SNS COLLEGE OF ENGINEERING

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19EC701 - ADHOC NETWORKS

Unit -2 – DATALINK LAYER – CONTENTION BASED PROTOCOLS WITH RESERVATION

Contention-based Protocols with Reservation Mechanisms

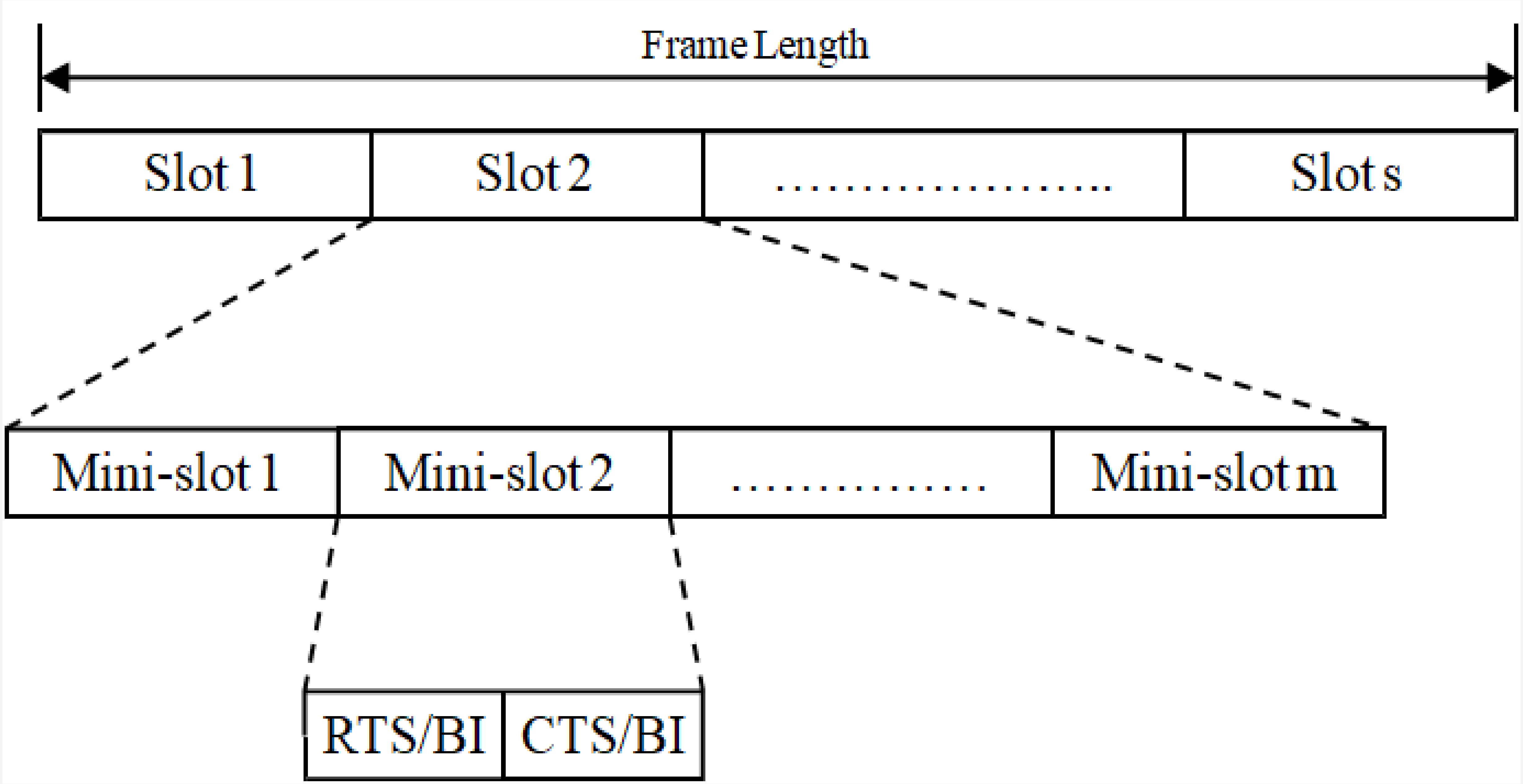
- Contention-based Protocols with Reservation Mechanisms
  - Contention occurs during the resource (bandwidth) reservation phase.
  - Once the bandwidth is reserved, the node gets exclusive access to the reserved bandwidth.
  - QoS support can be provided for real-time traffic.

D-PRMA: Distributed Packet Reservation Multiple Access Protocol

- The channel is divided into fixed and equal sized frames along the time axis.
- The RTS/BI and CTS/BI are used for slot reservation and for overcoming the hidden terminal problem
- If a terminal wins the contention through mini-slot 1, the extra (m – 1) mini-slots of this slot will be granted to the terminal as the payload

  -For voice node, the same slot in each subsequent frame can be reserved until the end of its packet transmission
- In the other cases, the extra (m – 1) mini-slots are continuously used for contention, and the winner of this contention will be granted the reservation of the same slot

D-PRMA: Distributed Packet Reservation Multiple Access Protocol



D-PRMA: Distributed Packet Reservation Multiple Access Protocol

- To prioritize voice terminals over data terminals
- Voice terminals starts contenting from mini-slot 1 with probability p = 1 while data terminals can start such content with p < 1
- Both voice and data terminals can content through the extra (m – 1) mini-slots with probability p < 1
- Only the winner of a voice terminal can reserve the same slot in each subsequent frame until the end of packet transmission while the winner of a data terminal can only use one slot

Problems:

- When a terminal wins the contention in mini-slot 1, how to prevent other terminals in the same slot for contention ? (Use RTS/CTS)
- How to prevent a terminal from contending for a reserved slot in each subsequent slot ? (Transmit a busy indication (BI) signal RTS/BI (receiver) (why?) and CTS/BI (sender) in mini-slot 1)

CATA: Collision Avoidance Time Allocation Protocol

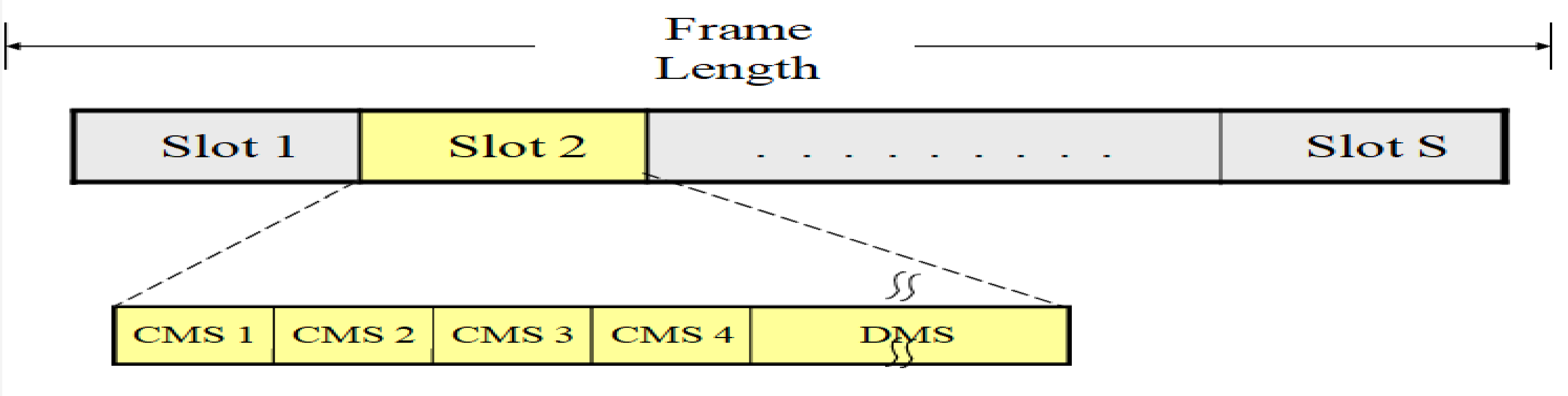
- Support broadcast, unicast, and multicast transmissions simultaneously
- Each frame consists of *S* slots and each slot is further divided into five mini-slots
  - CMS1: Slot Reservation (SR)
  - CMS2: RTS
  - CMS3: CTS
  - CMS4: not to send (NTS)
  - DMS: Data transmission

CATA: Collision Avoidance Time Allocation Protocol

- Each node receives data during the DMS of current slot transmits an SR in CMS1
- Every node that transmits data during the DMS of current slot transmits an RTS in CMS2
- CMS3 and CMS4 are used as follows:
  - The sender of an intend reservation, if it senses the channel is idle in CMS1, transmits an RTS in CMS2
  - Then the receiver transmits a CTS in CMS3
  - If the reservation was successful the data can transmit in current slot and the same slot in subsequent frames
  - Once the reservation was successfully, in the next slot both the sender and receiver do not transmit anything during CMS3 and during CMS4 the sender transmits a NTS.

CATA: Collision Avoidance Time Allocation Protocol

- If a node receives an RTS for broadcast or multicast during CMS2 or it finds the channel to be free during CMS2, it remains idle during CMS3 and CMS4
- Otherwise it sends a NTS packet during CMS4
- A potential multicast or broadcast source node that receives the NTS packet or detecting noise during CMS4, understands that its reservation is failed
- If it find the channel is free in CMS4, which implies its reservation was successful
- CATA works well with simple single-channel half-duplex radios



Frame format in CATA.

HRMA: Hop Reservation Multiple Access Protocol

- HRMA is a multi-channel MAC protocol, based on half- duplex very slow frequency hopping spread spectrum (FHSS) radios
- Each time slot is assigned a separate frequency channel (See Figure 6.17)
- Assumptions

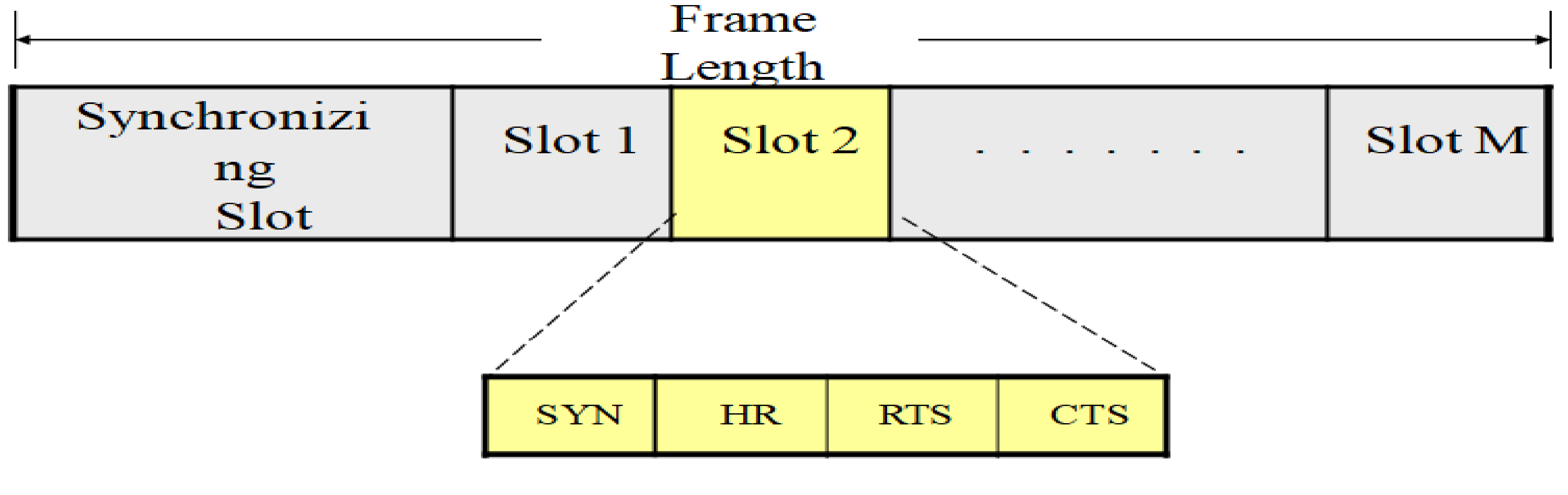
  L: frequency channels

  - f_0: dedicated synchronized channel frequency
  - The remaining L - 1 frequencies are divided into frequency pairs denoted by

$$M = \left\lfloor \frac{(L-1)}{2} \right\rfloor$$

$$(f_i, f_i^*), i = 1, 2, 3, \ldots, M$$

HRMA: Hop Reservation Multiple Access Protocol



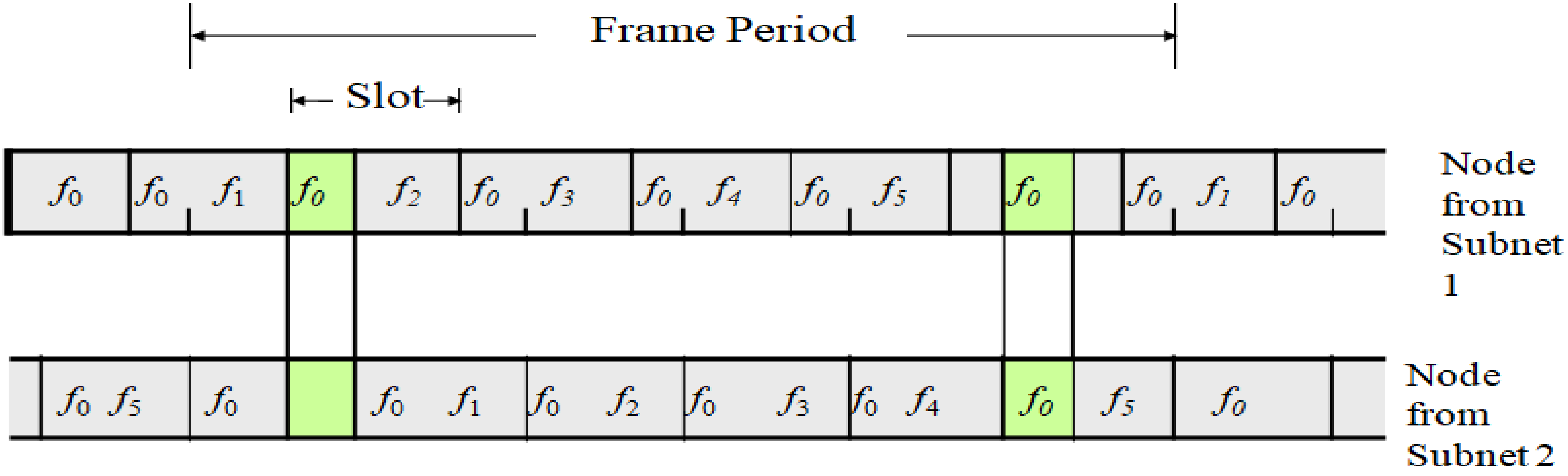
Frame format in HRMA.

- Hop reservation (HR), RTS, CTS, DATA : f_i
- ACK: f_i*
- All idle nodes hop to the synchronizing frequency f_0 and exchange synchronization information
- Synchronizing slot: used to identify the beginning of a frequency hop and the frequency to be used in the immediately following hop

Any two nodes from two disconnected networks have at least two overlapping time period of length μ_s on the frequency f_0

HRMA: Hop Reservation Multiple Access Protocol

If μ is the length of each slot and μ_s is the length of the synchronization period on each slot, then the dwell time of f_0 is $\mu + \mu_s$



f_0 synchronizing frequency

$M = 5$

Merging of subnets.

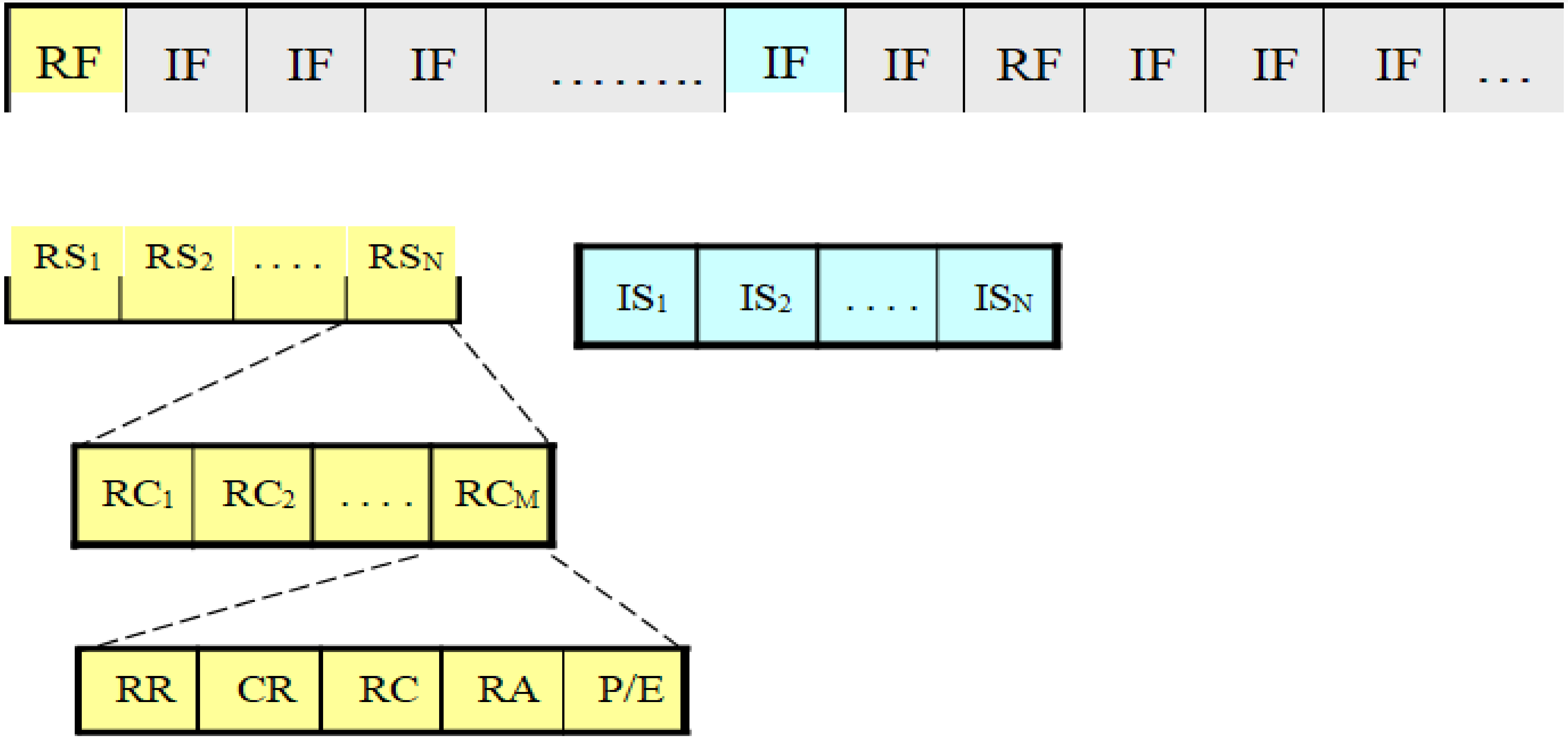
HRMA: Hop Reservation Multiple Access Protocol

- A node ready to transmit data, it senses the HR period of the current slot
  - If the channel is idle during HR period, it transmits an RTS during RTS period and waits for CTS during CTS period
  - If the channel is busy during HR period, it backs off for a randomly multiple slots
- Suppose the sender needs to transmits data across multiple frames, it informs the receiver through the header of the data packet
  - The receiver node transmits an HR packet during the HR period of the same slot in next frame to informs its neighbors
  - The sender receiving the HR packet, it sends an RTS during the RTS period and jams other RTS packets
  - Both the sender and receiver remain silent during the CTS period

FPRP: Five-Phase Reservation Protocol

- FPRP is a single-channel TDMA-based broadcast scheduling protocol:
  - need global time synchronization
  - fully distributed and scalable
  - reservation process is localized; it involves only two-hop neighbors
  - No hidden terminal problem
- Time is divided into frames: reservation frame (RF) and information frame (IF)
  - Each RF has *N* reservation slots (RS) and each IF has *N* information slots (IS)
  - Each RS is composed of *M* reservation cycles (RCs)
  - With each RC, a five-phase dialog takes place
- Corresponding to IS, each node would be in one of the following three states: transmit (T), receive (R), and blocked (B)

FPRP: Five-Phase Reservation Protocol



Five-phase reservation dialog

Frame structure in FPRP.

FPRP: Five-Phase Reservation Protocol

- 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

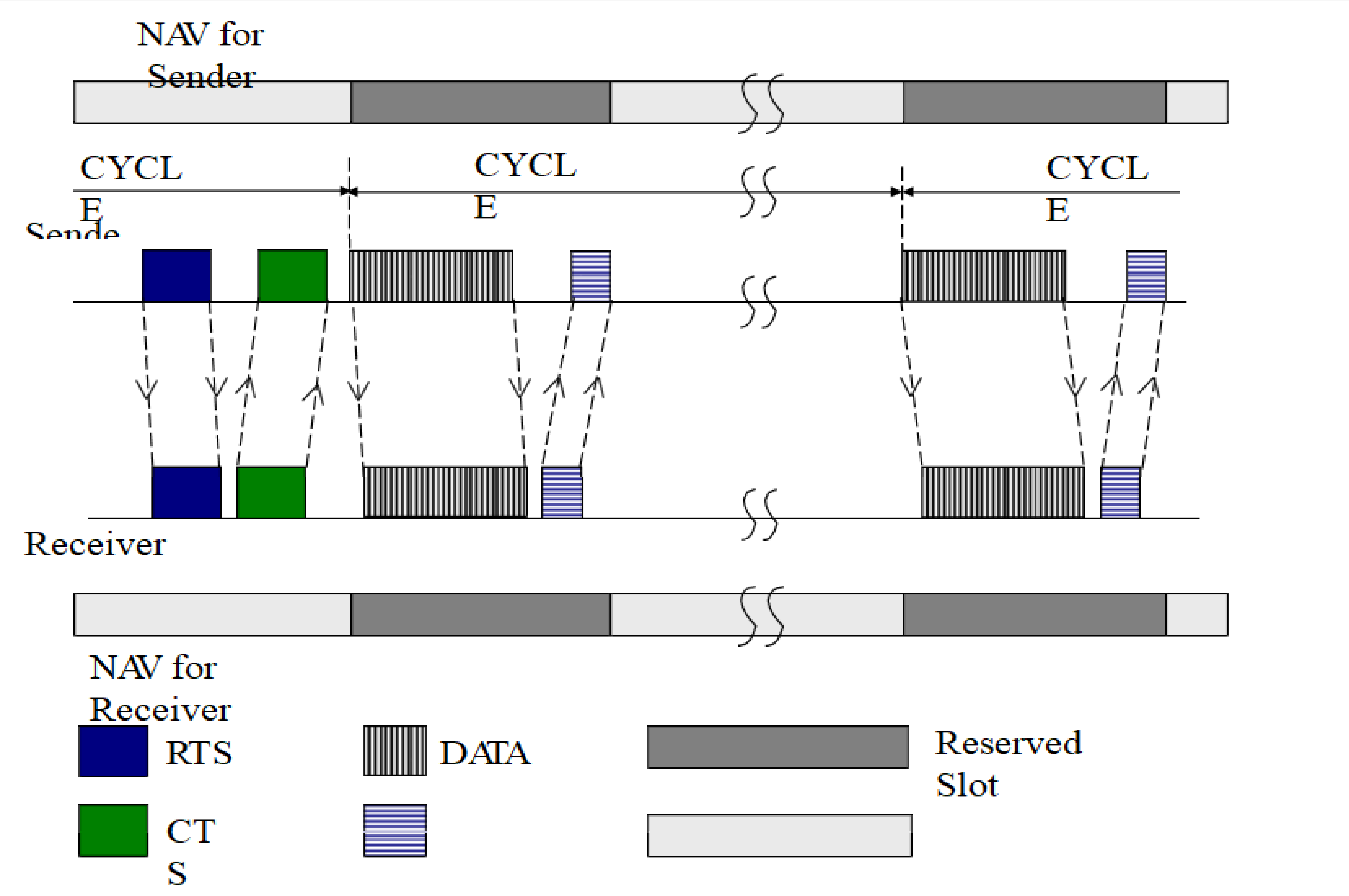
MACA/PR: MACA with Piggy- Backed Reservation

- MACA/PR is used to provide real time traffic support
- The main components: a MAC protocol (MACAW + non persistent CSMA), a reservation protocol, and a QoS routing protocol
- Each node maintains a reservation table (RT) that records all the reserved transmit and receive slots/windows of all nodes
- Non-real time packet: wait for a free slot in the RT + random time ⍰ RTS ⍰ CTS ⍰ DATA ⍰ ACK
- Real time packet:
  - Transmit real time packets at certain regular intervals (say CYCLE)
  - RTS – CTS - DATA (carry reservation info for next data) – ACK - … - DATA (carry reservation info) - ACK
    - Hear DATA and ACK: update their reservation table
  - The ACK packet serves to renew the reservation, in addition to recovering from the packet loss
    - Reservation fail: fail to receive ACK packets for a certain number of DATA packets

MACA/PR: MACA with Piggy- Backed Reservation

- For maintaining consistent information regarding free slots
  - Periodic exchange of reservation tables
- Best effort and real time packet transmissions can be interleaved at nodes
- When a new node joins: receive reservation tables from each of its neighbors and learns about the reservations made in the network
- QoS Routing protocol: DSDV (destination sequenced distance vector)
- MACA/PR does not require global synchronization among nodes
- Drawback: possibility of many fragmented free slots not being used at all

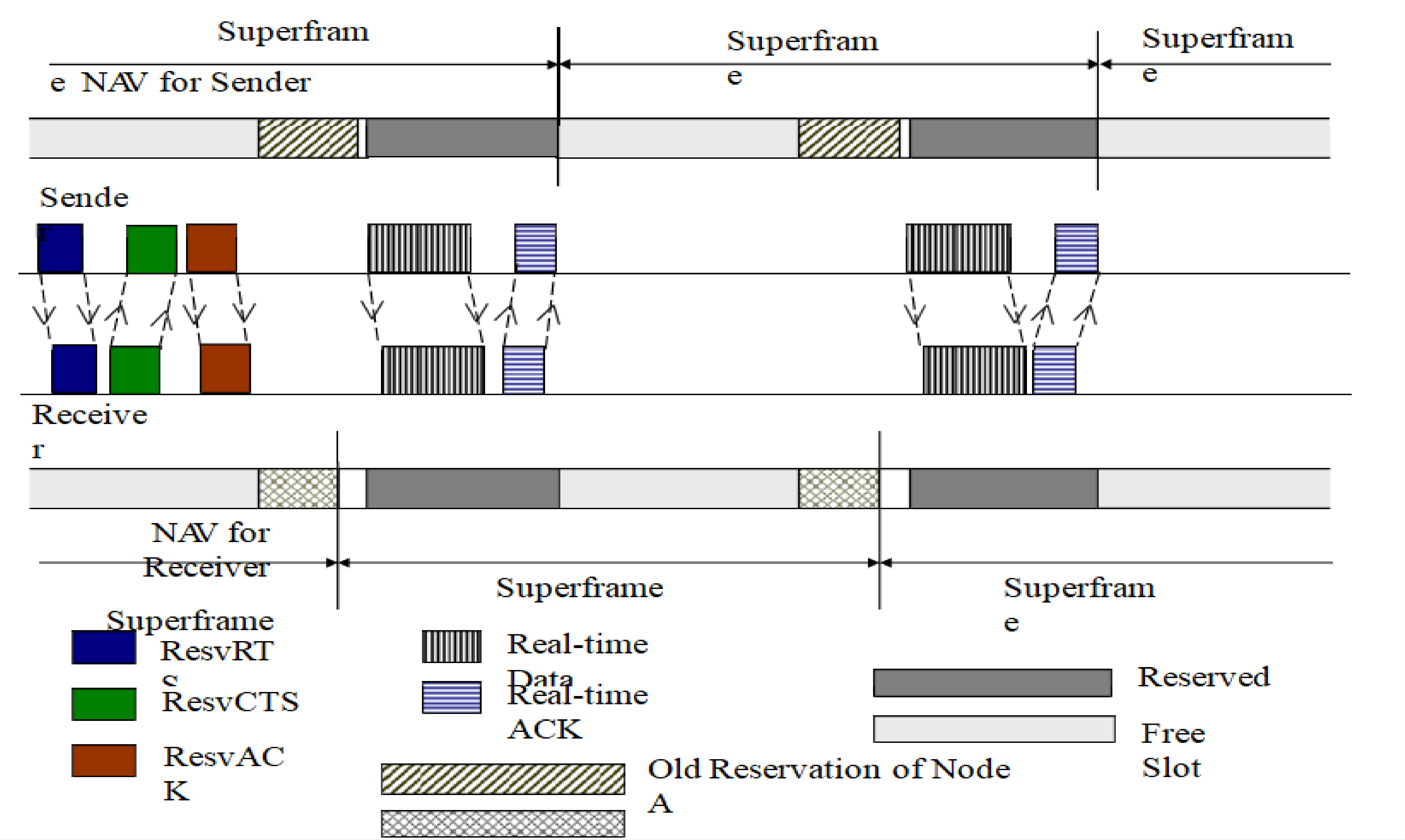
MACA/PR: MACA with Piggy- Backed Reservation



RTMAC: Real Time Medium Access Control Protocol

- The two components: MAC protocol and QoS routing protocol
- QoS routing: for end to end reservation + release of bandwidth
- MAC: medium access for best effort + reservation for real time
- Control packets
  - Real time : ResvRTS, ResvCTS, and ResvACK, half of DIFS
  - Best effort: RTS, CTS, and ACK
- The duration of each resv-slot is twice the maximum propagation delay
  - Transmit real time packets first reserves a set of resv-slots
  - The set of resv-slots for a connection is called a connection-slot
- The superframe for each node may not strictly align with the other
- nodes (use relative time for all reservation)

RTMAC: Real Time Medium Access Control Protocol



Assessment

List out the advantage and disadvantages of Contention based protocol with reservation?

THANK YOU