

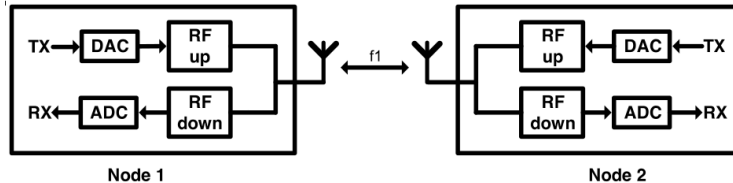
# Adaptive In-band Full-Duplex Collision Detection for Balancing Sensing and Collision Costs

Brecht Reynders; Tom Vermeulen; Fernando Rosas & Sofie Pollin



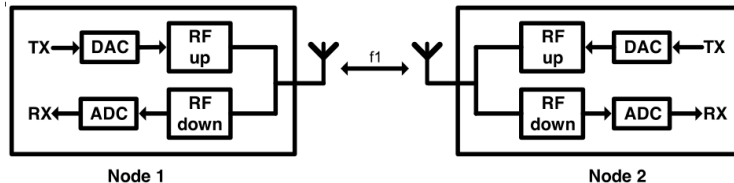
# Introduction: In-band Full-Duplex

- ▶ Simultaneous transmit and receive
- ▶ Same time **AND** same frequency



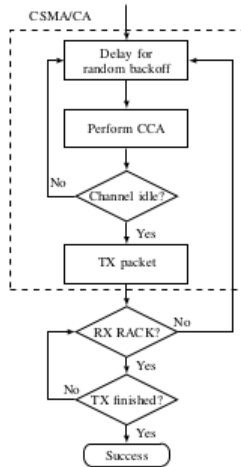
# Introduction: In-band Full-Duplex

- ▶ Simultaneous transmit and receive
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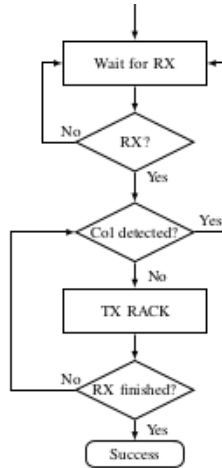


- ▶ Bi-directional communication → *double* throughput
- ▶ Collision Detection during transmission

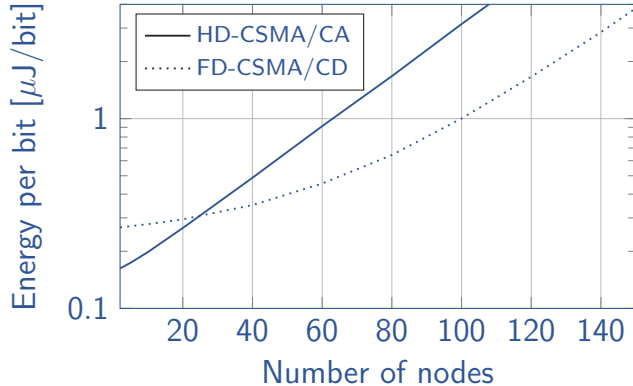
# In-band full duplex CSMA/CD: transmitter



# In-band full duplex CSMA/CD: receiver



# Power consumption difference



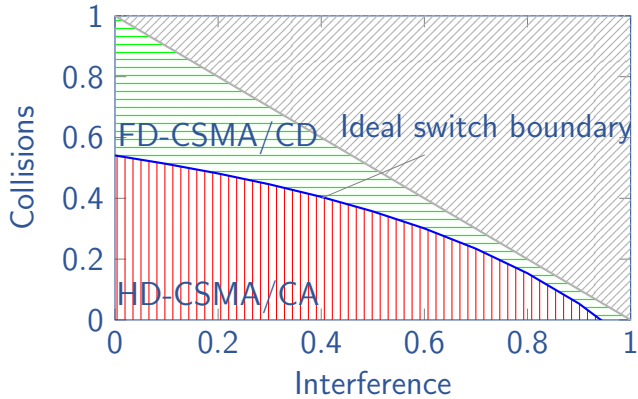
- ▶ Notice the equilibrium around 25 nodes.

# Power consumption difference

- ▶ So, how can we select the correct MAC layer for low power?
- ▶ This can be calculated:

$$N^* = \frac{1}{b} \ln \frac{a(1 - q_i + q_i \gamma_i - \gamma_c)}{K - \gamma_c} \quad (1)$$

# Zones of lowest power

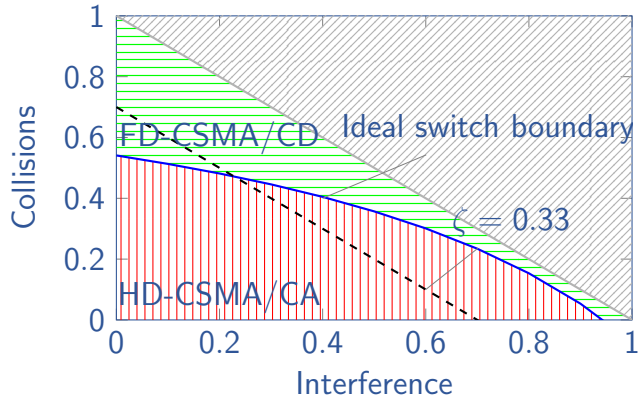




# Algorithm

- ▶ Difficult to distinguish packet loss due to
  - ▶ low SNR / interference
  - ▶ collision
  
- ▶ Therefore, we propose to switch MAC protocol after 3 retransmissions.

# Algorithm



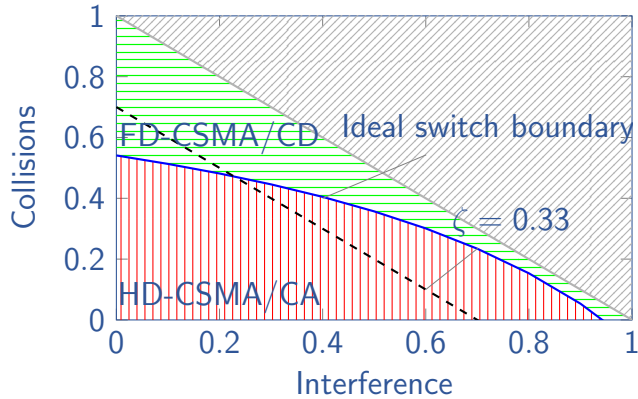
# Simulation Set-up

- ▶ All nodes have
  - ▶ 802.15.4 radio modules
  - ▶ data to send
  - ▶ a location at 1 meter from sink
    - ▶ This is a circle!
- ▶ Wifi interference is added that destroys all communication ( also CCA during CSMA )

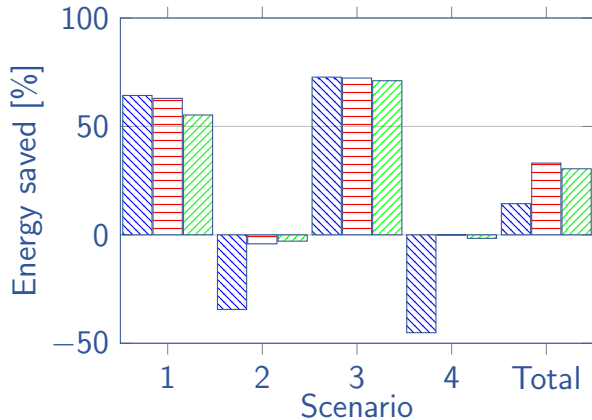
# Simulation Set-up: Part 2

Scenario	1	2	3	4
Time of day (6h)	Morning	Afternoon	Evening	Night
number of sensors	100	10	100	10
WiFi duty cycle	0%	5%	50%	0%
$N^*$ using (18)	25	24	14	25

# Simulation



# Results



- ▶ Algorithm selects best protocol.

# Conclusion

- ▶ Analysis of Collision detection in 802.15.4
  - ▶ more details in the paper.
- ▶ Practical switching algorithm that
  - ▶ automatically switches
  - ▶ saves power
  - ▶ up to 33%



Thanks!

**KU LEUVEN**



**TELEMIC**