Department of Computer Science and Engineering

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# Resource Management of Heterogeneous Wireless Sensor Networks

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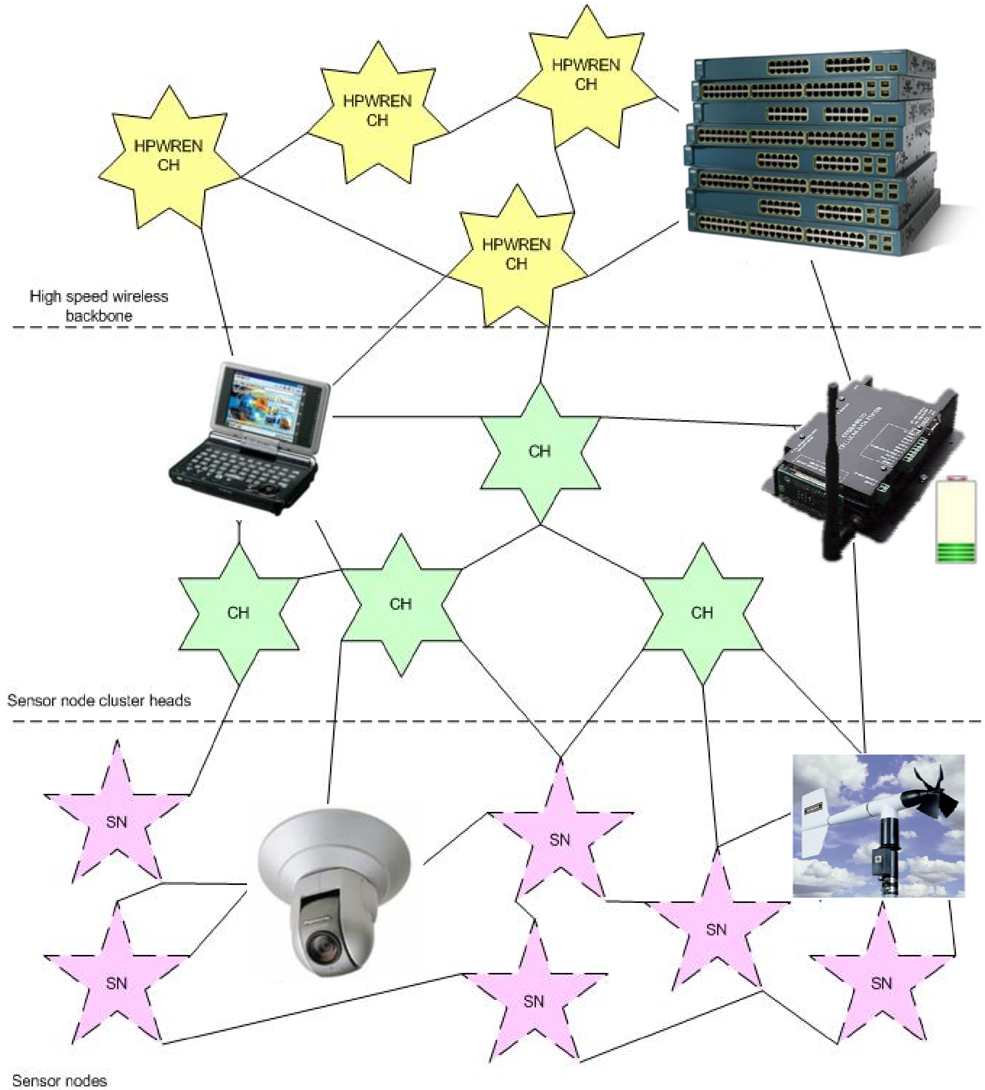
UCSD

# HPWREN - three tier network




## Wireless MESH

- QoS routing
- Fast wireless connectivity

## Sensor Cluster Heads

- Key issue:
  - Delivering good QoS
  - With long battery lifetime
- Use faster radio to support QoS requirements

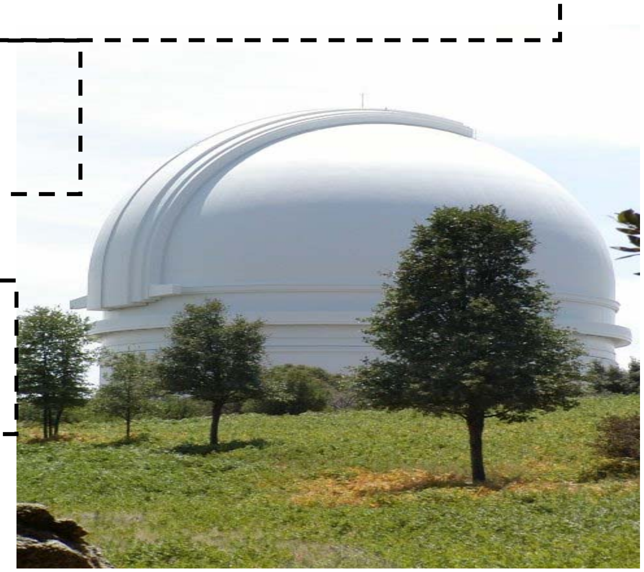
## Sensor Network

- QoS: not considered in traditional sensor net research
- Battery lifetime

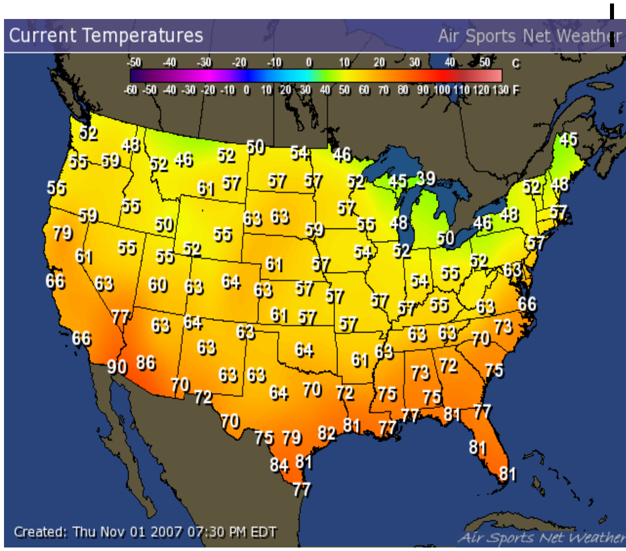
# Wireless MESH: QoS Routing

Quality of Service: guaranteeing router resources to a data flow in accordance with its priority

High Priority



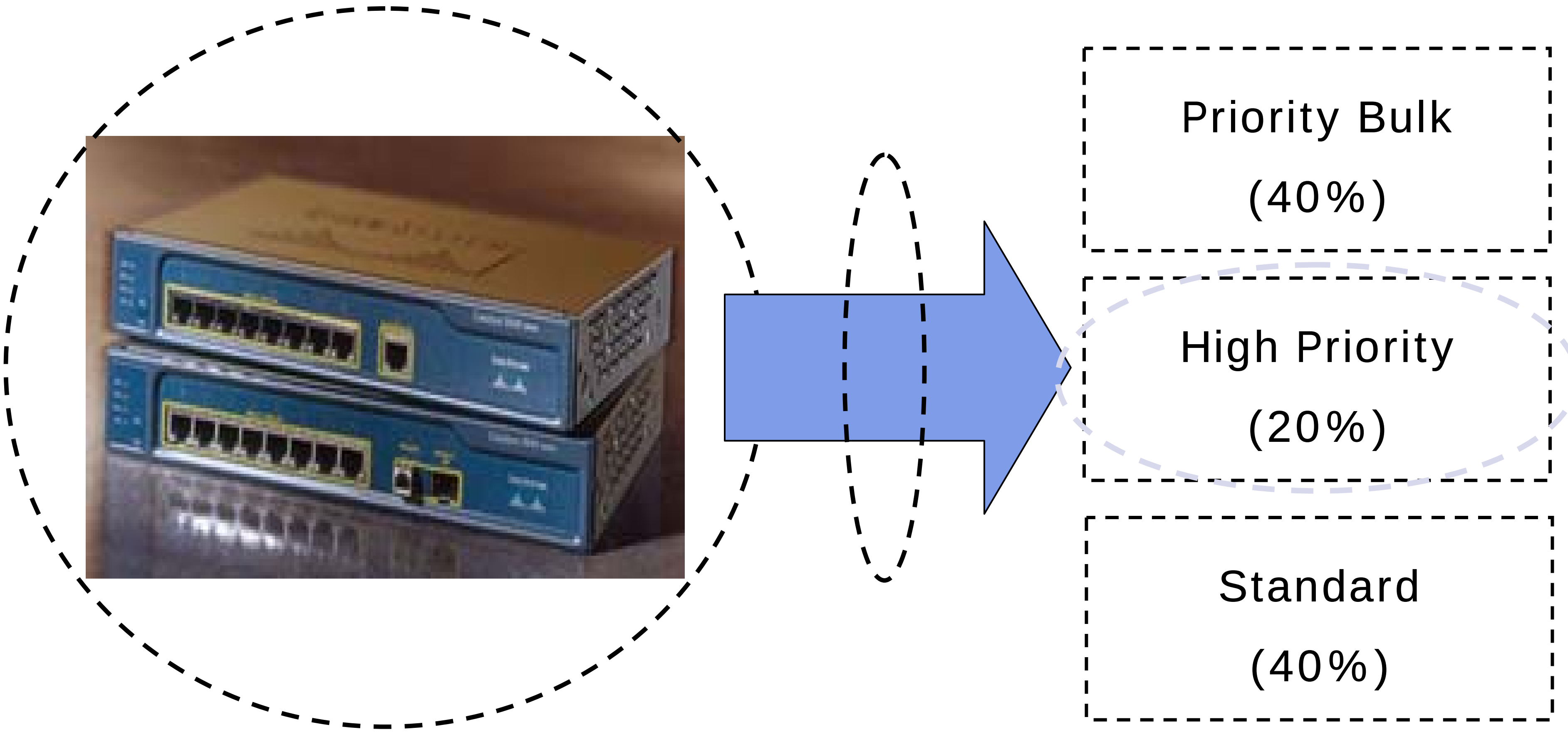
Priority Bulk




Standard

# QoS Guarantees

- Successful configuration and experimentation with Cisco 3560 for QoS



# QoS Scheduling & Routing for Sensor Node Cluster Heads

Objective:

Design an adaptive, distributed and low power QoS scheduling and routing methodology

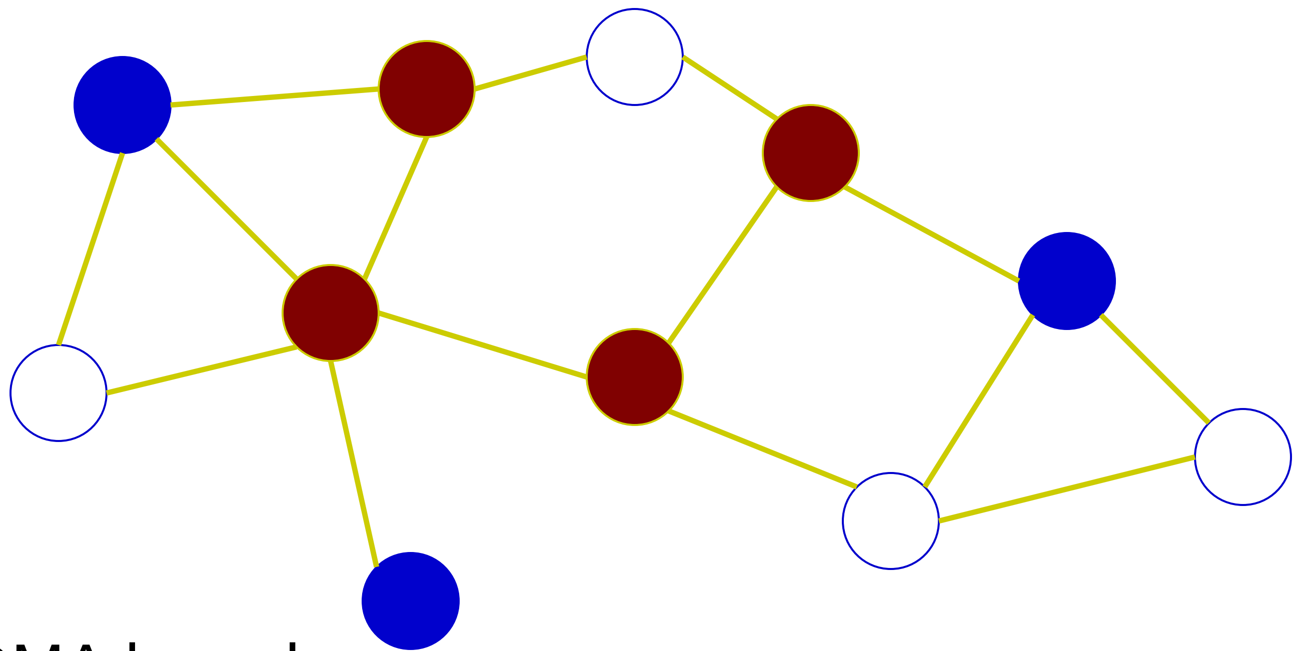
Why?

Lower cost to deploy: smaller batteries & solar cells

Main Challenges:

- Understand and characterize the incoming traffic
- Devise a good scheduling & routing model:
  - routing backbone – good QoS
  - scheduling – low power
- Implement and simulate on NS2 simulator
- Deploy in SMER and within HPWREN

# Sensor cluster heads: scheduling for low power



- TDMA based
- Distributed
  - Requires only the knowledge of the *two-hop* neighborhood

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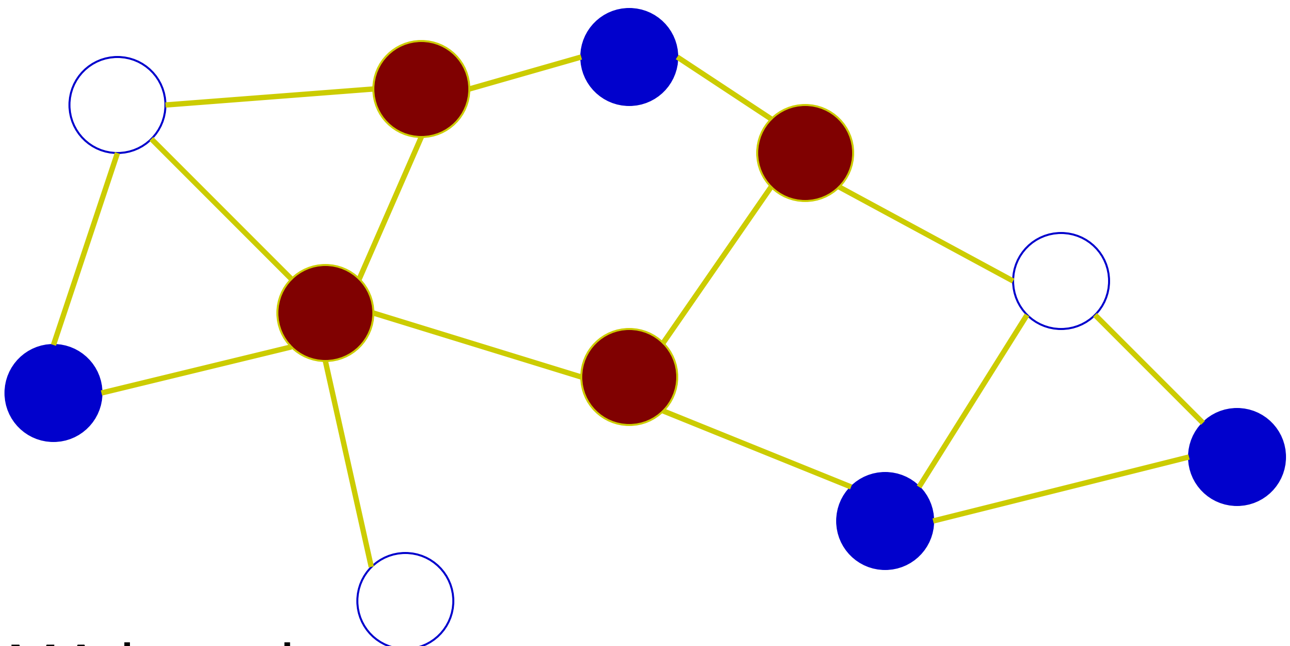

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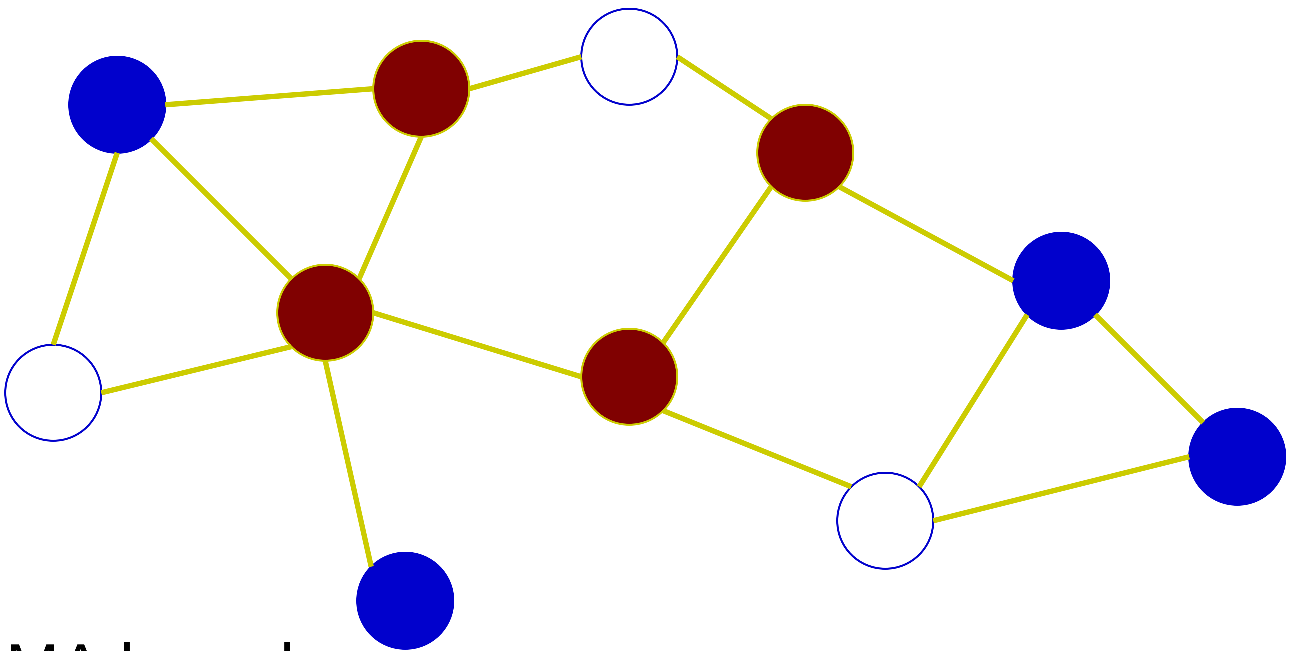

- TDMA based
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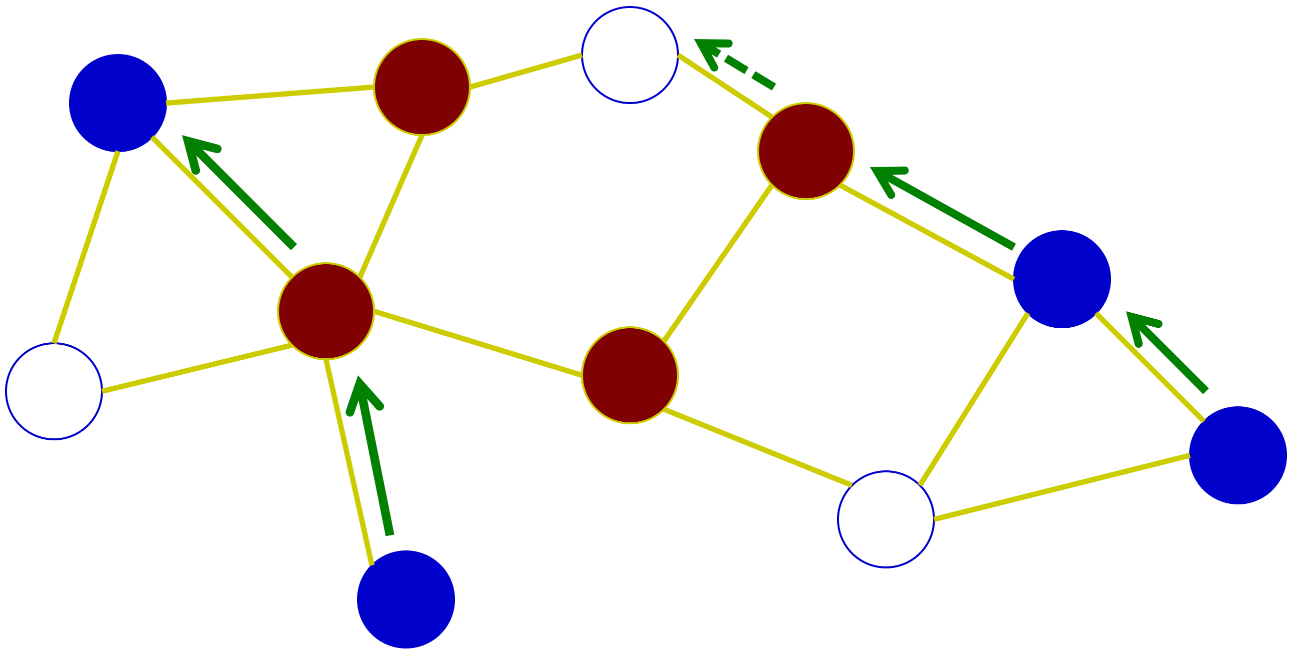
  - Requires only the knowledge of the *two-hop* neighborhood

# Sensor cluster heads: routing backbone



- *Energy aware* selection of nodes into the backbone using:
  - *Residual Energy*
  - *Utility*: a measure of how many neighbors the node can connect
- Requires knowledge of the neighbors within two hops

# Preliminary results: route selection & energy savings

| | 802.11 | Our Solution |
|---|---|---|
| **Area** | **# hops** | **# hops** |
| 500mx500m | 2.5 | 3.0 |
| 750mx750m | 3.9 | 4.8 |
| 1000mx1000m | 5.4 | 6.7 |
| 1250mx1250m | 7.2 | 8.2 |

Routing uses geographic greedy forwarding

| Area (m) | % Coord | % Sched | % Sleep |
|---|---|---|---|
| 500x500 | 21 | 22 | 57 |
| 750x750 | 28 | 22 | 50 |
| 1000x1000 | 34 | 25 | 41 |
| 1250x1250 | 39 | 29 | 32 |

Significant energy savings possible

# Future Work

- Implementation and measurements
- Deployment and testing under real traffic conditions
- Study adaptation to application specific requirements

# Publications to date


- Regini, E., Lim, D. and Rosing, T.S. “Scheduling Above MAC to Maximize battery Lifetime and Throughput in WLANs”. IASTED 2008
- Dhiman, G. and Rosing, T. S. *“System Level Power Management Using Online Learning”*. Submitted to IEEE TCAD
- Dhiman, G. and Rosing, T. S. *“Dynamic voltage frequency scaling for multi-tasking systems using online learning”*. ISLPED 2007
- Dhiman, G. and Rosing, T. S. *“Dynamic power management using machine learning”.* ICCAD 2006.
- D. Lim, J. Shim, T. Simunic Rosing, T. Javidi, “Scheduling data delivery in heterogeneous wireless sensor networks,” ISM’06.

# Sensor node cluster heads: Routing and Scheduling

| | | |
|---|---|---|
| Routing Layer | Routing | |
| → | Backbone Maintenance | Scheduler |
| MAC/PHY Layer | 802.11 | |

The routing layer knows if a neighbors is:

- Part of the *backbone*
- Active/sleeping

# Preliminary Results: Setup

- *NS-2* network simulator

- Different topologies:
  - 500X500m, 750X750m, 1000X1000m, 1250x1250m

- Routing layer - Greedy geographic forwarding:
  1. Fw to neighbor in the backbone closest to the destination
  2. Fw to active neighbor
  3. Buffer the packet