

Exploiting The Capture Effect For Collision Detection And Recovery

Kamin Whitehouse, Alec Woo, Fred Jiang, Joseph Polastre, David Culler

Overview

- The capture effect
 - Introduction
 - Use in collision detection and recovery
- Empirical evidence
 - Three-point experiment
 - Flooding experiment
- Implications for the MAC layer

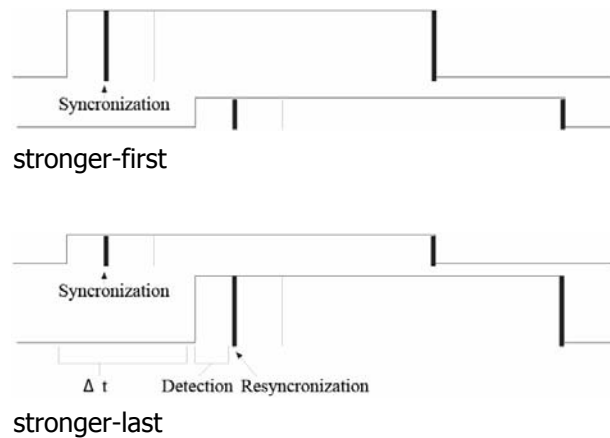
Overview

- **The capture effect**
 - Introduction
 - Use in collision detection and recovery
- Empirical evidence
 - Three-point experiment
 - Flooding experiment
- Implications for the MAC layer

The capture effect: introduction (1)

- When two packets overlap in time, a receiver may still be able to read the stronger of the two
- Goes against the 'collision as failure' assumption
- Allows for collision detection
 - Observed detection rate of 42%
- Allows for packet recovery
 - Observed recovery rate of 92%

The capture effect: introduction (2)



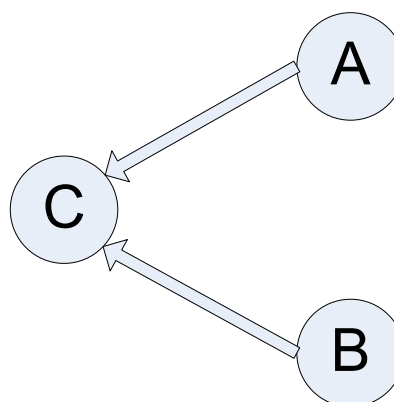
Use in collision detection and recovery

- Recover packets by re-initializing your radio upon detecting a second preamble
- Detect collisions by looking for a second preamble when receiving a message (stronger-last)
 - Can recover the source and destination address of the lost packet in many cases
 - Only works for stronger-last
 - Could work for stronger-first with changes to the mac layer

Overview

- The capture effect
 - Introduction
 - Use in collision detection and recovery
- **Empirical evidence**
 - Three-point experiment
 - Flooding experiment
- Implications for the MAC layer

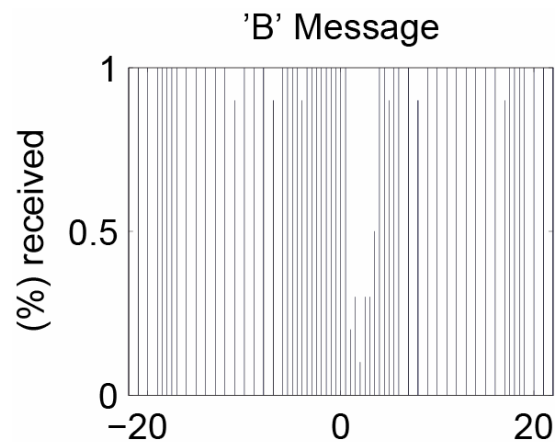
Three point experiment (1)



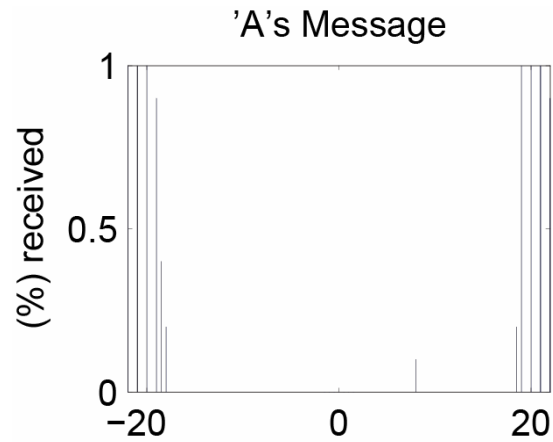
Three point experiment (2)

- Two transmitters (A,B) and one receiver (C)
- Transmitter B has a stronger signal at C
- Packet length is 17.9ms
- Time difference Δt varies from -23ms to 23ms with 1ms intervals, 0.5ms intervals around 0 and +/-18
- Berkely Mica2 hardware with TinyOS

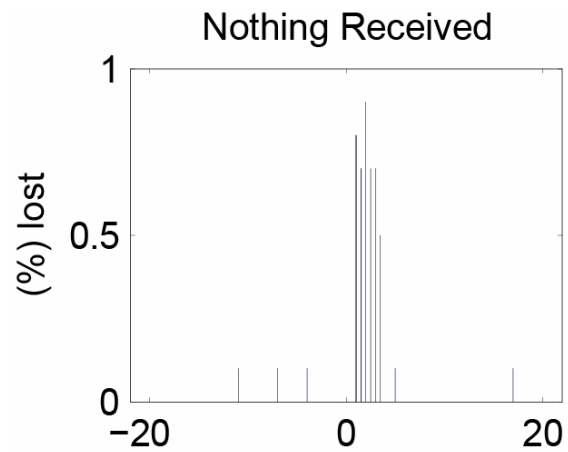
Three point experiment (3)



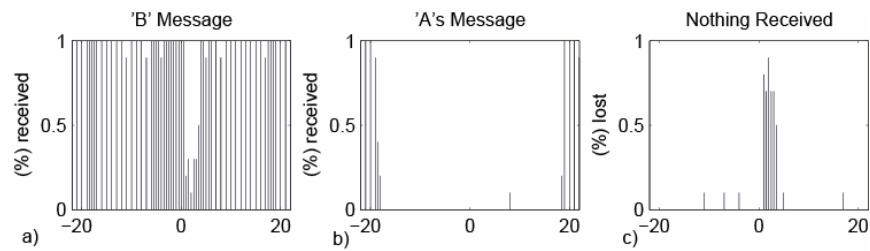
Three point experiment (4)



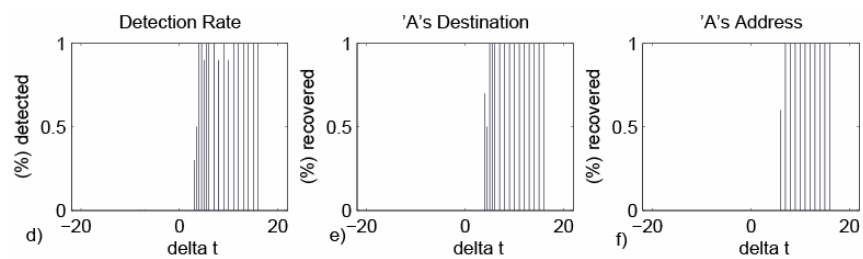
Three point experiment (5)



Three point experiment (6)



Three point experiment (7)



The flooding experiment

- Matrix of 9x4 nodes, 2 meter spacing
- Different power outputs, range from 2-3 meters to entire network
- Upon receipt of a message, resend it after 0-120ms (flooding)
- 857 transmissions, 12687 receptions, 2036 collisions and 1142 instances of capture and recovery
- 10% of all messages received during a collision
- 40-50% of messages involved in at least 1 collision

Overview

- The capture effect
 - Introduction
 - Use in collision detection and recovery
- Empirical evidence
 - Three-point experiment
 - Flooding experiment
- **Implications for the MAC layer**

Implications for the MAC layer

- Collision recovery increases throughput without changes to the MAC layer
- Adding a termination symbol to the MAC packet can help improve collision detection dramatically
- Enables ACK/NACK messages
- Not very useful for (short) control messages