Configurable Medium Access Control for Wireless Sensor Networks

Lucas F. Wanner, Augusto B. de Oliveira,
Antônio Augusto Fröhlich

http://www.lisha.ufsc.br/

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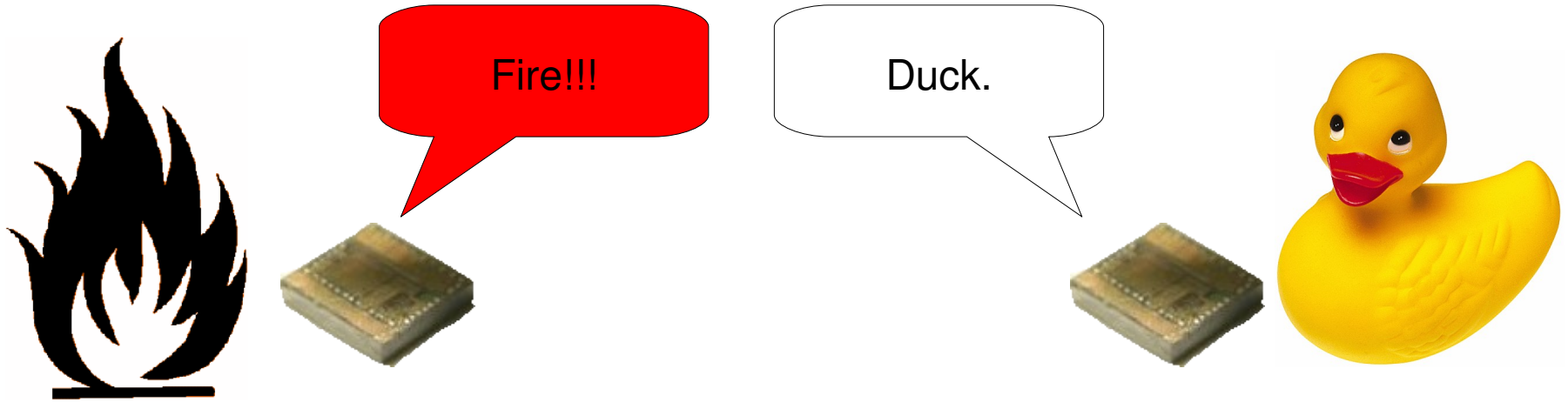
Outline

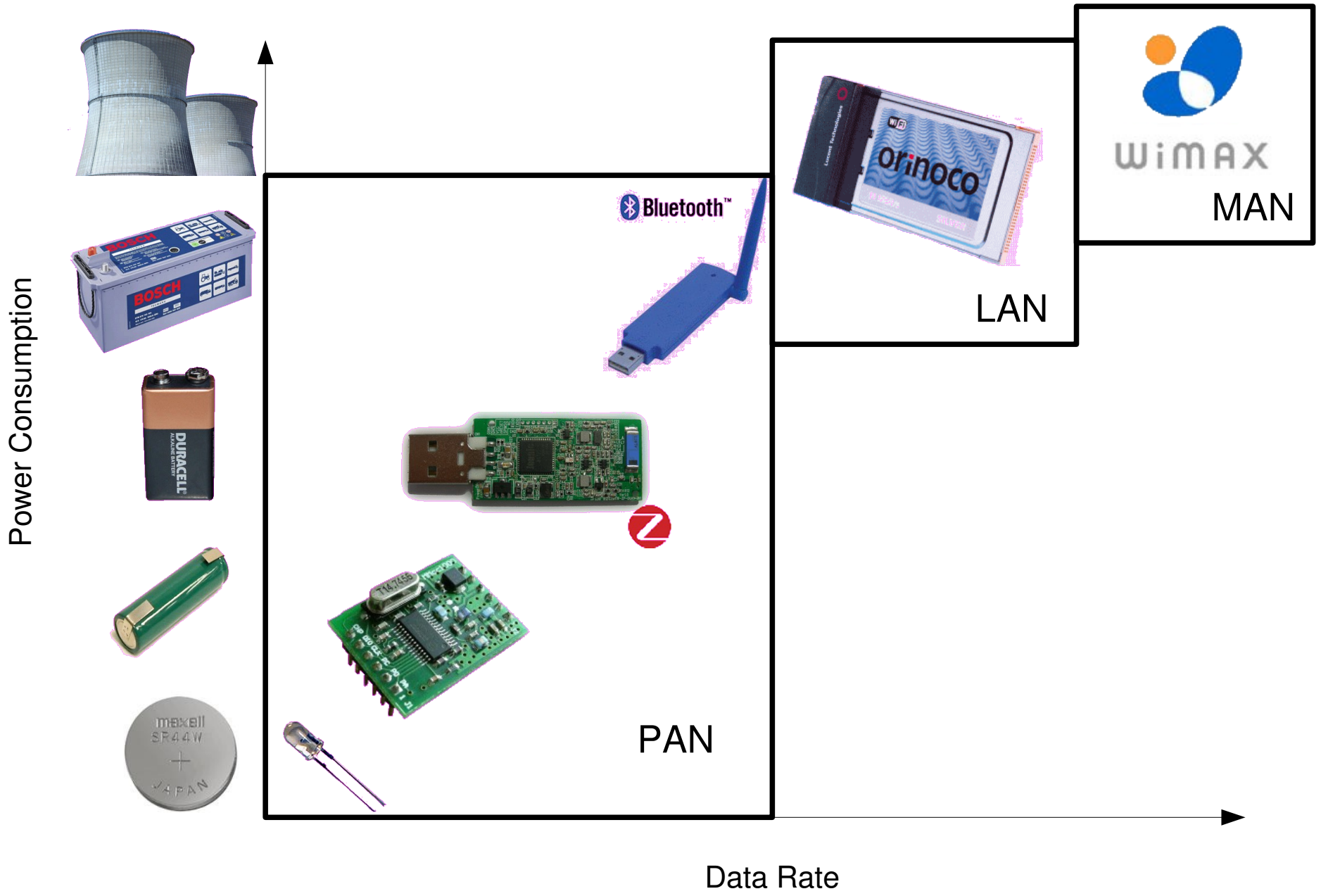
- Overview of WSN
- MACs for WSN
- Communication on WSN
- C-MAC
  - Proposal
  - Implementation
  - Evaluation
- Conclusions

Communication on WSN

- There is no “single best” MAC protocol
  - Aloha, B-MAC, S-MAC, T-MAC, WiseMAC, LMAC, ...
- Configurable communication
  - Different communication patterns for different applications
  - Energy efficiency is the main concern

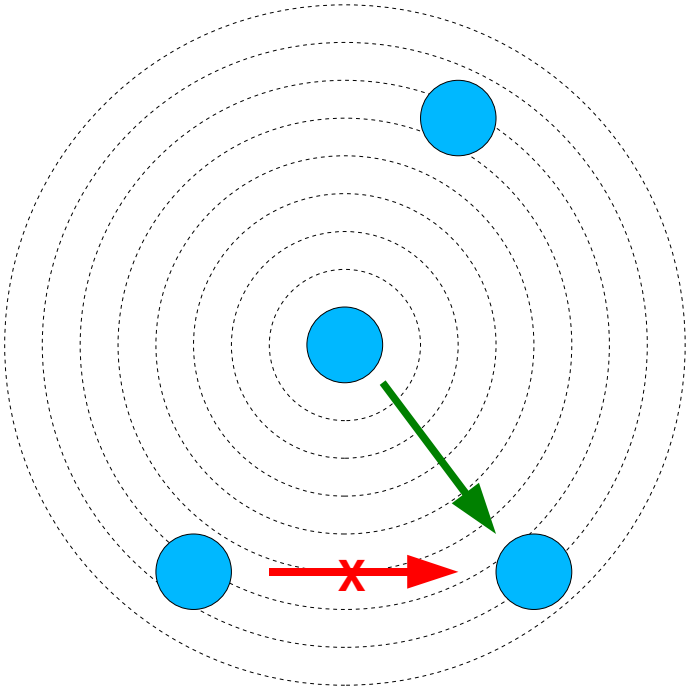


Wireless Communication HW



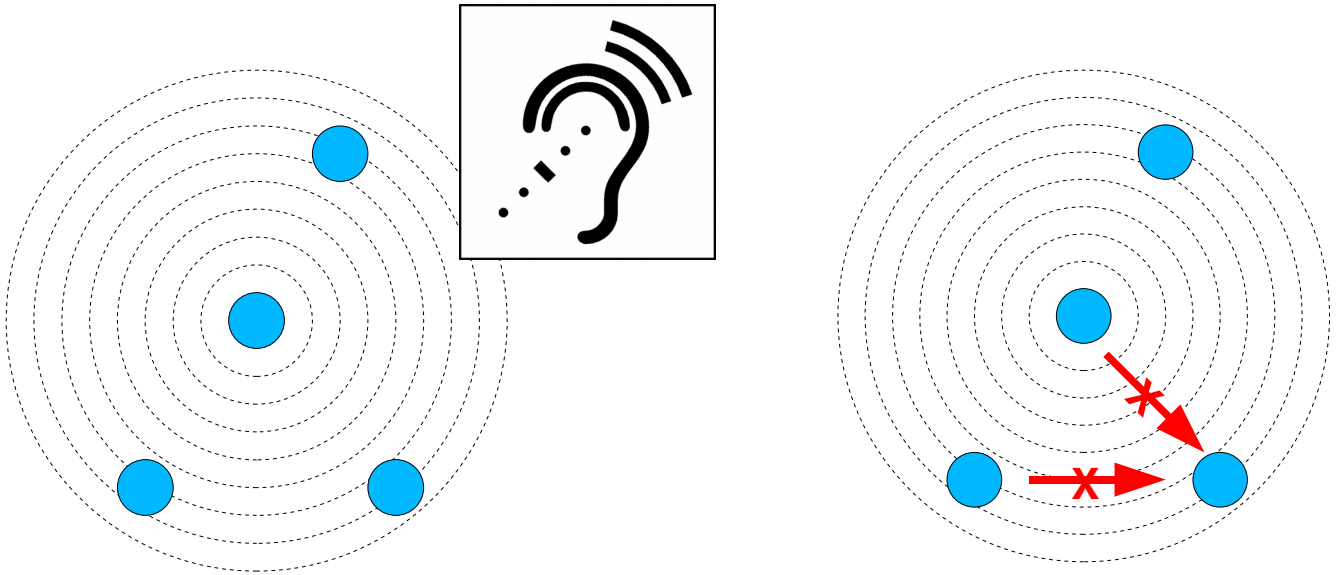
Wireless Sensor Networks

- Low-power hardware
- Limited resources
- Software-defined MAC
  - Control access to the shared medium
  - Avoid interferences between transmissions
  - Define packet format
  - Perform local/global synchronization



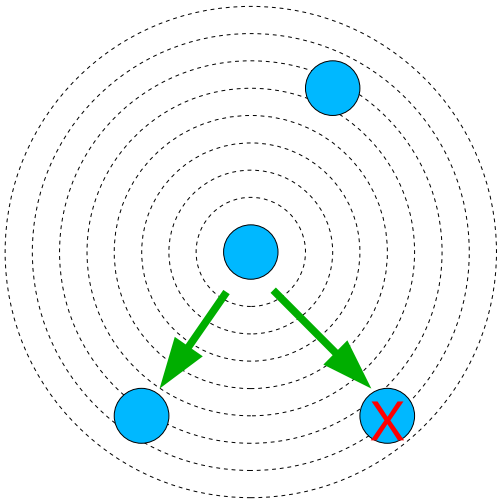
MACs for WSN

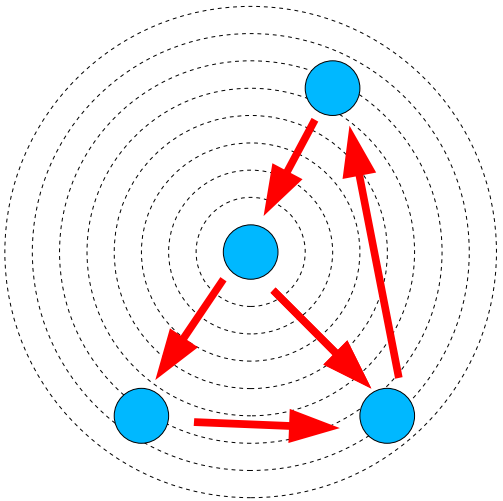
- Nodes powered by batteries
  - Turn off the radio whenever possible!
- Main sources of power overhead
  - Idle listening (nodes must listen for potential messages)
  - Collisions

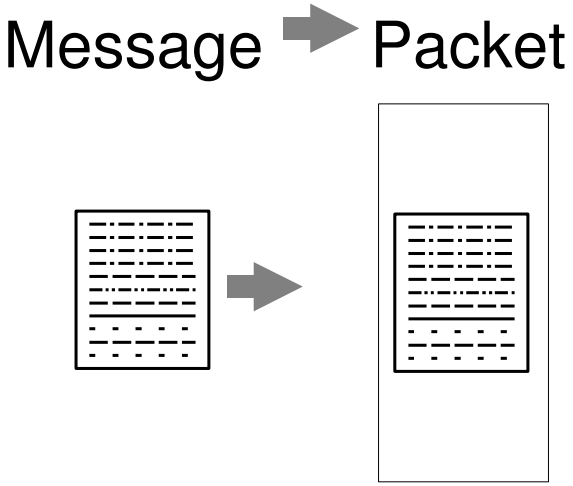


MACs for WSN

- Main sources of power overhead (cont.)
  - Overhearing (the radio channel is a shared medium)
  - Traffic fluctuations (higher competition for the medium)
  - Protocol overhead







Communication on WSN

- No “single best” MAC protocol
  - Different applications, different communication needs
- Configurable communication could
  - Provide an unified communication interface
  - Provide a configuration framework
  - Enable applications to reach energy/communication efficiency

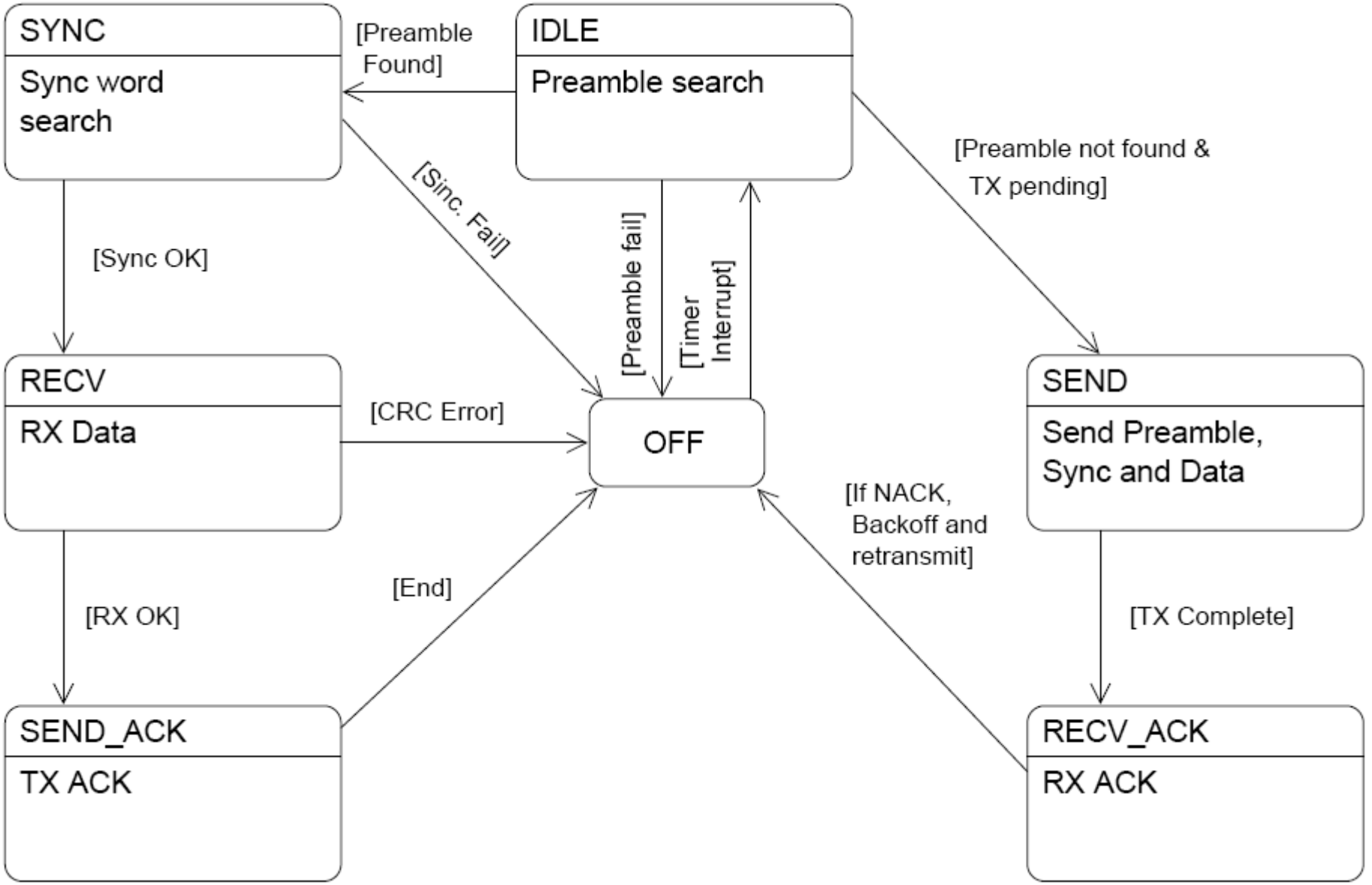
C-MAC

- Configurable Medium Access Control for Wireless Sensor Networks
  - Different MAC services
  - Different strategies
  - Configuration architecture
- Framework to build functional MAC protocols
  - Pre-defined configuration points
  - Protocol: compile-time (configurable traits)
  - Parameters: run-time

C-MAC

- Fundamental configuration points
  - Communication parameters
    - Frequency, power, modulation
  - Duty cycle
    - Defines organization, or lack thereof
  - Collision avoidance mechanism
    - None
    - Global synchronization
    - Chanel sampling
    - RTS/CTS
  - Collision detection mechanism
    - Confirmation
    - None
  - Collision handling mechanism
    - Retransmission
    - None

C-MAC: State Machine Overview

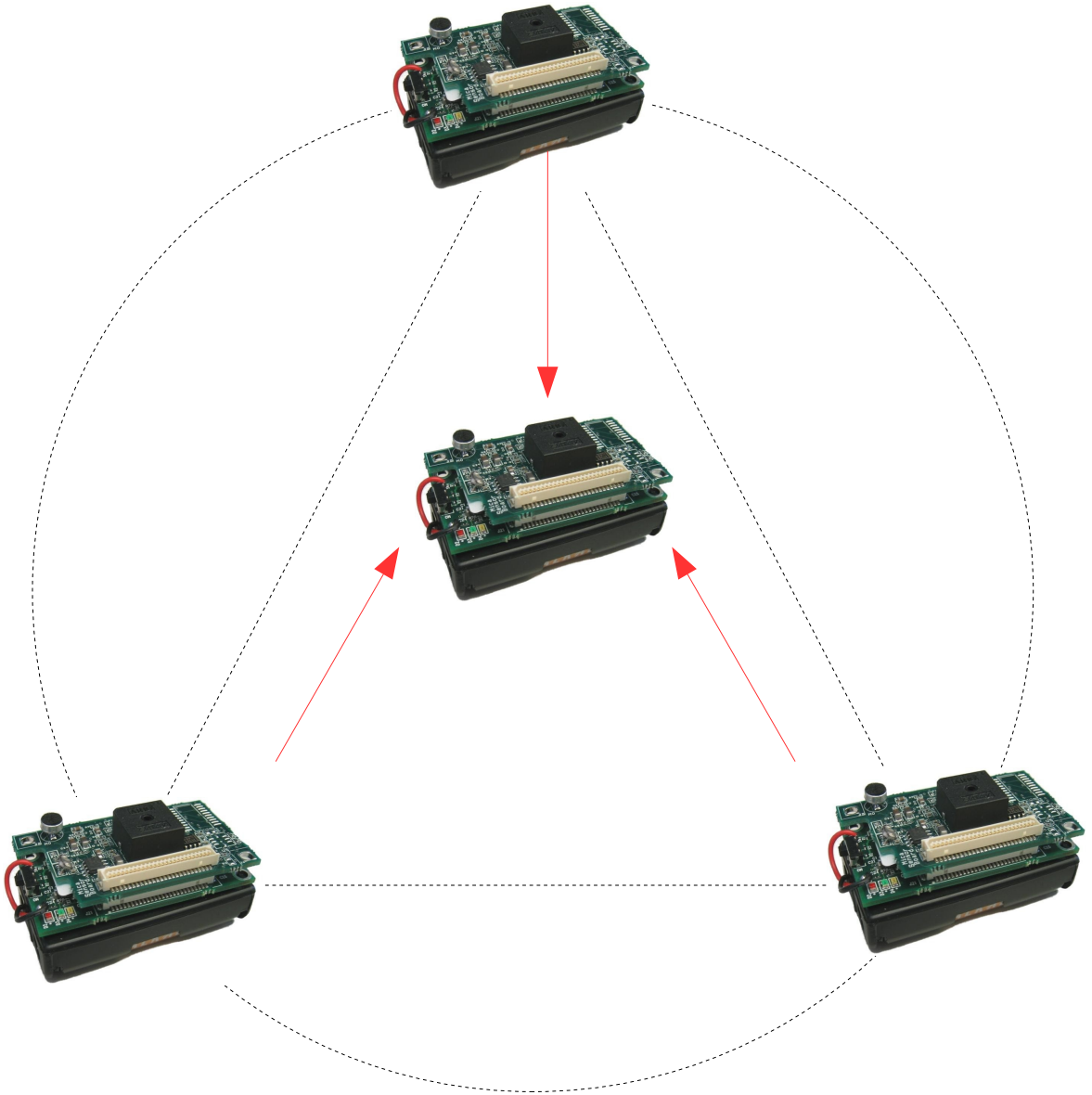


C-MAC: Evaluation

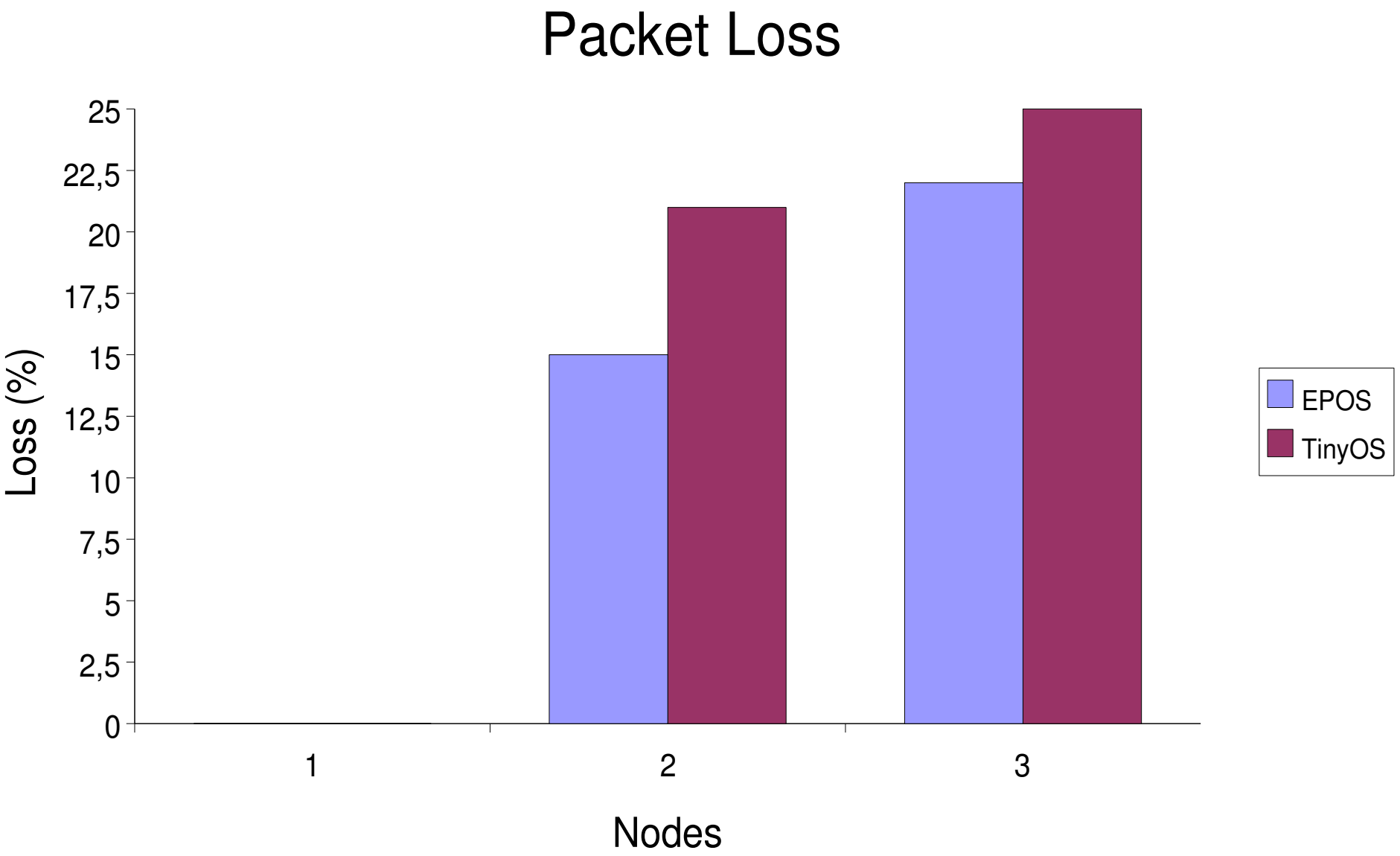
- Comparative Tests
  - C-MAC + EPOS
  - B-MAC + TinyOS
- Communication Parameters
  - Best reported results

Parameter	Value
Duty Cycle	100,00%
TX Power	5 dBm
Modulation	19.2 kbps, Manchester enc.
TX Backoff	0 ms
Collision detection	None
Collision handling	None
Max. data rate (theoretical)	16.4 kbps

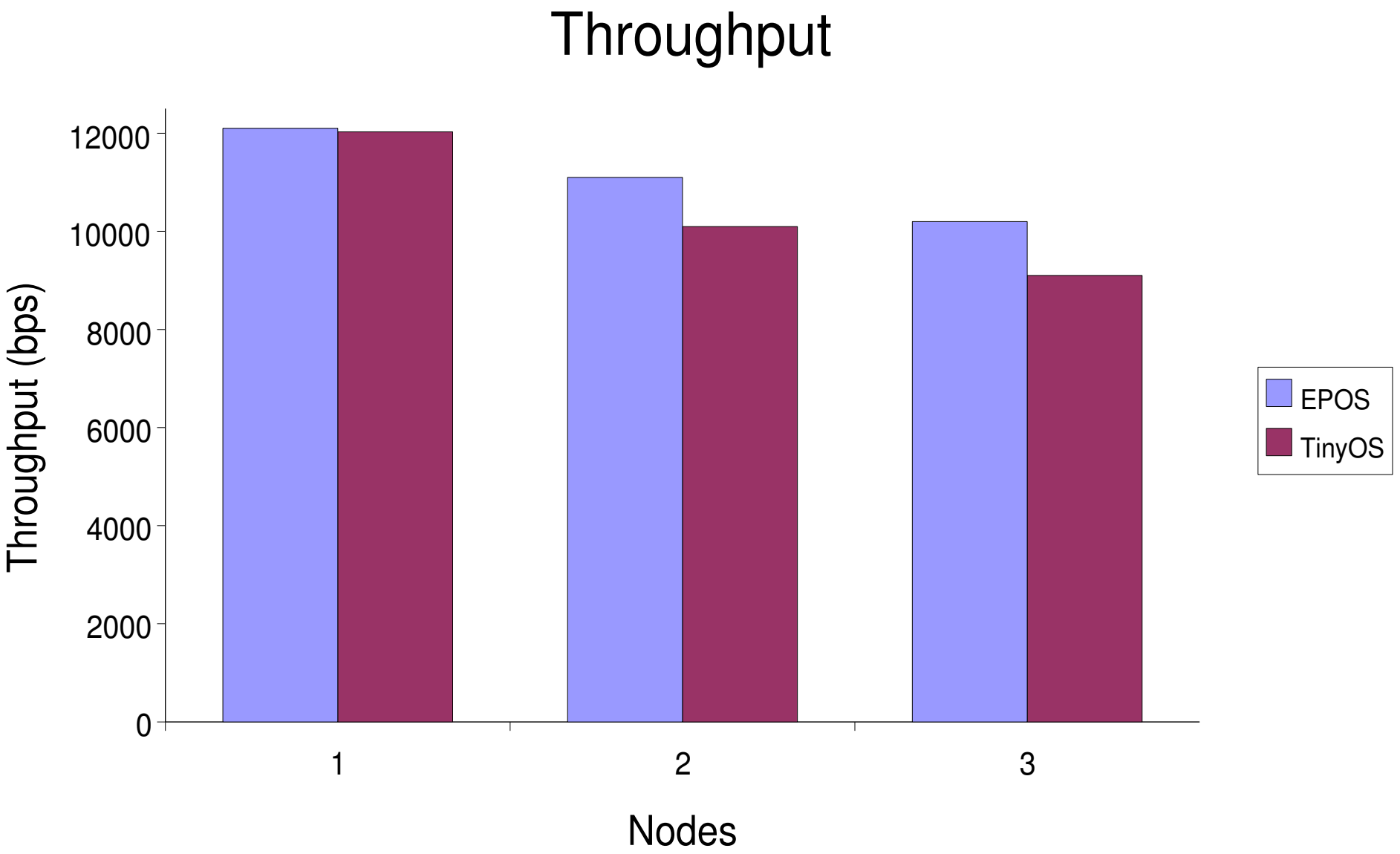
C-MAC: Evaluation



C-MAC: Evaluation

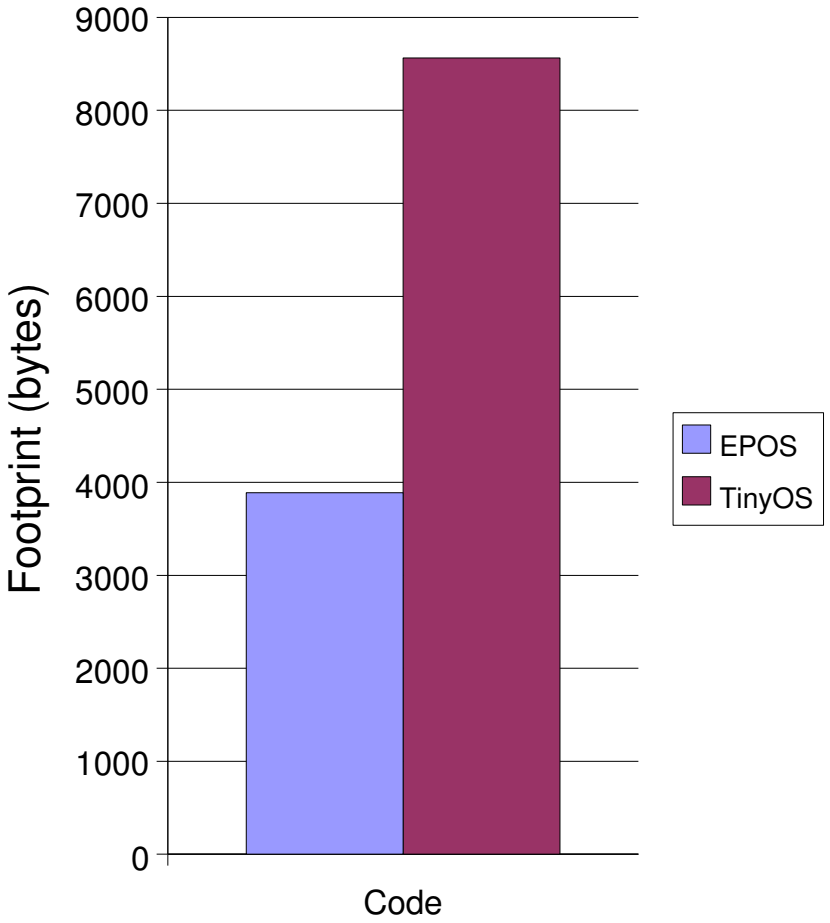


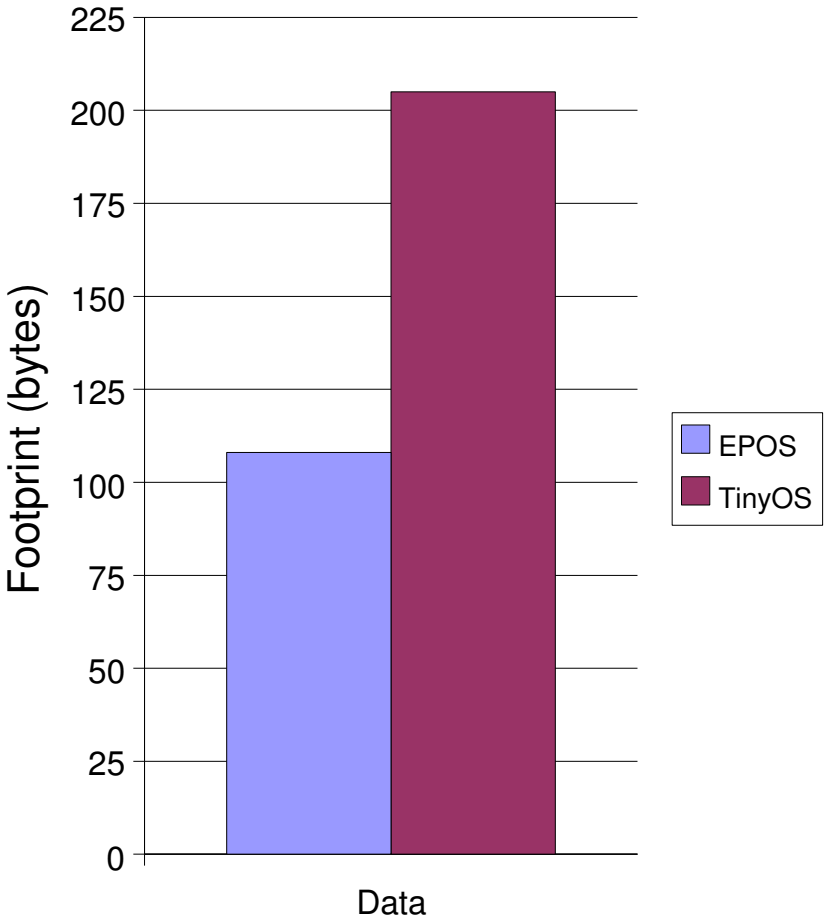
C-MAC: Evaluation



C-MAC: Evaluation

Footprint





Conclusions

- “Ideal” MAC for sensor networks
  - Compromise between power efficiency and communication flexibility / performance
  - Current protocol designs have little space for application-determined configuration
- C-MAC
  - MAC “framework”
  - Configuration architecture
  - Competitive performance

Perspectives

- Adaptability
  - Dynamic changes in protocol behavior
    - Reactive adaptation of parameters (e.g. duty cycle)
    - Coordinated protocol alterations (aided by a meta-protocol)
- Cross-layer optimizations
  - Protocol and service integration
    - Routing, transport, localization
    - First step: C-MAC + HECOPS Localization Protocol
  - Generalized configuration architecture
- Large-scale evaluations