FIRST TERM EXAMINATION [FEB. 2019]
EIGHTH SEMESTER [B.TECH]
AD HOC AND SENSOR NETWORK [ETEC–406]

me : 1.5 hrs. M.M. : 30

te: *Attempt Q. 1. is compulsory and any two more questions.*

Q.1. (a) Explain different characteristics of adhoc networks. (2.5)

Ans. Features of ad hoc networks are listed below

Autonomous behaviour: In ad hoc networks, each node acts as both host and router. ach node has autonomy to be

Multi-hop radio relaying: Ad hoc networks are capable of multi-hop routing when source node and a destination node for a data transmission are out of the radio range.

Decentralized control: In ad hoc networks there is distributed nature of operation r security, routing and host configuration. A centralized control is missing.

Dynamic topology: The nodes can join or leave the network anytime, making the twork topology dynamic in nature.

Limited bandwidth: The reliability, efficiency, stability, and capacity of wireless nks are often inferior when compared with wired links. This shows the fluctuating link ndwidth of wireless links.

Mobility: In ad hoc networks nodes are highly mobile.

Collaborative computing: There are intermediate nodes which will act as relays or the data that is sent by the source node to be delivered to the intended destination

Q.1. (b) Differentiate cellular and Ad hoc wireless networks. (2.5)

Ans.

Cellular Netowrks	Ad HOC Wireless Networks
(a) Fixed infrastructure-based	(a) Infrastructure-less
(b) Single-hop wireless links	(b) Multi-hop wireless links
(c) Guaranteed bandwidth (designed for voice traffic)	(c) Shared radio channel (more suitable for best-effort data traffic)
(d) Centralized routing	(d) Distributed routing
(e) Circuit-switched (evolveing toward packet switching)	(e) Packet-switched (evolving toward emulation of circuit switching)
(f) Seamless connectivity (low call drops during handoffs)	(f) Frequent path breaks due to mobility
(g) High cost and time of deployment	(g) Quick and cost-effective deployment
(h) Reuse of frequency spectrum through geographical channel reuse	(h) Dynamic frequency reuse based on carrier sense mechnism
(i) Easier to achieve time synchronization	(i) Time synchronization is difficult and consumes bandwidth
(j) Easier to employ bandwidth reservation	(j) Bandwidth reservation requires complex medium access control protocols
(k) Application domains include mainly civilian and commerical sectors	(k) Application domains include battle-fields, emergency search and resue operations, and collaborative computing.

(l) High cost of network maintenance (backup power source, staffing etc.)	(l) Self-organization and maintenance properties are built into the network
(m) Mobile losts are of relatively low complexity	(m) Mobile hosts require more intelligence (should have a transceiver as well as routing/switching capability)
(n) Major goals of routing and call admission are to maximize the call acceptance ratio and minimize the call drop ratio	(n) Main aim of routing is to find paths with minimum overhead and also quick reconfiguration of broken paths
(o) Widely deployed and currently in the third generation of evolution	(o) Several issues are to be addressed for successful commercial deployment even though widespread use exists in defense

Q.1. (c) What are the issues in adhoc and sensor networks? **(2.5)**

Ans. The major issues that affect the design, deployment, and performance of an ad hoc wireless network system are :

- Medium Access Scheme.
- Transport Layer Protocol.
- Routing.
- Multicasting.
- Energy Management.
- Self-Organization.
- Security.
- Addressing & Service discovery.
- Deployment considerations.
- Scalability.
- Pricing Scheme.
- Quality of Service Provision

Q.1. (d) Explain the different application areas of adhoc wireless network. **(2.5)**

Ans. Refer to Q.1. of End Term Examination 2017.

Q.2. What are the different issues in the designing of MAC protocol for Adhoc wireless network ? **(10)**

Ans. The main issues in designing MAC protocol for ad hoc wireless network are:

Bandwidth efficiency

- Bandwidth must be utilized in efficient manner.
- Minimal Control overhead
- BW = ratio of BW used for actual data transmission to the total available BW.

Quality of service support

- Essential for supporting time-critical traffic sessions.
- They have resource reservation mechanism that takes into considerations the nature of wireless.
- Channel and the mobility of nodes.

Synchronization

- MAC protocol must consider synchronization between nodes in the network.
- Synchronization is very important for BW (time slot) reservation by nodes.
- Exchanges of control packets may be requried for achieving time synchronization among nodes.

ıidden and exposed terminal problems

• The hidden terminal problem refers to the collision of packets at a receiving node ıue to the simultaneous transmission of those nodes that are not within the direct ransmission range of the sender but are within the transmission range of the receiver.

• Collision occurs when both nodes transmit packets at the same time without nowing about the transmission of each other

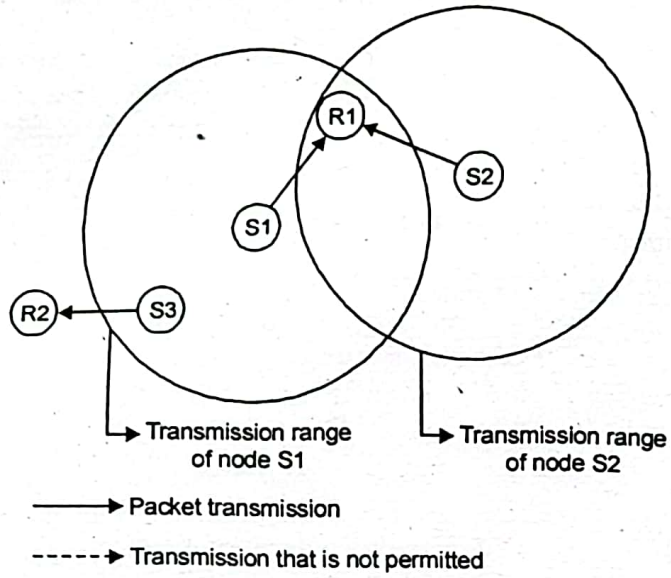


Fig.1. Hidden and exposed terminal problems

• S1 and S2 are hidden from each other & they transmit simultaneously to R1 ich leads to collision.

• The exposed terminal problem refers to the inability of a node, which is blocked ; to transmission by a nearby transmitting node, to transmit to another node.

• If S1 is already transmitting to R1, then S3 cannot interfere with on-going nsmission & it cannot transmit to R2.

• The hidden & exposed terminal problems reduce the throughput of a network en traffic load is high.

:or-prone shared broadcast channel

• When a node is receiving data, no other node in its neighbourhood should transmit ɔde should get access to the shared medium only when its transmission do not affect ' ongoing session.

• MAC protocol should grant channel access to nodes in such a manner that collision minimized.

• Protocol should ensure fair BW allocation.

• Distributed nature/lack of central coordination.

• Do not have centralized coordinates.

• Nodes must be scheduled in a distributed fashion for gaining access to the channel.

• MAC protocol must make sure that additional overhead, in terms of BW sumption, incurred due to this control information is not very high.

• Mobility of nodes.

• Nodes are mobile most of the time.

• The protocol design must take this mobility factor into consideration so that the ormance of the system is not affected due to node mobility.

Q.3. Give a detail classification of MAC protocol for adhoc wireless network l explain any two protocols in details. **(10)**

Ans. MAC protocols for ad hoc wireless networks can be classified into several categories based on various criteria such as initiation approach, time synchronization, and reservation approaches. Ad hoc network MAC protocols can be classified into three basic types:

- Contention-based protocols
- Contention-based protocols with reservation mechanisms
- Contention-based protocols with scheduling mechanisms

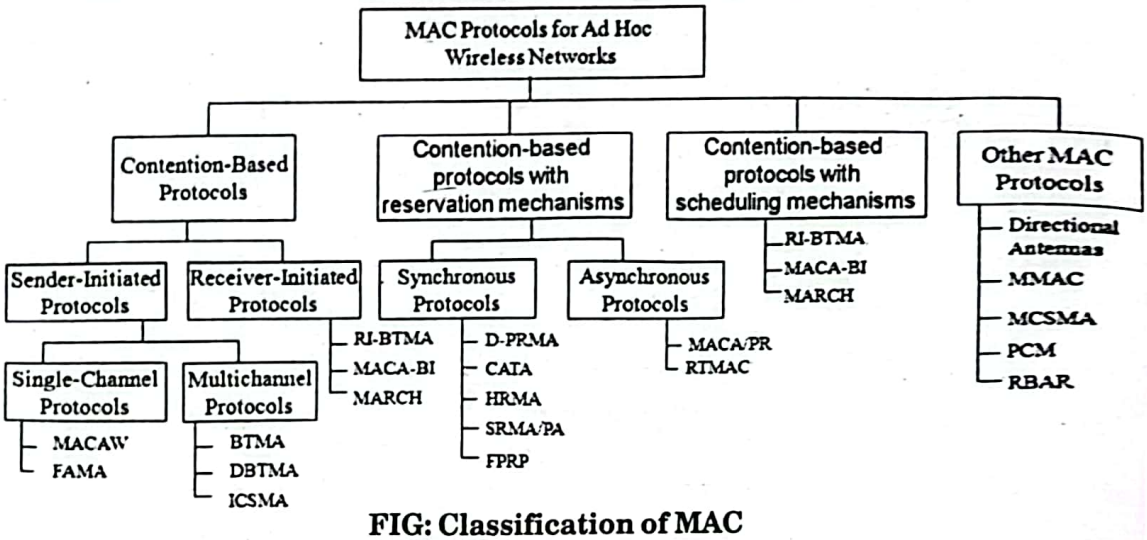


FIG: Classification of MAC

Contention-based protocols

- Sender-initiated protocols: Packet transmissions are initiated by the sender node.
- Single-channel sender-initiated protocols: A node that wins the contention to the channel can make use of the entire bandwidth.
- Multichannel sender-initiated protocols: The available bandwidth is divided into multiple channels.
- Receiver-initiated protocols: The receiver node initiates the contention resolution protocol.

Contention-based protocols with reservation mechanisms

- Synchronous protocols: All nodes need to be synchronized. Global time synchronization is difficult to achieve.
- Asynchronous protocols: These protocols use relative time information for effecting reservations.

Contention-based protocols with scheduling mechanisms

- Node scheduling is done in a manner so that all nodes are treated fairly and no node is starved of bandwidth.
- Scheduling-based schemes are also used for enforcing priorities among flows whose packets are queued at nodes.
- Some scheduling schemes also consider battery characteristics.

Q.4. What are designing issues in routing protocol for ad hoc wireless network? Explain any one table driven routing protocol. (10)

Ans. The major challenges that a routing protocol designed for ad hoc wireless networks faces are mobility of nodes, resource constraints, error-prone channel state, and hidden and exposed terminal problems.

- **Mobility:** The network topology in an ad hoc wireless network is highly dynamic due to the movement of nodes, hence an on-going session suffers frequent path breaks. Disruption occurs either due to the movement of the intermediate nodes in the path or due to the movement of end nodes.

• **Bandwidth Constraint:** Limited bandwidth

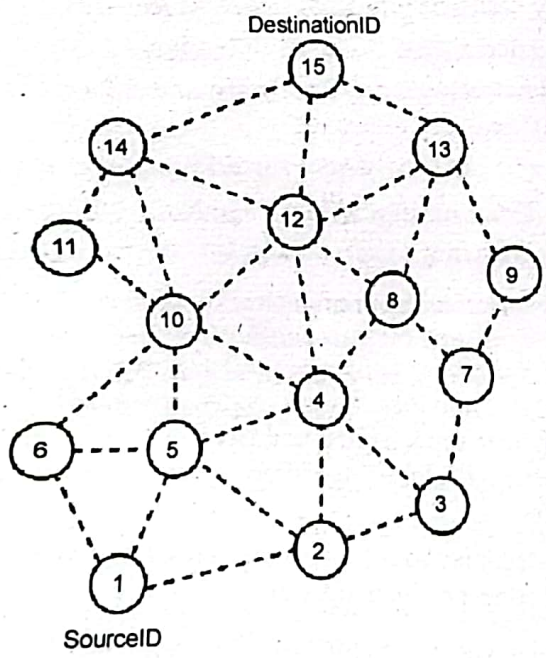
• Error-Prone Shared Broadcast Radio Channel

The broadcast nature of the radio channel poses a unique challenge in ad hoc less networks. The wireless links have time-varying characteristics in terms of link city and link-error probability.

• Hidden and Exposed Terminal Problems

The hidden terminal problem refers to the collision of packets at a receiving node to the simultaneous transmission of those nodes that are not within the direct smission range of the sender, but are within the transmission range of the receiver.

Destination Sequenced Distance-Vector Routing Protocol: As it is a table-driven ing protocol, routes to all destinations are readily available at every node at all times. tables are exchanged between neighbors at regular intervals to keep an up-to-date of the network topology. The tables are also forwarded if a node observes a significant ge in local topology. The table updates are of two types: incremental updates and full ps. An incremental update takes a single network data packet unit (NDPU), while a lump may take multiple NDPUs. Incremental updates are used when a node does bserve significant changes in the local topology. A full dump is done either when the topology changes significantly or when an incremental update requires more than a e NDPU. Table updates are initiated by a destination with a new sequence number h is always greater than the previous one. Upon receiving an updated table, a node r updates its tables based on the received information or holds it for some time to t the best metric (which may be the lowest number of hops) received from multiple ons of the same update table from different neighboring nodes. Based on the sequence ber of the table update, it may forward or reject the table. Consider the example as n in Figure Here node 1 is the source node and node 15 is the destination. As all the s maintain global topology information, the route is already available as shown in Figure. the routing table of node 1 indicates that the shortest route to the destination node



(a) Topology graph of the network

Dest	NextNode	Dist	Seq.No.
2	2	1	22
3	2	2	26
4	5	2	32
5	5	1	134
6	6	1	144
7	2	3	162
8	5	3	170
9	2	4	186
10	6	2	142
11	6	3	176
12	5	3	190
13	5	4	198
14	6	3	214
15	5	4	256

(b) Routing table for Node 1

END TERM EXAMINATION [MAY. 2019]
EIGHTH SEMESTER [B.TECH]
AD HOC AND SENSOR NETWORK [ETEC–06]

Time : 3 hrs. **M.M. : 75**

Note: *Attempt five questions in all including Q. 1. which is compulsory. Select one question from each unit.*

Q.1. (a) Define and explain the ad hoc network. Why ad hoc networks are needed? **(4)**

Ans. Ad hoc wireless networks are defined as the category of wireless networks that utilize multi-hop radio relaying and are capable of operating without the support of any fixed infrastructure (hence they are also called infrastructure less networks). The absence of any central coordinator or base station makes the routing a complex one compared to cellular networks.

Advantages of Ad Hoc Network: The rapid development in ad hoc technology is widely used in portable computing such as laptop, mobile phone used to access the web services, telephone calls when the user are in travelling. Development of self-organizing network decrease the communication cost. The growth of 4G technology enhances anytime, anywhere, anyhow communication in ad hoc network. Ad hoc network is simple to design and install. The advantages of an ad hoc network include: Separation from central network administration.

- Self-configuring nodes are also routers.
- Self-healing through continuous re-configuration.
- Scalability incorporates the addition of more nodes.
- Mobility allows ad hoc networks created on the fly in any situation where there are multiple wireless devices.
- Flexible ad hoc can be temporarily setup at anytime, in any place.
- Lower getting-started costs due to decentralized administration.
- The nodes in ad hoc network need not rely on any hardware and software. So, it can be connected and communicated quickly.

Q.1. (b) List the issues of designing a MAC protocol for ad hoc networks. **(4)**

Ans. Refer to Q.1. (b) of First Term Examination 2018. (Page No. 1-2018)

Q.1. (c) Relate the Sensor network with ad hoc network. **(4)**

Ans. While both ad hoc wireless networks and sensor networks consist of wireless nodes communicating with each other, there are certain challenges posed by sensor networks. The number of nodes in a sensor network can be several orders of magnitude larger than the number of nodes in an ad hoc network. Sensor nodes are more prone to failure and energy drain, and their battery sources are usually not replaceable or rechargeable. Sensor nodes may not have unique global identifiers, so unique addressing is not always feasible in sensor networks.

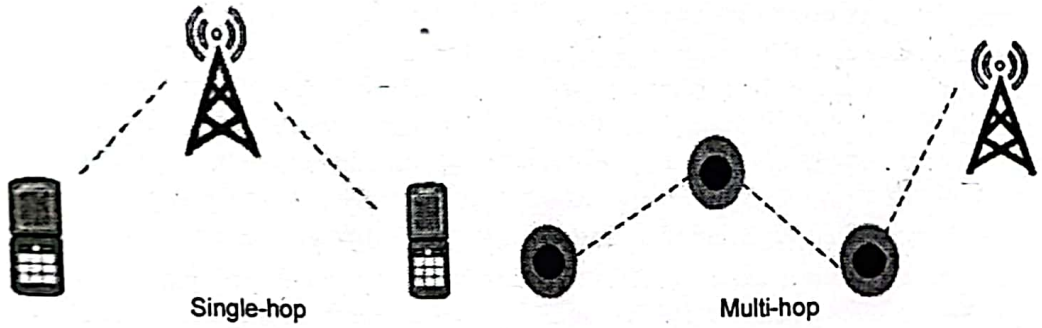
Sensor networks are data-centric, that is, the queries in sensor networks are addressed to nodes which have data satisfying some conditions.

On the other hand, ad hoc networks are address-centric, with queries addressed to particular nodes specified by their unique address. Hence, sensor networks require a different mechanism for routing and answering queries. Most routing protocols used in

ad hoc networks cannot be directly ported to sensor networks because of limitations in memory, power, and processing capabilities in the sensor nodes and the non-scalable nature of the protocols. An important feature of sensor networks is data fusion/ aggregation, whereby the sensor nodes aggregate the local information before relaying. The main goals of data fusion are to reduce bandwidth consumption, media access delay, and power consumption for communication.

Q.1. (d) What multihop wireless communication is required for WSN? Explain. **(4)**

Ans. Ad hoc networks are mainly based upon principle of 'multi-hop relaying'. In a multi-hop network, a data packet has to go through many nodes in order to reach its destination address. Basically the intermediate nodes can act as the peer nodes and these peer nodes can take part in transmitting the information from the source node to the destination node. These networks are self-organizing and self-configuring. If the destination node is not within the direct transmission range of the source node, then the source node will have to take help of some of the intermediate nodes in order to be able to send the data from it to the destination node. This is called multi-hoping relaying.



Q.1. (e) Why does TCP not work well in ad hoc network? Discuss. **(4)**

Ans. The major reasons behind throughput degradation that TCP faces when used in ad hoc wireless networks are the following:

- **Misinterpretation of packet loss:** Traditional TCP was designed for wired networks where the packet loss is mainly attributed to network congestion. Network congestion is detected by the sender's packet RTO period. Once a packet loss is detected, the sender node assumes congestion in the network and invokes a congestion control algorithm.

- **Frequent path breaks:** Ad hoc wireless networks experience dynamic changes in network topology because of the unrestricted mobility of the nodes in the network. The topology changes lead to frequent changes in the connectivity of wireless links and hence the route to a particular destination may need to be recomputed very often.

- **Effect of path length:** It is found that the TCP throughput degrades rapidly with an increase in path length in string (linear chain) topology ad hoc wireless networks.

- **Misinterpretation of congestion window:** TCP considers the congestion window as a measure of the rate of transmission that is acceptable to the network and the receiver. In ad hoc wireless networks, the congestion control mechanism is invoked when the network gets partitioned or when a path break occurs

• **Asymmetric link behavior:** The radio channel used in ad hoc wireless networks has different properties such as location-dependent contention, environmental effects on propagation, and directional properties leading to asymmetric links. The directional links can result in delivery of a packet to a node, but failure in the delivery of the acknowledgment back to the sender.

Q.1. (f) Explain 802.11g IEEE standard. (5)

Ans. IEEE 802.11g was one of the main Wi-Fi standards to follow on from 802.11a and 802.11b. It built on the performance and played a pivotal role in further establishing Wi-Fi as a major wireless standard.

IEEE 802.11g had the advantage that it could support the high data speeds using 2.4 GHz which had previously only attainable using 802.11a within the 5GHz ISM band.

The lower cost of chips using 2.4GHz combined with the higher speed meant that for many years it became the dominant Wi-Fi technology.

It is an amendment to the IEEE 802.11 specification that operates in the 2.4 GHz microwave band. The standard has extended throughput to up to 54 Mbit/s using the same 20MHz bandwidth as 802.11b uses to achieve 11 Mbit/s. This specification under the marketing name of Wi-Fi has been implemented all over the world

UNIT-I

Q.2. (a) Summarize about the schedule based MAC protocols in WSN. (6)

Ans. These protocols focus on packet scheduling at nodes, and also scheduling nodes for access to the channel. Node scheduling is done in a manner so that all nodes are treated fairly and no node is starved of bandwidth. Scheduling-based schemes are also used for enforcing priorities among flows whose packets are queued at nodes. Some scheduling schemes also take into consideration battery characteristics, such as remaining battery power, while scheduling nodes for access to the channel.

Distributed Priority Scheduling and Medium Access in Ad Hoc Networks

The first technique, called distributed priority scheduling (DPS), piggy-backs the priority tag of a node's current and head-of-line packets on the control and data packets. By retrieving information from such packets transmitted in its neighborhood, a node builds a scheduling table from which it determines its rank (information regarding its position as per the priority of the packet to be transmitted next) compared to other nodes in its neighborhood. This rank is incorporated into the back-off calculation mechanism in order to provide an approximate schedule based on the ranks of the nodes. The seccnd scheme, called multi-hop coordination, extends the DPS scheme to carry out scheduling over multi-hop paths. The downstream nodes in the path to the destination increase the relative priority of a packet in order to compensate for the excessive delays incurred by the packet at the upstream nodes.

Distributed Priority Scheduling: The distributed priority scheduling scheme (DPS) is based on the IEEE 802.11 distributed coordination function. DPS uses the same basic RTS-CTS-DATA-ACK packet exchange mechanism. The RTS packet transmitted by a ready node carries the priority tag/priority index for the current DATA packet to be transmitted. The priority tag can be the delay target for the DATA packet. On receiving the RTS packet, the intended receiver node responds with a CTS packet. The receiver node copies the priority tag from the received RTS packet and piggybacks it along with the source node id, on the CTS packet. Neighbor nodes receiving theRTS or CTS packets (including the hidden nodes) retrieve the piggy-backed priority tag information and make a corresponding entry for the packet to be transmitted, in their scheduling tables (STs). Each node maintains an ST holding information about packets, which were originally piggy-backed on control and data packets. The entries in the ST

e ordered according to their priority tag values. When the source node transmits a ATA packet, its head-of-line packet information (consisting of the destination and urce ids along with the priority tag) is piggy-backed on the DATA packet (head-of-ne packet of a node refers to the packet to be transmitted next by the node).

Q.2. (b) List and explain the approaches for power aware routing protocol. **(6.5)**

Ans. The limitation on the availability of power for operation is a significant ttleneck. Hence, the use of routing metrics contributes to the efficient utilization of ergy and increases the lifetime of the network.

Minimal energy consumption per packet

- This metric aims at minimizing the power consumed by a packet in traversing om source node to the destination node.
- The energy consumed by a packet when traversing through a path is the sum of e energies required at every intermediate hop in that path.
- This metric doesn't balance the load
- Disadvantages
- Selection of path with large hop length
- Inability to measure the power consumption in advance
- Inability to prevent the fast discharging of batteries at some nodes

Maximize network connectivity

- This metric attempt to balance the routing load among the cut set (the subset of e nodes in the network, the removal of which results in network partitions).
- It is difficult to achieve a uniform battery draining rate for the cut set.

Maximum variance in Node power levels

- This metric proposes to distribute the load among all nodes in the network so at the power consumption pattern remains uniform across them.
- This problem is very complex when the rate and size of the data packets vary

Minimum cost per packet

- In order to maximize the life of every node in the network, this routing metric is ade as a function of the state of the node's battery.
- A node's cost decreases with an increase in its battery change and vice versa.
- Cost of node can be easily computed
- Advantage congestion handling & cost calculation

Minimize maximum node cost

- This metric minimizes the maximum cost per node for a packet after routing a umber of packets or after a specific period.
- This delays the failure of a node, occurring due to higher discharge because of acket forwarding

Q.3. (a) Explain design challenge in Ad hoc and Sensor Networks. **(6)**

Ans. Refer Q.6 (b) of End Term Examination 2018. (Page No. 14-2018)

Q.3. (b) Explain the contention based protocols with scheduling and eservation in detail. **(6.5)**

Ans. Refer Q.2 (b) of End Term Examination 2017. (Page No. 13-2017)

UNIT-II

Q.4. (a) Define wireless sensor networks. Discuss the components present in sensor Networks. **(4)**

Ans. The main components of a sensor node are a microcontroller, transceiver, external memory, power source and one or more transducers (sensors).

Controller: The controller performs tasks, processes data and controls the functionality of other components in the sensor node. While the most common controller is a microcontroller, other alternatives that can be used as a controller are: a general purpose desktop microprocessor, digital signal processors, FPGAs and ASICs.

Transceiver: Sensor nodes often make use of ISM band, which gives free radio, spectrum allocation and global availability. The possible choices of wireless transmission media are radio frequency (RF), optical communication (laser) and infrared. Lasers require less energy , but need line-of-sight for communication and are sensitive to atmospheric conditions. Infrared, like lasers, needs no antenna but it is limited in its broadcasting capacity.

External memory: From an energy perspective, the most relevant kinds of memory are the on-chip memory of a microcontroller and Flash memory—off-chip RAM is rarely, if ever, used. Flash memories are used due to their cost and storage capacity. Memory requirements are very much application dependent. Two categories of memory based on the purpose of storage are: user memory used for storing application related or personal data, and program memory used for programming the device. Program memory also contains identification data of the device if present.

Power source: A wireless sensor node is a popular solution when it is difficult or impossible to run a mains supply to the sensor node. However, since the wireless sensor node is often placed in a hard-to-reach location, changing the battery regularly can be costly and inconvenient. An important aspect in the development of a wireless sensor node is ensuring that there is always adequate energy available to power the system. The sensor node consumes power for sensing, communicating and data processing.

Sensors (Transducers): Sensors are used by wireless sensor nodes to capture data from their environment. They are hardware devices that produce a measurable response to a change in a physical condition like temperature or pressure. Sensors measure physical data of the parameter to be monitored and have specific characteristics such as accuracy, sensitivity etc. The continual analog signal produced by the sensors is digitized by an analog-to-digital converter and sent to controllers for further processing. Some sensors contain the necessary electronics to convert the raw signals into readings which can be retrieved via a digital link (e.g. I2C, SPI) and many convert to units such as °C. Most sensor nodes are small in size, consume little energy, operate in high volumetric densities, be autonomous and operate unattended, and be adaptive to the environment. As wireless sensor nodes are typically very small electronic devices, they can only be equipped with a limited power source of less than 0.5-2 ampere-hour and 1.2-3.7 volts.

Q.4. (b) List the advantages and disadvantages of DSDV routing protocols. **(4)**

Ans. Advantages and Disadvantages of DSDV routing protocol

The availability of routes to all destinations at all times implies that much less delay is involved in the route setup process. The mechanism of incremental updates with sequence number tags makes the existing wired network protocols adaptable to

ad hoc wireless networks. Hence, an existing wired network protocol can be applied to ad hoc wireless networks with many fewer modifications. The updates are propagated throughout the network in order to maintain an up-to-date view of the network topology at all the nodes. The updates due to broken links lead to a heavy control overhead during high mobility. Even a small network with high mobility or a large network with low mobility can completely choke the available bandwidth. Hence, this protocol suffers from excessive control overhead that is proportional to the number of nodes in the network and therefore is not scalable in ad hoc wireless networks, which have limited bandwidth and whose topologies are highly dynamic.

Another disadvantage of DSDV is that in order to obtain information about a particular destination node, a node has to wait for a table update message initiated by the same destination node. This delay could result in stale routing information at nodes.

Q.4. (c) Discuss issues and challenges in security provisioning of transport layer. (4.5)

Ans. Designing a foolproof security protocol for ad hoc wireless is a very challenging task.

Shared broadcast radio channel: Unlike in wired networks where a separate dedicated transmission line can be provided between a pair of end users, the radio channel used for communication in ad hoc wireless networks is broadcast in nature and is shared by all nodes in the network.

Insecure operational environment: The operating environments where ad hoc wireless networks are used may not always be secure.

Lack of central authority: In wired networks and infrastructure-based wireless networks, it would be possible to monitor the traffic on then network through certain important central points (such as routers, base stations, and access points) and implement security mechanisms at such points.

Lack of association: Since these networks are dynamic in nature, a node can join or leave the network at any point of the time Limited resource availability: Resources such as bandwidth, battery power, and computational power (to a certain extent) are scarce in ad hoc wireless networks.

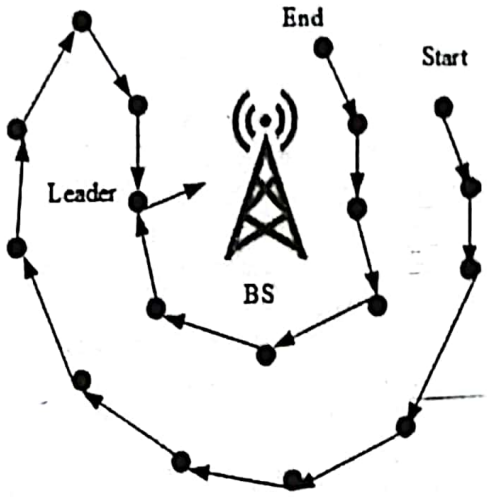
Physical vulnerability: Nodes in these networks are usually compact and hand-held in nature

Q.5. (a) Summarize the power management techniques in WSN. List the approaches for power aware routing protocol. (6)

Ans. Power-Efficient Gathering for Sensor Information Systems

It is data-gathering protocol based on the assumption that all sensor nodes know the location of every other node, that is, the topology information is available to all nodes. Also, any node has the required transmission range to reach the BS in one hop, when it is selected as a leader.

A greedy algorithm is used to construct a chain of sensor nodes, starting from the node farthest from the BS. At each step, the nearest neighbor which has not been visited is added to the chain. The chain is constructed a priori, before data transmission begins, and is reconstructed when nodes die out. At every node, data fusion or aggregation is carried out, so that only one message is passed on from one node to the next. A node which is designated as the leader finally transmits one message to the BS. Leadership is transferred in sequential order, and a token is passed so that the nodes know in which direction to pass messages in order to reach the leader.



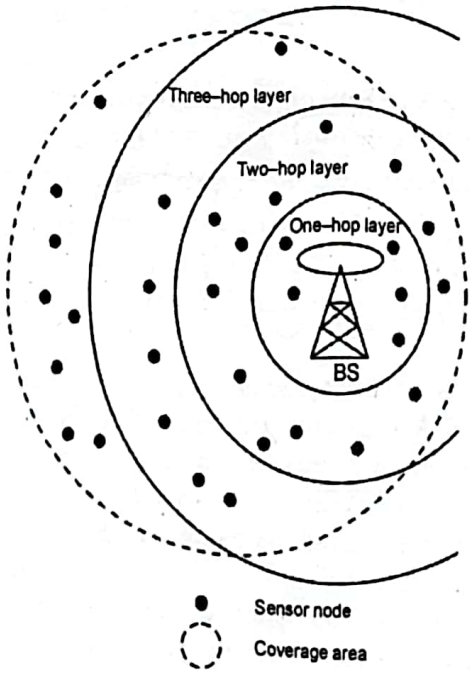
Q.5. (b) Discuss the classification of routing protocols based on the routing information update mechanism. **(6.5)**

Ans. Refer Q.5 (a) of End Term Examination 2018. (Page No. 12-2018)

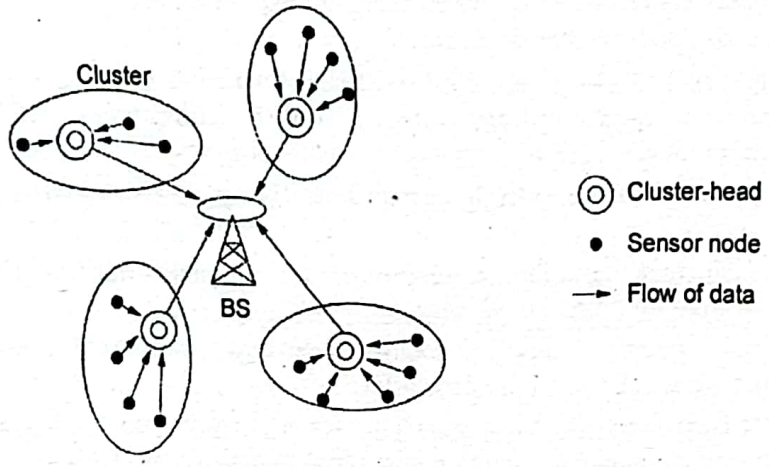
UNIT-III

Q.6. (a) Explain WSN Network architecture with sensor operations. **(6.5)**

Ans. The two basic kinds of sensor network architecture are layered and clustered. A layered architecture has a single powerful base station (BS), and the layers of sensor nodes around it correspond to the nodes that have the same hop-count to the BS. Layered architectures have been used with in-building wireless backbones, and in military sensor-based infrastructure, such as the multi-hop infrastructure network architecture (MINA). The users of the network have hand-held devices such as PDAs which communicate via the small nodes to the BS. Similarly, in a military operation, the BS is a data-gathering and processing entity with communication link to a larger network. A set of wireless sensor nodes is accessed by the hand-held devices of the soldiers. The advantage of a layered architecture is that each node is involved only in short-distance, low-power transmissions to nodes of the neighboring layers.



A clustered architecture organizes the sensor nodes into clusters, each governed by a cluster-head. The nodes in each cluster are involved in message exchanges with their respective cluster-heads, and these heads send messages to a BS, which is usually an access point connected to a wired network. Clustered architecture is especially useful for sensor networks because of its inherent suitability for data fusion. The data gathered by all members of the cluster can be fused at the cluster-head, and only the resulting information needs to be communicated to the BS. Sensor networks should be self-organizing, hence the cluster formation and election of cluster-heads must be an autonomous, distributed process. This is achieved through network layer protocols such as the low-energy adaptive clustering hierarchy (LEACH)



Q.6. (b) Highlight the salient feature in location based routing. **(6)**

Ans. Location based routing protocols are used in Wireless Sensor Network (WSN) in which the information about the location of nodes is used for communication. It is also known as geographic routing protocol or position based routing protocols. These protocols reduce the energy consumption and increase the lifetime of the network. As these are based on location information, it saves a lot of energy and also increase the lifetime of network. Location information can be obtained through various methods like GPS, GIS etc. Location based protocols can be used with flat as well as hierarchical topologies. Although there are many locations based routing protocols exist with a different working but the main aim of these protocols is to save energy.

Salient features

- It reduces control overhead as this scheme does not require flooding.
- It saves the energy consumption through various techniques.
- The cost of route setup is reduced as it is based on the location of destination.
- It requires less memory as there is no need to store the entire network information.
- It is scalable i.e. any number of nodes can join the network.
- It also needs less maintenance.

Q.7. (a) Discuss qualities of service metrics that are used to evaluate the performance of the network. **(6)**

Ans. There are many different ways to measure the performance of a network, as each network is different in nature and design.

The following measures are often considered important

Bandwidth commonly measured in bits/second is the maximum rate that information can be transferred.

Throughput is the number of messages successfully delivered per unit time. Throughput is controlled by available bandwidth, as well as the available signal-to-noise ratio and hardware limitations. Throughput for the purpose of this article will be understood to be measured from the arrival of the first bit of data at the receiver, to decouple the concept of throughput from the concept of latency. For discussions of this type the terms 'throughput' and 'bandwidth' are often used interchangeably.

Latency the delay between the sender and the receiver decoding it, this is mainly a function of the signals travel time, and processing time at any nodes the information traverses

Jitter is the undesired deviation from true periodicity of an assumed periodic signal in electronics and telecommunications, often in relation to a reference clock source. Jitter may be observed in characteristics such as the frequency of successive pulses, the signal amplitude, or phase of periodic signals.

The bit error rate or bit error ratio (BER) is the number of bit errors divided by the total number of transferred bits during a studied time interval. BER is a unit less performance measure, often expressed as a percentage.

Q.7. (b) Differentiate single hop and multi hop networks with neat diagram. (6.5)

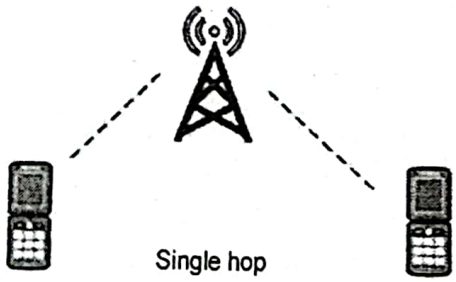
Ans. A hop means number of different networks a packet has to go through in order to reach its final destination address.

The main difference between single & multi-hop network is the number of hops a packet takes to reach the final destination.

Single hop network: In a single hop network , when a packet leaves the source it just takes a single hop (goes through another network or you can say it passes through another router from a different network) before reaching its destination address.

Multi-hop network: In a multi-hop network a packet has to go through 2 or more networks in order to reach its destination address.

While taking a hop through a different network a packet may go through various devices like Routers, network bridges, switches, etc...



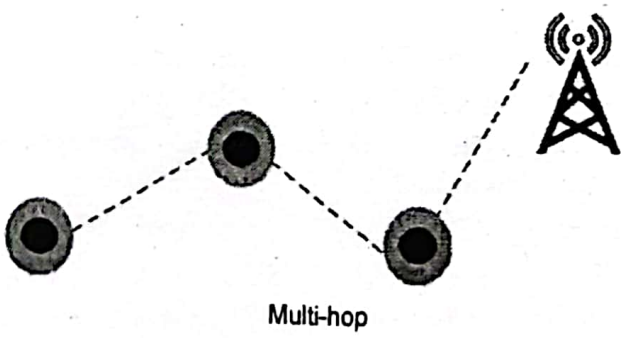


Fig. Single hop and multi hop relaying.

UNIT-IV

Q.8. (a) What is Geolocation? Give the architecture of geolocation. List various services offered by localization. **(6)**

Ans. Refer Q.8 of End Term Examination 2017. (Page. No. 27-2017).

Q.8. (b) Discuss the design issues on higher layer in WSN. **(6.5)**

Ans. Sensor networks pose certain design challenges due to the following reasons:

• Sensor nodes are randomly deployed and hence do not fit into any regular topology. Once deployed, they usually do not require any human intervention.

Hence, the setup and maintenance of the network should be entirely autonomous.

• Sensor networks are infrastructure-less. Therefore, all routing and maintenance algorithms need to be distributed.

• An important bottleneck in the operation of sensor nodes is the available energy. Sensors usually rely only on their battery for power, which in many cases cannot be recharged or replaced. Hence, the available energy at the nodes should be considered as a major constraint while designing protocols. For instance, it is desirable to give the user an option to trade off network lifetime

for fault tolerance or accuracy of results.

• Hardware design for sensor nodes should also consider energy efficiency as a primary requirement. The micro-controller, operating system, and application software should be designed to conserve power.

• Sensor nodes should be able to synchronize with each other in a completely distributed manner, so that TDMA schedules can be imposed and temporal ordering of detected events can be performed without ambiguity.

• A sensor network should also be capable of adapting to changing connectivity due to the failure of nodes, or new nodes powering up. The routing protocols should be able to dynamically include or avoid sensor nodes in their paths.

• Real-time communication over sensor networks must be supported through provision of guarantees on maximum delay, minimum bandwidth, or other QoS parameters.

Q.9. Write short note on:-

Q.9. (a) Optical wireless network. **(6)**

Ans. Optical wireless communication enables communication using infrared rays and light waves operating at frequencies well beyond the visible spectrum for high data rate local communication. Optical wireless communication technology exhibits a number of properties that makes it a suitable alternative to indoor RF communication. The advantages of optical wireless communication include significantly less interference due to its lack of penetration through walls, positioning of spectrum at a completely unregulated and unlicensed band, increased security, and high data rate. Optical wireless technology promises broadband data delivery at short ranges in point-to multipoint LANs and point-to-point medium-distance optical links. Optical wireless transmission can be classified into short-range communication and long-range communication systems. A comparison of these two types of optical wireless transmission schemes is given in Table. Long-range communication systems are mainly used for outdoor point-to-point optical links and short-range systems are used in indoor and outdoor applications. Unlike the long-haul networks in fiber-based optical networks, the long-range optical wireless systems can operate over a distance of hundreds of meters only. The short-range systems operate over a distance of few meters. With the ever growing

demand for broadband wireless connectivity, the utilization of RF spectrum is a bottleneck due to the spectrum congestion, licensing requirements, and unsuitability of certain bands for broadband applications.

Table: Comparisons of optical wireless technologies.

Issue	Short-Range	Long-Range
Distance	< 10 m	< 1,000 m
Data Rate	9600 bps to 4 Mbps	< 10 Gbps
Source Power	Low	High
Preferred Transmitter	LED	Laser
Preferred Receiver	PIN Diode	Avalanche Diode
Mode of Propagation	Line of Sight (LoS) and Diffused	LoS
Effect of Atmospheric Conditions	Limited	Significant
Cost of Equipment	Low	High

Q.9. (b) Ultra wide band radio communication. **(6.5)**

Ans. Ultra-Wide Band (UWB) is a communication method used in wireless networking that uses very low power consumption to attain high bandwidth connections or we can say, it's meant to transmit a lot of data over a short distance without using too much power. Originally UWB was designed for commercial radar systems. UWB wireless radios send short signal pulses over an extensive spectrum. This means the data is transmitted over a number of frequency channels at once, anything over 500 MHz. it is also called digital pulse wireless.

For example, a UWB signal centred at 5 GHz typically extends across 4 GHz and 6 GHz. The wide signal allows UWB to commonly support high wireless data rates of 480 Mbps up to 1.6 Gbps, at distances up to a few meters.

When compared to the spread spectrum, UWB uses broad spectrum use means that it doesn't interfere with other transmissions in the same frequency band, like narrowband and carrier wave transmissions. After some initial successes in the mid-2000s, interest in UWB declined considerably in favor of Wi-Fi and 60 GHz wireless network protocols.The major differences between the ultra-wide band (UWB) technology and the existing narrow-band and wide-band technologies are the following:

(i) The bandwidth of UWB systems, as defined by the Federal Communications Commission (FCC), is more than 25% of the center frequency or a bandwidth greater than 500 MHz.

(ii) The narrow-band and wide-band technologies make use of a radio frequency (RF) carrier to shift the base band signal to the center of the carrier frequency, whereas theUWB systems are implemented in a carrier- less fashion in which the modulation scheme can directly modulate base band signals into an impulse with very sharp rise and fall time, thus resulting in a waveform ranging several GHz of bandwidth.