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UNIVERSITÄT FREIBURG

Algorithms for Radio Networks

MACA

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Problem of Wireless Media Access

- **Unknown number of participants**
  - broadcast
  - many nodes simultaneously
  - only one channel available
  - asymmetric situations
- **Collisions produce interference**
- **Media Access**
  - Rules to participate in a network

Aims

- **Delay**
- **Throughput**
- **Fairness**
- **Robustness and stability**
  - against disturbances on the channel
  - against mobility
- **Scalability**
- **Energy efficiency**

Methods

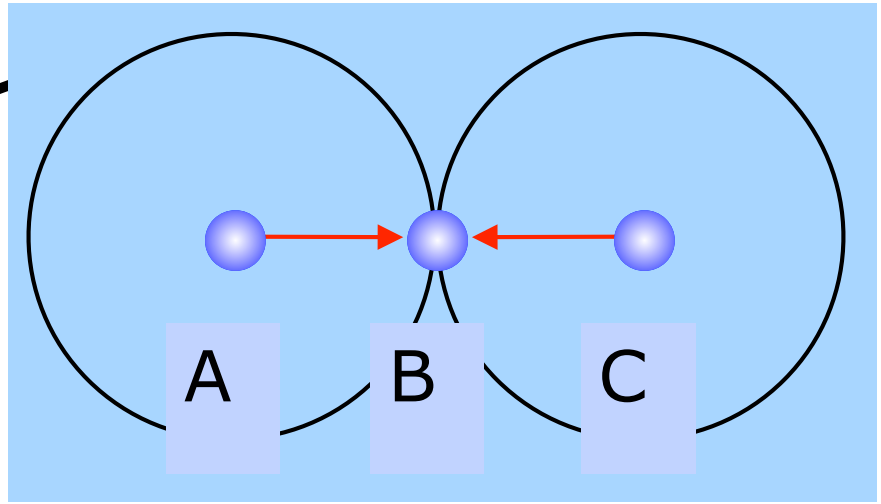
- **Organisation**
  - Central control
  - Distributed control
- **Access**
  - without contention
  - with contention

Problem of Media Access

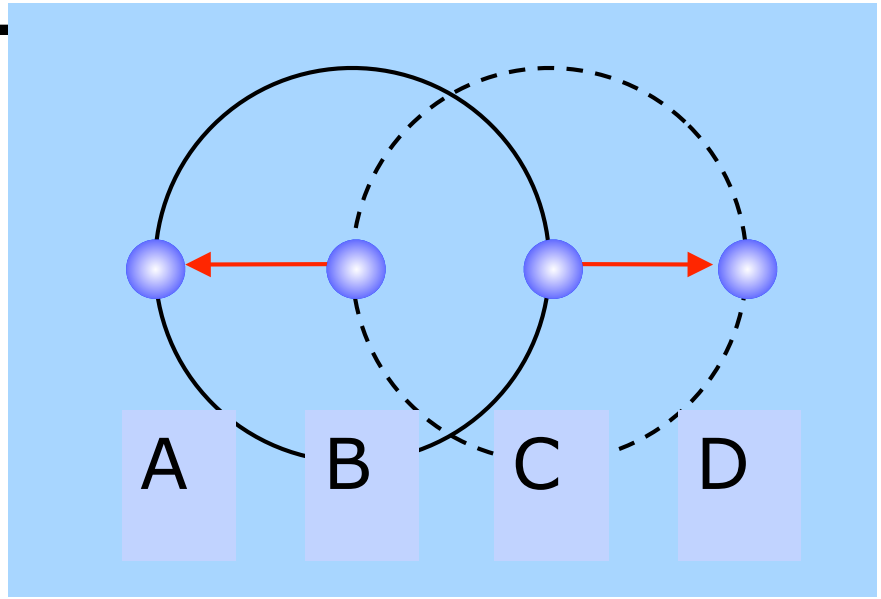
- **CSMA/CD not applicable**
  - Media is only locally known
  - Bounded range
- **Hidden Terminal**
  - Receiver collision despite *carrier sensing*
- **Exposed Terminal**
  - Opportunity costs of unsent messages because of c*arrier sensing*

Hidden Terminal and Exposed Terminal

Hidden Terminal Problem



Exposed Terminal Problem



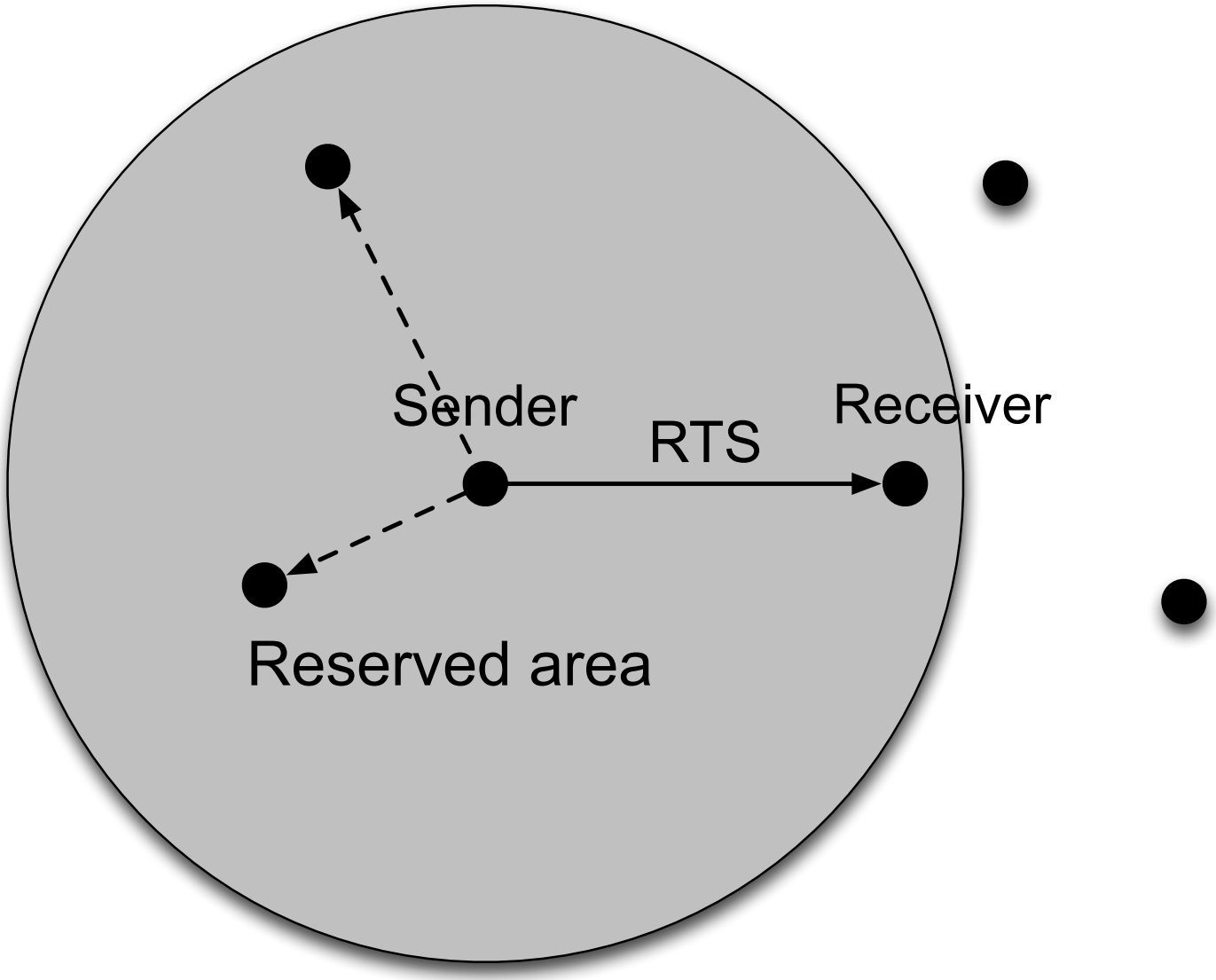
Alternative Solutions

- **Extended hardware**
  - Addition carrier signal blocks and ensures transmission
- **Centralized solution**
  - Base station is the only communication partner
  - Base station coordinates the media access

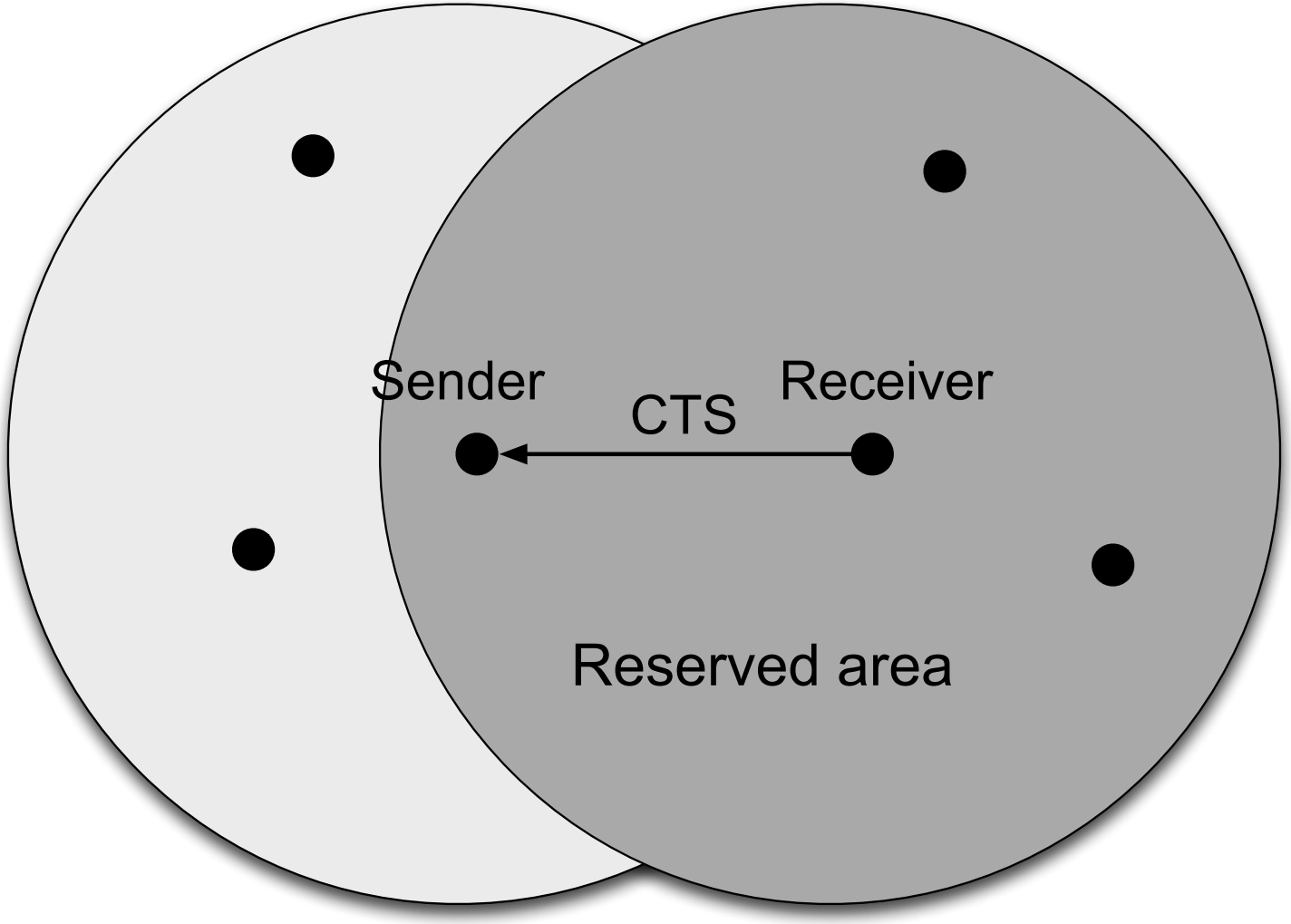
MACA

- **Phil Karn**
  - MACA: A New Channel Access Method for Packet Radio 1990
- **Alternative names:**
  - Carrier Sensing Multiple Access / Collision Avoidance (CSMA/CA)
  - Medium Access with Collision Avoidance (MACA)
- **Aim**
  - Solution of the Hidden and Exposed Terminal Problem
- **Idea**
  - Channel reservation before the communication
  - Minimization of collision cost

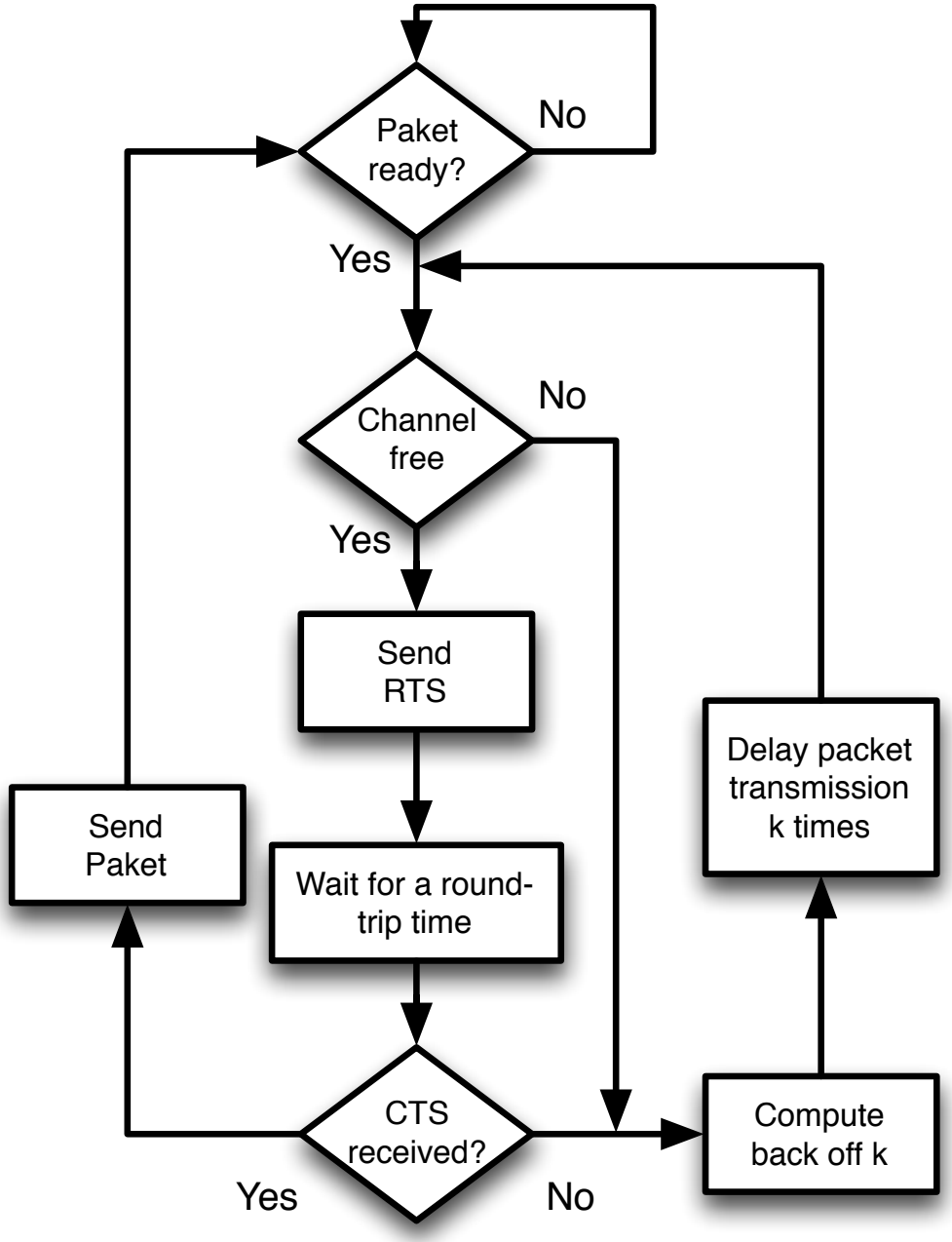
Request to Send



Clear to Send



RTS/CTS
MACA
CSMA/CA



Details for Sender

- **A sends RTS**
  - waits certain time for CTS
- **If A receives CTS in time**
  - A sends packet
  - otherwise A assumes a collision at B
    - doubles *Backoff*-counter
    - and chooses a random waiting time from {1,...,*Backoff* }
  - After the waiting time A repeats from the beginning

Details for Receiver

- **After B has received RTS**
  - B sends CTS
  - B waits some time for the data packet
  - If the data packet arrives then the process is finished
    - Otherwise B is not blocked

Details for Third Parties

- **C receives RTS of A**
  - waits certain time for CTS of B
- **If CTS does not occur**
  - C is free for own communication
- **If CTS of B has been received**
  - then C waits long enough such that B can receive the data packet

Details for Third Parties

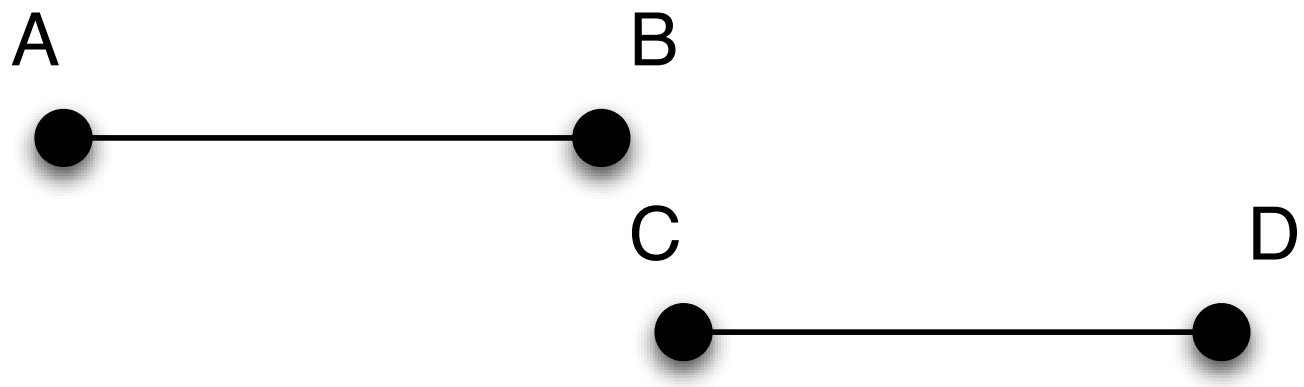
- **D receives CTS of B**
  - waits long enough such that B can receive the data packet
- **E receives RTS of A and CTS of B**
  - waits long enough such that B can receive the data packet

Hidden Terminal because of Mobility

- A sends RTS to B
- B sends CTS to A
- C moves in this time close enough to B to disturb the transmission

Hidden Terminal the paralell case

- **A sends RTS to B**
- **B sends CTS**
- **In parallel C sends RTS to D**
- **D answers with CTS**
  - while A has started sending data
- **C sends to D (and B)**



Exposed Terminals in MACA

- **B wants to send to A**
- **C wants to send to D**

Conclusions

- **MACA**
  - solves the Hidden Terminal Problem only partially
  - Exposed Terminal Problem is not solved

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