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Unit -1

#) MANETS :-

MANETS stands for Mobile Adhoc Network also called a wireless Adhoc network or Adhoc wireless network that usually has a routable networking environment on top of a link layer ad hoc network. A MANET consist of a number of mobile devices that come together to form a network as needed, without any support from any existing internet interference.

- A MANET can be defined as a autonomous system of nodes or MSs connected by wireless links, the union of which forms a communication network modeled in the form of arbitrary communication graph.
- No Infrastructure exist and network topology may be changed dynamically in an unpredictable manner since nodes are free to move & each node has limiting transmitting power, restricting access to the node only in the neighbouring range.
- MANETs are basically peer-to peer, multi-hop wireless network in which information packets are transmitted in a store and forward manner from a source to an arbitrary distination.

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#) Characteristics of MANETs

Some of main characteristics are :-

- Dynamic Topologies :- Nodes are free to move arbitrarily thus the network topology may be changed randomly and unpredictably & primarily consist of bidirectional links. In some cases, where the transmission power of two nodes is different, a unidirectional link may exist
- Bandwidth - constrained and variable capacity links: Wireless links continue to have significantly lower capacity than infrastructured networks
- Energy - Constrained operation - Some or all of the MSs in a MANET may rely on batteries or other exhaustible means for their energy. For these nodes or devices, the most important system design optimization criteria may be energy conservation
- Limited Physical security - MANETs are generally more prone to physical security threats than wire line networks. The increased possibility of eavesdropping, spoofing & denial of services (DoS) attacks should be considered carefully. To reduce security threats, many existing link security techniques are often applied within wireless networks

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#) Applications of MANETs :-
some of specific applications of ad hoc networks include industrial and commercial applications involving cooperative mobile data exchange. There are many existing and future military network requirements for robust, IP compliant data services within mobile wireless communication networks, with many of these networks consist of highly dynamic autonomous topology segments.

- Defense applications - Many defense applications require on the fly communications set-up and ad hoc / sensor networks are excellent candidates for use in battlefield management.

- Crisis Management applications - These arise, for example, as a result of natural disasters in which the entire communication infrastructure is in disarray. Restoring communications quickly is essential.

- Telemedicine - The paramedic assisting the victim of a traffic accident in a remote location must access medical records and many need video conference assistance from a surgeon for an emergency intervention.

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Tele-geoprocessing application - The combination of GPS, GIS and high capacity wireless mobile system enables a new type of application referred to as tele-geoprocessing.

Virtual Navigation - A remote database contains the Geographical representation of building, streets any physical characteristics of a large metropolis.

Education via the internet - Educational opportunities available on the internet or remote areas because of the economic infeasibility of providing expensive last mile wire line internet access in these areas to all subscribes.

Vehicular area Network - this a growing and very useful application of adhoc network in providing emergency services and other information. This is equally effective in both urban and rural setup. the basic & exchange necessary data that is benefical in a given situation.

Limitations of MANETs

A Manet has to overcome certain issues of limitations and inefficiency. It includes

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- The wireless link characteristics are time varying in Nature - There are transmission impediments like fadding, path, loss, blockage and interference that adds to the suspectible behaviour of wireless channels. The reliability of wireless transmission is resisted by different factors.

- Limited range of wireless transmission - The limited radio band results in reduced data rates compared to the wireless networks. Hence optimal usage of bandwidth is necessary by keeping low overhead as possible

- Packet losses due to errors in transmission - MANETs experience higher packet loss due to factors such as hidden terminals that results in collisions, wireless channel issues, interference, frequent breakage in path caused by mobility of nodes, increased collisions due to the presence of hidden terminals and uni directional links.

- Route changes due to mobility - The dynamic nature of network topology result in frequent path breaks.

- Frequent Network Partitions - The random movement of nodes often leads to the partition of the network. This mostly affect Intermediate nodes.

This application of this wireless network is limited due to mobile and ad hoc nature. It also faces a multitude of security threads just like wired networks. It includes spoofing, passive, eavesdropping, denial of service and many others.

Ad-hoc Network

An ad-hoc network is a network that is compose of individual devices communicating with each other directly. The term implies spontaneous or impromptu construction because these networks often bypass the gatekeeping hardware or central access point such as a router. Many ad hoc networks are local area networks where computers or other devices are enabled to send data directly to one another rather than going through a centralized access point

Cellular Network

A Cellular Network or Mobile network is a radio network distributed over land areas called cells each served by at least one fixed location transceiver, known as cell site or base station. At present sent cell remote syetem. For example, GSM/CDMA/HSPA/LTE are foundation type. Cell organize comprises of local element

known as base station and cell phones as Mobile Subscribers (MS). In the event that MS-A needs to speak with MS-B, corresponding happens by means of speak with BS or base station. It follows hexagonal pattern.

#) Difference Between Adhoc Network & Cellular Network

Cellular Network	Adhoc Network
1) It has fixed infrastructure.	1) It is infrastructureless
2) Circuit switching are used.	2) Packet Switching are used.
3) It has single hop type	3) It has multiple hops
4) Star topology are used.	4) Mesh topology are used.
5) It take high cost and takes more time for deployment	5) It takes lowest cost and does not take more time for deployment.
6) It is used in designed & developed for voice traffic.	6) It is used in designed to meet best effort data traffic requirements.
7) It has guaranteed bandwidth.	7) The allocation of bandwidth is based on Shared Channel
8) Seamless connectivity	8) Frequency path breaks due to mobility
9) Reuse of frequency Spectrum through geographical Chanel reuse	9) Dynamic frequency Reuse

10) Easier to achieve time Synchronization	10) Time Synchronization is difficult
11) Easier to employ bandwidth reservation	11) Bandwidth reservation required complex MAC (Medium Access Control) Protocol.
12) Cellular N/w are used in commercial sectors & civilians sectors	12) It is mainly used in Battle field Rescue operations, Military et
13) Mobile host are of less complexity	13) Mobile host require more Intelligent (Transreceiver, Switchin Capabilities, routing)
14) Major Goal of routing & call addition are to max call acceptance ratio & Minimize the call drop ratio	14) Main Aim of routing is to find path with minimum overhead.
15) High cost of maintainence	15) Self organisations maintaince properties are built into the Network.

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MAC Protocol (Medium Access Control)

MAC Protocol is first protocol layer above the Physical layer in ad hoc. The primary task of any MAC protocol is to control the access of the nodes to share meduim. It is used to provide the data linker of the Ethernet LAN System. It works on data linker layer of OSI Model.

Design Issues of MAC Protocol

There are five major issues :-

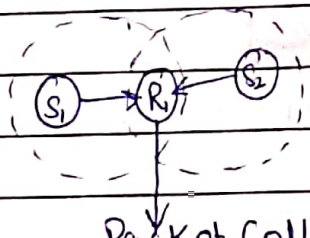
Bandwidth Efficiency → The shortage of data transfer capacity assets in these network requires its proficient use. To evaluate this, Bandwidth capacity is the proportion of the bandwidth used for data transmission to complete accessible bandwidth capacity.

Quality of Service Support → It is difficult due to the mobility of the nodes. Once a node moves out of reach, the reservation in it is lost. In these network, QoS is extremely important because if it is being used in military environments, the service support needed time to time.

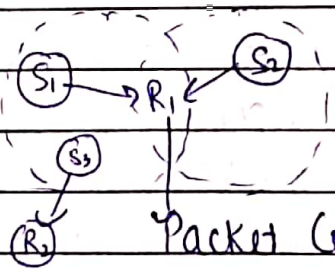
Synchronization → Some instruments must be found so as to give synchronization among the

nodes. Synchronization is significant for directing the bandwidth reservation.

⇒ Hidden Terminal Problem → When there are two nodes, both are outside of each other's range and try to communicate with same node within their range at same time, then there must be packet collision.



⇒ Exposed Terminal Problem → Uncovered nodes might be denied channel access pointlessly, which implies under usage of the bandwidth resources.



⇒ Error Prone Shared Broadcast Channel
⇒ Lack of Central Coordination
⇒ Node Mobility

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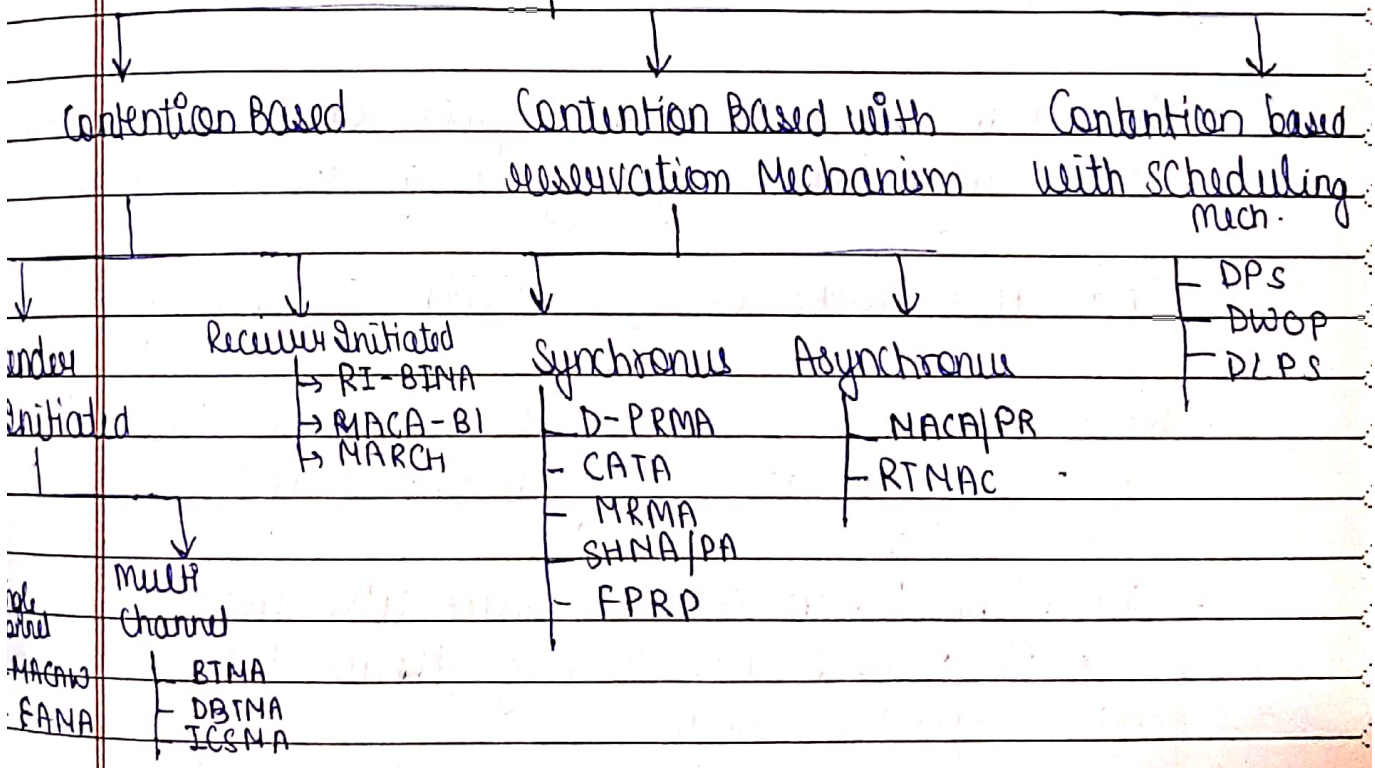
Responsibilities of MAC Protocol

- Network overhead should be low
- Efficiently allocate the bandwidth
- Distributed MAC operation
- Power control mechanism should be present
- Maximum utilization of channel
- Hidden & exposed problem should be removed
- Nodes should be sync with time.

#) Classification of MAC protocol



1) Contention based protocol -

- Sender-Initiated - Packet transmissions are initiated by the sender node.

Single Channel → A node that wins the contention to the channel can make use of the entire bandwidth.

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Multichannel → The available bandwidth is divided into multiple channels

- Receiver initiated protocol → The receiver node initiates the contention resolution protocol

2) Contention based protocol with reservation mechanism

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

3) Contention based protocol with Scheduling mechanism

- 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.

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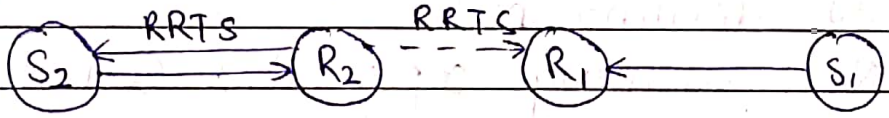
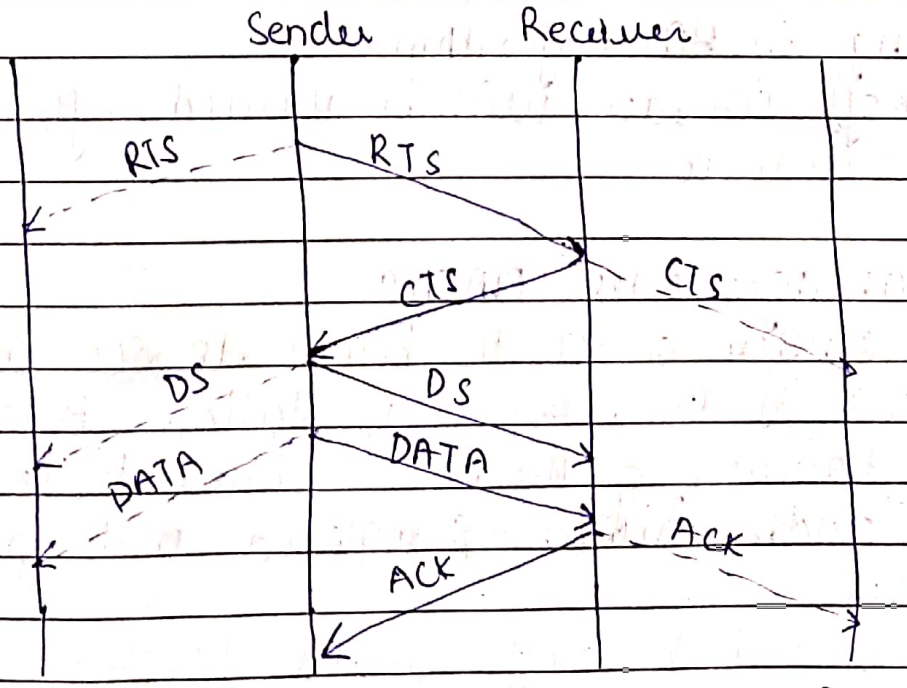
Contention Based Protocol

Single Channel :-

1) MACAW → (Media Access Protocol for wired LAN's)
MACAW is a revision of MACA. MACA proposed due to shortcoming of CSMA protocol (Carrier Sense Multiple Access)

- The Sender sends 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 request for request to send (RRTS)





DS - Data Sending Packet
ACK - Acknowledgement

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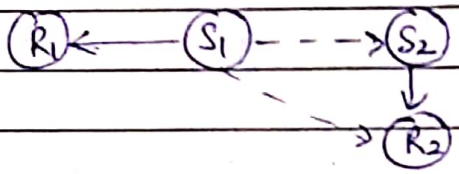
BEB (Binary Exponential Back-off)

- Retransmission occur if and only if a station does not receive a CTS in response.
- Back off then retransmit
- whenever a CTS is received :-
  Backoff counter BO = Fdec (BO)
- whenever a CTS is not received
  Backoff counter BO = Finc (BO)



The Packet contains current back off value of transmitting node
Node receiving copies this counters value into its own back off counter.

Change in BEB algorithm :-

→ Backoff Counter will be varied after successful transmission

Advantages over MACAW :-

- The sender detects the beacon to see and transmit a RTS if no close by station transmits a RTS
- The fairness of MACAW is much better than MACA
- It handle hidden & exposed node problem better.
- It also incorporate carrier detecting to additionally diminish collision.

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2) Floor Acquisition Multiple Access Protocol (FAMA) →
- Based on a channel access discipline which consist of carrier-sensing operation and a collision avoidance dialog between the sender and the intended receiver of a packet
- Floor Acquisition refers to the process of gaining control of the channel
- At any time only one node is assigned to use the channel.
- Carrier-Sensing by the sender, followed by the RTS-CTS control packet exchange, enables the protocol to perform as efficiently as MACA.
- Two variations of FAMA RTS-CTS exchange with no carrier-sensing uses the ALOHA protocol for transmitting RTS packets.
- RTS-CTS exchange with non-presistent carrier-sensing uses non-presistent CSMA for the same purpose.

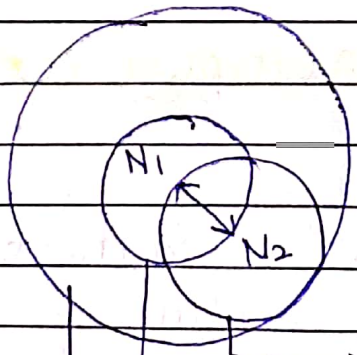
Multi Channel

1) BTMA (Busy tone Multiple access)

- The protocol named busy tone multiple access relies on a centralized network operation; i.e. a network with base stations
- When a base station senses the transmission of a terminal, it broadcasts a busy-tone signal

to all terminals, keeping them from accessing the channel.

- BTMA have been used in multi-hop networks to reduce the effect of hidden terminal problem
- The transmission channel is split into two parts : Data Channel & Control Channel
- The data channel is used for data Packet transmission whereas Control Channel is used to transmit the busy tone signal
- When a node is ready for transmission, it senses the channel to check whether the busy tone is active
  → If not, it turns on busy tone signal & starts data transmission.
  → Otherwise it reschedules the packet for transmission after some random rescheduling delay
- When a node is transmitting, no other node in the two-hop neighbourhood of transmitting node is permitted to simultaneously transmit.



→ Transmission range of Node N_2
→ Transmission range of Node N_1
→ Busy tone
→ Region in which simultaneous transmission are not possible when N_1 is transmission data.

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2) DBTMA (Dual Busy Tone Multiple Access)

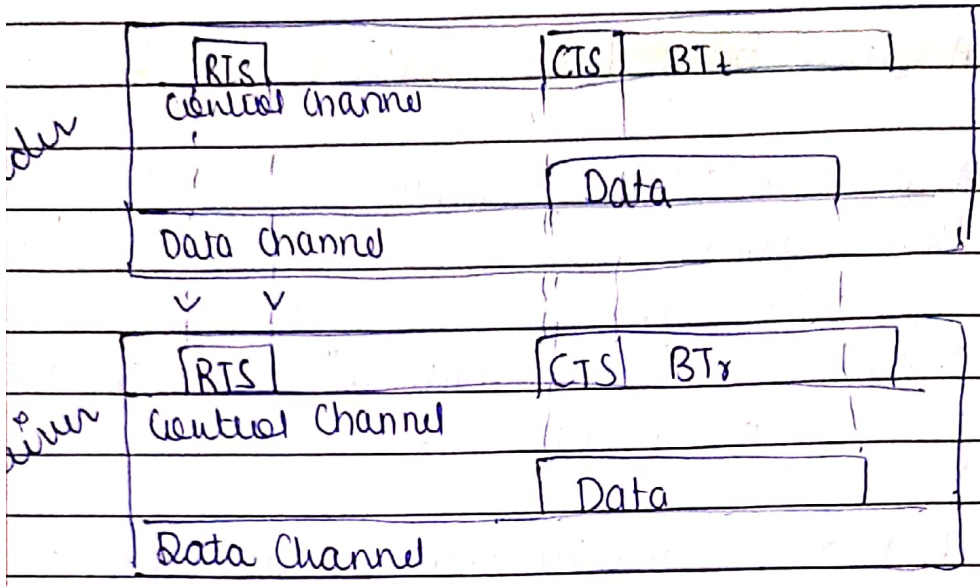
- DBTMA is the extension of BTMA scheme in which the transmission channel is divided into two:-
  → a data channel for data transmission.
  → a control channel - to transmit the control signal along with Busy tones.

- When a node is ready for transmission it senses the channel for busy tone active
  → If not, it turns on the busy tone signal and starts transmission.
  → Otherwise, the packet for transmission is rescheduled after some random delay

- In DBTMA, when a node has data to transmit, it will send a RTS signal to the channel. The destination or the receiver that has to receive the data will reply, CTS signal along with BT_r (Receive Busy Tone). On hearing the CTS from the hardware of the node transfer, the sender will raise the BT_t (transmit Busy tone) signal high and starts the data transmission

Sender receive CTS → Turn on BT_t signal - Start Data → BT_t turnoff

Receiver Receive CTS - Turn off BT_r



MACA - By Invitation (Receiver Initiated Busy Tone Multiple Protocol)

It is receiver initial protocol
It reduces the number of control packets used in MACA protocol.
It eliminates the need for the RTS packet.
It is divided into two slotted channels :-
→ Data Channel - Data packet transmission
→ Control Channel - Busy tone signal

A node can transmit the data channel only if it finds the busy tone to be absent on the Control Channel.
The data Packets is divided into 2 portions

a preamble — Actual data packets.

The Busy tone serves two purposes
* Ack the sender the successful of receiving

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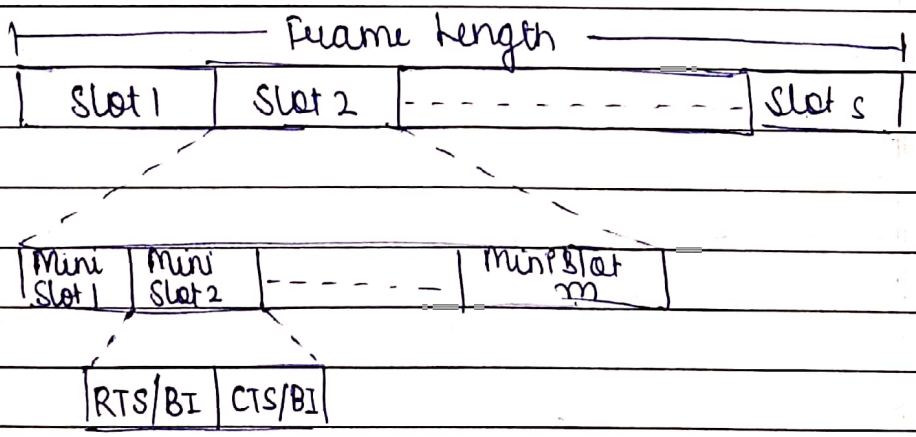
preemable
* Inform the nearby the hidden nodes the impending transmission.

#) CONTENTION BASED PROTOCOLS WITH RESERVATION MECHANISMS

Distributed Packet Reservation Multiple Access Protocol (D-PRMA) :-

- 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 & equal size frames along the time axis.



- Each frame is composed of s slots and each slot consist of m minislots.

- Each minislot is further divided into two control fields, RTS/BI and CTS/BI.
- These control fields are used for slot reservation & 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.
- 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.

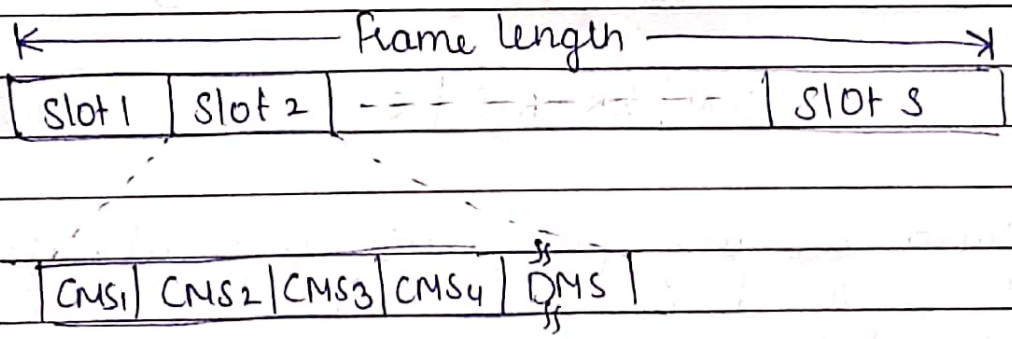
Collision Avoidance Time Allocation Protocol (CATA)

- It is Based on dynamic topology-dependent transmission scheduling.
- Nodes contend for & and reserve time slots by means of a distributed reservation and handshake mechanism.
- The operation is based on two principles:-
  ⇒ The receiver of a flow must inform the

potential source nodes about a reserved slot on which it is currently receiving packets. The source node must inform the potential destination nodes about interferences in the slot.

⇒ Usage of negative acknowledgements for reservation request and control packet transmission at the beginning of each slot, for distributing slot reservation information to senders of broadcast or multicast sessions.

- Time is divided into equal sized frames and each frame consist of s slots and each slot is divided into five minislots.
- The first four minislot are called control minislot (CMS) and last one is called data minislot (DMS)

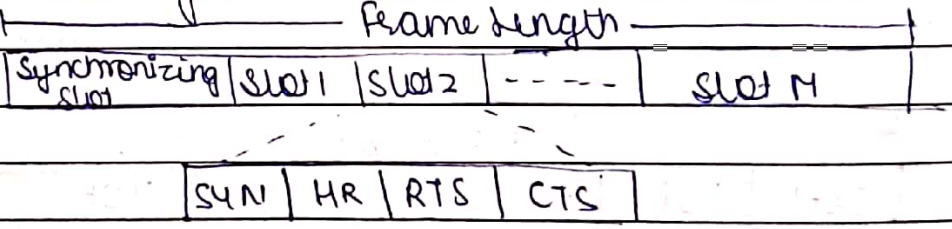


- Each node that receive data during DMS of the current slot transmits a slot Reservation (SR) packet during the CMS1 of the slot.
- CMS 2 - RTS (Request to Send)
- CMS 3 - CTS (Clear to send)
- CMS 4 - NTS (Not to Send) - Negative Acknowledgement

- CATA works well with simple single channel half duplex radios
- It is simple & provides support for collision free broadcast and multicast traffic.

Hop Reservation Multiple Access Protocol (HRMA)

- A Multichannel MAC Protocol which is based on half duplex very slow frequency hopping spread spectrum (FHSS) radios
- Uses a reservation and handshake mechanism to enable a pair of communicating nodes to reserve a frequency hop, thereby guaranteeing collision free data transmission



- HRMA uses one frequency channel, denoted by f_0 as a dedicated Synchronising channel.
- The data packets transmitted can be of any size
- In HRMA, time is slotted and each slot is assigned a separate frequency hop.
- The nodes exchange synchronisation information on f_0.
- The remaining $l-1$ frequencies are divided into

M = (L-1)/2 frequency pairs

- When node receive data to be transmitted, it first checks the HR period if it finds the channel to be free during the SR period, it transmits an RTS packets to the destination during the RTS period of the slot and waits for CTS.
- On receiving RTS, the destinated node transmit the CTS packets.
- After this, the receiver sends an ACK packet back to the source.

Mobility Management

It refers to the way the network manages the movement of mobile subscriber which significantly affect the performance of network.

Functions of Mobility Management

- Registration
- Authentication
- Identification
- Location Updating
- Provision of temporary mobile subscriber identity.