CMR
INSTITUTE OF
TECHNOLOGY

Internal Assessment Test - I

Sub:	Ad-hoc Networks							Code:	10IS841
Date:	30/03/2017	Duration:	90 mins	Max Marks:	50	Sem:	VIII	Branch:	ISE (A&B)

1. Explain any five differences between Cellular Networks and Ad-hoc Networks. [5]

Cellular Networks	Ad Hoc Wireless Networks
Fixed infrastructure-based	Infrastructure-less
Single-hop wireless links	Multi-hop wireless links
Guaranteed bandwidth (designed for voice traffic)	Shared radio channel (more suitable for best-effort data traffic)
Centralized routing	Distributed routing
Circuit-switched (evolving toward packet switching)	Packet-switched (evolving toward emulation of circuit switching)
Seamless connectivity (low call drops during handoffs)	Frequent path breaks due to mobility
High cost and time of deployment	Quick and cost-effective deployment
Reuse of frequency spectrum through geographical channel reuse	Dynamic frequency reuse based on carrier sense mechanism
Easier to achieve time synchronization	Time synchronization is difficult and consumes bandwidth
Easier to employ bandwidth reservation	Bandwidth reservation requires complex medium access control protocols
Application domains include mainly civilian and commercial sectors	Application domains include battlefields, emergency search and rescue operations, and collaborative computing
High cost of network maintenance (backup power source, staffing, etc.)	Self-organization and maintenance properties are built into the network
Mobile hosts are of relatively low complexity	Mobile hosts require more intelligence (should have a transceiver as well as routing/switching capability)
Major goals of routing and call admission are to maximize the call acceptance ratio and minimize the call drop ratio	Main aim of routing is to find paths with minimum overhead and also quick reconfiguration of broken paths
Widely deployed and currently in the third generation of evolution	Several issues are to be addressed for successful commercial deployment even though widespread use exists in defense

2. Explain the wireless Sensor Networks with its issues compared to ad-hoc networks. [5]

▼ Table 1. The difference between WMN and mobile Ad hoc network

Network	WMN	Mobile Ad Hoc Network
Mobility	The network main body is Mesh routers, which are of low mobility but without any power restraint.	The network main body is user nodes, which have high mobility but power restraints.
Network Scale and Scalability	Being an integration of various wireless networks, it supports a large number of nodes.	Being a single wireless network, it only supports several dozens of nodes.
Services	It provides wireless access from the user terminal to the gateway or from wireless access subnet to the network.	It mainly provides P2MP data collection services, as well as access for the users.

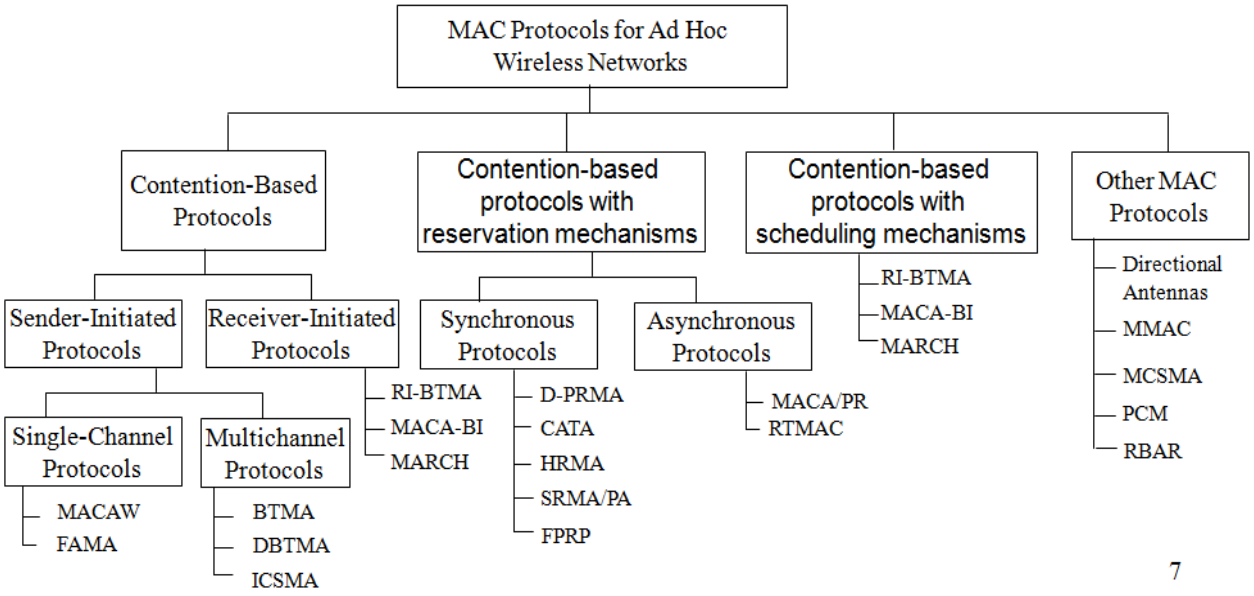
WMN: Wireless Mesh Network

3. Explain classifications of MAC Protocol. [3+1]

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.
Other protocols are those MAC protocols that do not strictly fall under the above categories.



2 b Explain any five issues of Ad-hoc Networks [6]

The major issues that affect the design, deployment, & 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 Provisioning

3 Describe in detail MACAW and MACA-BY Invitation Protocol

a MACAW (MACA for Wireless) is a revision of MACA. **[5]**

• The sender senses the carrier to see and transmits a **RTS** (**Request To Send**) frame if no nearby station transmits a RTS.

• The receiver replies with a **CTS** (**Clear To Send**) frame.

• The MACAW protocol uses one more control packet called the **request-for-request-to-send (RRTS)**

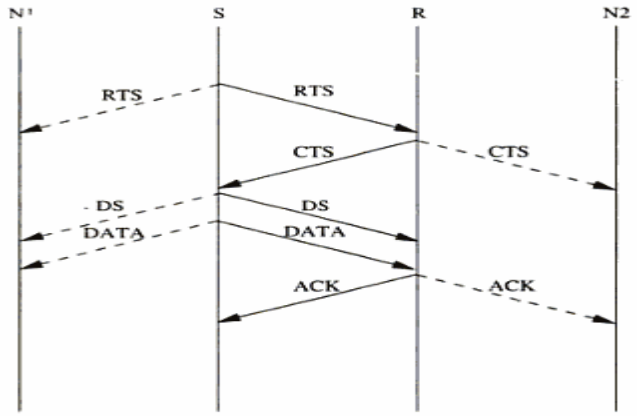


Figure 6.7. Packet exchange in MACAW.

Neighbors
• see CTS, and then keep quiet.
• see RTS but not CTS, and then keep quiet until the CTS is back to the sender.
• The receiver sends an ACK when receiving an frame.
• Neighbors keep silent until see ACK.
• Collisions
• There is no collision detection.
• The senders know collision when they don't receive CTS.
• They each wait for the exponential back-off time.

MACA-By Invitation Protocol **[5]**

- It is a receiver-initiated protocol
- It reduces the number of control packets used in the MACA protocol
- It eliminated the need for the RTS packet
- In MACA-BI, the receiver node initiates data transmission by transmitting a ready-to-receive (RTR) control packet to the sender as shown in the figure

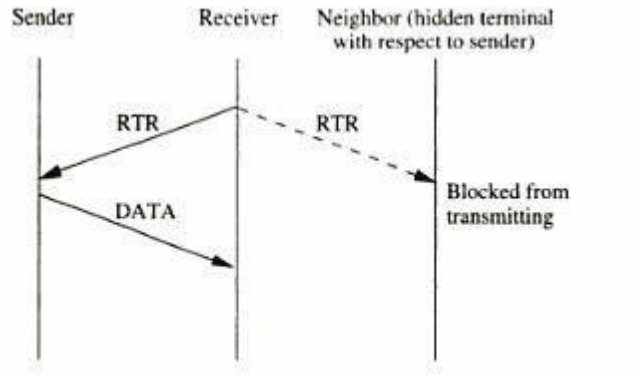


Figure 6.11. Packet transmission in MACA-BI.

If it is ready to transmit, the sender node respond by sending a DATA packet

- Thus data transmission in MACA-BI occurs through a two-way handshake mechanism
- The efficiency of the MACA-BI scheme is mainly dependent on the ability of the receiver node to predict accurately the arrival rates of traffic at the sender nodes

4a Explain Hidden and Exposed Terminal Problem. [5+2(Figure)]

Hidden and exposed terminal problems

- The hidden terminal problem refers to the collision of packets at a receiving node due to the simultaneous transmission of those nodes that are not within the direct transmission 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 knowing about the transmission of each other.

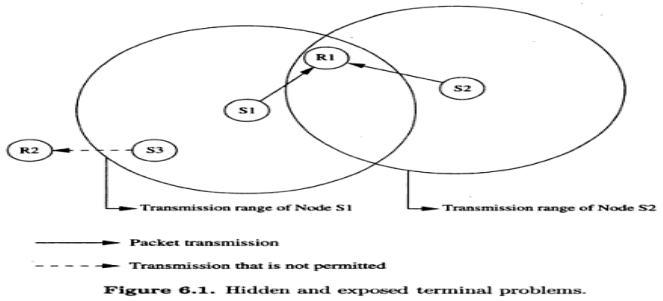


Figure 6.1. Hidden and exposed terminal problems.

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

- The exposed terminal problem refers to the inability of a node, which is blocked due 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 transmission & it cannot transmit to R2.
- The hidden & exposed terminal problems reduce the throughput of a network when traffic load is high

5a. Explain Five Phase Reservation Protocol. [8+2]

Five Phase Reservation Protocol (FPRP)

• It is a single-channel TDMA-based broadcast scheduling-protocol.

• The protocol is fully distributed i.e. multiple reservations can be simultaneously made throughout the network (Figure 6.21). Time is divided into 2 frames:1) Reservation frame (RF) & 2) Information frame (IF)

• Each RF has N reservation-slots (RS). Each IF has N information-slots (IS). Each RS has M reservation-cycles (RCs).

• In order to reserve an IS, a node needs to contend during the corresponding RS. Based on these contentions, a TDMA schedule is generated in the RF and is used in the subsequent IFs until the next RF.

• During the corresponding IS, a node would be in one of the 3 states:

1. Transmit (T) 2. Receive (R) 3. Blocked (B)

• The reservation takes place in following 5 phases:

1. Reservation Request Phase

• A source-node sends reservation-request (RR) packet to the destination node.

2. Collision Report Phase

• If a collision is detected by any node during the reservation-request phase, then that node broadcasts a collision-report (CR) packet.

3. Reservation Confirmation Phase

• A source-node is said to have won the contention for a slot if it does not receive any CR messages in the previous phase.

• Then, the source-node transmits a reservation-confirmation (RC) message to the destination-node.

4. Reservation Acknowledgment Phase

• The destination-node acknowledges reception of the RC by sending back a reservation acknowledgment (RA) message to the source-node.

• The hidden nodes that receive this message defer their transmissions during the reserved slot.

5. Packing & Elimination (P/E) Phase

• Two types of packets are: 1) Packing packet (PP) & 2) Elimination packet

• A PP is sent by each node that is located within 2 hops from a TN, and that had made a reservation since the previous P/E phase.

• A node receiving a PP understands that there has been a recent success is slot reservation 3 hops away from it.

[6+2+2]

6a Explain Soft Reservation Multiple Access with Priority Assignment (SRMA/PA), using Frame Structure. How is it different from Hop Reservation Multiple Access Protocol?

Developed with the main objective of supporting integrated services of real-time and non-real-time application in ad hoc networks, at the same time maximizing the statistical multiplexing gain.

- Nodes use a collision-avoidance handshake mechanism and a soft reservation mechanism
- Unique frame structure
- Soft reservation capability for distributed ad dynamic slot scheduling
- Dynamic and distributed access priority assignment and update policies
- Time constrained back-off algorithm
- Time is divided into frames, with each frame consisting of a fixed number of slots
- Each slot is further divided into 6 different fields (figure) namely SYNC, soft reservation (SR), reservation request (RR), reservation confirm (RC), data sending (DS) and acknowledgement (ACK)

The SYNC field is used for synchronization purposes

- The SR, RR, RC, and ACK fields are used for transmitting and receiving the corresponding control packets
- The DS field is used for data transmission
- The SR packet serves as a busy tone
- It informs the nodes about the reservation of the slot
- SR packet also carries the access priority value assigned to the node that has reserved the slot
- When an idle node receives a data packet for transmission, the node waits for a free slot and transmits the RR packet in the RR field of that slot
- A node determines whether or not a slot is free through the SR field of that slot
- In case of a voice terminal node, the node tries to take control of the slot already reserved by a data terminal if it finds it priority level to be higher than that of the data terminal

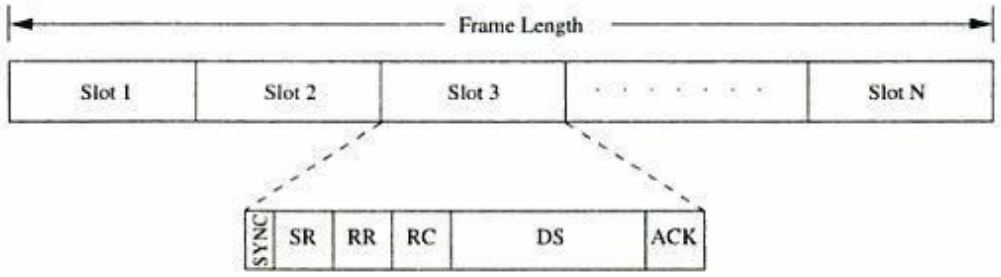


Figure 6.19. Frame structure in SRMA/PA.

This process is called *soft reservation.*

- Priority levels are initially assigned to nodes based on the service classes in a static manner
- It is required that priority of voice terminal pv(R) > priority of data terminal pd(R) such that delay-sensitive voice applications get preference over normal data applications
- A node that is currently transmitting is said to be in active state
- A node that is said to be in the idle state if it does not have any packet to be transmitted
- In the active state itself, nodes can be in one of the two states: access state and reserved state
- Access state is one in which the node is backlogged and is trying to reserve a slot for transmission
- The access priorities are assigned to nodes and updated in a distributed and dynamic manner
- This allows dynamic sharing of the shared channel
- In order to avoid collisions, a binary exponential back-off algorithm is used for non-real time connections and a modified binary exponential back-off algorithm is used for real time connections

Q7a Explain D-PRMA in detail. [8+2]

It extends the centralized packet reservation multiple access (PRMA) scheme into a distributed scheme that can be used in ad hoc wireless networks.
• PRMA was designed in a wireless LAN with a base station.
• D-PRMA extends PRMA protocol in a wireless LAN.
• D-PRMA is a TDMA-based scheme.
• The channel is divided into fixed- and equal-sized frames along the time axis.

Each frame is composed of s slots and each slot consists of m minislots
• Each minis lot is further divided into two control fields, RTS/BI and CTS/BI
• These control fields are used for slot reservation and for overcoming the hidden terminal problem
• All nodes having packets ready for transmission contend for the first minislot of each slot
• The remaining (m-1) minislots are granted to the node that wins the contention.
• Also, the same slot in each subsequent frame can be reserved for this winning terminal until it completes its packet transmission session
• Within a reserved slot, communication between the source and receiver nodes takes by means of either time division duplexing (TDD) or frequency division duplexing (FDD)

Any node that wants to transmit packets has to first reserve slots

• A certain period at the beginning of each minislot is reserved for carrier sensing

• In order to prioritize nodes transmitting voice traffic over nodes transmitting normal data traffic, two rules are followed in D-PRMA

 1st rule voice nodes are allowed to start contending from minislot 1 with probability p=1. Others with p<1

 2nd rule only if the node winning the minislot contention is a voice node, it is permitted to reserve the same slot in each subsequent frame until the end of the session

 In order to avoid the hidden terminal problem, all nodes hearing the CTS sent by the receiver are not allowed to transmit during the remaining period of that same slot

 In order to avoid the exposed terminal problem, a node hearing the RTS but not the CTS is still allowed to transmit

 Requirement 1 when a node wins the contention in minislot 1, other terminals must be prevented from using any of the remaining (m-1) minislots in the same slot for contention

 Requirement 2 when a slot is reserved in subsequent frames, other nodes should be prevented from contending for those reserved slots

 D-PRMA is more suited for voice traffic than for data traffic applications