Integrated Distributed Energy Awareness

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A new GROUP DIET for Wireless Sensor Networks!!!

IDEA
Optima
Helps Control Hunger
Chocolate Drink Shake Mix

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Overloading Nodes Leads To...

Reduced activity levels...
Overloading Nodes Leads To...

...premature node death!
Single Node Diets Exist...

Integrating Concurrency Control and Energy Management in Device Drivers
Klues et. al., SOSP 2007
Single Node Diets Exist...

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Quanto: Tracking Energy in Networked Embedded Systems
Fonseca et al., OSDI 2009

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Single Node Diets Exist...
A large amount of load is produced by other nodes! Cannot shed this load without help...
...But Nodes Depend on Each Other!

A large amount of load is produced by other nodes! Cannot shed this load without help...
IDEA Is a Group Diet
IDEA: Improving Load Distribution

**Goal:** Improve application fidelity by matching system *load* to *availability*

:: Capture all incident energy
:: Shift load towards *underutilized* nodes
:: Shift load away from *threatened* nodes

First piece of a *distributed OS* for sensor networks!

May not perform all actions in the way that minimizes the total energy consumed by all involved nodes!
IDEA: Integration

App State

State 1
\((s_1^0, s_1^1, s_1^2, \ldots)\)

State 2
\((s_2^0, s_2^1, s_2^2, \ldots)\)

State 3
\((s_3^0, s_3^1, s_3^2, \ldots)\)

Example Applications:
- Routing Layers
- MAC Protocols
- Distributed Consensus Algorithms
- Distributed Computation
IDEA: Integration

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App State

State 1
(s1_0, s1_1, s1_2, ...)

State 2
(s2_0, s2_1, s2_2, ...)

State 3
(s3_0, s3_1, s3_2, ...)

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IDEA: Distribution

State Sharing

State Table

\((C_0, B_0, L_0)\)

\((C_n, B_n, L_n)\)

Charge Model

Battery Monitor

Load Model

Load Monitor

Distributed State:
- Load Model Parameters
- Charging Model Parameters
- Battery Levels

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IDEA: Awareness

State Table
\[(C_0, B_0, L_0)\]
\[(C_n, B_n, L_n)\]

App State
State 1
\[(s1_0, s1_1, s1_2, ...)\]
State 2
\[(s2_0, s2_1, s2_2, ...)\]

Scoring

App

Maximize Time Until First Node Failure

Maximize Captured Charge

Time
Battery Level

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Questions?

Project Status:
- Prototype Implementation Complete
- Several Example Applications Underway
  - Modified Routing Layer (CTP)
  - Energy-aware Low-Power Listening Interval Tuning

State Table
\[(C_0, B_0, L_0), (C_n, B_n, L_n)\]

State Sharing

App State
- State 1 \((s_1_0, s_1_1, s_1_2...\))
- State 2 \((s_2_0, s_2_1, s_2_2...\))

Scoring

App

Charge Monitor

Battery Monitor

Load Monitor

Load Model

Charge Model

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