Avoiding 1-hop neighborhood knowledge in Wireless Sensor Network using 1-hopMAC.

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IRAMUS meeting, September 15th, 2006.
Wireless Sensor Networks

Far from traditional networks
• No fixed infrastructure
• Changing topology
• Multi-hop communication

Different from ad-hoc networks
• Scarce energy source
• Very low data rates
• Autonomous communication
Sources of Energy Wastage

- Radio budget > 80% total energy budget
- Collision
- Overhearing
- Overheads
- Idle-listening
- Layering approach

→ cross-layering thru layer communication or integration
Neighborhood knowledge

Why?
• No knowledge at all a priori
• Centralized DNS-like solutions not applicable

Know your neighbors

How?
• Periodic Hello packets
• Out of date information…
• Expensive…

Used for Clustering, Energy-efficiency, Routing, …
Assumptions

• all nodes contain a metric $f$
• all nodes know the deployment-dependent node density *(not critical)*

Simple Energy Model

• $P_{Tx} = P_{Rx}$
• $P_{\text{radio\_off}} = P_{\text{sensing}} = P_{\text{processing}} = P_{\text{switching}} = 0$
Energy-Efficient MAC

- coordinated on-off scheduling (synchronization)
- preamble sampling

Micro-frame preamble sampling (A. Bachir et al.)
1-hopMAC

1-hopMAC\textsubscript{basic}

1. \( \Delta t \)
2. \( \Delta t \)
3. \( \Delta t \)

\( (T_{\text{max}} - T_{\text{min}}) \cdot \Delta t + \text{TACK} \)

"beaconless greedy routing" (Heissenbüttel et al., 2003)
1-hopMAC_{var1}

- reduce S's listening time
1-hopMAC\textsubscript{var2}

- avoid multiple ACK messages

1-hopMAC\textsubscript{var1}

1-hopMAC\textsubscript{var2}
1-hopMAC\textsubscript{var3}

\begin{itemize}
  \item direct answer
\end{itemize}

\begin{itemize}
  \item \(\Delta t\)
  \item \(\Delta t\)
  \item \(\Delta t\)
  \item \((f_{\text{max}} - f_{\text{min}}) \cdot \Delta t + d + \text{TACK}\)
\end{itemize}
Analysis

Time radios are on

1. $1$-hopMAC_{var1} always better than $1$-hopMAC_{basic}

2. $1$-hopMAC_{var2} better than $1$-hopMAC_{var1} iff first ACK received after $t_{thresh} = f_{max}.\Delta t + (2-N)T_{ACK} + 2d$

3. $1$-hopMAC_{var3} always better than $1$-hopMAC_{var2}

$\rightarrow$ if first ACK received before $t_{thresh}$, use $1$-hopMAC_{var3}
if first ACK received after $t_{thresh}$, use $1$-hopMAC_{var1}
Conclusion

Multi-mode energy-efficient protocol, with a localized and overhead-free decision

Future work

• Simulation and performance extraction
• Analysis to extract optimal value for $\Delta t$
• Collision resolution
• Integrating with more functionalities (i.e. self-organization)

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Gradient-based routing


- setup phase
- bounded and known number of hops
- real-time?
Geographic routing

Assumptions:
• node knows its position, its neighbor's, and the destination's
• 1-hop neighborhood knowledge
# Berkeley Motes Family

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<td>Microcontroller Type</td>
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<td>AT90LS8535</td>
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* Based on the Mica mote, these commonly used derivatives are manufactured by Crossbow Technology.
Microframe preamble sampling

• preamble sampling

Micro-frame preamble sampling (A. Bachir et al., 2006)
Chipcon CC2500

• hardware preamble sampling support

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### Table

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<thead>
<tr>
<th></th>
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<td>8.1</td>
<td></td>
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<td>Automatic RX polling once each second, using low-power RC oscillator, with 460 kHz filter bandwidth and 250 kbps data rate. PLL calibration every 4th wakeup. Average current with signal in channel below carrier sense level.</td>
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<tr>
<td></td>
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<td>21.2</td>
<td>Transmit mode, 0 dBm output power</td>
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Legend:
- Inserted automatically in TX, processed and removed in RX.
- Optional user-provided fields processed in TX, processed but not removed in RX.
- Unprocessed user data (apart from FEC and/or whitening)