Abstract

In EnHANTS project, the network needs to
- Harvest energy
- Exchange information (battery state, location, etc)
- Survive as long as possible

Following these requirements, we built a platform of sensor motes to
- Implement and evaluate energy-aware communication protocols
- Emulate real EnHANTS network situation
- Evaluate protocol parameters in runtime
- Get experiment results from the whole network, in runtime
- Analyze the result, make improvements
- Evaluate the protocols in real network situations

Using the developed platform, we can
- Implement energy-aware communication protocols
- Set protocol parameters in runtime
- Get experiment results from the whole network, in runtime
- Analyze the result, make improvements
- Evaluate the protocols in real network situations

Platform Demonstration

1. Pairwise coordination of communication rate

Factors affecting decision
- Light harvesting rate \((K_{\text{LH}})\) of itself
- Light harvesting rate of the other mote (pairwise decision)

The algorithm works as follows
- When \(K_{\text{LH}}\) from either mote falls below a threshold \((KL)\), the transmission rate between these two motes will be set to minimum.
- When both \(K_{\text{LH}}\) exceeds a threshold \((KU)\), they both use maximum sending rate.
- In the medium state, the transmission rate is decided linearly between minimum and maximum value.

2. Use battery state and light harvesting rate

Factors affecting decision
- Light harvesting rate \((K_{\text{LH}})\) of a mote itself
- Battery State of itself

The algorithm works as follows
- When \(K_{\text{LH}}\) falls below a threshold \((KL)\), the transmission rate will be set to minimum. When \(K_{\text{LH}}\) exceeds a threshold \((KU)\), maximum sending rate will be used. In the medium state, the transmission rate is decided linearly between minimum and maximum value.
- The battery percentage plays the same role as the \(K_{\text{LH}}\). The transmission rate will be divided by a division factor (between 0.2 and 1), which is linear to the current battery percentage.

System Architecture

Hardware Platform

<table>
<thead>
<tr>
<th>Mica2 Sensor Mote</th>
<th>Solar Cell</th>
<th>Sensor Board</th>
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</thead>
<tbody>
<tr>
<td>Programming Board (USB)</td>
<td>Programming Board (Ethernet)</td>
<td>Moto Power Supply</td>
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</tbody>
</table>

Platform Demonstration

Screenshot of a running experiment, with two sensor motes. It demonstrates pairwise decision of communication rate.

Screenshot of a running experiment, with two sensor motes. It demonstrates decision using battery state and light state.

Protocol & Implementation

Implementation

Overall - Take small steps each time, improve bit by bit.

Detail:
- Implement a protocol on the platform
- Run experiment
- Get experiment data
- Analyze result
- Make improvement

Protocols

1. Linear communication rate depending on light harvesting rate
2. Pairwise coordination of communication rate
3. Use battery state and light harvesting rate
4. Step-wake duty cycle determination in conjunction with battery and light state

Conclusions

With the current software platform, we are able to experiment with the existing energy-aware communication protocols, as well as develop new ones.

Acknowledgements

Thanks to Maria Gorlatova for algorithm support.
Thanks to Deep Shrestha for the power supply, the solar cell and the software component.

This work is supported in part by Google and by the Vodafone Americas Foundation Wireless Innovation Project

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