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
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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

Receiver

Reserved area

RTS
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,\ldots,\text{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 parallel 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

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