SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19EC402- WIRELESS ADHOC AND SENSOR NETWORKS

IV ECE / VII SEMESTER

UNIT 2 – MEDIA ACCESS CONTROL (MAC) PROTOCOLS

TOPIC 3 –-Media access with reduced handshake

Classifications of MAC Protocols:

- ***Contention-based protocols :***

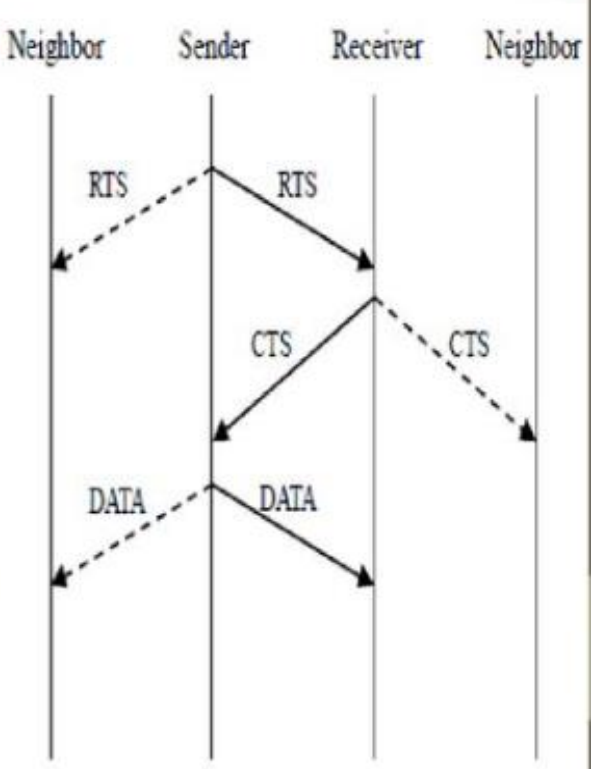
- ***Single-channel sender-initiated protocols:***

EXAMPLES: MACAW, FAMA

MACAW: A Media Access Protocol for Wireless LANs is based on MACA (Multiple Access Collision Avoidance) Protocol

MACA:-

- ✓ When a node wants to transmit a data packet, it first transmit a **RTS** (**Request To Send)** frame.
- ✓ The receiver node, on receiving the RTS packet, if it is ready to receive the data packet, transmits a **CTS (Clear to Send)** packet.
- ✓ Once the sender receives the CTS packet without any error, it starts transmitting the data packet.
- ✓ If a packet transmitted by a node is lost, the node uses the **Binary Exponential Back-off (BEB)** algorithm to back-off a random interval of time before retrying. The problem is solved by MACAW



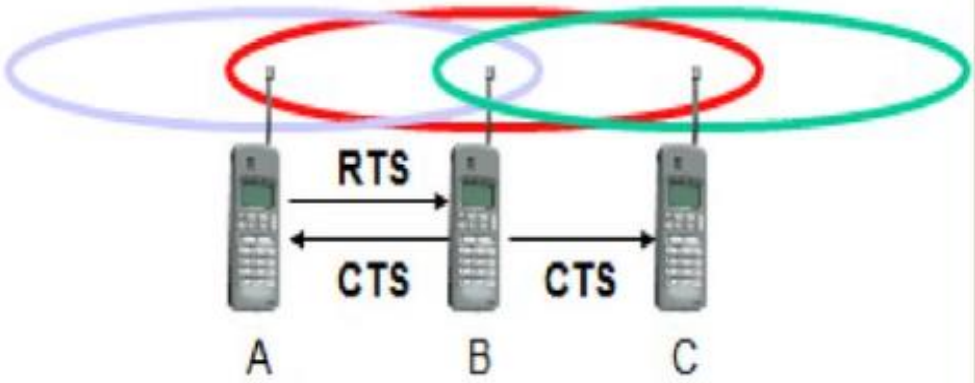
Classifications of MAC Protocols:

➢ ***Contention-based protocols :*** ***...cntd***

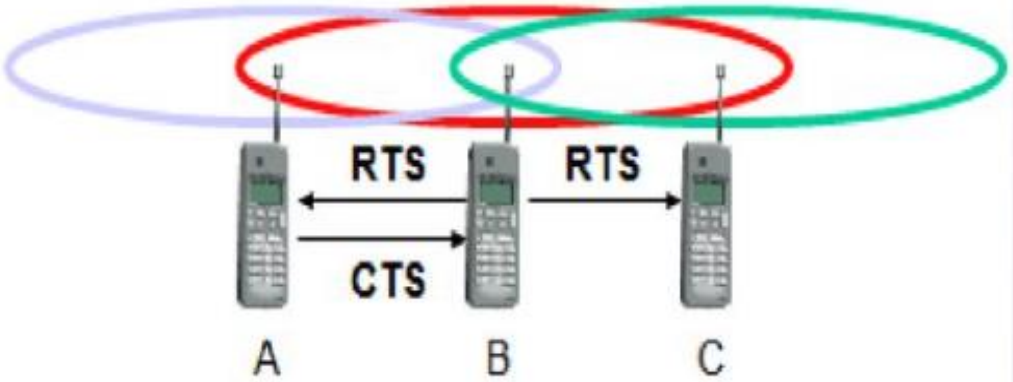
❖ ***Single-channel sender-initiated protocols:***

MACA EXAMPLES:

- MACA avoids the problem of hidden terminals
  - ✓ A and C want to send to B
  - ✓ A sends RTS first
  - ✓ C waits after receiving CTS from B



- MACA avoids the problem of exposed terminals
  - ✓ B wants to send to A, C to another terminal
  - ✓ now C does not have to wait for it cannot receive CTS from A



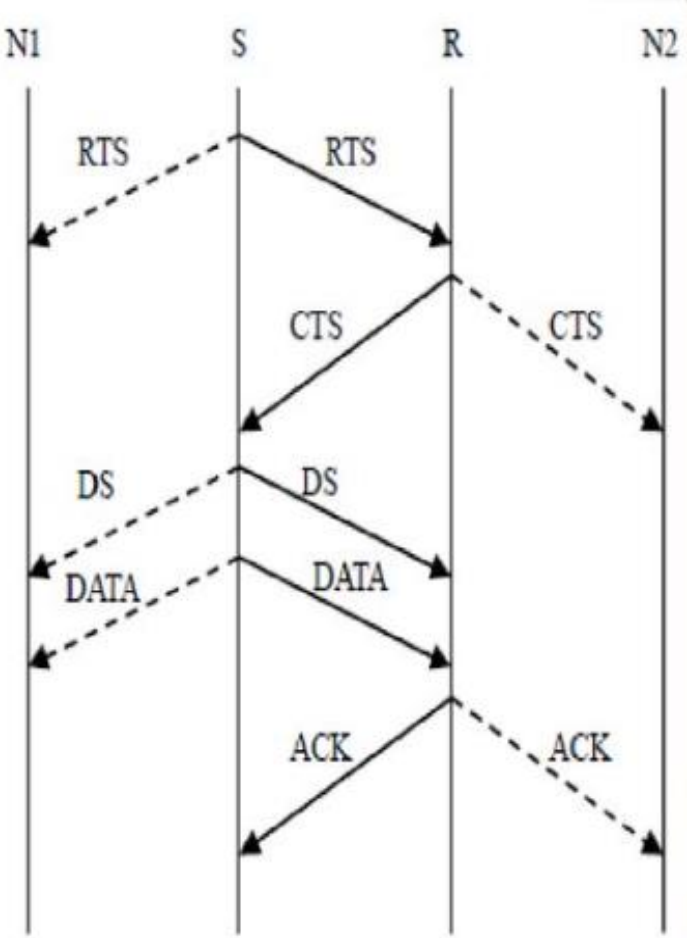
Classifications of MAC Protocols:

➢ ***Contention-based protocols :*** ***...cntd***

❖ ***Single-channel sender-initiated protocols:***

MACAW: (MACA for Wireless) is a revision of MACA.

- *The sender* transmits a **RTS** (**Request To Send)** frame if no nearby station transmits a RTS.
- *The receiver* replies with a **CTS** (**Clear To Send**) frame.
- *Neighbors*
  - see CTS, then keep quiet.
  - see RTS but not CTS, 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.



Classifications of MAC Protocols:

- ***Contention-based protocols :*** ***...cntd***
- ***Single-channel sender-initiated protocols:***

FAMA: Floor Acquisition Multiple Access Protocols.

- ✓ Channel access consists of a carrier-sensing operation and a collision avoidance
- ✓ Carrier-sensing by the sender, followed by the RTS-CTS control packet exchange.
  - Data transmission to be collision free, the duration of an RTS must be at least twice the maximum channel propagation delay
- ✓ Two FAMA protocol variants
  - RTS-CTS exchange with no carrier sensing (MACA)
  - RTS-CTS exchange with non-persistent carrier sensing (FAMA-NTR)

FAMA-NTR(Non-persistent Transmit Request)

- Before sending a packet, the sender senses the channel
- If channel is busy, the sender back-off a random time and retries later
- If the channel is free, the sender sends RTS and waits for a CTS packet
- If the sender cannot receive a CTS, it takes a random back-off and retries later
- If the sender receives a CTS, it can start transmission data packet
- In order to allow the sender to send a burst of packets, the receiver is made to wait a time duration τ seconds after a packet is received.

Classifications of MAC Protocols:

- ***Contention-based protocols :*** ***...cntd***
- ***Multi-channel sender-initiated protocols:***

- ***Busy Tone Multiple Access Protocols (BTMA):***
  - ✓ The transmission channel is split into two parts:
    - a data channel for data packet transmissions
    - a control channel 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 the busy tone signal and starts data transmissions.
    - Otherwise, it reschedules the packet for transmission after some random rescheduling delay.
- ***Dual Busy Tone Multiple Access Protocol (DBTMAP)*** is an extension of the BTMA scheme.
  - a data channel for data packet transmissions
  - a control channel used for control packet transmissions (RTS and CTS packets) and also for transmitting the busy tones.
  - ✓ Use two busy tones on the control channel, BTt and BTr.
    - BTt : indicate that it is transmitting on the data channel
    - BTr: indicate that it is receiving on the data channel
  - ✓ Two busy tone signals are two sine waves at different frequencies

Classifications of MAC Protocols:

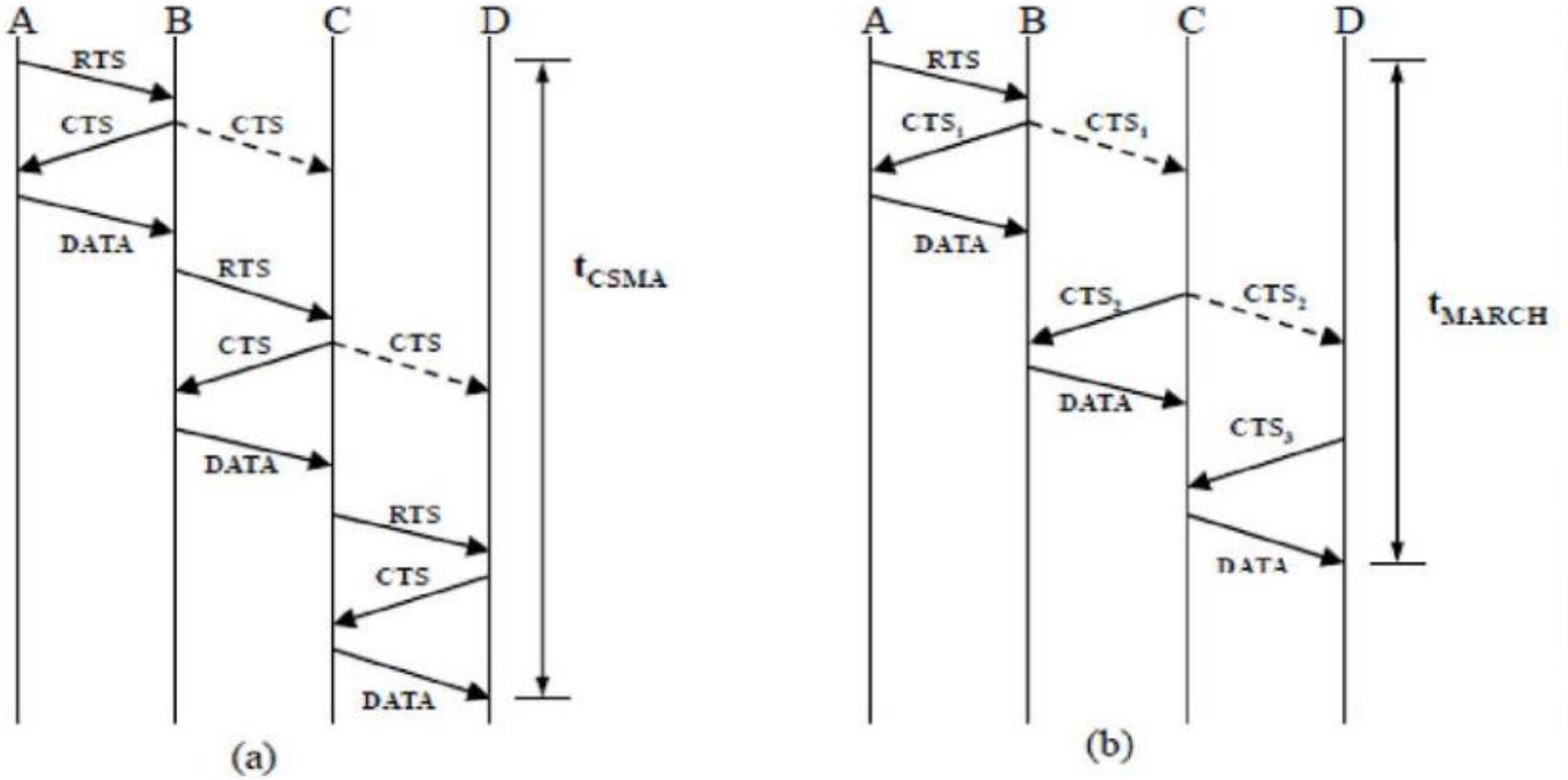
➢ ***Contention-based protocols :*** ***...cntd***

❖ ***Receiver-initiated protocols:***

- **RI-BTMA**: Receiver-Initiated Busy Tone Multiple Access Protocol
  - ✓ The transmission channel is split into two:
    - a data channel for data packet transmissions
    - a control channel used for transmitting the busy tone signal
  - ✓ A node can transmit on the data channel only if it finds the busy tone to be absent on the control channel.
  - ✓ The data packet is divided into two portions: a preamble and the actual data packet.
- **MACA-BI:** MACA-By Invitation
  - ✓ By eliminating the need for the RTS packet it reduces the number of control packets used in the MACA protocol which uses the three-way handshake mechanism.
- **MARCH:** Media Access with Reduced Handshake.

Classifications of MAC Protocols:

- ***Contention-based protocols :*** ***...cntd***
- ***Receiver-initiated protocols:***



Handshake mechanism in (a) MACA and (b) MARCH

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TOPIC 5 –Media access protocol for wireless LAN-media access with reduced handshake- contention based with reservation mechanisms-Distributed priority-scheduling.

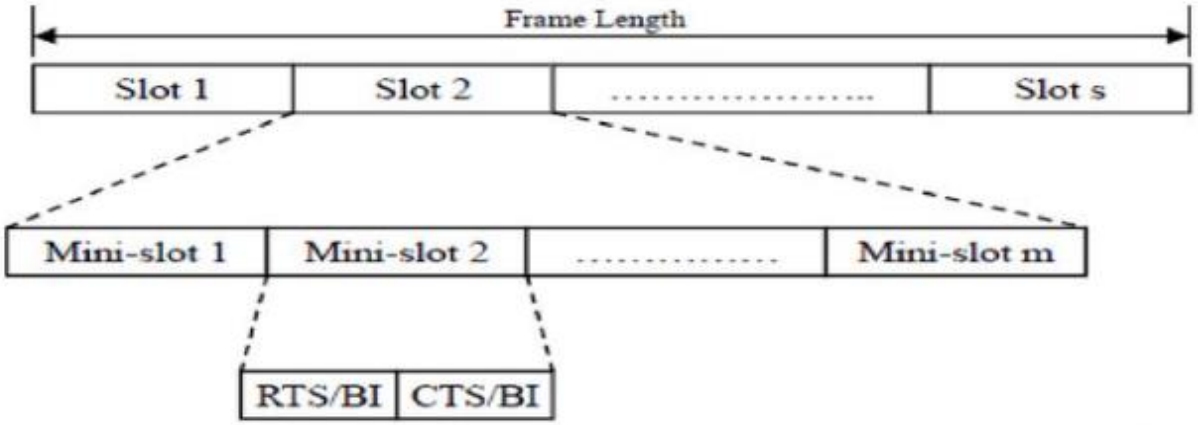
Classifications of MAC Protocols:

- ***Contention-based Protocols with Reservation Mechanism:***
  - ✓ Contention occurs during the resource (bandwidth) reservation phase.
  - ✓ Once the bandwidth is reserved, the node gets exclusive access to the reserved bandwidth.
  - ✓ QoS support can be provided for real-time traffic.

❖ ***Synchronous protocols:***

❑ **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 is a TDMA-based scheme. The channel is divided into fixed- and equal-sized frames along the time axis.



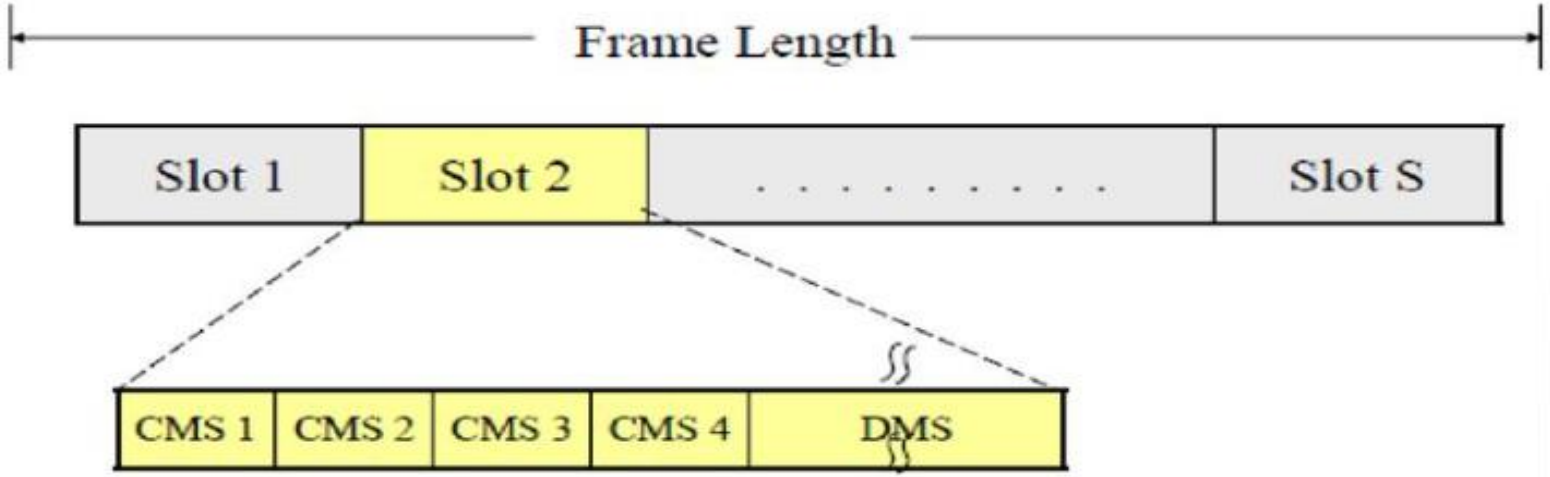
Classifications of MAC Protocols: ...cntd

- ***Contention-based Protocols with Reservation Mechanism:***
  - ***Synchronous protocols:***
    - **Collision Avoidance Time Allocation Protocol(CATA):**

✓ Support broadcast, unicast, and multicast transmissions simultaneously.

✓ Each frame consists of S slots and each slot is further divided into five Control Mini-Slots

- CMS1: Slot Reservation (SR)
- CMS2: RTS
- CMS3: CTS
- CMS4: Not To Send (NTS)
- DMS: Data transmission



Classifications of MAC Protocols: ...cntd

- ***Contention-based Protocols with Reservation Mechanism:***
  - ***Synchronous protocols:***

Soft Reservation Multiple Access with Priority Assignment (SRMA/PA):

- ✓ Developed with the main objective of supporting integrated services of real-time and non-real-time application in Ad-hoc networks.
- ✓ Nodes use a collision-avoidance handshake mechanism and a soft reservation mechanism.

Five-Phase Reservation Protocol (FPRP)

- ✓ A single-channel TDMA based broadcast scheduling protocol.
- ✓ Nodes uses a contention mechanism in order to acquire time slots.
- ✓ The protocol assumes the availability of global time at all nodes.
- ✓ The reservation takes five phases:
  - Reservation,
  - Collision Report,
  - Reservation Confirmation,
  - Reservation Acknowledgement,
  - Packing And Elimination Phase.

Classifications of MAC Protocols: ...cntd

➢ ***Contention-based Protocols with Reservation Mechanism:***

❖ ***Synchronous protocols:***

❑ **Five-Phase Reservation Protocol (FPRP)**

Five-phase protocol:

- **Reservation request**: send reservation request (RR) packet to dest.
- **Collision report**: if a collision is detected by any node, that node broadcasts a CR packet
- **Reservation confirmation**: a source node won the contention will send a RC packet to destination node if it does not receive any CR message in the previous phase
- **Reservation acknowledgment**: destination node acknowledge reception of RC by sending back RA message to source
- **Packing and elimination**: use packing packet and elimination packet.

Classifications of MAC Protocols: ...cntd

➢ ***Contention-based Protocols with Reservation Mechanism:***

❖ ***Asynchronous protocols:***

- **MACA with Piggy-Backed Reservation (MACA/PR):**
  - ✓ Provide real-time traffic support in multi-hop wireless networks
  - ✓ Based on the MACAW protocol with non-persistent CSMA
  - ✓ The main components of MACA/PR are:
    - A MAC protocol
    - A reservation protocol
    - A QoS routing protocol

- **Real-Time Medium Access Control Protocol (RTMAC)**
  - ✓ Provides a bandwidth reservation mechanism for supporting real-time traffic in ad-hoc wireless networks
  - ✓ RTMAC has two components
    - A MAC layer protocol is a real-time extension of the IEEE 802.11 DCF.
      - A medium-access protocol for best-effort traffic
      - A reservation protocol for real-time traffic
    - A QoS routing protocol is responsible for end-to-end reservation and release of bandwidth resources.

Classifications of MAC Protocols:

- ***Contention-based protocols with Scheduling Mechanism:***

- ✓ Protocols in this category focus on packet scheduling at the nodes and transmission scheduling of the nodes.
- ✓ The factors that affects scheduling decisions
  - Delay targets of packets
  - Traffic load at nodes
  - Battery power
- ✓ Distributed priority scheduling and medium access in Ad Hoc Networks present two mechanisms for providing quality of service (QoS)
  - **Distributed priority scheduling (DPS)** – Piggy-backs the priority tag of a node's current and head-of-line packets to the control and data packets
  - **Multi-hop coordination** – Extends the DPS scheme to carry out scheduling over multi-hop paths.

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Classifications of MAC Protocols: ...cntd

- ***Contention-based protocols with Scheduling Mechanism:***

  - **Distributed Wireless Ordering Protocol (DWOP)**
    - A media access scheme along with a scheduling mechanism based on the distributed priority scheduling scheme

  - **Distributed Laxity-based Priority Scheduling (DLPS) Scheme**
    - Scheduling decisions are made based on the states of neighboring nodes and feed back from destination nodes regarding packet losses
    - Packets are recorded based on their uniform laxity budgets (ULBs) and the packet delivery ratios of the flows. The laxity of a packet is the time remaining before its deadline.

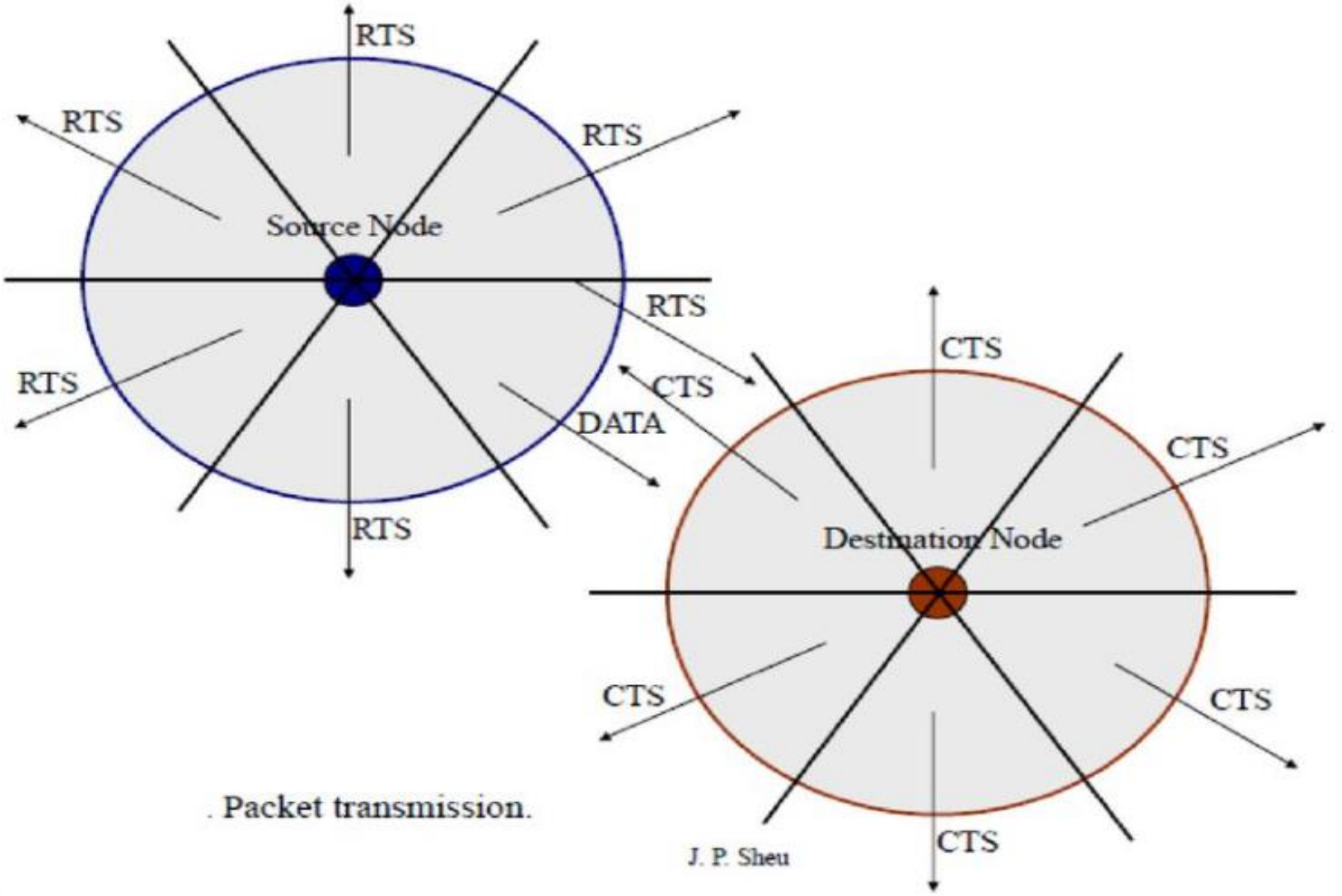
Classifications of MAC Protocols:

- ***MAC Protocols that use directional Antennas:***

  - ✓ MAC protocols that use directional antennas have several advantages:
    - Reduce signal interference
    - Increase in the system throughput
    - Improved channel reuse
  - ✓ **MAC protocol using directional antennas**
    - Make use of an RTS/CTS exchange mechanism
    - Use directional antennas for transmitting and receiving data packets
  - ✓ **Directional Busy Tone-based MAC Protocol (D-BTMA)**
    - It uses directional antennas for transmitting the RTS, CTS, data frames, and the busy tones.
  - ✓ **Directional MAC Protocols for Ad Hoc Wireless Networks**
    - DMAC-1: A directional antenna is used for transmitting RTS packets and Omni-directional antenna for CTS packets.
    - DMAC-1, both directional RTS and omni-directional RTS transmission are used.

Classifications of MAC Protocols: ...cntd

- ***MAC Protocols that use directional Antennas:***



. Packet transmission.

Classifications of MAC Protocols: ...cntd

- ***Other MAC Protocols:***
  - ✓ **Multi-channel MAC Protocol (MMAC)**
    - Multiple channels for data transmission
    - There is no dedicated control channel.
    - Based on channel usage channels can be classified into three types: high, medium and low preference channels.
  - ✓ **Multi-channel Carrier Sense Multiple Access(MCSMA) MAC Protocol :**
    - The available bandwidth is divided into several channels
  - ✓ **Power Control MAC Protocol (PCM) for Ad Hoc Networks**
    - Allows nodes to vary their transmission power levels on a per-packet basis
  - ✓ **Receiver-based Autorate Protocol (RBAR)**
    - Use a rate adaptation approach
  - ✓ **Interleaved Carrier-Sense Multiple Access Protocol (ICSMA)**
    - The available bandwidth is split into tow equal channels
    - The handshaking process is interleaved between the two channels.

Note: *A directional antenna or beam antenna is an antenna which radiates or receives greater power in specific directions allowing for increased performance and reduced interference from unwanted sources.*

Note: *Omnidirectional refers to the notion(feeling) of existing in every direction. Omnidirectional antenna is that radiates equally in all directions.*

Note: *Handshaking is the exchange of information between two modems and the resulting agreement about which protocol to use that precedes each telephone connection.*