MAC protocol for WSNs (S-MAC)

Wireless Seminars

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Article Reference

Wei Ye, John Heidemann and Deborah Estrin

Medium Access Control with Coordinated Adaptive Sleeping for Wireless Sensor Networks

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Introduction

- WSNs usual characteristics:
  - Energy consumption constrain
  - Large number of sensors
  - Multihop networks
- MAC different from traditional Wireless MAC protocols
- Transceiver is the most consuming component
- MAC protocol directly influences its operation

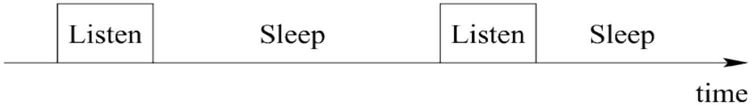
Introduction

- Sensor MAC (S-MAC)
  - Main goal → Reduce energy consumption
  - Scalability
  - Collision avoidance

- Sources of energy waste
  - Collisions
  - Overhearing *(node picks up packet destined to other nodes)*
  - Control packet overhead *(RTS/CTS and ACK packets)*
  - Idle listening *(listening to receive possible traffic that is not sent)*

S-MAC Design

- Low duty-cycle operation
  - Periodically put nodes into sleep state (radio off)
  - Reduces idle listening



- Neighbouring nodes synchronize together
  - Listen and go to sleep at the same time
  - Schedules are exchanged by SYNC messages
  - A node talks to all its neighbours at their listen time
  - Known as a virtual cluster

S-MAC Design

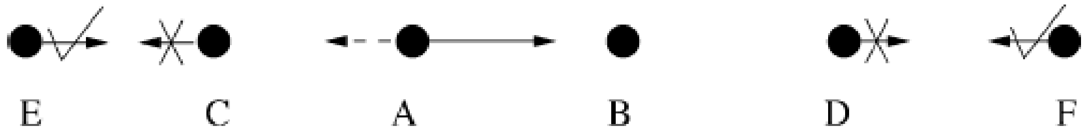
- Collision avoidance
  - Neighbours that want to talk to a node → Listening period
  - They need to contend for the medium
- Channel is sensed for possible transmissions
  - Physical Carrier Sense
- Duration field included in each packet → NAV
  - Virtual Carrier Sense
- RTS/CTS is used
  - Hidden terminal problem

Coordinated Sleeping

- Choosing a schedule
  - Node listen for at least a synchronization period
    - If any schedule is heard → Chooses its own and follow it
    - If it receives a schedule → It adopts it
- Maintain synchronization
  - Clock drift could cause synchronization errors
  - SYNC packet includes the relative time of the next sleep
- Adaptive listening
  - Node that overheads RTS or CTS wake up at the end of the tx
  - Immediately pass data if it is the next hop
  - Reduce latency

Overhearing and Fragmentation

- Overhearing
  - Interfering nodes go to sleep after they heard an RTS or CTS

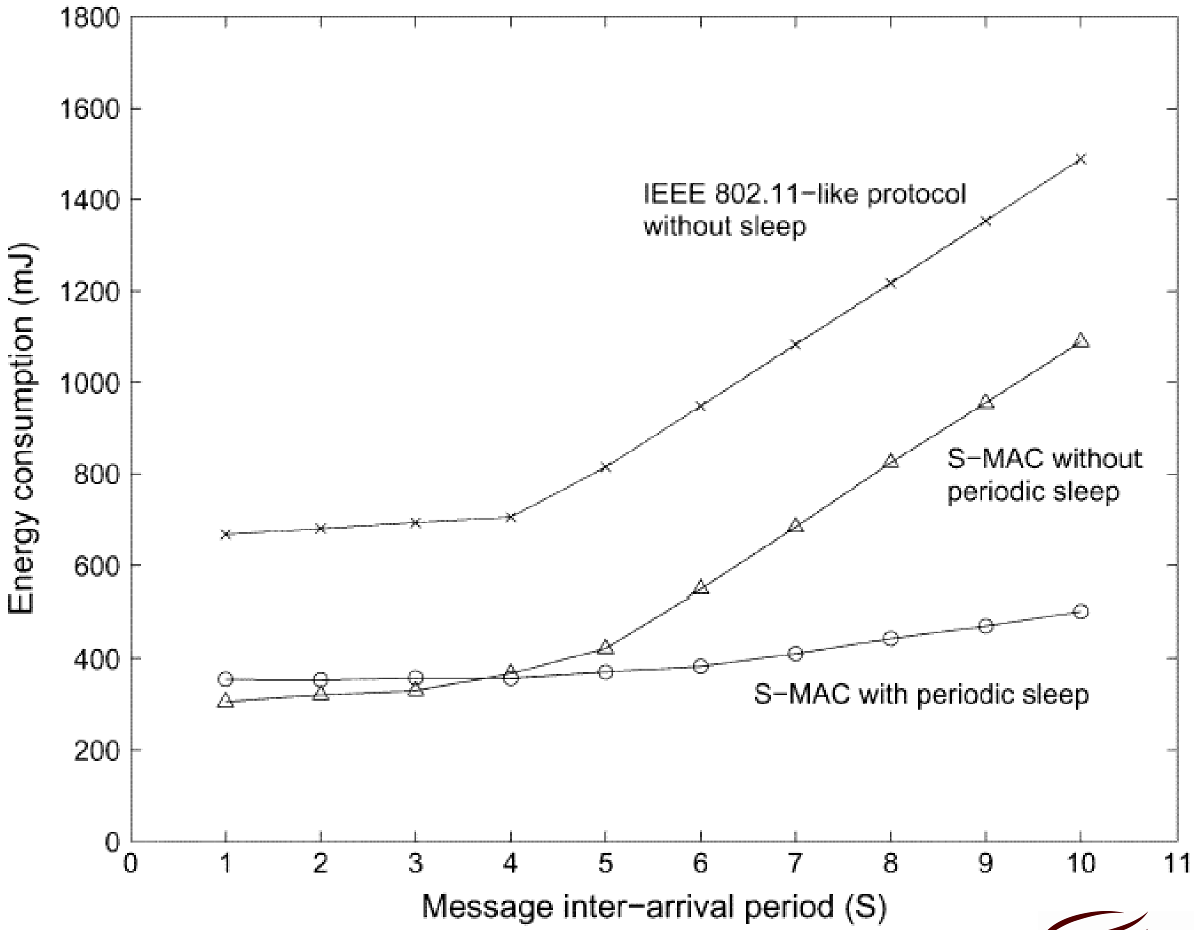


- Fragmentation
  - High cost of retransmit a long message
  - Fragment the long message into small ones
  - Transmit all in a burst (only one RTS/CTS used)
  - Fairness is not so important in WSNs

Implementation

- Implementation on two types of Motes
- TinyOS
  - Efficient event-driven OS for tiny sensor nodes
- Three MAC modules are tested
  - 802.11-like protocol
  - S-MAC without sleep
  - S-MAC with periodic sleep
    - Duty cycle selection
    - Adaptive listen

Experiments



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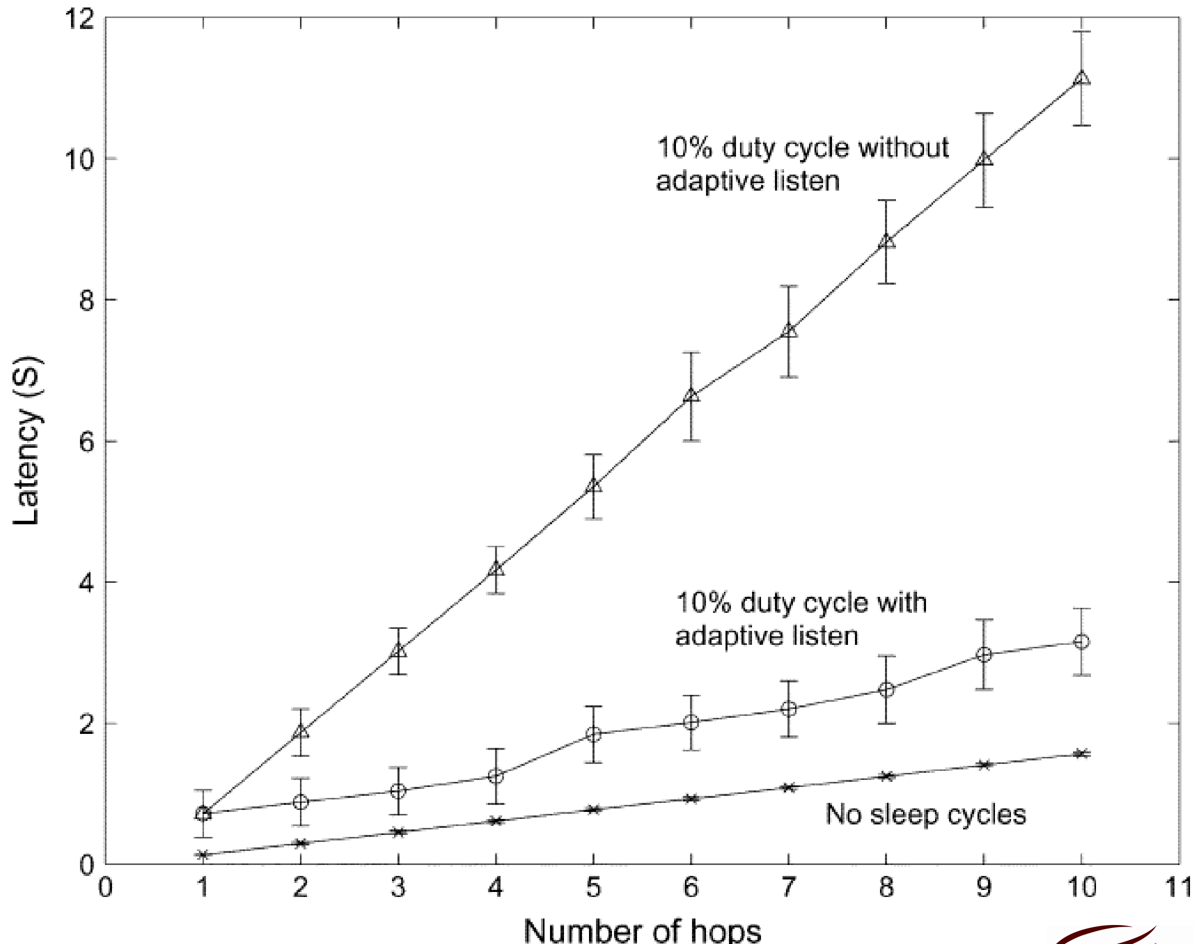
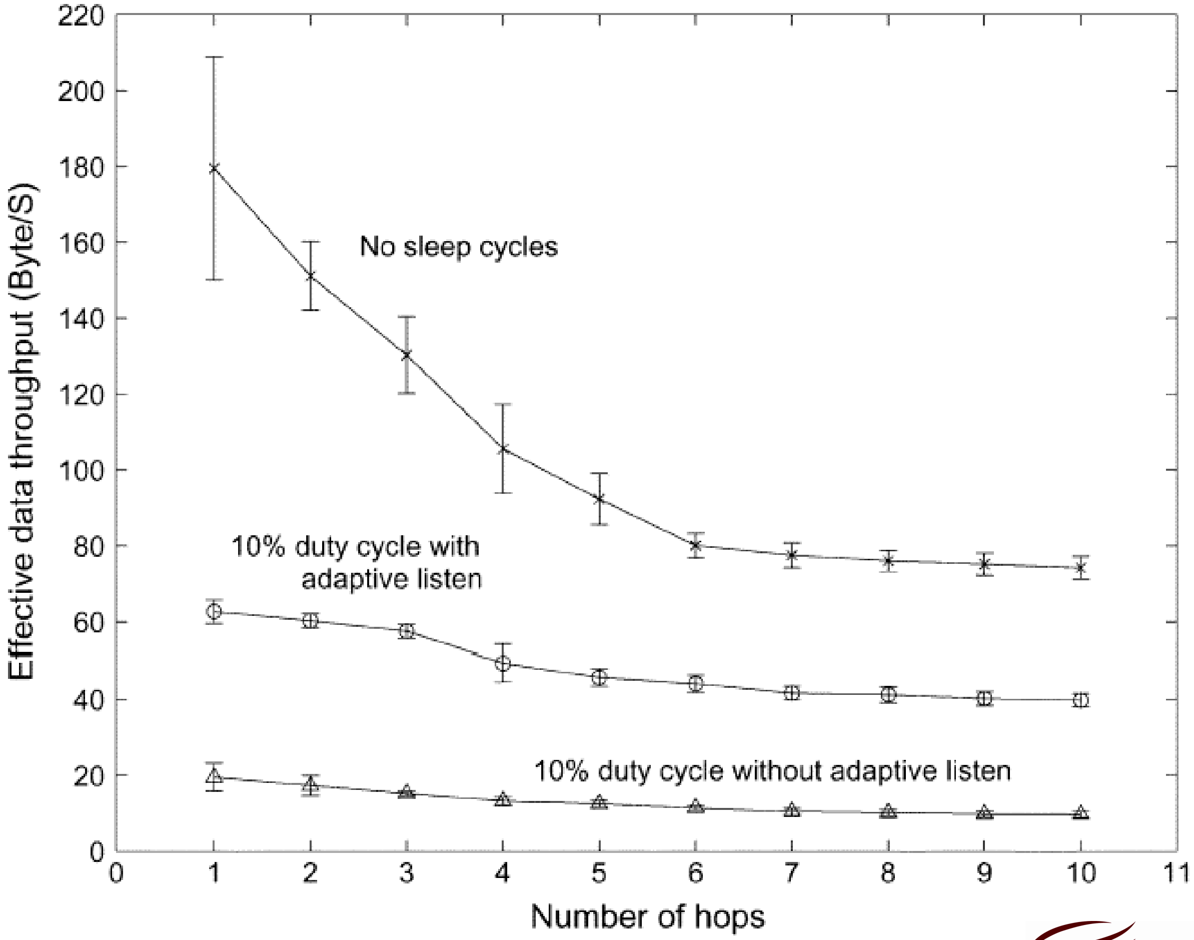
Experiments



Experiments



Conclusions

- Advantages
  - Scalability
  - Reduced and distributed energy waste
  - Needs moderate resources
- Disadvantages
  - Increases latency
  - Delay accumulated in each hop
  - Not adaptable to traffic load conditions
- S-MAC variants
- Application dependent protocol

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