X-MAC: A Short Preamble MAC Protocol for Duty-Cycled Wireless Sensor Networks

Presented by: Fatima Rivera

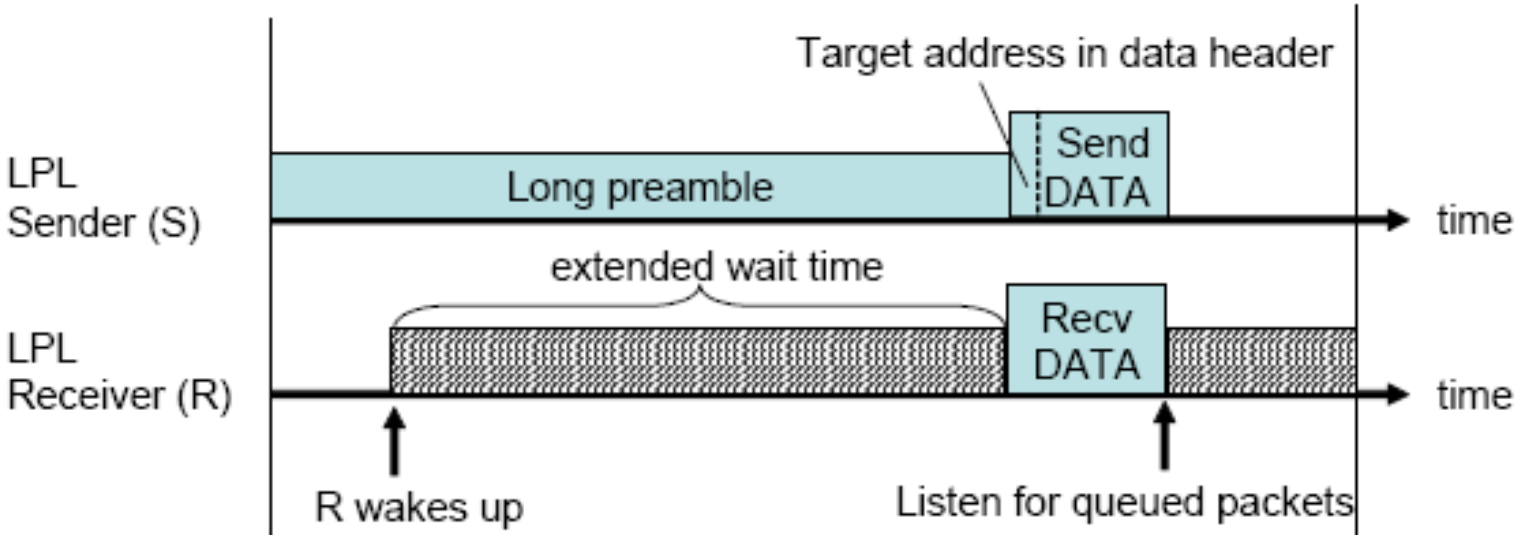
Purpose

- To minimize the preamble in MAC protocols
  - Reduce latency at each hop
  - Optimize energy consumption
  - Minimize energy consumption at non-target receivers

MAC Protocols

- Synchronous
  - Keeps an awake and sleep schedule
  - Reduces idle listening
  - Overhead associated with schedule
- Asynchronous
  - Low power listening a.k.a **preamble**
  - Reduce idle listening for receiver
  - Sender has to send preamble with length ≥ receiver sleep period

Asynchronous Duty Cycling



Why is a long preamble bad?

- Overhearing problem
- Sender Receiver has to wait
- Increased latency

Overhearing

- Problem: Receiver does not know if it is the target until preamble is complete
- X-MAC Solution: Embed address of target into preamble

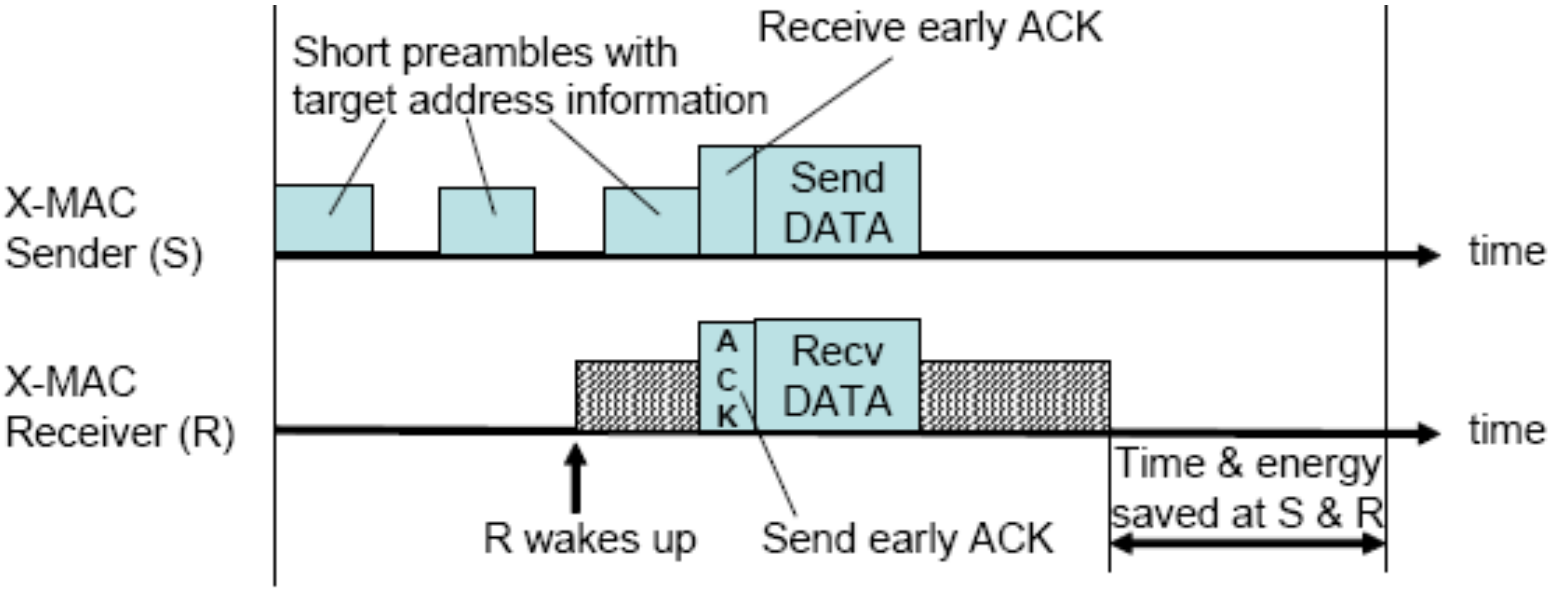
Receiver Waiting

- Problem: Receiver has to wait until the preamble is finished wasting time and energy
- X-MAC Solution: Target receiver interrupts the preamble a.k.a **strobing.**

Sender Waiting

- Problem: Sender sends preamble packet and other senders stay awake until the channel is clear
- X-MAC Solution: Strobing allows for the insertion of a pause between preambles letting the receiver send an early ACK

X-MAC Design


Short preambles with
target address information
Receive early ACK
Send
DATA
X-MAC
Sender (S)
time
A
C
K
Recv
DATA
X-MAC
Receiver (R)
time
Time & energy
saved at S & R
R wakes up
Send early ACK

Results

- X-MAC reduces energy consumption while sending and receiving
- X-MAC reduces per hop latency
- X-MAC adapts to bursty and periodic traffic
- Can be implemented in software so applicable to packetized and bit stream radios

Evaluation

- Compared with LPL MAC because closest approximation supported by packetizing radio
  - Does not inspect preamble for target name
  - Sender sends the entire extended preamble and the receiver does not send an ACK
  - It's not adaptable
  - Receiver can adjust sleep but sender will not know to adjust preamble length

X-MAC Performance

	X-MAC	LPL
Duty Cycle-No Contention, Single Sender	Remains constant with increasing network density	Increases with network density
Energy Use	Remains constant with increasing network density	Increases with network density
Duty Cycle-Contention	Remains constant with increasing network density	Increases with network density
Fairness	More Fair	Less Fair
TX Success Rate	About 90% success for varying transmitters and sleep time	About 50% successful for 9 transmitters and 500ms sleep time
Latency	Latency increases with number of hops but 50% shorter than LPL	Latency increases with number of hops but 50% longer than X-MAC

X-MAC with Adaptation

- X-MAC has the option to adapt sleep time based on traffic load
- Algorithm calculates best sleep time
- When X-MAC is optimized to be adaptive it performs better than LPL and static X-MAC