Power-Saving Protocols for IEEE 802.11-Based Ad Hoc Networks

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Outline

- Introduction
- Problem Definition
- S-MAC protocol
- Experiment
- Conclusion

Introduction

- MANET: Mobile Ad hoc Network
- Various aspects of solution for saving power
  - Transmission power control
  - Power aware routing
  - Low-power mode
- Power saving modes in IEEE 802.11
  - Active mode
  - Power saving mode (PS)

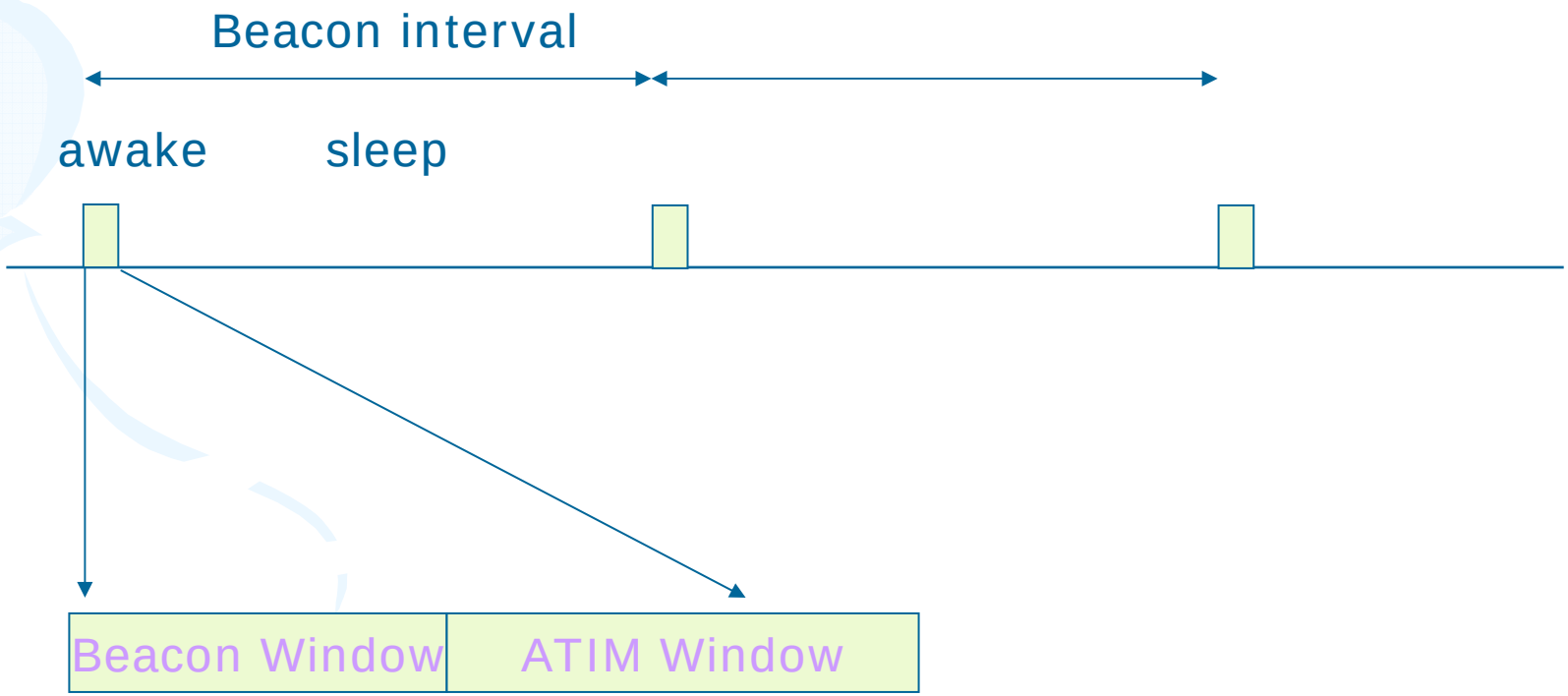
Introduction

- The node have to monitor the channel and consume power even through the packets are not directed to them , a large amount of energy is consumed unnecessarily
- Lucent IEEE 802.11 WaveLan pc card characteristics (2Mbps)

Modes	Energy Consumption
Sleep Mode	14 mA
Idle Mode	178 mA
Receive Mode	204 mA
Transmit Mode	280 mA

Introduction

- Power Saving at MAC Layer in IEEE 802.11(PS mode)



Problem Definition - What causes Energy wastage?

- Collisions
  - leads to retransmission
- Idle listening
  - Major source - consumes 50-100% of energy for receiving
- Control packet overhead
- Overhearing
  - Hearing packets intended for other receivers
- Lucent IEEE 802.11 WaveLan pc card characteristics (2Mbps)

Modes	Energy Consumption
Sleep Mode	14 mA
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What is S-MAC?

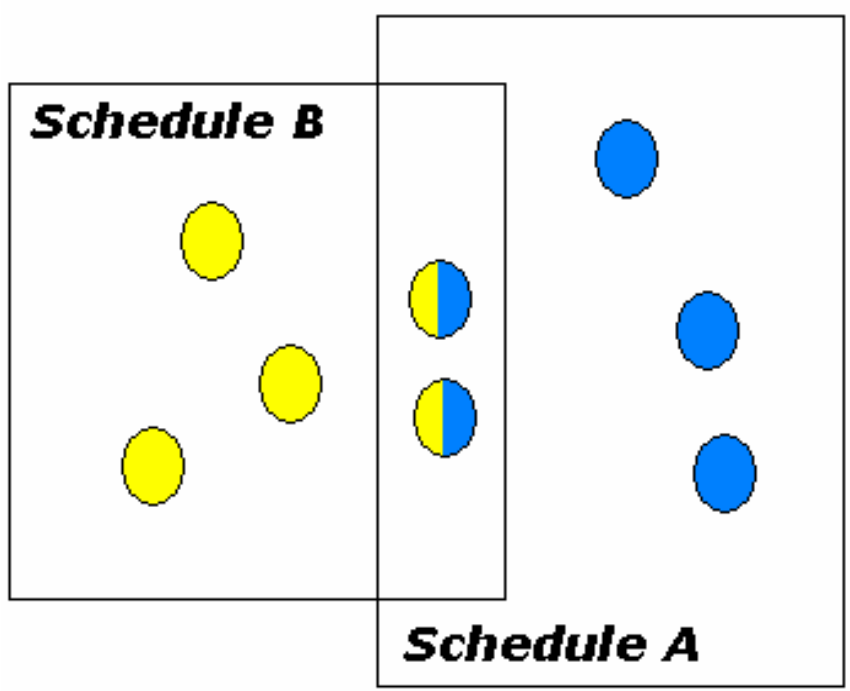
- MAC protocol for wireless sensor networks
- Main emphasis on
  - Energy conservation
  - Collision avoidance
  - Scalability
- Secondary emphasis on
  - Fairness
  - Latency
  - Bandwidth usage
  - Throughput

S-MAC gives solutions

- Periodic listen and sleep
- Collision avoidance
- Overhearing avoidance
- Massage passing

Listen and Sleep periodically

- Each node follows a schedule of interleaved sleep and listen
- Radio is switched off during sleep and the node sets a timer to awaken itself
- Neighboring nodes preferably follow same schedules
- Border nodes follow 2 schedules and broadcast twice



Neighbors Co-operate

- Keep track of neighbors schedule
- Neighbors periodically broadcast their schedules.
- Tasks
  - Listen for fixed amount of time for schedule broadcast from neighbor
  - If no schedule is received, node follows its own schedule
  - If it receives a schedule from neighbor, it follows it and broadcasts its own during next listen period

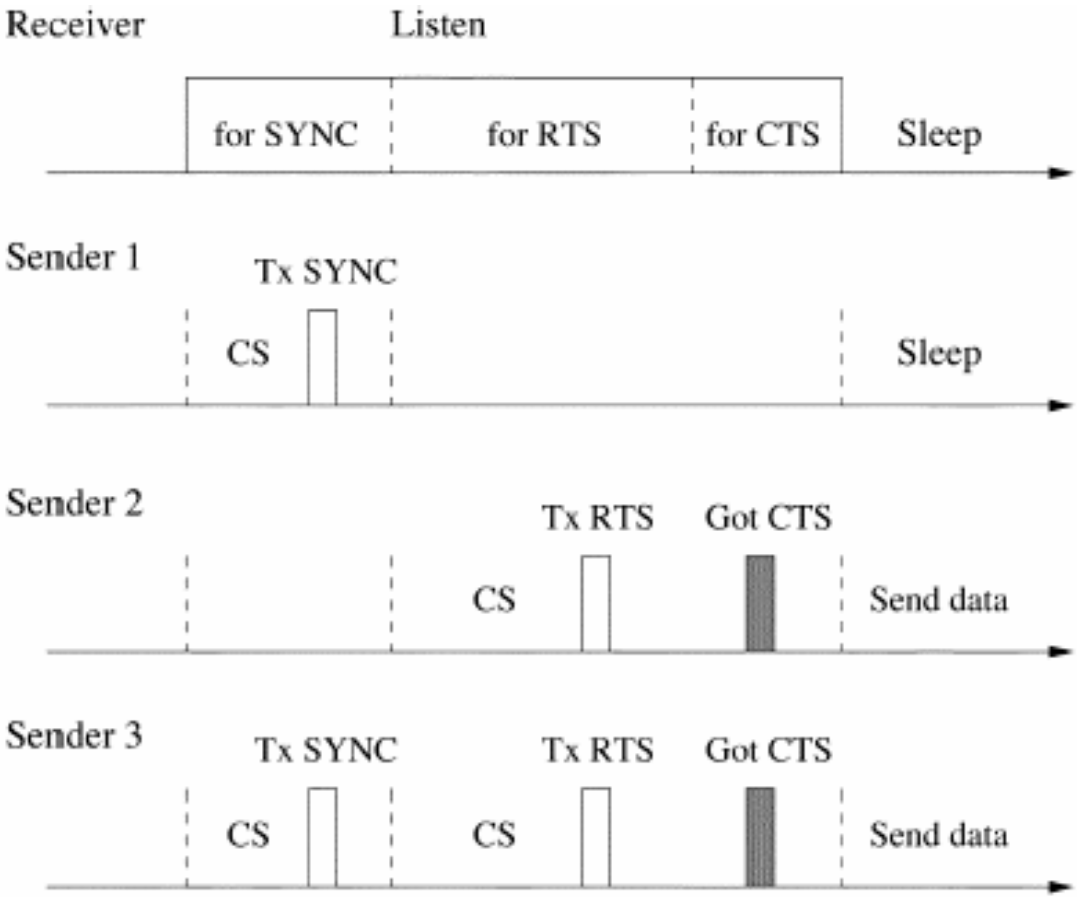
Collision Avoidance

- S-MAC follows 802.11 similar approach to resolve contention
  - Physical Carrier Sense: Performed at physical layer by listening to the medium
  - Virtual Carrier: Using Network Allocation Vector
  - Medium is free if both physical and virtual carrier sense indicate it is free
  - If medium is BUSY then the sender backs off using a randomized counter value
  - Control messages RTS CTS DATA ACK

Overhearing Avoidance: No Eavesdropping

- Overhearing - significant energy wastage
- Interfering nodes are required to sleep when they overhear RTS and CTS
- All immediate neighbors of sender and receiver are required to sleep
- The duration field in each packet informs other nodes the sleep interval

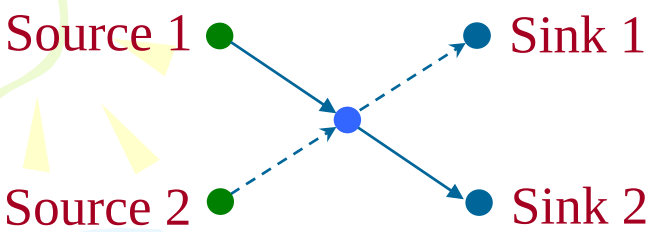
Message Passing

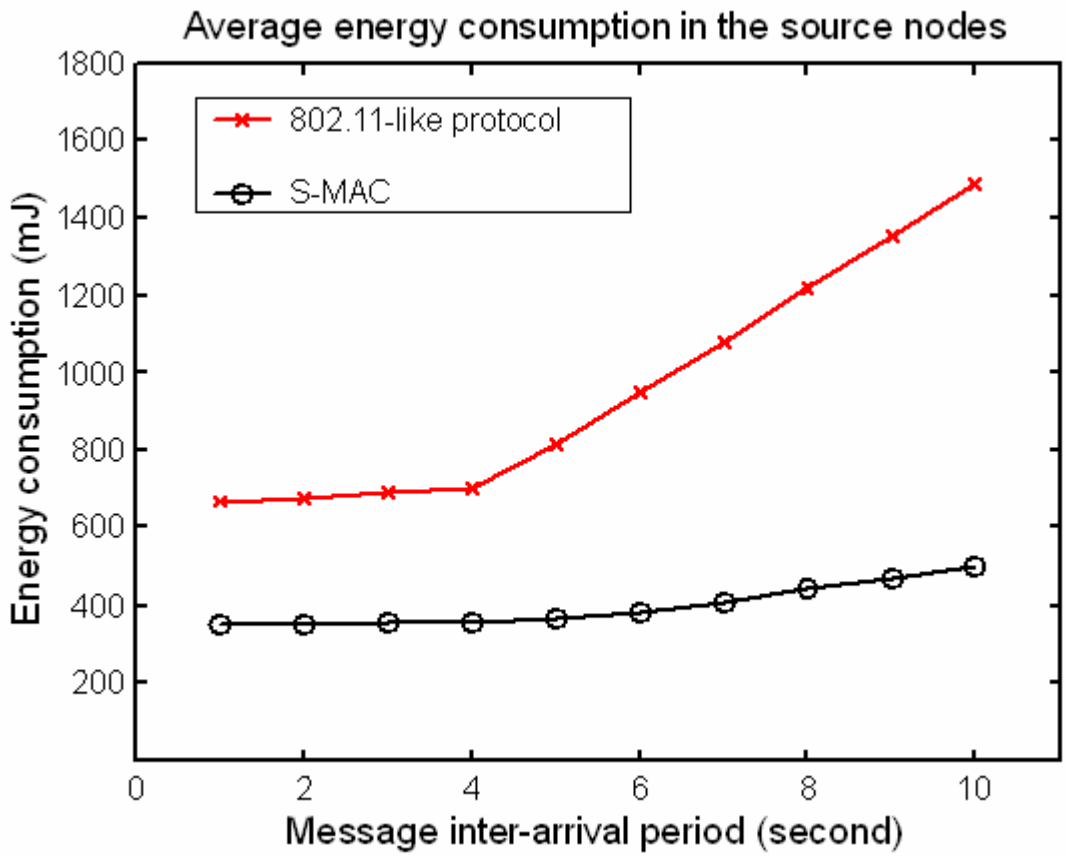


All this at what cost?

- Performance reduction in
  - Latency
- Adaptive Listening
  - Tries to reduce latency due to periodic sleep
  - Overhearing node wakes up at the end of transmission
  - If a next-hop-node neighbor can pass data immediately instead of waiting for scheduled listen time
  - If it is not the next-hop-node it goes back to sleep

Experiment



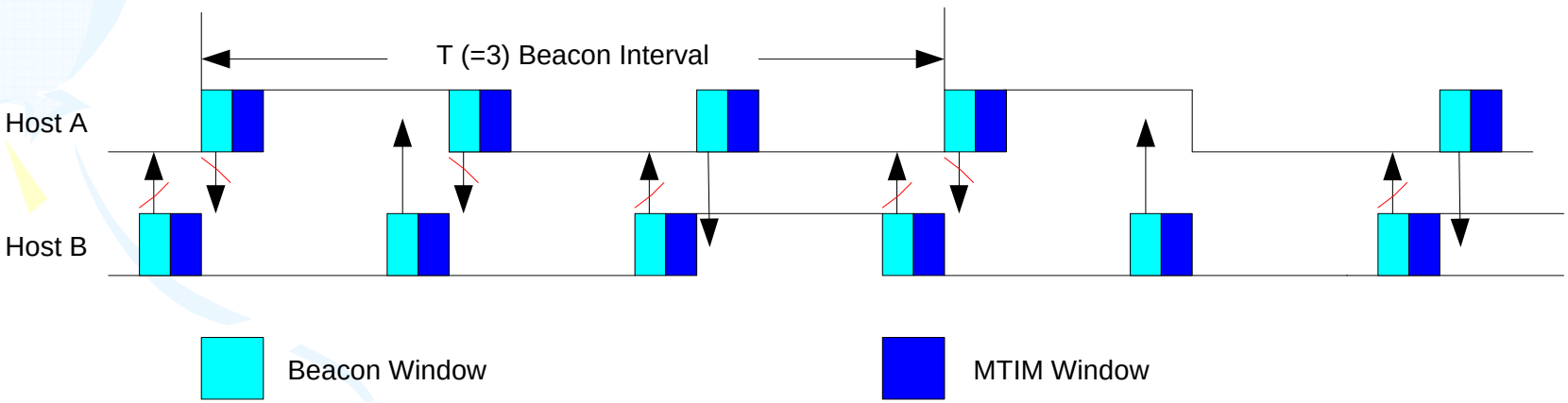


Each source node sends 10 messag
— Each message has 400B in 10 fragments

Measure total energy over time to send all messages

Conclusion

- S-MAC has better energy conserving properties as compared to IEEE 802.11
- My idea：



References

- [1] Wei Ye, John Heidemann and Deborah Estrin, Medium Access Control with Coordinated, Adaptive Sleeping for Wireless Sensor Networks, IEEE/ACM Transactions on Networking, June 2004
- [2] V. Bharghavan and A. Demers and S. Shenker and L. Zhang, MACAW: Media Access Protocol for Wireless LANs, Proc. of the ACM SIGCOMM Conference, 1994
- [3] Ming Liu; Liu, M.T. , A Power-saving Scheduling for IEEE 802.11 Mobile Ad Hoc Network, ICCNMC 2003. 2003 International Conference on , 20-23 Oct. 2003 Pages:238 - 245
- [4] Yu-Chee Tseng; Chih-Shun Hsu; Ten-Yueng Hsieh, Power-Saving Protocols for IEEE 802.11-Based Multi-Hop Ad Hoc Networks ,INFOCOM 2002.