**Capture Sensing Simultaneous Access**

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**Motivation**

- **Cascade**
  - Fast sequential flooding
  - Safe concurrent transmissions
  - Massive spatial reuse
  - Optimization in the network layer

**CAPTURE SENSING SIMULTANEOUS ACCESS**

**UNDER BROADCAST**
- Fast sequential flooding
- Safe concurrent transmissions
- Massive spatial reuse
- Optimization in the network layer

**UNDER UNICAST**
- Spatial reuse
- Reduce hidden-terminal
- More precise backoff than CSMA
- Pipelining

**TRADEOFFS BETWEEN:**
- Complexity
- Hidden-terminal
- Memory requirement
- Link vs Transport Layer

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**Protocols**

**BROADCAST / FLOOD**

- **Application**
  - Flooding / reprogramming / dissemination

- **Protocols**
  - CSMA+MsgID (CSSA-B1)
    - Fast sequential flooding
    - Pipelining
    - TxD: MsgID Payload
    - Rx: Will receive at least one correctly

- **CSSA-B1 +**
  - Reduce hidden-terminal
  - TxD: MsgID Payload
  - Rx: MCTS if not yet muted by other

- **CSSA-B2**
  - More precise backoff than CSMA
  - TxD: MsgID+MCTS*(+TTS*)(+ACK)
  - Rx: Will receive at least one correctly

**UNICAST**

- **Application**
  - MintRoute / STRAW / Trickle / Drip&Drain / etc

- **Protocols**
  - CSMA-B2 for unicast
    - Reduce hidden-terminal
    - TxD: MsgID Payload
    - Rx: MCTS if not yet muted by other

**2-lvl table+TTS+NCTS (CSSA-U2)**

- **Application**
  - Spatial reuse
  - Reduce hidden-terminal
  - Require setup phase for table construction

**Simulation**

**Multi-hop Flooding using CSSA-B1**

**Multiple Unicasts using CSSA-U2**

**Multi-hop Flooding using CSSA-B1**

**Setup**

- **Capture table building in unicast scenarios**
- **Conservative setup:**
  - Refrain from sending if anybody is in data section
  - Only listen to NACK when I want to transmit (no time-stamping)

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**Simulation Setup and Assumptions**

**Assumptions:**
- Symmetric radio links
- Unit disk model
- Capture works (but not always true as stated above)
- Gaussian backoff time
- Carrier sensing is simulated by mote checking if any neighbor is in transmit mode
- Does NOT simulate all possible hidden-terminal scenarios, but treat CSMA and CSSA equally

**Setup:**
- Capture table building in unicast scenarios
- **Conservative setup:**
  - Refrain from sending if anybody is in data section
  - Only listen to NACK when I want to transmit (no time-stamping)

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**Related Work**

  - A study of the capture effect in simple 3 node scenarios
  - Shown that the capture effect is significant and can be fairly easily used
- Experimental Analysis of Concurrent Packet Transmissions in Low-Power Wireless Networks [Son, et al.]
  - A systematic study of the capture effect in terms of SINR, and also multiple interferences
  - Shown that RSSI correlates to packet reception ratio if RSSI < -55dBm
  - Shown that additivity of interference does not hold ( |RSSI(m) - RSSI(e)| )
  - J RSS(m) follows the single strongest interferer if number of interferers not large; J RSS(m) approaches J RSS(e) as # of interferers becomes large
  - THIS MEANS THAT MY SIMULATIONS IS LESS ACCURATE WHEN NEIGHBORHOOD BECOMES LARGE

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**Conclusions / Future Work**

- Capture effect can be exploited to improve spatial reuse in both broadcasts and unicasts
- Capture often involve tradeoffs between simultaneity, hidden-terminal, and cost (preamble length, memory, energy)
- Plan to implement in MICA2 (CC1000) and possibly Telos (CC2420)

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