DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

CS6003 – ADHOC AND SENSOR NETWORKS

UNIT - I INTRODUCTION

PART – A (2 MARKS)

1.   Distinguish between shadowing and reflection of signal propagation.

Shadowing	Reflection
Fading caused by the large buildings or other structures, that block the direct transmission path from the transmitter to the receiver is known as shadowing.	When the propagating radio wave hits an object which is very large compared to its wavelength (such as the surface of Earth, or tall buildings), the wave gets reflected by that object. Reflection causes a phase shift of 180 degrees between the incident and reflected rays.

2.   List the transmission impediments of wireless channel. (or)   (M/J-13)
      List the characteristics of wireless channels.
         The characteristics of wireless channel are
                    1.   Path loss
                    2.   Fading
                    3.   Interference
                    4.   Doppler Shift
                    5.   Transmission rate constraints

3.   Define path loss.
         Path loss is defined as the ratio of power of the transmitted signal P_t to power of the same signal received by the receiver P_r.
      Path loss = Transmitted power / Received power
      For free space, path loss is
           $P_r = P_t \, G_r G_t \lambda^2 / (4 \pi d)^2$
           $P_t / P_r = (4 \pi d)^2 / G_r G_t \lambda^2$
           where, P_t – Transmitted power, P_r – Received power
                      G_t – Gain of the transmitting antenna, G_r – Gain of the receiving antenna
                      λ – Wavelength T_X – Transmitter, R_X – Receiver
      It involves no noise, stationary transmitter and receiver, only direct path component and is proportional to the distance 'd' between the T_X and R_X.

4. **What is fading? List the different types of fading.**

Fading refers to the fluctuations in signal strength, when received at the receiver. It occurs due to multipath propagation.

The different types of fading are

1. Slow/long term fading
2. Fast/short term fading
3.

5. **State Shannon's theorem.(N/D-12) (or)**

Write the equation for maximum data rate according to Shannon's theorem. (M/J-13)

Shannon's theorem states the maximum data rate possible on a noisy channel.

The maximum data rate is

$C = B \times \log_2 (1+(S/N))$ bits per second

Where C = maximum data rate, B = bandwidth

S/N = signal to noise ratio.

The Noise level is represented by SNR – Signal to Noise Ratio.

6. **What is an ad hoc network?**

An ad hoc network is a multihop, infrastructure less network which has no centralized server to control the communication between the nodes and resources cannot be reserved beforehand. It is used in battlefields and military applications.

7. **Why are ad hoc networks needed?** (M/J-12)

Ad hoc networking is often needed where an infrastructure network cannot be deployed and managed. The presence of dynamic and adaptive routing protocols enables quick formation of ad hoc networks and is suitable for emergency situations like natural disasters, spontaneous meetings or military conflicts.

8. **What are the challenging issues in ad hoc network maintenance?** (M/J-12)

The challenging issues in ad hoc network are

1. Medium access scheme
2. Routing
3. Multicast routing
4. Transport layer protocol
5. Pricing Schemes
6. Quality of Service Provisioning
7. Self-Organization
8. Security
9. Addressing and Service Discovery

9. List the applications of ad hoc networks.

Ad hoc networks are widely used in
1. Military applications and battlefields
2. Collaborative and distributed computing
3. Emergency search and rescue operations
4. Wireless sensor and mesh networks

10. What is hidden terminal problem?

Hidden terminals are nodes that are hidden (or not reachable) from the sender of a data transmission session, but are reachable to the receiver of the session. The hidden terminal can cause collisions at the receiver node.

Or

When two transmitter nodes try to send data at the same time, to the same receiver, they will sense the carrier to be free at the same time, leading to collisions. This is called hidden terminal problem.

11. Define Mobile Ad Hoc networks. Give an example.

It is an infrastructure less IP based network of mobile and wireless machine nodes connected with radio. In operation, the nodes of a MANET do not have a centralized administration mechanism. It is known for its routable network properties where each node act as a "router" to forward the traffic to other specified node in the network.

12. Differentiate an ad hoc network and a cellular network with respect to
   a) Bandwidth usage
   b) Cost effectiveness   (N/D-12)

PARAMETER	CELLULAR NETWORK	AD HOC NETWORK
Bandwidth usage	Easier to employ bandwidth reservation	Bandwidth reservation requires complex medium access control protocols
	Guaranteed bandwidth (designed for voice traffic)	Shared radio channel (more suitable for best-effort data traffic)
Cost effectiveness	Cost of network maintenance is high (backup power source, staffing, etc.)	Self-organization and maintenance properties are built into the network. Hence the cost of network maintenance is less.

13. What are the characteristics of wireless channel?   (M/J-12)

Path loss
Fading
Interference
Doppler shift
Transmission rate constraints

14. List out the issues in Ad Hoc networks.

- Medium access scheme
- Routing
- Multicasting
- Transport layer protocol
- Pricing scheme
- QoS provisioning
- Self-organization

15. What is the choice of modulation schemes?

- Several factors have to be balanced here the required and desirable data rate and symbol rate. The implementation complexity the relationship between radiated power and target BER.
- M-ary modulation requires more complex digital and analog circuitry than 2-ary modulation.
- Many m-ary modulation schemes require for increasing M an increased. (E_b/N_o)

16. What is meant by dynamic modulation scaling?

- It is possible to determine the optimal scheme for a given combination of BER target, range, packet sizes and so forth, such an optimum is only valid for short time. As soon as one of the constraints changes, the optimum can change too.
- It is interesting to consider methods to adapt the modulation scheme to the current situation. Such an approach called dynamic modulation scaling.

17. Define RBS.

- The key idea of the *reference broadcast system* (RBS) is to use the broadcast nature of the wireless communication medium to reduce delays and delay uncertainty in the synchronization protocol.
- This is achieved by having the receiver nodes within the communication range of a broadcast message sent by a sender node synchronize with one another, rather than with the sender.

18. Define sensor selection.

- In the probabilistic framework, this belief is represented as a probability distribution over the state space.
- We consider two scenarios, localizing a stationary source and tracking a moving source, to illustrate the use of information-based sensor tasking.

PART – B (16 Marks)

1. What are the characteristics and features of ad hoc networks?   (M-12)

2. Explain path loss and fading in detail.

3. Explain the two main forms of interference, Doppler shift and Nyquist theorem.

4. Explain the applications areas of ad hoc networks.

5. Explain the characteristics of wireless channels.

6. Explain the design issues in adhoc network?   (M-15)

7. Differentiate between cellular network and Adhoc Network.   (M-12)

8. How is scheduling mechanism achieved in distributed wireless ordering protocol. Explain in detail. How are

Information symmetry and perceived collisions handled?   (M-12)

9. Explain ad hoc indoor mobility models in detail.   (M-12)

UNIT- II: MEDIUM ACCESS PROTOCOLS FOR ADHOC WIRELESS NETWORKS

PART – A (2 Marks)

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

   Design goals of a MAC protocol for ad-hoc networks are

   1. The operation of the protocol should be distributed.
   2. The protocol should provide QoS support for real-time traffic.
   3. The access delay, which refers to the average delay experienced by any packet to get transmitted, must be kept low.
   4. The available bandwidth must be utilized efficiently.
   5. The protocol should ensure fair allocation of bandwidth to nodes.
   6. Control overhead must be kept as low as possible.
   7. The protocol should minimize the effects of hidden and exposed terminal problems.
   8. The protocol must be scalable to large networks.
   9. The protocol should have power control mechanisms.
   10. The protocol should have mechanisms for adaptive data rate control.
   11. The protocol should try to use directional antennas.
   12. The protocol should provide synchronization among nodes.

2. **List the issues of designing a MAC protocol for ad-hoc networks.** (M/J-14)

   The issues of designing a MAC protocol for ad-hoc networks are

   1. Bandwidth efficiency:

      The ratio of bandwidth used for actual data transmission to the total available bandwidth. MAC protocol should maximize it.

   2. QoS support:

      MAC protocol should consider the constraint of ad hoc networks for time critical applications

   3. Hidden and exposed terminal problem

   4. Synchronization:

      It can be achieved by exchange of control packets between transmitter and receiver

   5. Error-Prone Shared Broadcast Channel

   6. Distributed Nature/Lack of Central Coordination

   7. Mobility of Nodes:

      Nodes are mobile most of the time

3. What are the classifications of MAC protocol? (M/J-12)
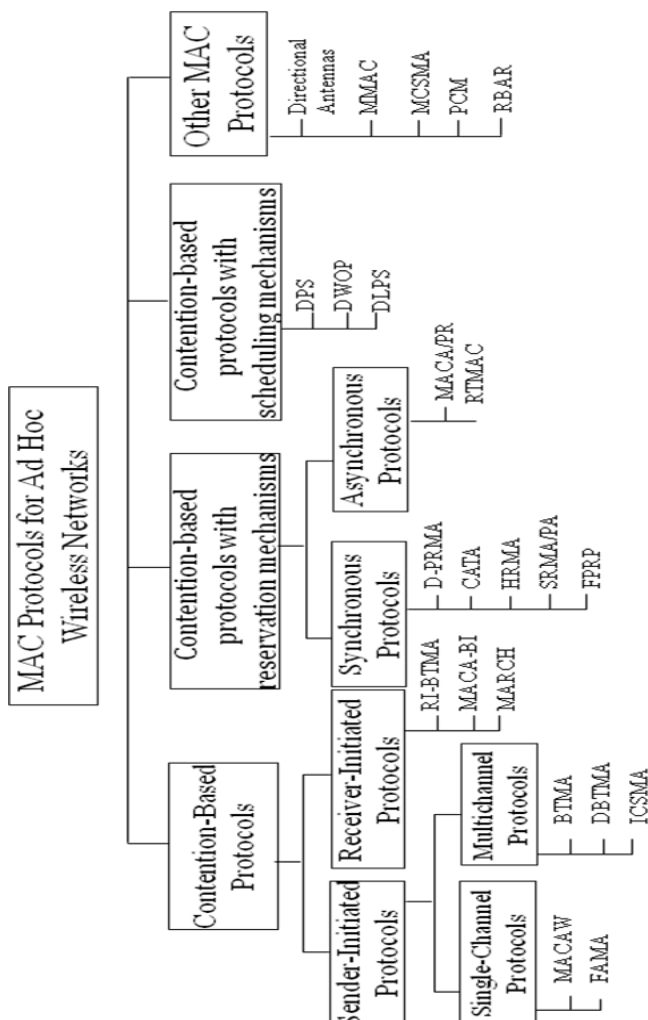
4. What are the effects of exposed terminal problem in wireless networks? (N/D-13)

The effects of exposed terminal problem in wireless networks are

1. Channel throughput is reduced

2. Inefficient bandwidth utilization

3. Reusability of radio spectrum affected

5. What is the topology control?

- A sensor network node that first wakes up executes a protocol to discover which other nodes it can communicate with (bidirectional).

- This set of neighbors is determined by the radio power of the nodes as well as the local topography and other conditions that may degrade radio links.

- A wireless sensor network can change the topology of the network by choosing to broadcast at less than their maximum possible power.

6. What are the mechanisms used in the MAC layer?

The mechanisms used in the MAC layer are

1. Contention based protocols
2. Contention based protocols with reservation mechanisms
3. Contention based protocols with scheduling mechanisms
4. Protocols with directional antennas

7. What are the differences between HRMA and SRMA?

S.No.	HRMA	SRMA
1	A multichannel MAC protocol which is based on half-duplex, very slow frequency-hopping spread spectrum (FHSS) radios	TDMA frame based dynamic reservation MAC protocol
2	Time slot reservation protocol where each fixed time slot is assigned a frequency channel	Nodes are allocated different time slots so that transmissions are collision free
3	Uses a reservation and handshake mechanism to enable a pair of communicating nodes to reserve a frequency hop, thereby guaranteeing collision-free data transmission	Nodes use a collision-avoidance handshake mechanism and a soft reservation mechanism
4	Supports real time transmission	Developed with the main objective of supporting integrated services of real-time and non-real-time application in ad hoc networks

8. What are the advantages of directional antennas MMAC over MACAW?

The advantages of directional antennas over MACAW are

1. Reduced signal interference
2. Increase in system throughput
3. Improved channel reuse
4. Increase in overall capacity of the channel

9. List the five phases of FPRP. (N/D-13)

The five phases of FPRP are

1. Reservation request phase
2. Collision report phase
3. Reservation confirm phase
4. Reservation acknowledge phase
5. Packing/elimination phase

10. List any two needs of real-time MAC protocol. (N/D-12)

RTMAC provides a bandwidth reservation mechanism to support real time traffic in ad hoc wireless network. The real-time MAC protocol is needed where

1. Nodes do not require global time synchronization:

   RTMAC has no time synchronization since nodes operate in the asynchronous mode.

2. Successive reservation slots need not align with each other:

   Small slot can be used to transmit DATA and ACK packet and it can use some other slot for control packets (Resv RTS, Resv CTS, Resv ACK) for transmitting best effort packet.

11.Compare the efficiency of the packet queuing mechanism adopted in MACA and MACAW. (N/D-12)

MACAW implements per flow fairness as opposed to the per node fairness in MACA. This is done by manipulating multiple queues at every node, one each for each data stream, and running the back-off algorithm independently for each queue. Thus the efficiency of the packet queuing mechanism is better in MACAW.

12. How is directional antenna MMAC superior over MACAW?

Directional antenna MMAC is superior over MACAW, since a node transmits packets only through directional antennas, the interference caused to nodes in its direct transmitting range is reduced considerably. This leads to an increase in the overall throughput of the system.

13. List the features of 802.15 standard. (M/J-12)

IEEE has approved a Bluetooth based standard (IEEE 802.15.1) for WPANS. The standard covers only MAC and the physical layers.

The features of 802.15 standard are

1. It employs radio frequency technology for communication.
2. It makes use of frequency modulation to generate radio waves in the ISM band.
3. Low power consumption.
4. It covers range up to 10 meters.
5. Can establish ad hoc network of laptops.

14. Write the frame format of 802.11a.

The frame format of 802.11a is

FC	D/I	Address	Address	Address	SC	Address	Data	FCS	Bytes
2	2	6	6	6	2	6	0 – 2312	4	

Bits

Protocol version	Type	Subtype	To DS	From DS	MF	RT	PM	MD	W	O
2	2	4	1	1	1	1	1	1	1	1

FC- Frame Control, SC- Sequence control, FCS –Frame check sequence
DS-distribution system, MF-more fragments, RT-retry, PM-power management,
MD-more data, W-wired equivalent privacy bit, O-order

15. What is HIPERACCESS?

HIPERACCESS (originally called HIPERLAN/3) covers "the last mile" to the customer. It enables establishment of outdoor high speed radio access networks, providing fixed radio connections to customer premises. HIPERACCESS provides a data rate of 25Mbps. It can be used to connect HIPERLAN/2 deployments that are located far apart (up to 5Km away). It offers point - to - multipoint communication.

16. Give the difference between AODV and DSR.

- DSR has less routing overhead than AODV.
- AODV has less normalized MAC overhead than DSR.
- DSR is based on a source routing mechanism whereas AODV uses a combination of
- DSR and DSDV mechanisms.
- AODV has better performance than DSR in higher-mobility scenarios.

DSR has less frequent route discovery processes than AODV

17. Mention any four qualities of service metrics that are used to evaluate the performance of the network.

The QOS metrics that are used to evaluate the performance of the network are

1. Minimum Bandwidth
2. Maximum Delay
3. Maximum Delay variance (Jitter)
4. Maximum packet loss rate
5. Security – Military
6. Availability of network – Emergency
7. Battery life – Group communications

PART- B (16 Marks)

1. Explain MACAW protocol in detail.   (M-14)

2. Explain the contention based protocols with scheduling and reservation in detail.   (D-14)

3. List and explain the issues in designing a MAC protocol for ad hoc wireless networks.   (M-14)

4. List the important goals of designing a MAC protocol for ad hoc wireless networks.

5. Illustrate various steps involved in five phase reservation protocol with its frame format.

 (M-13)

6. How is scheduling mechanism achieved in distributed wireless ordering protocol? Explain in

detail. How are Information symmetry and perceived collisions handled?   (M-15)

7. What are the advantages of reservation based MAC protocol over contention based MAC

Protocol?

8.Explain 802.11g IEEE standard in detail.   (M-12)

UNIT – III: ROUTING PROTOCOLS AND TRANSPORT LAYER IN ADHOC WIRELESS NETWORKS

PART – A (2 Marks)

1. List out the issues in Ad Hoc networks.
   - Medium access scheme
   - Routing
   - Multicasting
   - Transport layer protocol
   - Pricing scheme
   - QoS provisioning
   - Self-organization

2. Differentiate proactive and reactive routing protocols. Write examples for each.   (M/J-12)

S.No.	Proactive	Reactive
1	Route is pre-established	Route establishment is on-demand
2	Continuously discover the routes	Route discovery by some global search
3	Updates topology information(table) periodically	No information update is done
4	No latency in route discovery	longer delay due to latency of route discovery
5	Large capacity is needed to update network information	Large capacity is not needed
6	A lot of routing information may never be used	May not be appropriate for real-time communication
7	Eg: DSDV, WRP	Eg: AODV, ABR

3. What is the approach used to find link stability in ABR?
   Associativity-based routing (ABR) protocol selects route based on the stability of the wireless link. A link is classified as stable or unstable based on its temporal stability. Temporal stability is determined based on number of beacon signal that node receives from its neighbors.
   - Large number of beacon signals implies stable link
   - Lesser number of beacon signals implies unstable link

4. How does energy aware routing work?   (M/J-12)
   The energy aware routing works based on the routing metrics such as low energy, cost and remaining battery charge. It aims mainly at increasing the lifetime of the network.

5. List the classification of routing protocols based on the routing information update mechanism. **(N/D-14)**

The classification of routing protocols based on the routing information update mechanism are

1. Table driven routing protocols

   - Periodic exchange of routing information.

   - Each node maintains its own routing table.

2. On-demand routing protocols

   - No periodic exchange of routing information.

   - Route is found when only required.

3. Hybrid routing protocols

   - Uses both table driven routing and on-demand routing protocols.

   - Table driven routing (at a defined local zone) + on-demand routing (among zones)

6. List the approaches for power aware routing protocol.

The approaches for Power aware routing are

1. Minimize Energy Consumption per Packet

2. Maximize Network Connectivity

3. Minimize Variance in Node Power Levels

4. Minimize Cost per Packet

5. Minimize Maximum Cost per Node

7. What is the need for power management in Adhoc network? **(N/D-15)**

In Adhoc networks, the routers are power constrained just as the nodes. There is limitation in availability of power for operation. The power management is needed for

1. Efficient utilization of energy

2. Increase in life time of the network

3. Portability, weight, size of the hand held devices

4. Difficulties in replacing batteries

5. Improving channel utilization

6. Selection of optimal transmission power

8. List the advantages and disadvantages of DSDV routing protocols.

The advantages and disadvantages of DSDV routing protocols are

Advantages

1. Less Delay is involved in route setup process.

2. DSDV protocol guarantees loop free paths.

3. Incremental updates with sequence number tags make the existing wired network protocols adaptable to ad-hoc wireless networks.

4. Count to infinity problem is reduced in DSDV.

5. Path Selection: DSDV maintains only the best path instead of maintaining multiple paths to every destination. With this, the amount of space in routing table is reduced.

Disadvantages

1. Updates due to broken links lead to heavy control overhead during mobility.

2. The control overhead is directly proportional to the number of nodes.

3. Small network with high mobility or large network with low mobility can choke the available bandwidth.

4. Wastage of bandwidth due to unnecessary advertising of routing information even if there is no change in the network topology.

5. Delay in obtaining information about a node could result in stale routing at the nodes.

9. What is hybrid routing protocol?

Hybrid routing protocol combines the features of table driven and on demand routing protocol. It uses table driven routing at a defined local zone and on-demand routing beyond routing (local) zones.

10. Mobility of nodes in a sparsely populated mobile Adhoc network is less. What is the choice between proactive routing protocol and reactive routing protocol?

If the Mobility of nodes in a sparsely populated mobile Adhoc network is less, Proactive routing protocol is chosen. Routes are already available in proactive routing rather than reactive protocol in which routes are on demand. The nodes are sparsely populated hence the routing table will occupy less memory. The routing table can be periodically exchanged in proactive routing and this overhead will not occupy more bandwidth since the mobility is less. Route converges faster compared to reactive routing protocol. Hence Proactive routing protocol can be used.

11.What are the pros and cons of tree based and mesh based routing?

S.no.	Tree based	Mesh based
1	One path between source and receiver	Multicast routing protocols provide multiple paths between source-receiver pair
2	They are not robust enough to operate in highly mobile environment	They are robust due to multiple path, hence can operate in highly mobile environment
3	Bandwidth-efficient and fast deployment, make them well-suited for critical environments	The multiple wireless hops suffer very much due to link breaks in high mobility Environments. Hence multicast efficiency is less.
4	Eg. Multicast Ad hoc On -demand Distance Vector routing protocol (MAODV).	Eg. On - Demand Multicast Routing Protocol (ODMRP)

12. What is call rerouting?

In MANET, nodes move frequently, the probability of connectivity loss between nodes might be high, and communication sessions may easily loose connectivity during transmission. The routing protocol is designed to find alternative paths in these situations. This rerouting takes time, and the latency is referred to as the rerouting time.

13. Mention any four qualities of service metrics that are used to evaluate the performance of the network.

The QOS metrics that are used to evaluate the performance of the network are

8. Minimum Bandwidth

9. Maximum Delay

10. Maximum Delay variance (Jitter)

11. Maximum packet loss rate

12. Security – Military

13. Availability of network – Emergency

14. Battery life – Group communications

14. Where is network layer solution used for QoS?

Network layer solution for QoS is used for

1. Enduring end-end resource negotiation

2. Reservation and

3. Reconfiguration

15. AMRIS may not exhibit high packet delivery ratio even when all nodes restrict their mobility to a small region. Why?   (N/D-12)

    Since the selection of potential parent node is based on MSM-ID, AMRIS tends to increase the average hop-length between the receivers and the source.

    This leads to increased delay and increased probability of packet losses even when all nodes restrict their mobility to a small region.

16. Is hop – length always the best metric for choosing paths in MANETs? Defend your answer.   (N/D-12)

    No, hop length is not always the best metric for choosing paths in MANETs.

It is the best metric only in the shortest path protocol. For secure routing, all the nodes along the path must be secure nodes else security is compromised. For energy aware routing, low power consumption and remaining battery backup must also be considered for choosing path.

17. What is the typical value of time out period in traditional TCP? In what ways these become a problem in mobile ad hoc networks?

    The timeout period is atleast as much as the timer granularity, which is typically 100-500ms and typically 500 ms for ATM LANs and WANs. The time out period depends on RTT (round trip time).
TCP in ad hoc networks becomes a problem due to
    1. Misinterpretation of packet loss
    2. Frequent path breaks
    3. Effect of path length
    4. Misinterpretation of congestion window
    5. Asymmetric link behavior
    6. Uni-directional path
    7. Multipath routing
    8. Network partitioning and remerging
    9. Use of sliding-window-based transmission

18. Define security routing.
    Security routing is defined as routing the data packets from the source to the destination in a secured manner. Secured routing provides
    1. Confidentiality
    2. Integrity
    3. Avalilability
    4. Non-repudiation

19.What are not supported by the traditional TCP for handling Adhoc network?

    The features that are not supported by the traditional TCP for handling adhoc network are

1. Throughput
2. Power consumption
3. Path break handling mechanisms
4. Scheduling of packet loss and rate of transmission
5. Bandwidth consumption due to RTS-CTS-DATA-ACK

20.How is secure routing done on wireless channels?

    Secure routing is done on wireless channels by having secure routing protocols which support

1. Detection of malicious nodes
2. Guarantee of correct route discovery
3. Confidentiality
4. Stability against attacks

21.List issues and challenges in security provisioning of transport layer.   **(N/D-13)**

    The issues and challenges in security provisioning of transport layer are

1. Shared broadcast radio channel
2. Insecure operational environment
3. Lack of central authority
4. Lack of association
5. Limited resource availability
6. Physical vulnerability

22.Why does TCP not work well in ad hoc network?   **(M/J-12)**

    The TCP does not work well in ad hoc network because of the following reasons

1. Misinterpretation of packet loss
2. Frequent path breaks
3. Effect of path length
4. Misinterpretation of congestion window
5. Asymmetric link behavior
6. Uni-directional path
7. Multipath routing
8. Network partitioning and remerging
9. Use of sliding-window-based transmission

23.What are the issues in designing transport layer protocol?

    The issues in designing transport layer protocols are

1. Induced traffic
2. Induced throughput unfairness
3. Separation of congestion control, reliability and flow control
4. Power and bandwidth constraints
5. Misinterpretation of congestion
6. Completely decoupled transport layer

24.Why secure routing protocols are needed?

In ad hoc wireless networks, nodes act both as regular terminals (source or destination) and also as routers for other nodes. In the absence of dedicated routers, providing security becomes a challenging task in these networks. Due to certain unique characteristics of ad hoc wireless networks the task of ensuring secure communication in ad hoc wireless networks is difficult. Hence in order to provide secure communication, secure routing protocols are needed.

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PART - B (16 Marks)

1. Explain the route establishment in location - based routing.   (M-15)

2. Device a pseudo code that present various steps involved in neighbor Degree- Based preferred link algorithm.

(D-14)

3. How is routing table constructed in fisheye state routing protocol? Explain in detail.

4. Discuss table driven protocols with examples.   (D-12).

5. Explain multicast routing algorithms in detail.

6. How routing table is constructed in fisheye state routing protocol? Explain in detail.   (D-14).

7. List the characteristics of ideal routing protocol for ad hoc wireless network.   (D-12).

8. Classify and explain adhoc wireless network based on routing topology.

9. Explain the types of ad hoc network routing protocols based on routing information update

Mechanism.   (M-13)

10. Explain on demand routing protocol in detail.   (M-12)

11. Explain the major challenges that a routing protocol designed for adhoc wireless networks face.

(M-15)

12. Describe how the packets are transmitted in multiple access collision avoidance protocol.   (M-13)

13. Explain the scheduling table update mechanism in distributed priority scheduling.

UNIT – IV: WIRELESS SENSOR NETWORKS AND MAC PROTOCOLS

PART – A (2 MARKS)

1. Draw the Diagram for sensor node hardware components? (N/D-13)
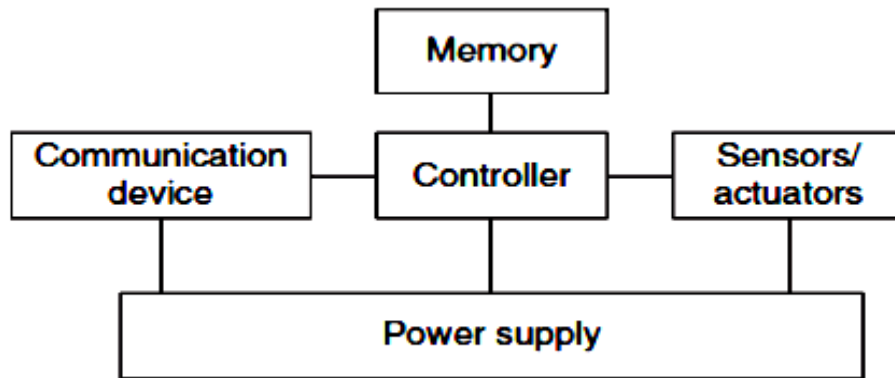
2. Give some example for microcontroller?
    - Intel Strong ARM
    - Texas Instruments MSP 430
    - Atmel Atmega

3. What is power consumption and energy efficiency? (M/J-14)
    - The simplest interpretation of energy efficiency is the energy required to transmit and receive a single bit. Also, to be suitable for use in WSNs, transceivers should be switchable between different states, e.g. active and sleeping.
    - The idle power consumption in each of these states and during switching between them is very important.

4. Define Noise figure? (M/J-12)
    Noise Figure of an element is defined as the ratio of the Signal-to-Noise Ratio (SNR) ratio SNR_I at the input of the element to the SNR ratio SNR_o at the element's output:

    $$NF = \frac{SNR_I}{SNR_O}$$

    It describes the degradation of SNR due to the element's operation and is typically   given in dB:

    $$NF\ dB = SNR_I\ dB - SNR_o\ dB$$

5. What is Receiver Sensitivity?
    The receiver sensitivity of the radio front end is given as the ratio of the radiated power to the overall power consumed by the front end; for a power amplifier; the efficiency describes the ratio of the output signal's power to the power consumed by the overall power amplifier.

6. What is Idle and Sleep state? (N/D-14)
    Idle state
    - A transceiver that is ready to receive but is not currently receiving anything is said to be in an idle state.
    - In this idle state, many parts of the receive circuitry are active, and others can be switched off.
    Sleep state

- In the sleep state, significant parts of the transceiver are switched off.
- This sleep states differ in the amount of circuitry switched off and in the associated recovery times and startup energy.

7. What is energy scavenging? (M/J-15)

Some of the unconventional energy described above-fuel cells, micro heat engines, radioactivity-convert energy from some stored, secondary form into electricity in a less direct and easy to use way than a normal battery would do. The entire energy supply is stored on the node itself-once the fuel supply is exhausted, the node fails.

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8. What is Active and Passive Sensors? (M/J-13)

Active sensors

- This last group of sensors actively probes the environment.
- These are quite specific-triggering an explosion is certainly not a lightly under taken action-and require special attention.

Passive, omnidirectional sensors

- These sensors can measure a physical quantity at the point of the sensor node without actually manipulating the environment by active probing-in this sense, they are passive.
- There is no notion of "direction" involved in these measurements.

Passive, narrow-beam sensors

- These sensors are passive as well, but have a well-defined notion of direction of measurements. A typical example is a camera, which can "take measurements" in a given direction, but has to be rotated if need be.

9. What is Relaxation effect?

The seeming self-recharging of an empty or almost empty battery when no current is drawn from it, based on chemical diffusion processes within the cell-should be clearly understood. Battery lifetime and usable capacity is considerably extended if this effect is leveraged.

10. What is Dynamic voltage scaling?

The rational is the fact that a controller running at lower speed, that is, lower clock rates, consumes less power than at full speed. This is due to the fact that the supply voltage can be reduced at lower clock rates while still guaranteeing correct operation. This technique is called Dynamic Voltage Scaling.

11. What are the two task of Radio Transceiver?

A radio transceiver has essentially two tasks: transmitting and receiving data between a pair of nodes. Similar to microcontrollers, radio transceivers can operate in different modes; the simplest ones are being turned on or turned off.

WIRELESS NEWORK ARCHITECTURE – DATA RELAYING AND AGGREGATION STATERGIES – MAC LAYER PROTOCOLS

12. Difference between single-hop and multihop networks? (N/D-13)

S.No	Single-hop Network	Multihop Network

1.	Because of this limited distance, the simple, direct communication between source and sink is not always possible.	It is an evident and working solution to overcome problems with large distances.
2.	They intended to cover a lot of ground.	The attenuation of radio signals is at least quadratic in most environments.

13. What are the three types of mobility?

- Node mobility
- Sink mobility
- Event mobility

14. What is QOS?

WSN networks essentially only move bits from one place to another. additional requirements about the offered Quality of Services (QOS) are made, especially in the context of multimedia applications. Such QOS can be regarded as a low-level, networking-device-observable attribute-bandwidth, delay, jitter and packet loss rate.

15. What is network lifetime?

The time for which the network is operational or, put another way, the time during which it is able to fulfill its tasks (starting from a given amount of stored energy).

16. What is Scalability? (M/J-12)

Scalability is an evidently indispensable requirement. Scalability is ill served by any construct that requires globally consistent state, such as addresses or routing table entries that have to be maintained. Hence, the need to restrict such information is enforced by and goes hand in hand with the resource limitations of sensor nodes, especially with respect to memory.

17. What is meant by fixed assignment protocol?

The available resources are divided between the nodes such that the resource assignment is long term and each node can use its resources exclusively without the risk of collisions.

18. What is Overheading?

Unicast frames have one source and one destination node. The wireless medium is a broadcast medium and all the source's neighbors that are in receive state hear a packet & drop it when it is not destined to them these nodes overhead the packet.

19. List the features of 802.15 standards.

IEEE 802.15.3-2003 is a MAC and PHY standard for high-rate (11 to 55 Mbit/s) WPANs. IEEE 802.15.3a was an attempt to provide a higher speed UWB PHY enhancement amendment to IEEE 802.15.3b-2005 amendment was released on May 5, 2006. It enhanced 802.15.3 to improve implementation and interoperability of the MAC. This will include minor optimizations while preserving backward compatibility.

PART – B(16 Marks)

1. Explain about the hardware components of sensor nodes   (D-15)

2. Explain about the software components of sensor nodes   (M-15)

3. With a neat diagram, Explain the sensor network architecture

4. Write notes on Dynamic Energy and power management   (M-13)

5. Explain in detail about aggregation as an optimization problem.

6. Explain about the MAC protocol in WSN.   (M-13)

7. Write in detail about the IEEE 802.15.4   (D-13)

8. Explain Ad hoc TCP states and event action mapping in detail.

9.Explain feedback based TCP and TCP Bus in detail.

10. Explain the issues in designing a transport layer protocol for ad hoc wireless networks.

UNIT – V: WSN ROUTING, LOCALIZATION AND QOS

PART – A (2 Marks)

1. **What is STEM and define?**
   - The sparse Topology and Energy Management (STEM) .
   - It does not cover all aspects of a MAC protocol but provides a solution for the idle listening problem.

2. **What is use of addresses and names in sensor network?**
   - Unique node identifier.
   - MAC address.
   - Network address.
   - Network identities.

3. **What is the address management task?**
   - Address allocation.
   - Address deallocation.
   - Binding.
   - Conflict detection.

4. **What is address allocation assignment?**
   - The address assignment can happen a priori or a demand, by using an address assignment protocol.
   - Such an on-demand address assignment protocol can be either centralized or distributed

5. **What is min-max battery cost routing?**
   - MMBCR follows a similar intention, to protect nodes with low energy battery resources.
   - The same effect is achieved by using smallest battery level along a path and maximizing over path values.

6. **What is minimum total transmission power routing?**
   - Without actually considering routing as several nodes transmitting directly to their destination, mutually causing interference with each other.
   - MTPR is of course applicable to Multihop networks.

7. **What is example of unicast protocols?**
   - Attracting routes by redirecting.
   - Distance vector routing on top of topology control.
   - Maximizing number of messages.

8. **What is called beacons?**

Sensor node localization is a highly desirable capability for wireless sensor network applications. Localization refers to the process of estimating the coordinates of the sensor nodes in a network based on various types of measurements and with the aid of a number of beacon or anchor nodes that know their location.

9. How to determine the distance in triangulation? (N/D-13)

Triangulation is the method for finding location of unknown nodes is localization triangulation method in which three or four known nodes along with (RSSI) signal as distance based measurement are used.

10. What is the two domain classification of QOS?

1. End to End QOS
2. Mobile QOS

11. What is energy efficient routing design?

Energy efficient routing protocol is designed based on the energy constraint of the sensor node. The designed protocol uses less amount of energy by reducing number of bits in packets and by making less duty cycle.

12. Define OLSR?

OLSR is a proactive link-state routing protocol, which uses hello and topology control (TC) messages to discover and then disseminate link state information throughout the mobile ad hoc network.

13. What geocasting and position based routing?

- The first aspect sending data to arbitrary nodes in a region is referred as geo casting.
- The second aspect is called position based routing in this techniques to make nodes and aware of their position.

14. What is meant by clustering?

- The nodes in a sensor network often need to organize themselves into clusters.
- Clustering allows hierarchical structures to be built on the nodes and enables more efficient use of scarce resources, such as frequency spectrum, bandwidth, and power.

15. What is demand assignment protocol?

Exclusive allocation of resources to nodes is made on a short-term basis, typically the duration of a data burst. Protocols are broadly subdivided into centralized and distributed protocols.

16. What is random access protocol?

- The nodes are uncoordinated, and the protocols operate in a fully distributed manner.
- Random access protocols often incorporate a random element.
- Very important access protocols is the ALOHA.

17. What is time of arrival?

A second way to estimate distance is to measure the time it takes for a signal to travel from sender to receiver; this can be multiplied by the signal propagation speed to yield distance. Such methods are called time of arrival (TOA) techniques and can use either RF or ultrasound signals.

18. Define Transport layer protocol.

Transport layer protocol is responsible for end-end delivery of packets, reliability, congestion control , flow and error control.

19. What are the different types of energy sufficient routing techniques?

- Lifetime Prediction Routing (LPR)

- Energy Saving Dynamic Source Routing

- Energy Dependent DSR (EDDSR)

- Energy Efficient broadcast OLSR

PART – B (16 Marks)

1. Briefly explain the issues in WSN routing   (M-13)

2. What is meant by OLSR and explain about OLSR routing protocol?   (D-13)

3. Explain about the absolute and relative localization.   (D-14)

4. Write notes on triangulation.   (M-12)

5. Explain about the QOS in WSN.

6. Explain about the Synchronization in WSN.   (M-13)

7. Explain the issues in designing a transport layer protocol for ad hoc wireless sensor networks.

8. Explain multicast routing algorithms of wireless sensor network in detail.   (M-12)

9. Explain the energy aware routing protocols in detail.   (M-15)

10. Briefly explain cluster based routing and its merits and demerits.