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Analyzing MAC Protocols for Low Data-Rate Applications

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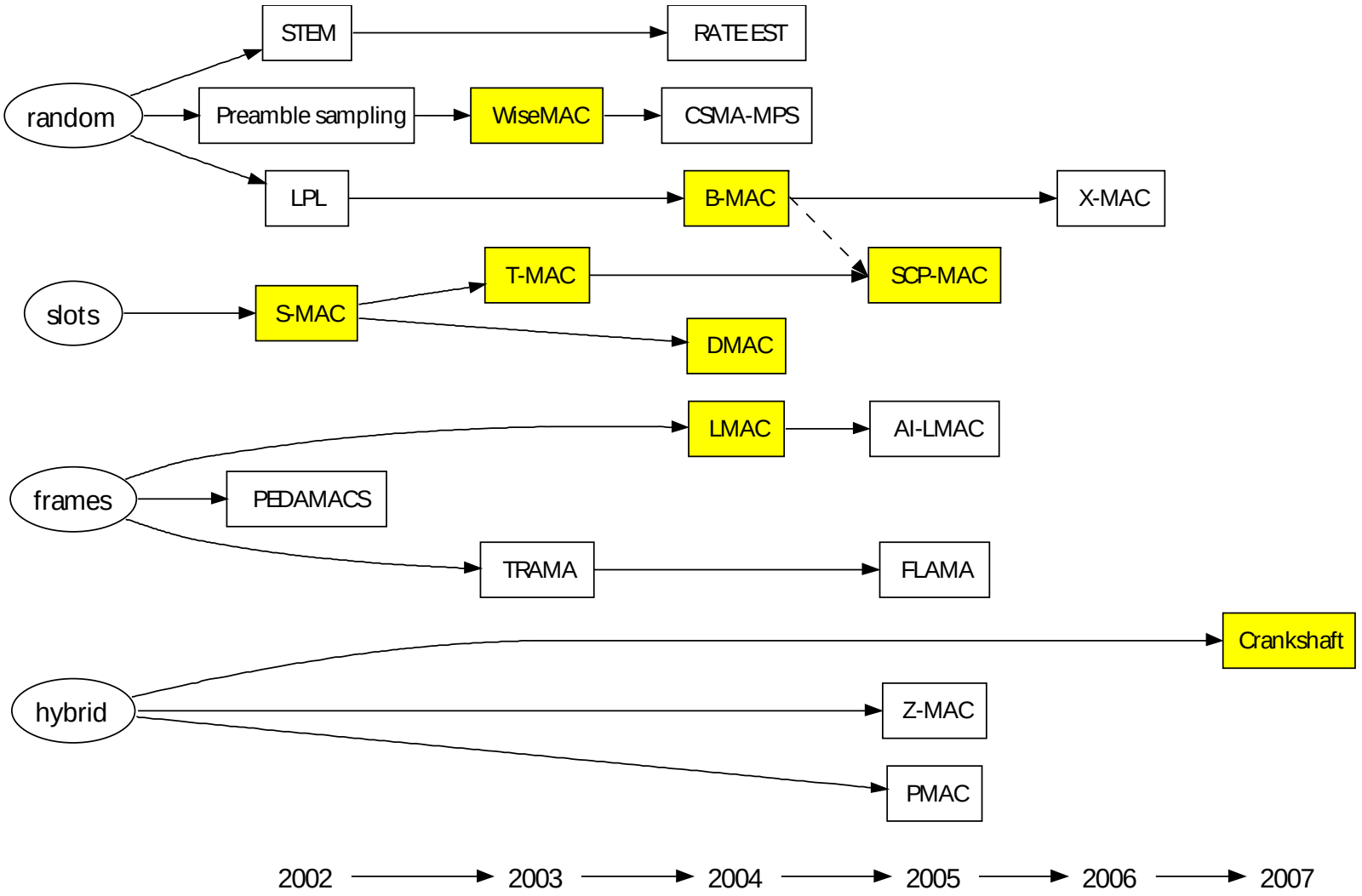
Joint work with Koen Langendoen [TU Delft]

Sensor MAC Alphabet Soup – Taxonomy



Motivation

- Which MAC protocol is suited best for my app?
  - Energy, latency, bandwidth trade-off
- Every new protocol is be better than S-MAC ☺
- Protocols allow a wide range of parameterization
  - Comparison requires parameter optimization
  - Extensive simulation or implementation not feasible

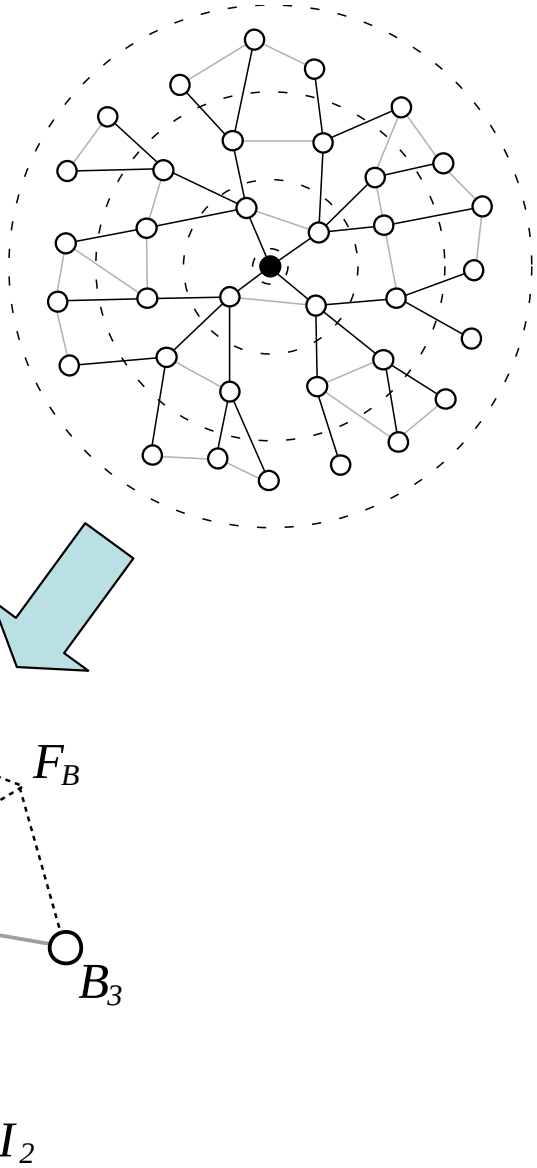
Modeling the MAC protocols for performance estimation

Model Idea

- Long running, low data-rate applications
- Abstract network topology (spanning tree)
- Keep model simple
  - All protocols are equally treated
- Worst case analysis
  - Bottleneck node next to the sink
- Relative performance estimation

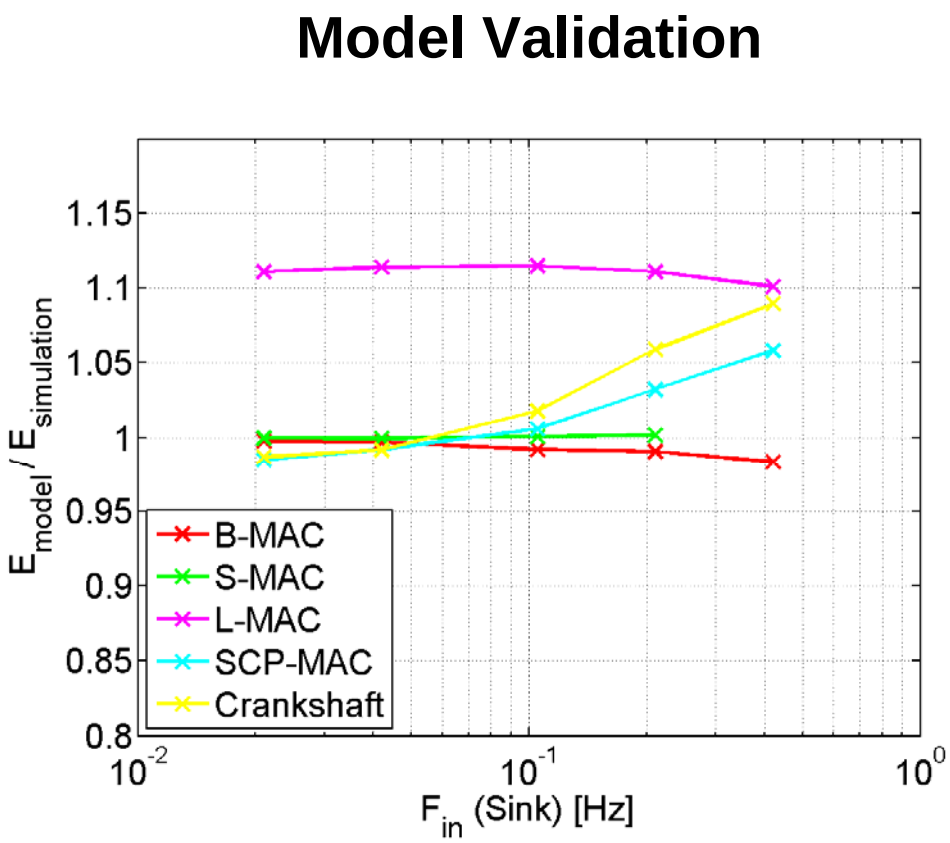
Application and Radio Model

- Application Model
  - Children I
  - Background nodes B
  - Message frequency F
  - Payload P
- Radio Model
  - Data rate R
  - Radio startup time $T_{startup}$
  - Clock drift θ
  - …



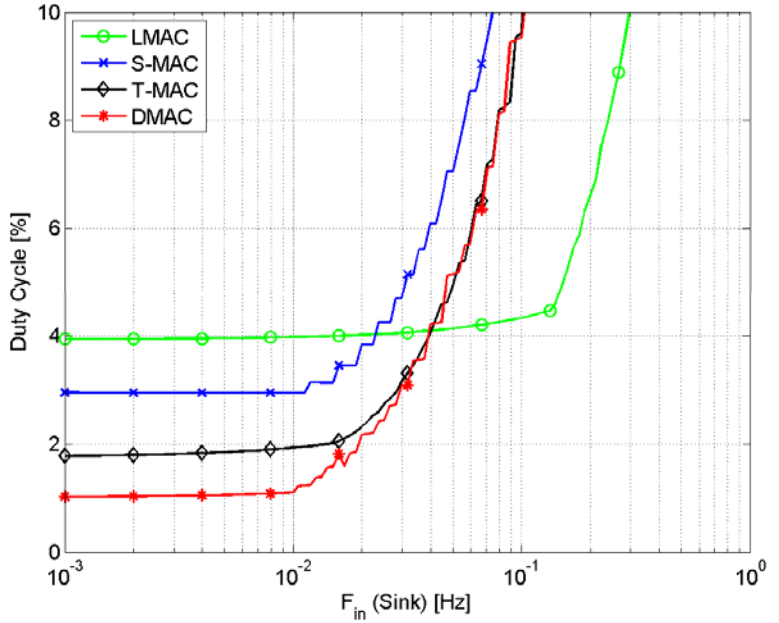
Model Validation

- Model-based performance compared with simulation
- Results match well
- Simulation takes several hours, calculation a few seconds

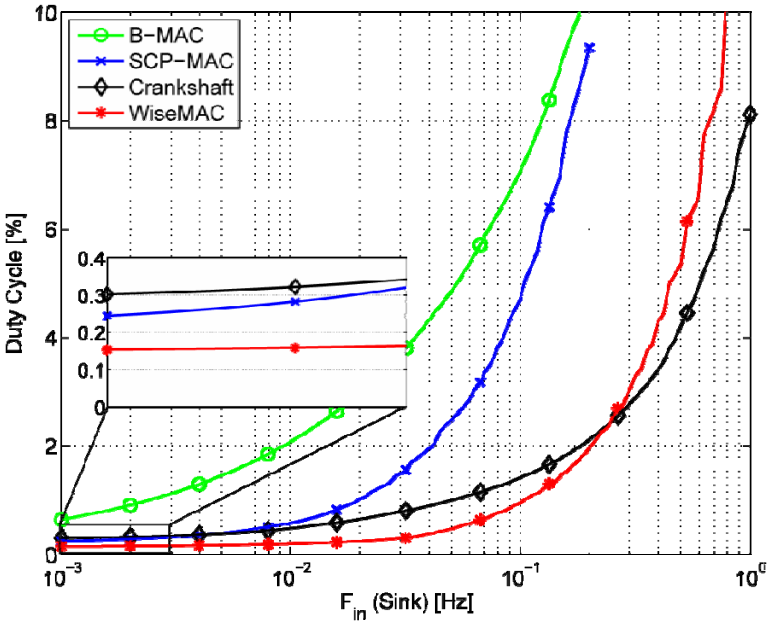


Data Gathering App.

- Channel polling based superior to slot based
- WiseMAC especially efficient for low data rate
- TDMA suffers overhead
- Crankshaft's structured channel access pays off for high data rates



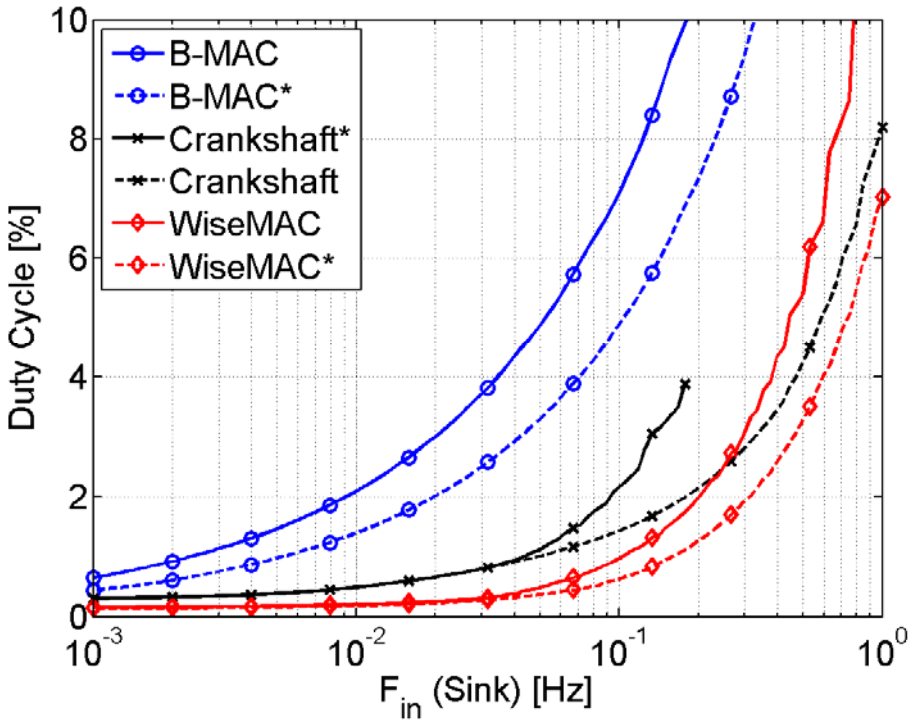
Slot based



CP based

Bottleneck Sink – Always Listening Sink

- Sink is not energy constrained
  - Sink can keep the radio switched on
  - Allows an increasing bandwidth at the sink
  - Nodes next to the sink might save energy



dashed line: always listening
straight line: duty cycled

Summary & Conclusion

- Model based performance evaluation
- WiseMAC with always listening sink does well
  - Almost no synchronization overhead
  - Random wake-up times allow exploiting the channel bandwidth
- TDMA protocols suffer protocol overhead
  - Custom built system required [e.g. Dozer IPSN'07]