, the police car with the siren) is moving towards the observer, the

observed frequency will be higher than the emitted frequency. The formula for calculating the observed frequency (*f′*) in this scenario is given by:

f′=v+vsf·(v+vo)

Where:

- *f′* is the observed frequency,
- *f* is the emitted frequency (800 Hz in this case),
- *v* is the speed of sound in air (343 m/s),
- *vo* is the observer's velocity (0 m/s since the observer is stationary),
- *vs* is the source's velocity (-30 m/s since the police car is moving towards the observer).

Given the values:

- =800*f*=800 Hz,
- =343*v*=343 m/s,
- =0*vo*=0 m/s,
- =−30*vs*=−30 m/s.

Plug these values into the formula:

f′=800·(343+0)343−30f′=343−30800·(343+0)

Calculating:

f′≈800·343313≈876.05 Hzf′≈313800·343≈876.05Hz

So, the frequency heard by the observer is approximately 876.05 Hz. This means that the siren's sound wave will be perceived as having a higher frequency due to the Doppler effect caused by the relative motion between the police car and the stationary observer.

4.Mention the types of propogation mechanisms?

Ans:

Reflection, diffraction, and scattering are the three basic propagation mechanisms that impact propagation in mobile communication systems. Reflection occurs when a propagating electromagnetic wave impinges upon an obstacle that has very large dimensions compared to the wavelength of the propagating wave.

5.List the design goals of a MAC protocol for ad-hoc networks.

Ans:

The operation of the protocol should be distributed. The protocol should provide QoS support for real-time traffic. The access delay, which refers to the average delay experienced by any packet to get transmitted, must be kept low.

6.List out the types of Contention-based protocols.

Ans:

1. **Contention-based protocols without reservation/scheduling**

- Sender-initiated protocols:
  The transmission of packets are initiated by the sender node.
  - Single-channel sender initiated. For example, MACAW, FAMA.
  - Multiple-channel sender initiated protocols. For example, BTMA, DBTMA, ICSMA.
- Receiver-initiated protocols:
  The connection is initiated by the receiver node. For example, RI-BTMA, MACA-BI, MARCH.

2. Contention-based protocols with reservation mechanisms.

- Synchronous protocols:
  All node are kept synchronized. For example, D-PRMA, CATA, HRMA, SRMA/PA, FPRP.
- Asynchronous protocols:
  Relative time information is used to achieve effecting reservations. For example, MACA/PR, RTMAC..

Contention-based protocols with scheduling mechanisms.

All the nodes are treated equally and no node is get deprived of bandwidth. For example, Eg. DPS, DWOP, DLPS.

7.A coffee shop offers free Wi-Fi to its customers. The owner is concerned about the security of the network. Explain at least two security mechanisms provided by the IEEE 802.11 standard to protect wireless communications.

Ans:

The IEEE 802.11 standard, commonly known as Wi-Fi, includes several security mechanisms to protect wireless communications. Here are two important security mechanisms provided by the IEEE 802.11 standard:

1. **WPA2 (Wi-Fi Protected Access 2)**: WPA2 is a security protocol designed to enhance the security of wireless networks. It addresses the vulnerabilities of its predecessor, WEP (Wired Equivalent Privacy), which was found to be easily compromised. WPA2 uses the Advanced Encryption Standard (AES) encryption algorithm, which is more robust and secure than the encryption methods used in WEP.

WPA2 provides two modes of operation:

- **WPA2-Personal (WPA2-PSK)**: In this mode, users share a pre-shared key (PSK) or passphrase. This key is used to derive encryption keys for securing communications. While this mode is convenient for small networks, it's important to use a strong and complex passphrase to prevent unauthorized access.
- **WPA2-Enterprise**: This mode employs a RADIUS (Remote Authentication Dial-In User Service) server for authentication. User credentials are typically stored on a centralized server, enhancing security and enabling features like individual user

accounts and access control.

2. **802.11i (WPA3)**: IEEE 802.11i is an evolution of the security mechanisms introduced in WPA2. It includes stronger encryption and authentication mechanisms to further enhance wireless network security. The primary authentication method used in WPA3 is the Simultaneous Authentication of Equals (SAE), also known as "Dragonfly." SAE provides stronger protection against brute-force attacks during the authentication process.

8.A company is developing a real-time video streaming application that relies on a Wi-Fi network for data transmission. What is the significance of the packet delivery ratio in this context, and how might network congestion, interference, and signal quality affect the PDR?

Ans:

To mitigate these factors and maintain a high PDR for real-time video streaming:

- **Quality of Service (QoS)** mechanisms can prioritize video traffic over other types of data, reducing the impact of congestion.
- **Use of Higher Frequencies**: The 5 GHz band typically offers less interference than the 2.4 GHz band due to fewer devices operating in that range.
- **Signal Strength**: Ensure that devices have strong signal strength and are within a reasonable range of the Wi-Fi router.
- **Channel Selection**: Use Wi-Fi channels with less interference.
- **Error Correction**: Implement error correction techniques at the application or transport layer to recover lost or corrupted packets.

9.List the major functions performed by the TCP?

Ans:

TCP organizes data so that it can be transmitted between a server and a client. It guarantees the integrity of the data being communicated over a network. Before it transmits data, TCP establishes a connection between a source and its destination, which it ensures remains live until communication begins.

10.How the table-driven routing protocols work in Ad hoc networks?

Ans:

Table-driven (proactive) routing. This type of protocols maintains fresh lists of destinations and their routes by periodically distributing routing tables throughout the network. The main disadvantages of such algorithms are: Respective amount of data for maintenance.

11.Imagine you're in a crowded stadium during a live event. You're trying to send a text message using your smartphone, but you notice that the message takes a long time to send, and sometimes it fails to send altogether. Explain how the concept of "capacity" in wireless communication could be relevant to this scenario.

Ans:

In wireless communication, "capacity" refers to the maximum number of users or devices that a network can support while maintaining acceptable quality of service. In the crowded stadium scenario, the high density of users trying to access the wireless network can lead to congestion and reduced network capacity. As more users attempt to send messages, make calls, or use data simultaneously, the available bandwidth becomes divided among them. This can result in longer delays, dropped messages, or failed connections due to the network's capacity being exceeded.

12.A radio station broadcasts music at a frequency of 100 MHz. The receiver has a signal-to-noise ratio (SNR) of 30 dB. Calculate the maximum achievable data transmission rate for this communication using Shannon's theorem.

Ans:

Using Shannon's theorem formula $C = B \cdot \log_2(1+SNR)$, where C is the channel capacity (maximum achievable data transmission rate), B is the bandwidth, and SNRSNR is the signal-to-noise ratio:

Given:

- Frequency f = 100 MHz = 100×106100×106 Hz
- Bandwidth B = 2 ×× f = 200×106200×106 Hz
- SNR = 30 dB

Converting SNR to a linear ratio:

SNR (linear)=1030/10=1000SNR (linear)=1030/10=1000

Substitute values into the formula: $C = 200\times10^6 \cdot \log_2(1+1000)$C=200×106·log2 (1+1000) $C \approx 200\times10^6 \cdot \log_2(1001)$C≈200×106·log2(1001) $C \approx 200\times10^6 \cdot 9.967$C≈200×106·9.967 $C \approx 1.9934\times10^9$ bpsC≈1.9934×109 bps

So, the maximum achievable data transmission rate is approximately 1.99341.9934 Gbps.

13.A car is moving towards an observer with a constant velocity of 20 m/s. The car's horn emits a sound wave at a frequency of 500 Hz. Given the speed of sound as 343 m/s, calculate the frequency heard by the observer.

Ans:

The Doppler shift formula for a moving source towards an observer is given by $f' = f \cdot (v + v_o)$, where:

- f is the emitted frequency (500 Hz),
- v is the speed of sound (343 m/s),
- v_o is the observer's velocity (0 m/s for a stationary observer),
- v_s is the source's velocity (-20 m/s for the car moving towards the observer).

Substitute the values into the formula: $f' = 500 \cdot (343+0) 343 - 20 f' = 343 - 20500 \cdot (343+0)$ $f' \approx 500 \cdot 343323 f' \approx 323500 \cdot 343$ $f' \approx 532.81$ Hz $f' \approx 532.81$ Hz
So, the frequency heard by the observer is approximately 532.81 Hz.

14. In a large corporate office, a table-driven routing protocol is being used to manage routing in the network. Explain how the routing tables are established and updated in this scenario.
ANS:
In a table-driven routing protocol, such as OSPF (Open Shortest Path First) or RIP (Routing Information Protocol), routing tables are established and updated through periodic exchanges of routing information among network routers.
Initially, routers exchange their routing tables containing information about network destinations and associated metrics. As routers receive routing updates, they populate their routing tables with this information. The updates help routers determine the optimal paths to various destinations.
As the network topology changes (due to link failures, additions, or modifications), routers continue to exchange updates to reflect these changes. The routing tables are then updated based on the received information. This process ensures that each router maintains accurate and up-to-date knowledge of the network's topology.

BIG QUESTIONS

1.Explain the concept of cellular networks and their architecture,including base stations,cells and handoffs.How do cellular networks provide seamless connectivity as users move between cells?

2. Analyze the concept of fading in wireless communication, and how does it occur due to multipath propagation?How can fading lead to signal strength fluctuations?

3. How does Doppler Shift occur in the wireless channel and what is its effect on signal frequency?How can Doppler Shift be mitigated in certain applications?

4. Describe the concept of Energy harvesting in Wireless Sensor Networks.How can ambient energy sources be harnessed to power sensor nodes and extend their Operatonal life time?

5. Compare and contrast infrastructure networks with adhoc networks.Give example situations where one type of network is preferred to the other

6. In a busy office, multiple computers are connected to the same Ethernet LAN. Explain how a contention-based protocol like Carrier Sense Multiple Access with Collision Detection (CSMA/CD) works to manage access to the shared network medium. What happens when a collision is detected?

7. A company has a large office space with multiple Wi-Fi access points (APs) to ensure coverage. Employees often move around while working. Explain how the IEEE 802.11 standard supports seamless roaming between different APs, ensuring uninterrupted connectivity.Explain briefly.

8. Elaborately explain different steps involved in five phase reservation protocol with its frame format

9. Illustrate the working of destination sequenced distance vector routing protocol for wireless adhoc networkswith an example and diagrammatic illustrations

10. Present a comparison of TCP solutions for wireless adhoc networks.

11 .As a environmental researcher, You're studying the potential of solar energy as a renewable resource. How does your understanding of the Electromagnetic spectrum help you explain the conversion of solar radiation into electricity through photovoltaic cells..

12. Discuss the scheduling mechanism achieved in distributed wireless ordering protocol? Explain in detail. How are Information symmetry and perceived collisions handled?

13. In a busy hospital, there is a need to establish a wireless network for medical equipment monitoring and communication. The network will consist of various devices transmitting critical patient data and alarms. Discuss how different scheduling mechanisms, such as TDMA (Time Division Multiple Access) and CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance), could be applied in this scenario. Assess the advantages and limitations of each mechanism in ensuring reliable and timely data transmission.