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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 *carrier sensing*

Hidden Terminal and Exposed Terminal

Hidden Terminal Problem
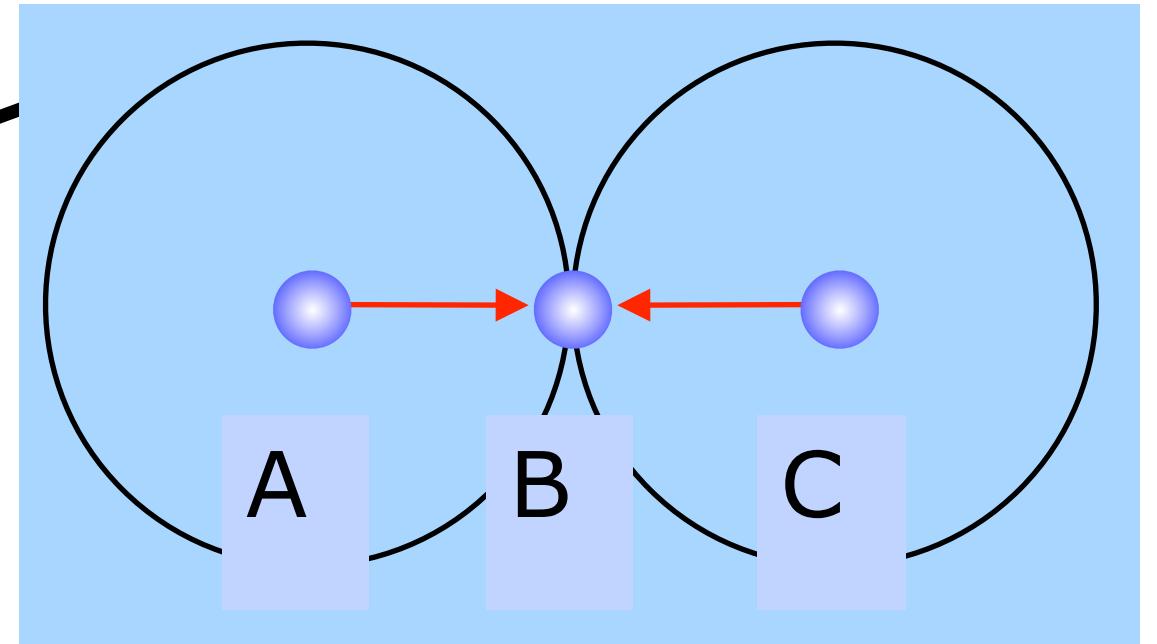
Exposed Terminal Problem
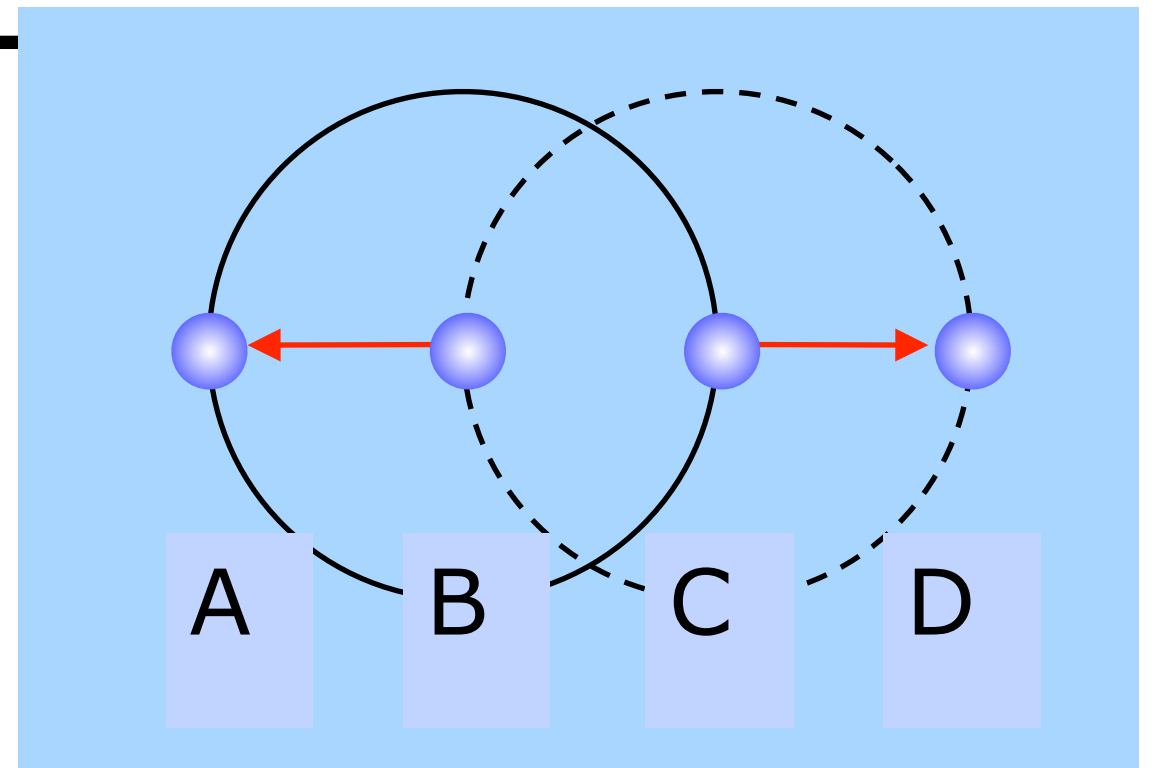
Alternative Solutions

▸ **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)
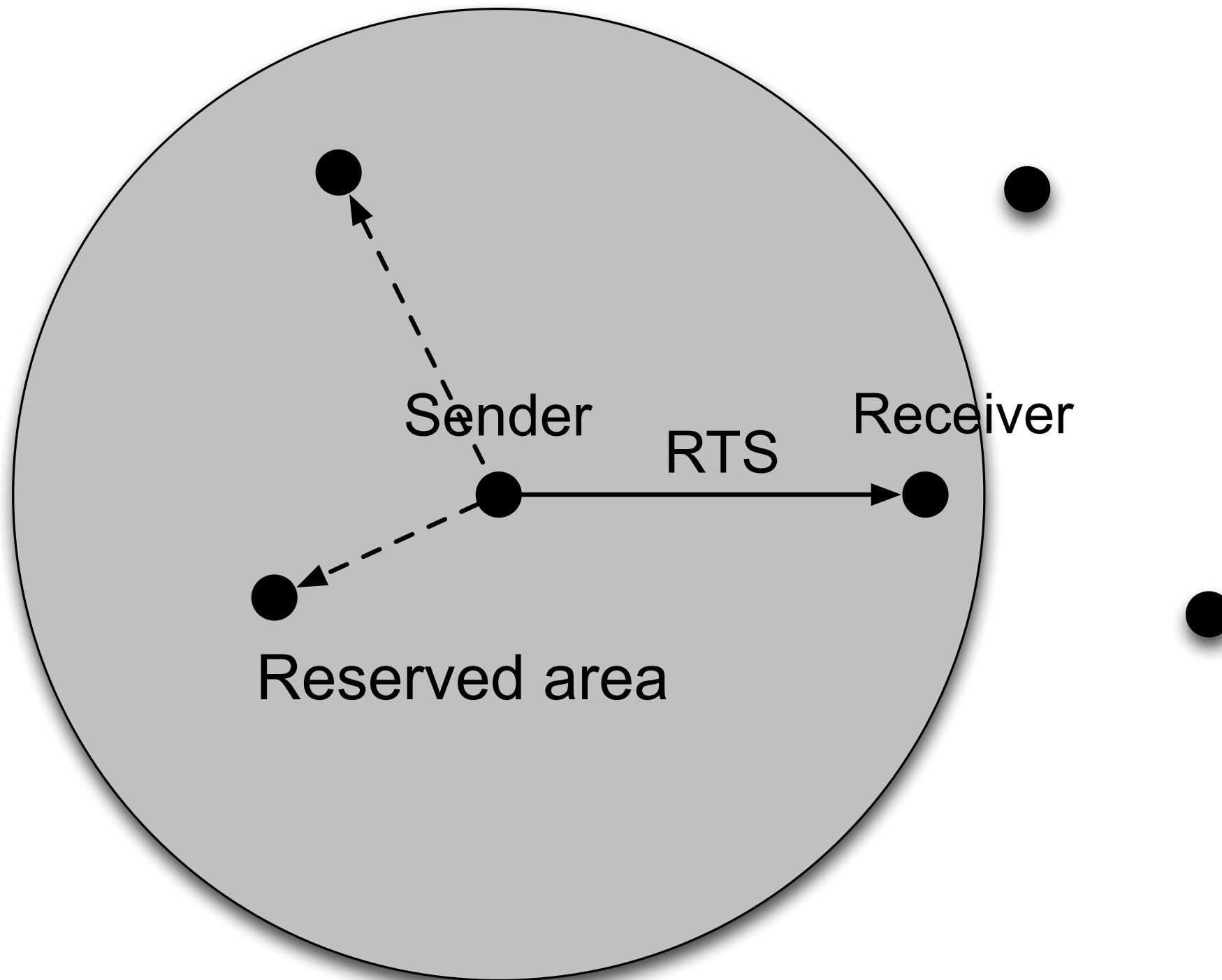 - Medium Access with Collision Avoidance (MACA)
- **Aim**
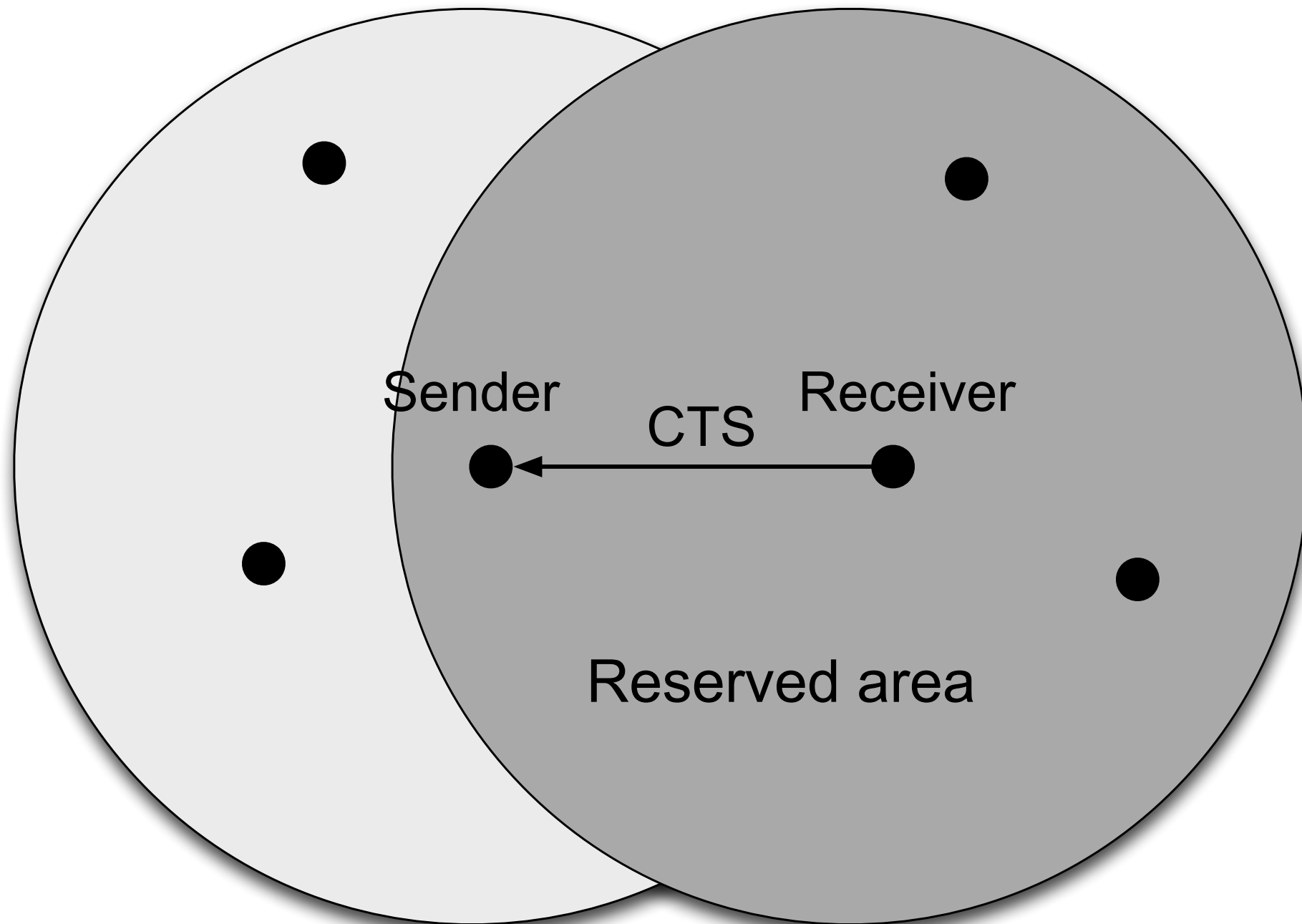 - Solution of the Hidden and Exposed Terminal Problem
- **Idea**
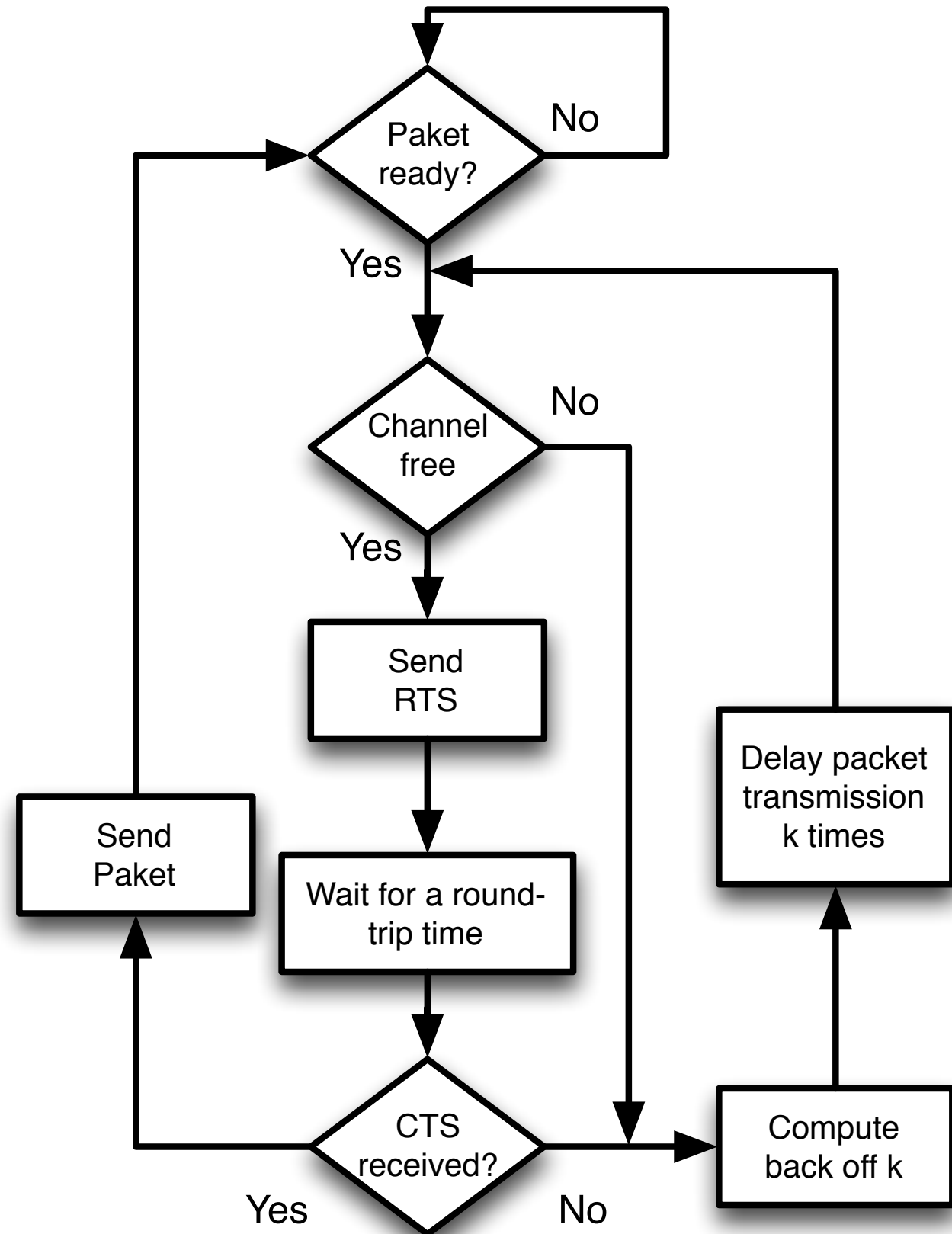 - Channel reservation before the communication
  - Minimization of collision cost

Request to Send

Sender RTS Receiver

Reserved area

Clear to Send

Sender · — CTS — · Receiver

Reserved area

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**

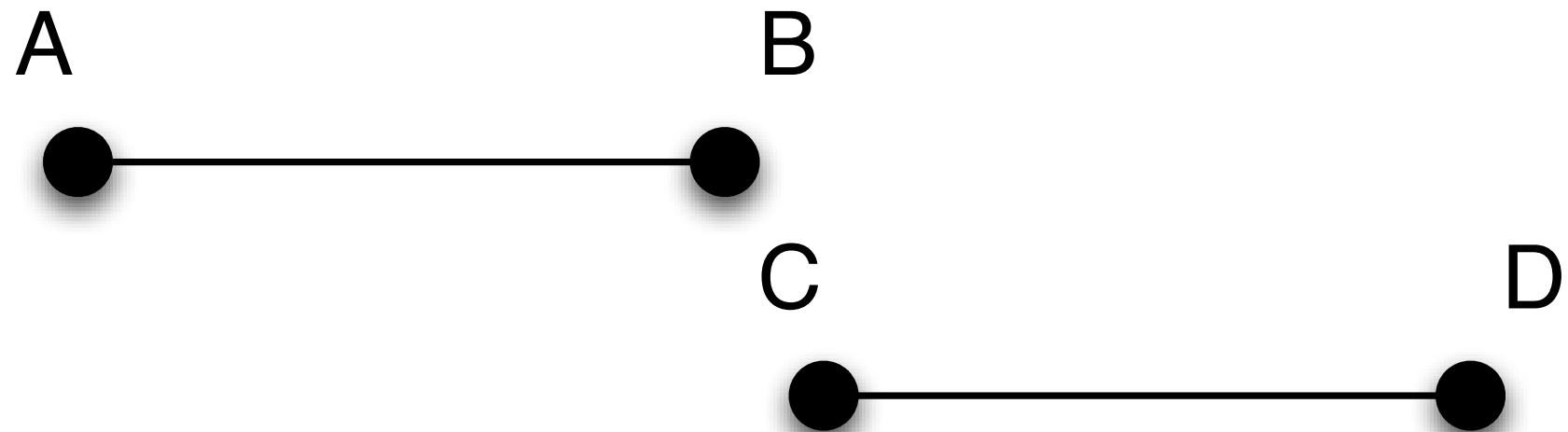- waits long enough such that B can receive the data packet

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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