MAC protocols, Contention-based with reservation and scheduling

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Overview

- Introduction
- Design issues
- Design principles
- Classification of MAC protocols
- Contention-based prot. with reservation mechanisms
  - D-PRMA
  - CATA
  - HRMA
  - MACA/PR
- Contention-based prot. with scheduling mechanisms
  - DPS
  - DWOP

Introduction

Features

- High mobility of the nodes
- Limited bandwidth
- Power constraints

Result

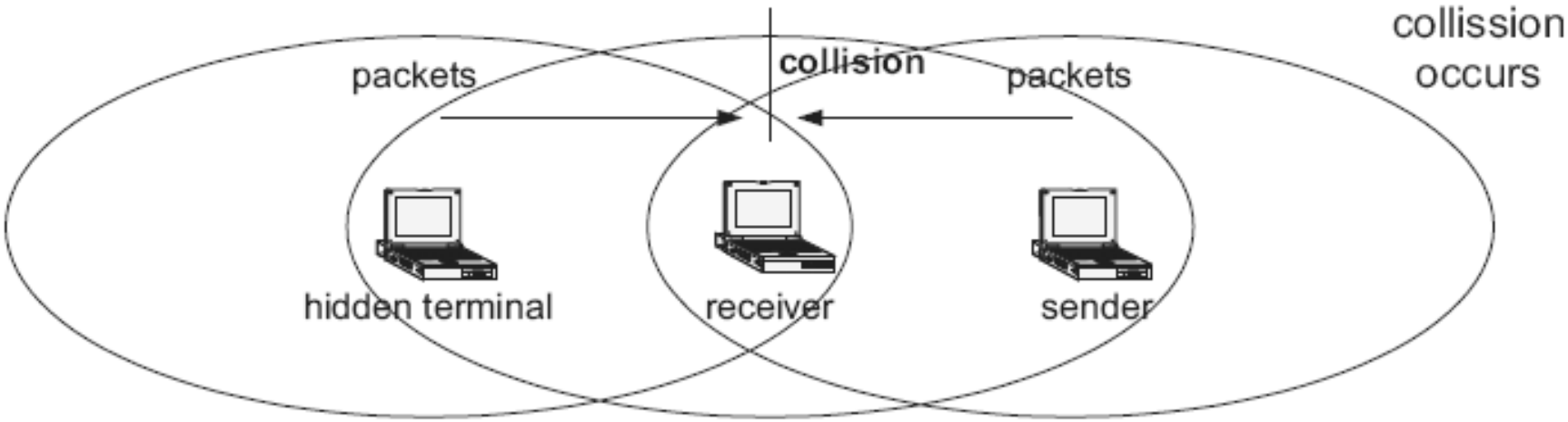
- Specific Mac protocols for the access to the physical medium

Design Issues

- Bandwidth efficiency
- QoS support
- Synchronization
- Error-prone shared broadcast channel
- No central coordination
- Node mobility
- Signal propagation delay
- Hardware constraints

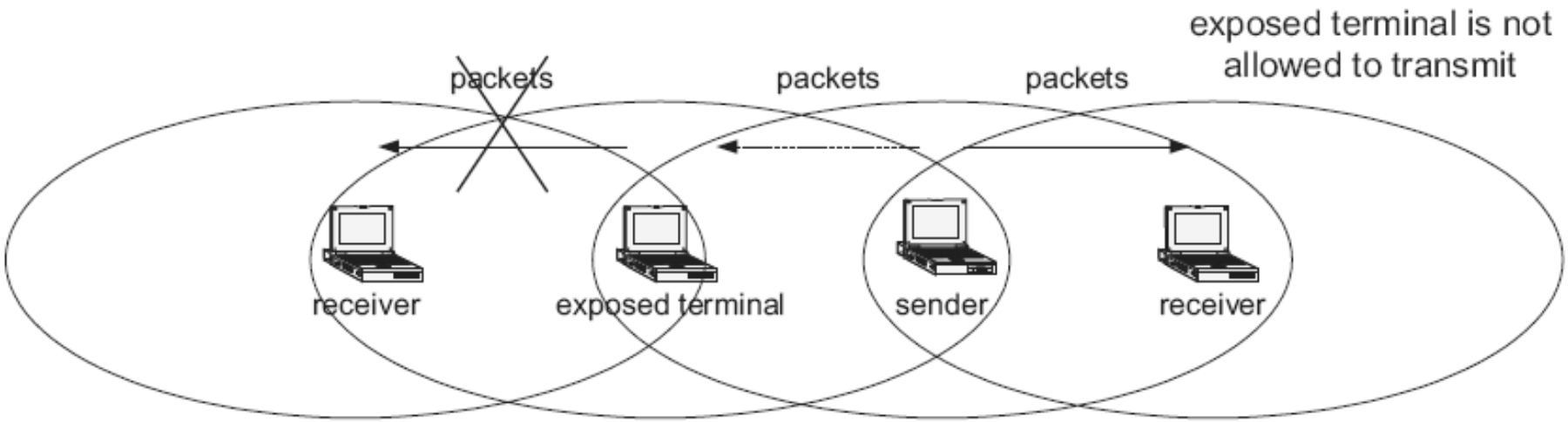
Design Issues cont.

- Hidden terminal problem



Design Issues cont.

- Exposed terminal problem



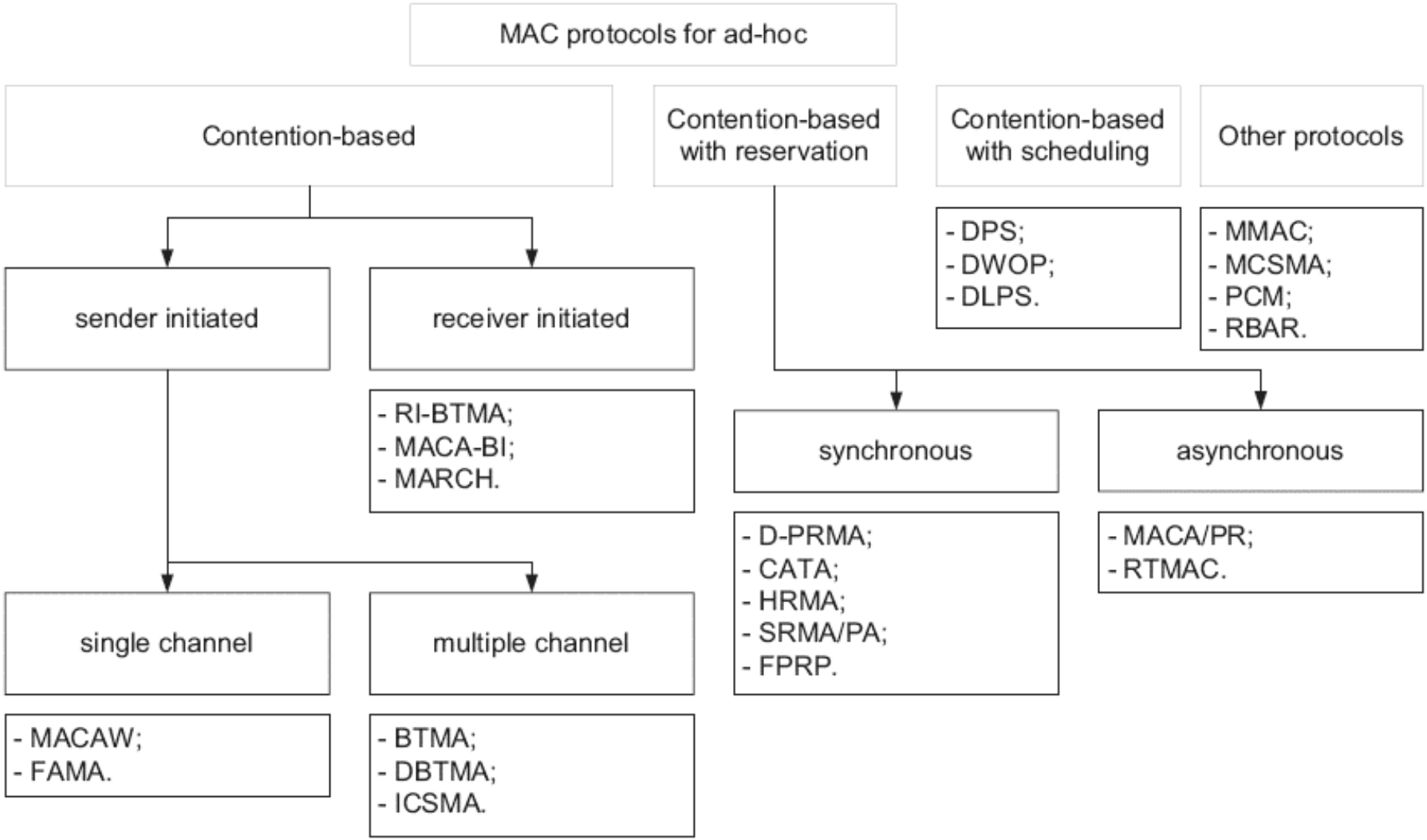
Design principles

- Protocol operation should be distributed through all the nodes
- QoS support for real-time traffic
- Average delay for packet transmission should be as small as possible
- Each node must have a fair share of the available bandwidth
- Control overhead should be minimized
- The hidden and exposed terminal problems should be minimized
- The protocol must be scalable to large networks.

Design principles

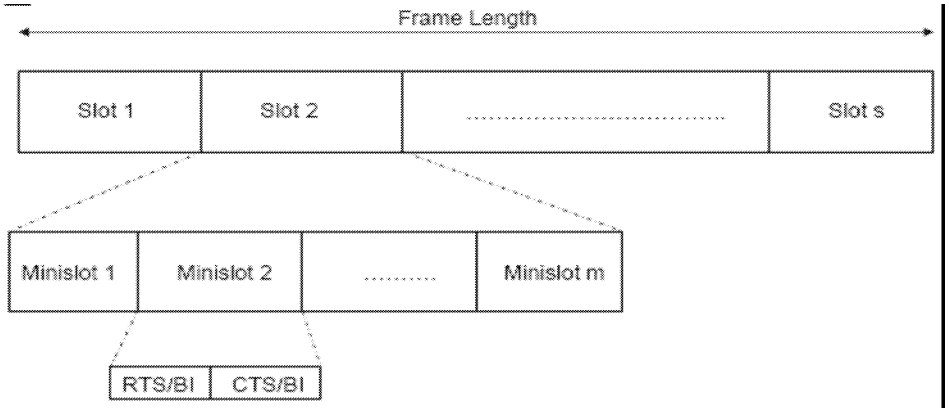
- Efficient management of the nodes' energy consumption
- Adaptive data rate control should be provided – a node controls the rate of outgoing traffic in relation also to the network load and to the status of the other nodes
- Directional antennas are encouraged, the advantages are reduced interference, increased spectrum reuse, and reduced power consumption
- Time synchronization between the nodes should be provided

Classification of MAC protocols



Contention-based protocols with reservation mechanisms

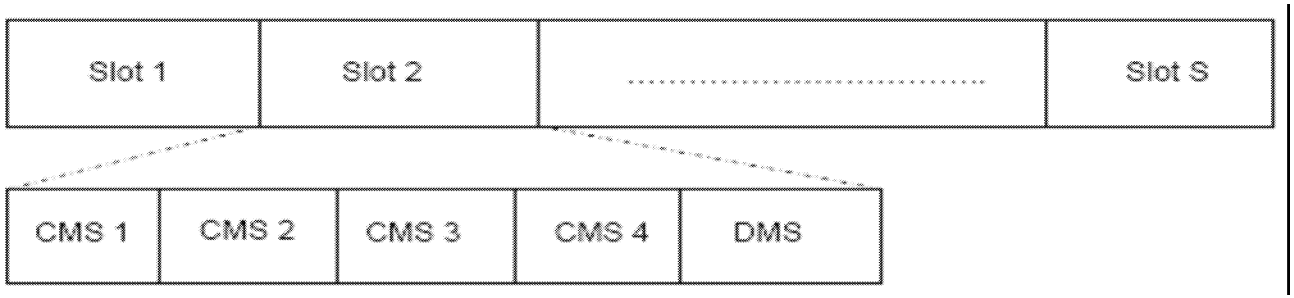
Distributed Packet Reservation Multiple Access (D-PRMA)



- Competition for the first minislot of the slot
- The mechanism id RTS/BI – CTS/BI

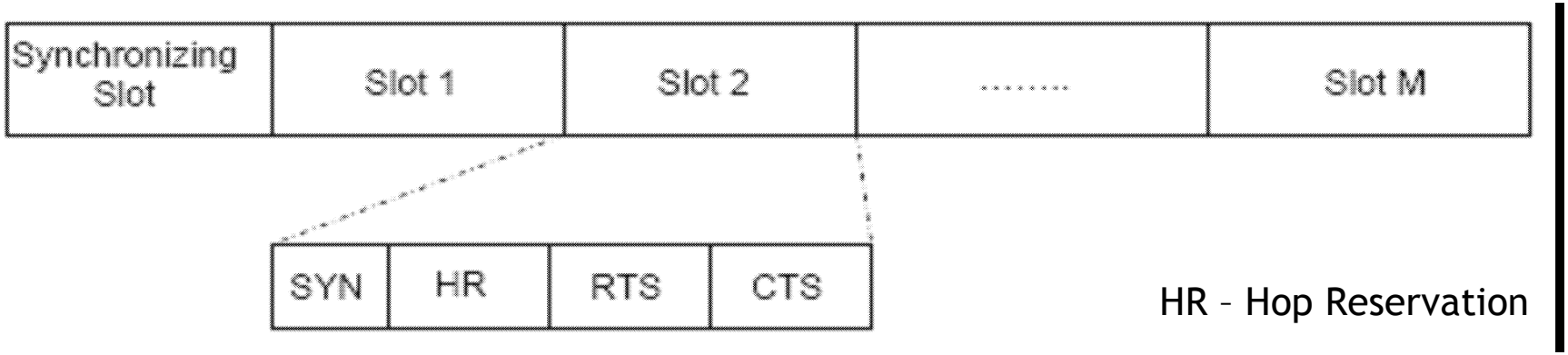
- Within a time slot, communication between the source and destination nodes is done either by TDD or FDD
- Contention for the first minislot is done with probability 1 for voice traffic, and a smaller probability for other traffic
- Only voice nodes can reserve subsequent slots

Collision Avoidance Time Allocation (CATA)



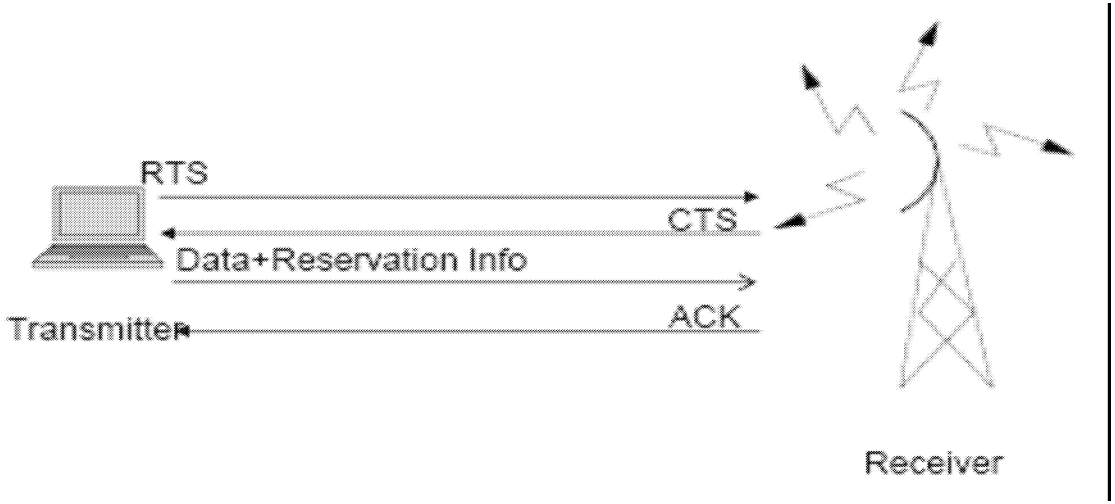
- First four minislots – control, the fifth – data
- Supports unicast, multicast, and broadcast transmission
- CMS1 and CMS2 are used to inform neighbors about reservations, to avoid collisions
- CMS3 and CMS4 are used for channel reservation
- CATA provides support for collision-free broadcast and multicast traffic

Hop Reservation Multiple Access (HRMA)



- Each slot has a separate frequency channel
- One dedicated synchronizing channel
- Remaining channels are paired, one for reservation and data packets, the other one for ACKs

MACA with Piggy-backed Reservation (MACA/PR)



- Time division into slots of different length
- Each node keeps a table of the reservations of its neighbors
- To send data:
  - Wait for two same empty slots
  - Exchange RTS/CTS packets, that contain the time reservation
  - Exchange the data
- Real-time traffic piggy-backs reservation information in the data packets

Contention-based protocols with scheduling mechanisms

Distributed Priority Scheduling (DPS)

- Uses the RTS-CTS-DATA-ACK mechanism
- RTS and CTS packets contain piggy-backed information about the priority of the coming DATA packet
- The DATA packet itself contains piggy-backed information about the priority of the following DATA packet
- Each node keeps a table with the priorities of its neighbors
- When the ACK arrives, the entry is deleted
- This mechanism helps establish relative priority

Distributed Wireless Ordering Protocol (DWOP)

- The purpose is to achieve a distributed FIFO schedule
- When a node transmits a packet, it adds the information about the arrival time of queued packets. This is recorded in the scheduling table of the neighbors
- The node with the lowest arrival time has the priority
- Entries in the tables are deleted when the ACK packets are heard

Conclusion

The issues associated with the design of a MAC protocol for wireless ad hoc networks are:

- node mobility
- an error- prone, broadcast and shared channel
- time-synchronization
- bandwidth efficiency
- QoS support