Cross-Layer Scheduling for Power Efficiency in Wireless Sensor Networks

INFOCOM 2004

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Sep. 15, 2005

Outline

- Introduction
- Proposed approach
  - A. The Steady State Phase
  - B. The Setup and Reconfiguration Phase
- Simulation Results
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Introduction

- There are several power saving scheduling algorithms proposed in different layers.
- The main power savings in these papers results from reducing the idle listening power, but also from decreasing the number of collisions.

Proposed Approach

- The setup and reconfiguration phase
  - Its goal is to set up the schedules that will be used during the steady state phase.
- The steady state phase
  - Similar to the forwarding phase.
  - It utilizes the schedule established in the setup and reconfiguration phase to forward the data to the base station.

Proposed Approach

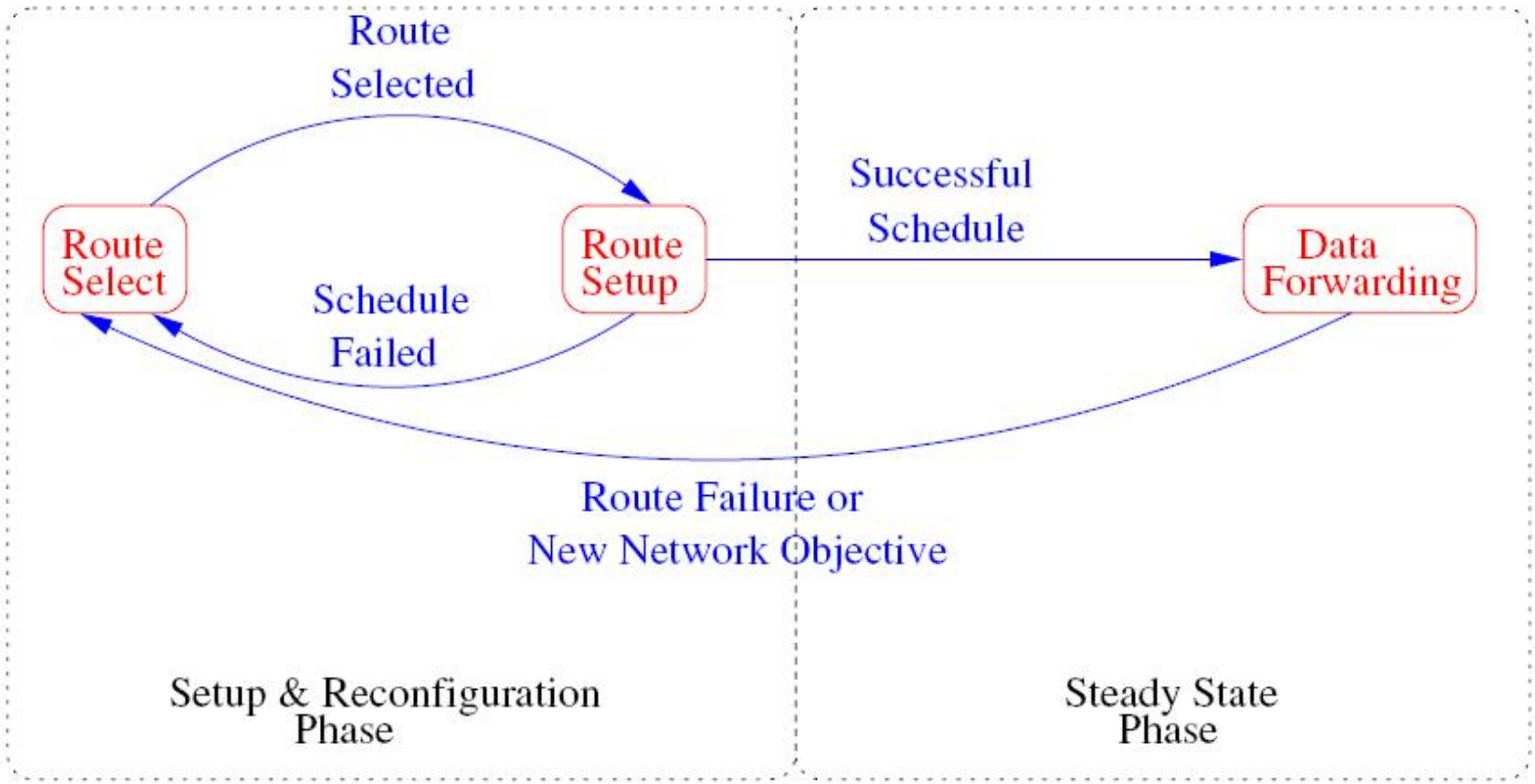


Fig. 1. State diagram for each data flow in the network.

The Steady State Phase

- Sample

  This sample will be forwarded along the path to the base station.

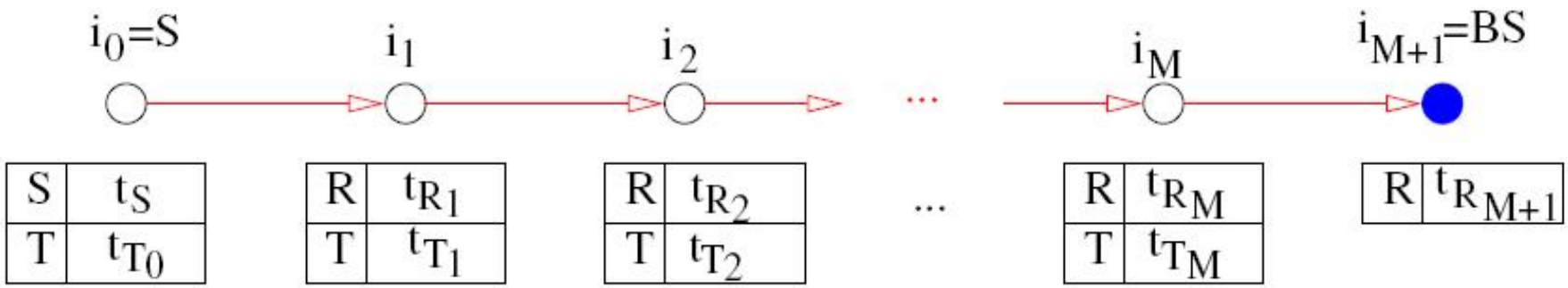
- Transmit

  All nodes on the path of a flow, expert for the **base station**, have a **transmit action** associated with the flow.

- Receive

  All nodes on the path of a flow, expert for the **source node**, have a **receive action** associated with the flow.

The Steady State Phase



S – Obtain a Sample from the Sensor(s)

T – Transmit a Packet

R – Receive a Packet

Fig. 2. The actions associated with a flow originating at the source S and being forwarded to the base station BS.

The Steady State Phase

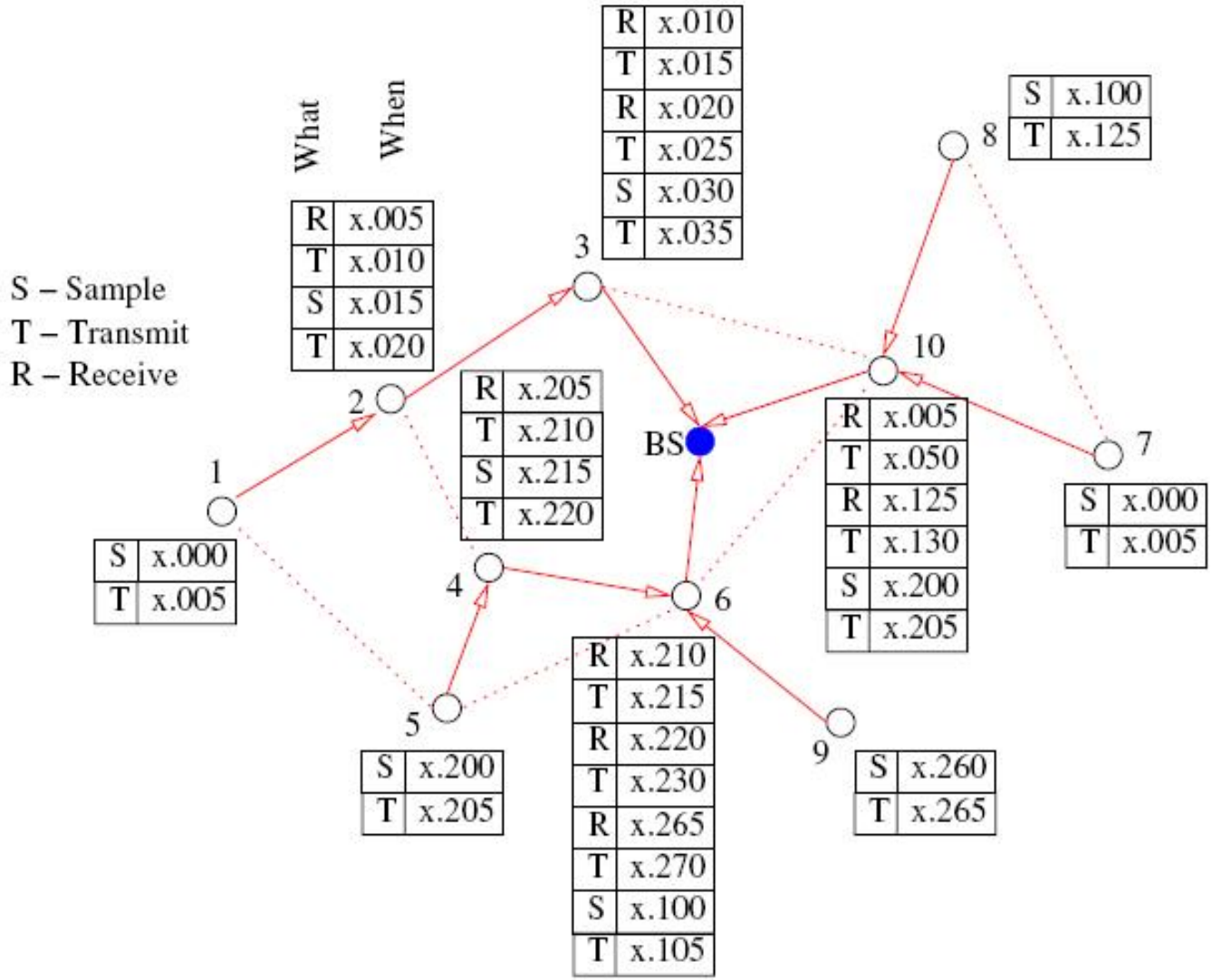


Fig. 3. Example of a 10-node sensor network with a base station BS and a possible distributed schedule.

The Steady State Phase

- If the application tolerates transmission fails, we can simply ignore lost packets.
- In case the medium access control layer supports retransmission.
- The schedule can have one (or several) special spare cycle(s) reserved specifically for retransmissions.

The Setup and Reconfiguration

- Route select

  Each node chooses one parent with a smaller hop count than itself as its default route.

- Route setup

  A special route setup (RSETUP) packet will be sent on the selected route from the source of the flow to the base station.

The Setup and Reconfiguration

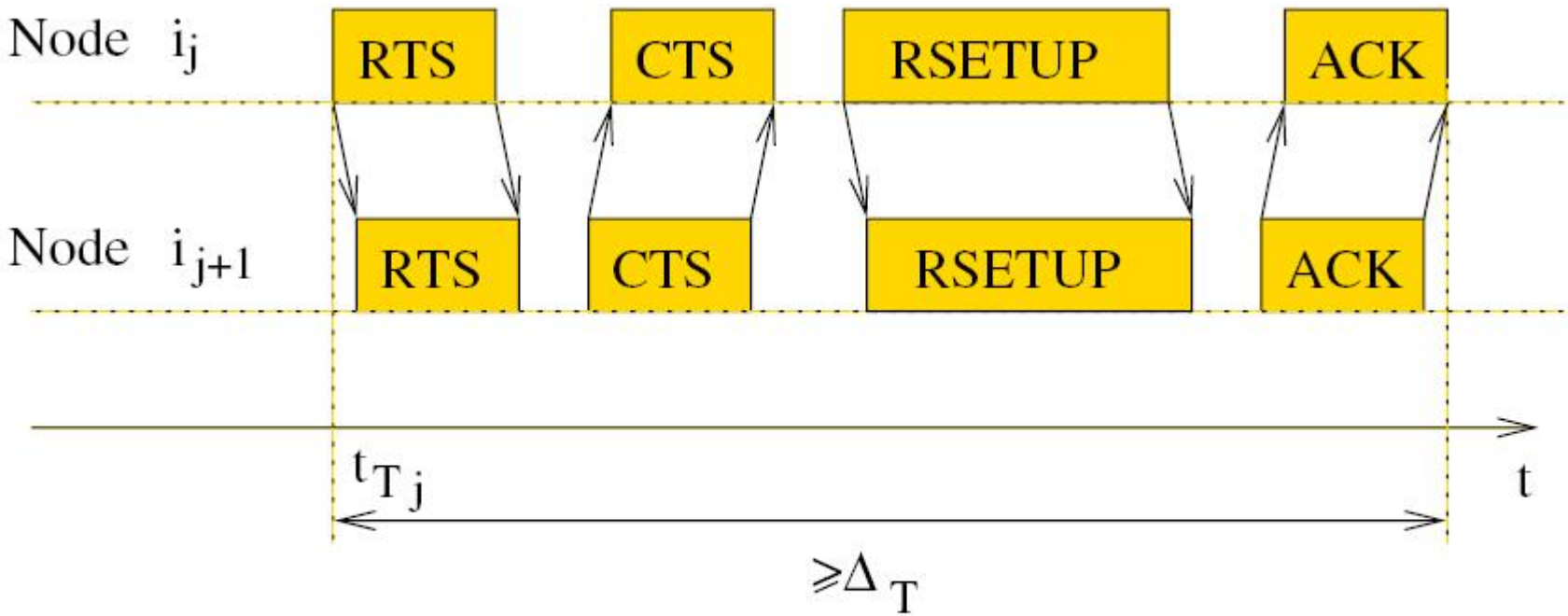


Fig. 4. An RTS/CTS exchange of an RSETUP packet between nodes j and $j+1$.

The Setup and Reconfiguration

- If the packet is postponed for more than a period, a route error (RERR) is sent back to the source.
- If the RSETUP packet arrives at the base station, a RACK packet will be sent from the base station to the source on the reverse path.

The Setup and Reconfiguration

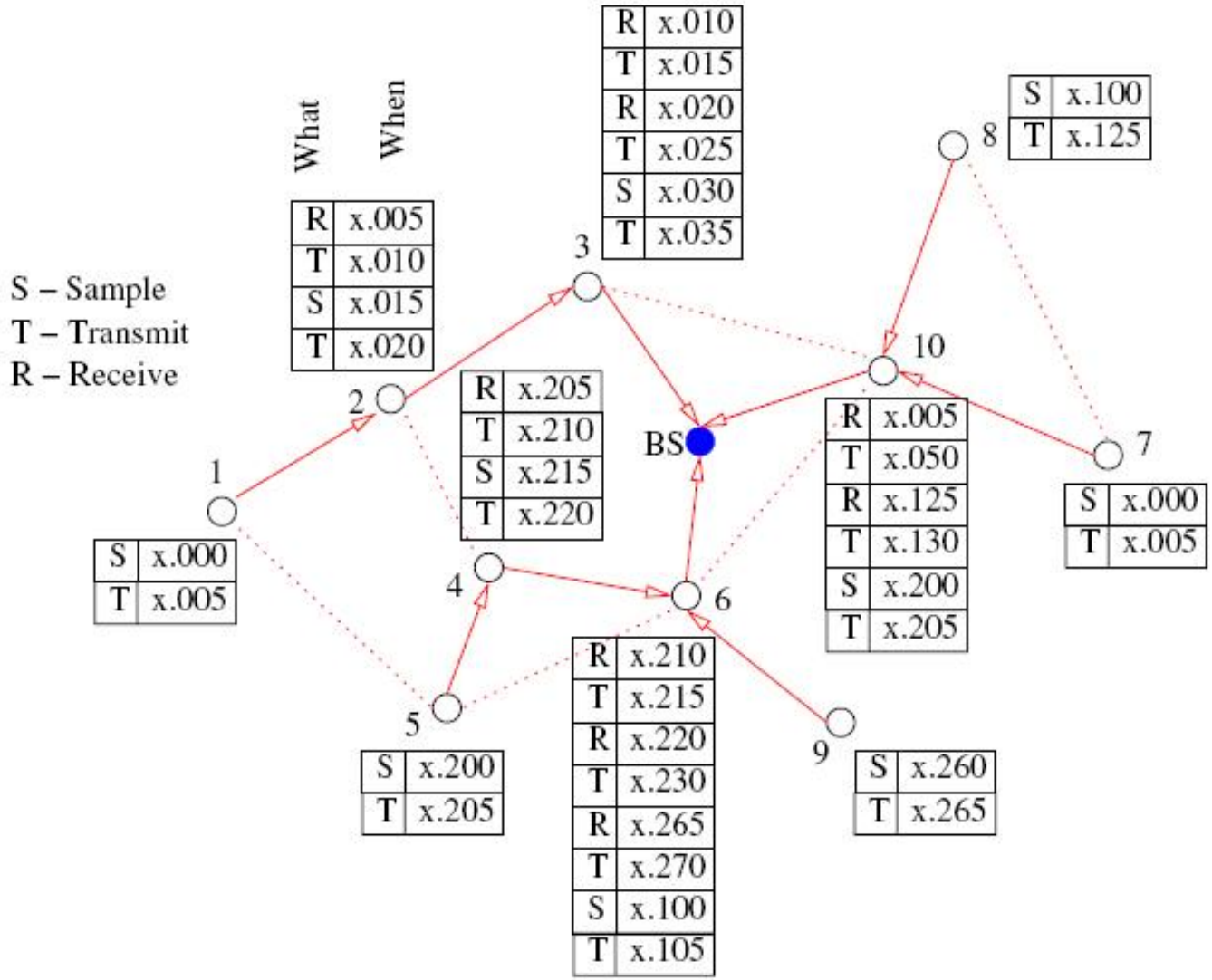


Fig. 3. Example of a 10-node sensor network with a base station BS and a possible distributed schedule.

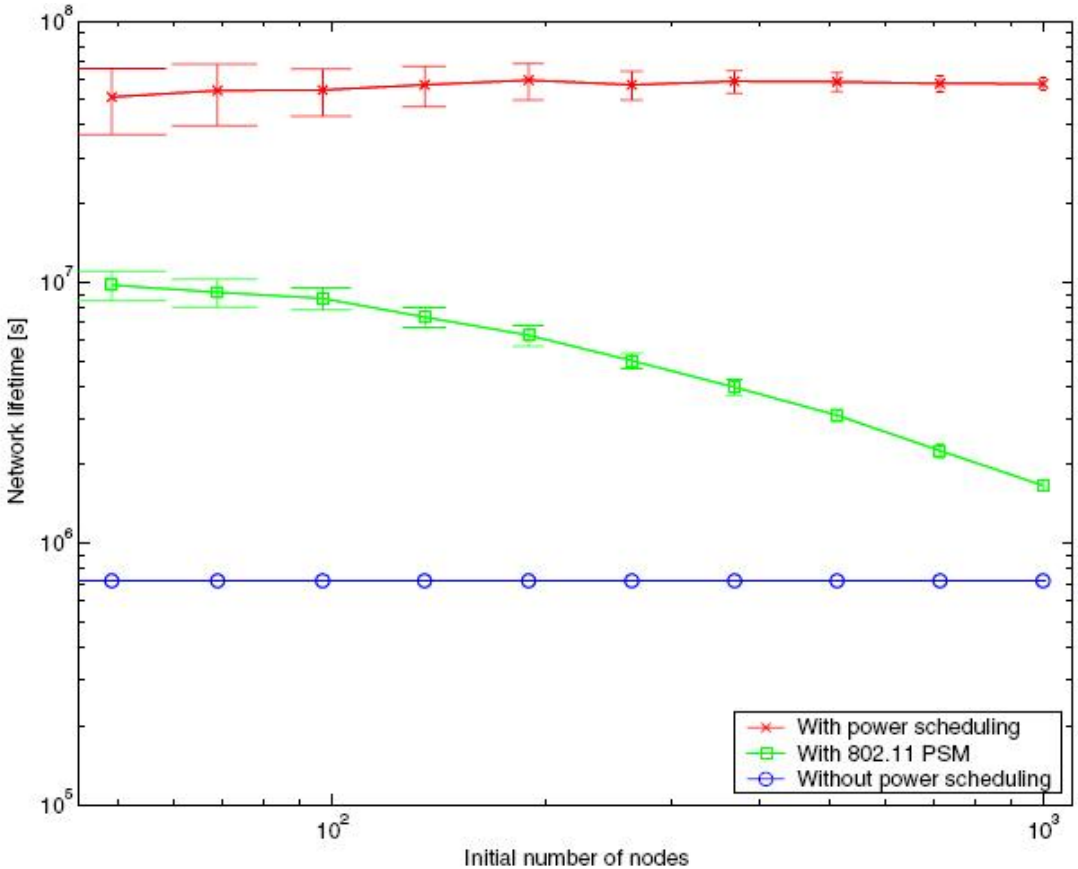
Simulation Results

	Network Lifetime	
	Mean	Std. Deviation
No power savings	8.3 days	4 minutes
802.11 PSM	3.2 months	7.5 days
Power scheduling	24.2 months	5 months

TABLE I

AVERAGE NETWORK LIFETIMES FOR THE BASE CASE USING THE THREE POWER SAVING STRATEGIES.

Simulation Results



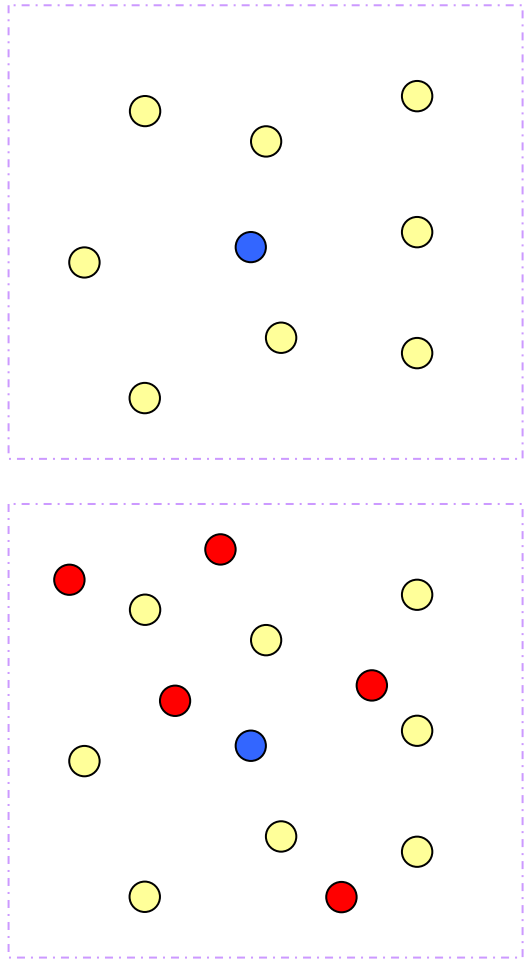
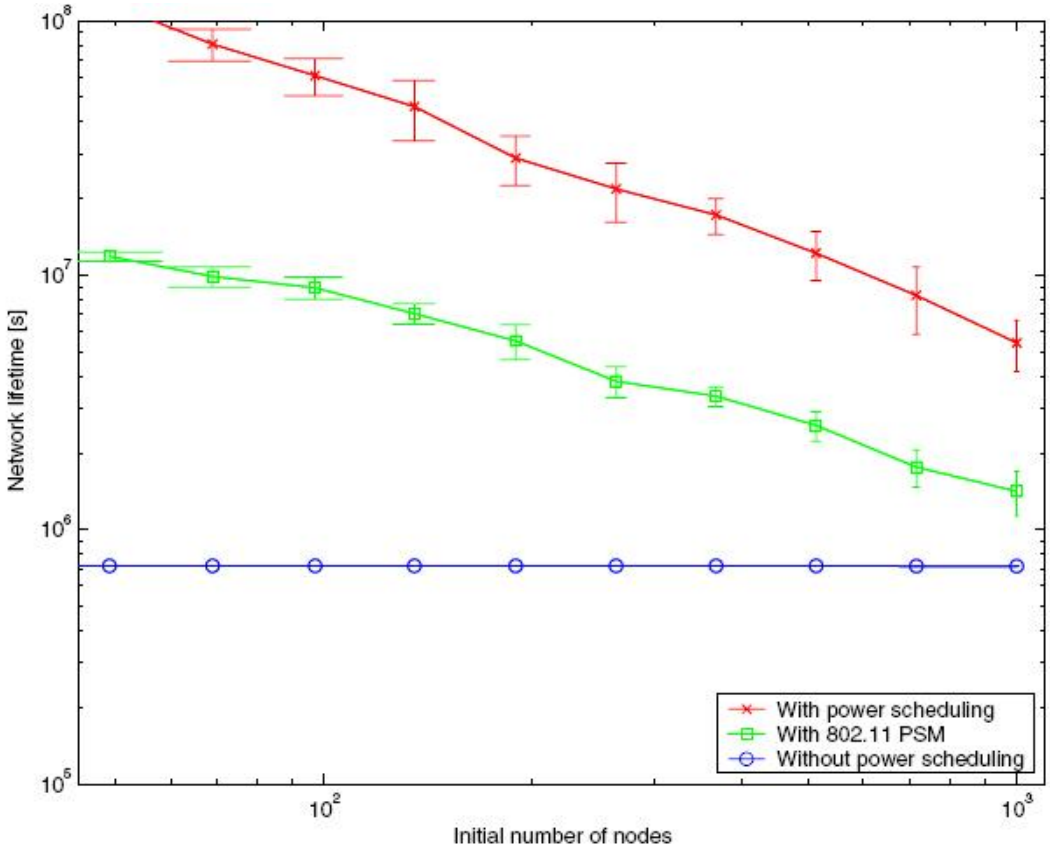


Fig. 6. Dependency of the network lifespans on the number of nodes for a constant deployment area.

Simulation Results



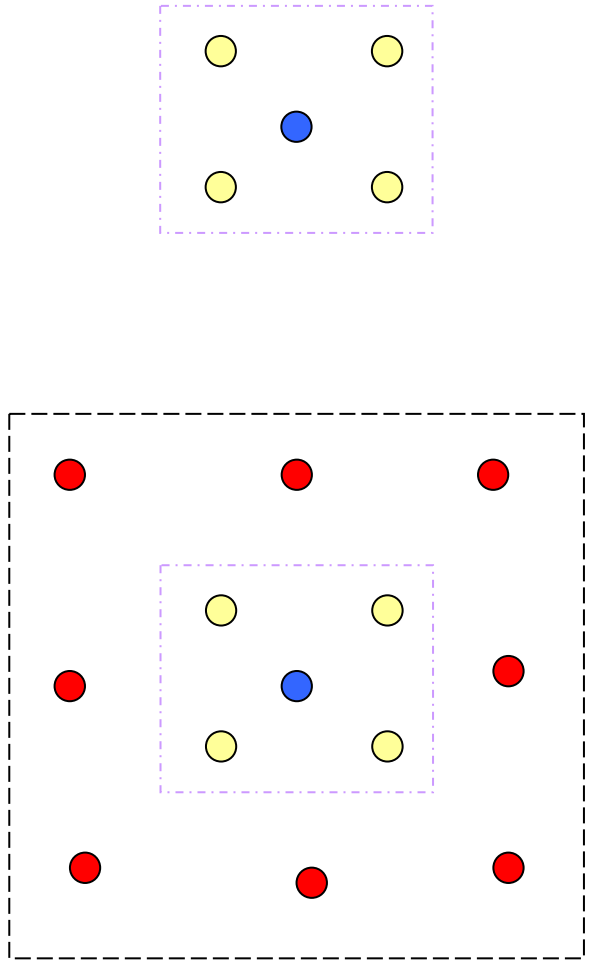


Fig. 7. Dependency of the network lifespans on the number of nodes for a constant density.

Simulation Results

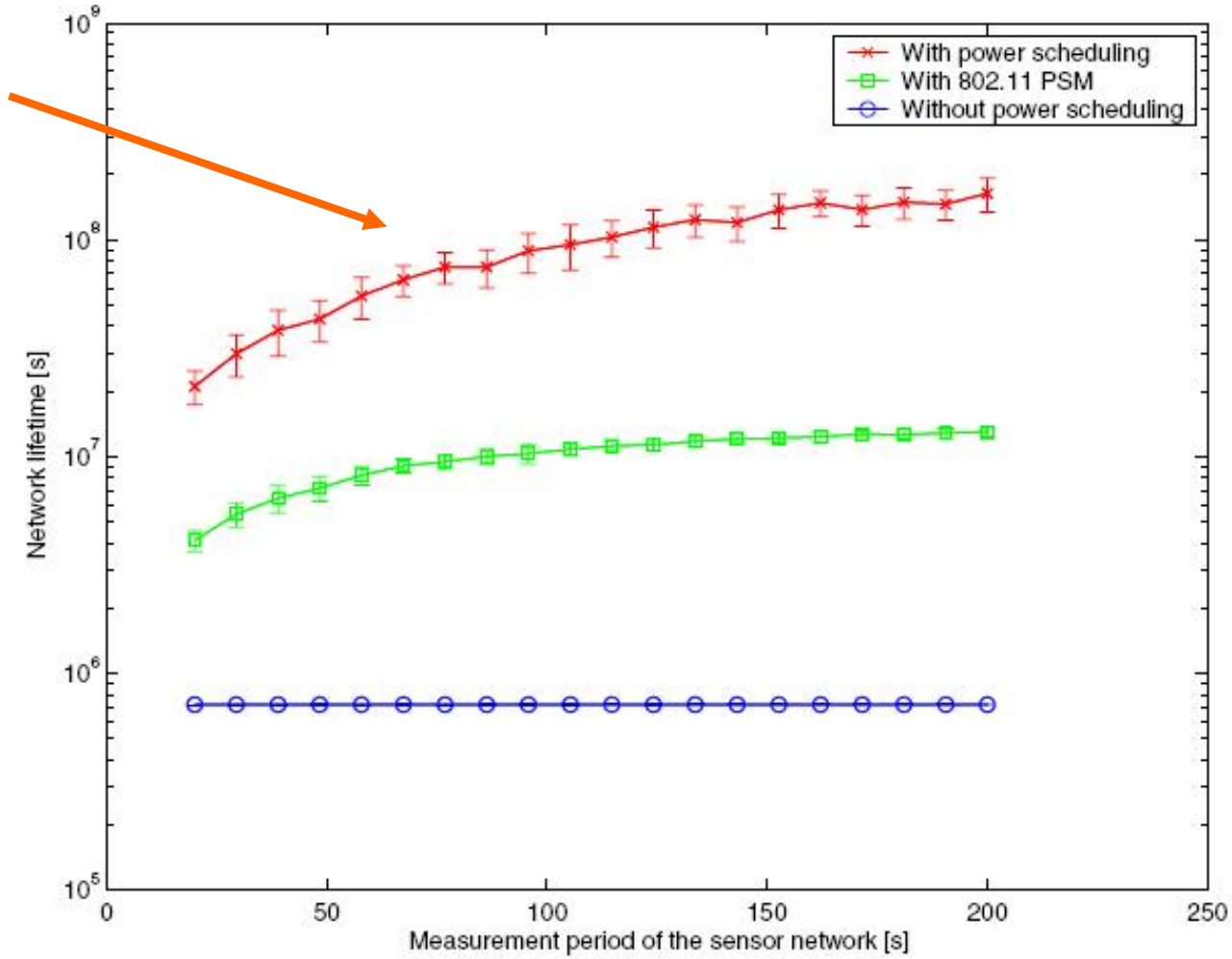


Fig. 8. Dependency of the network lifespans on the measurement period of the network.

Simulation Results

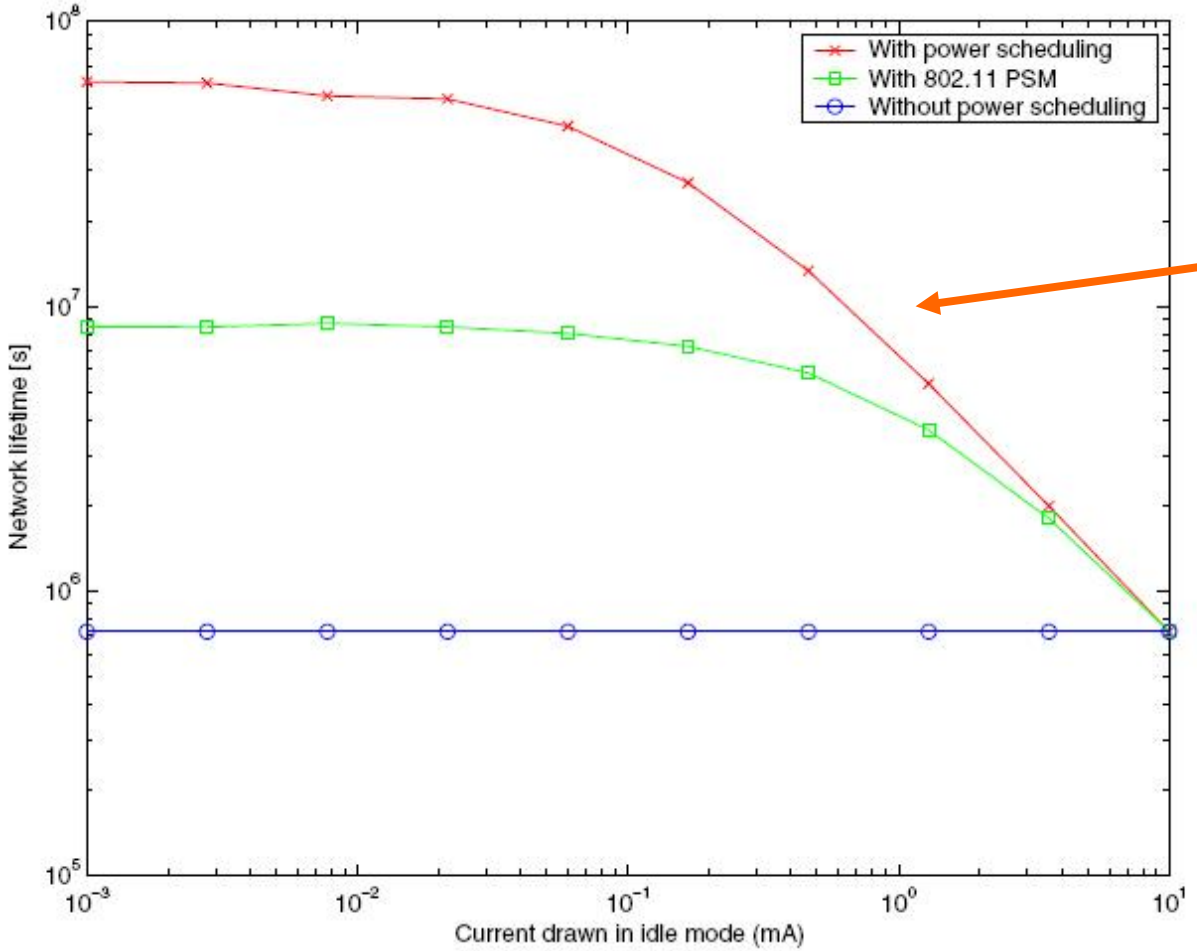


Fig. 9. Dependency of the network lifespans on the power consumption in idle mode.

Simulation Results

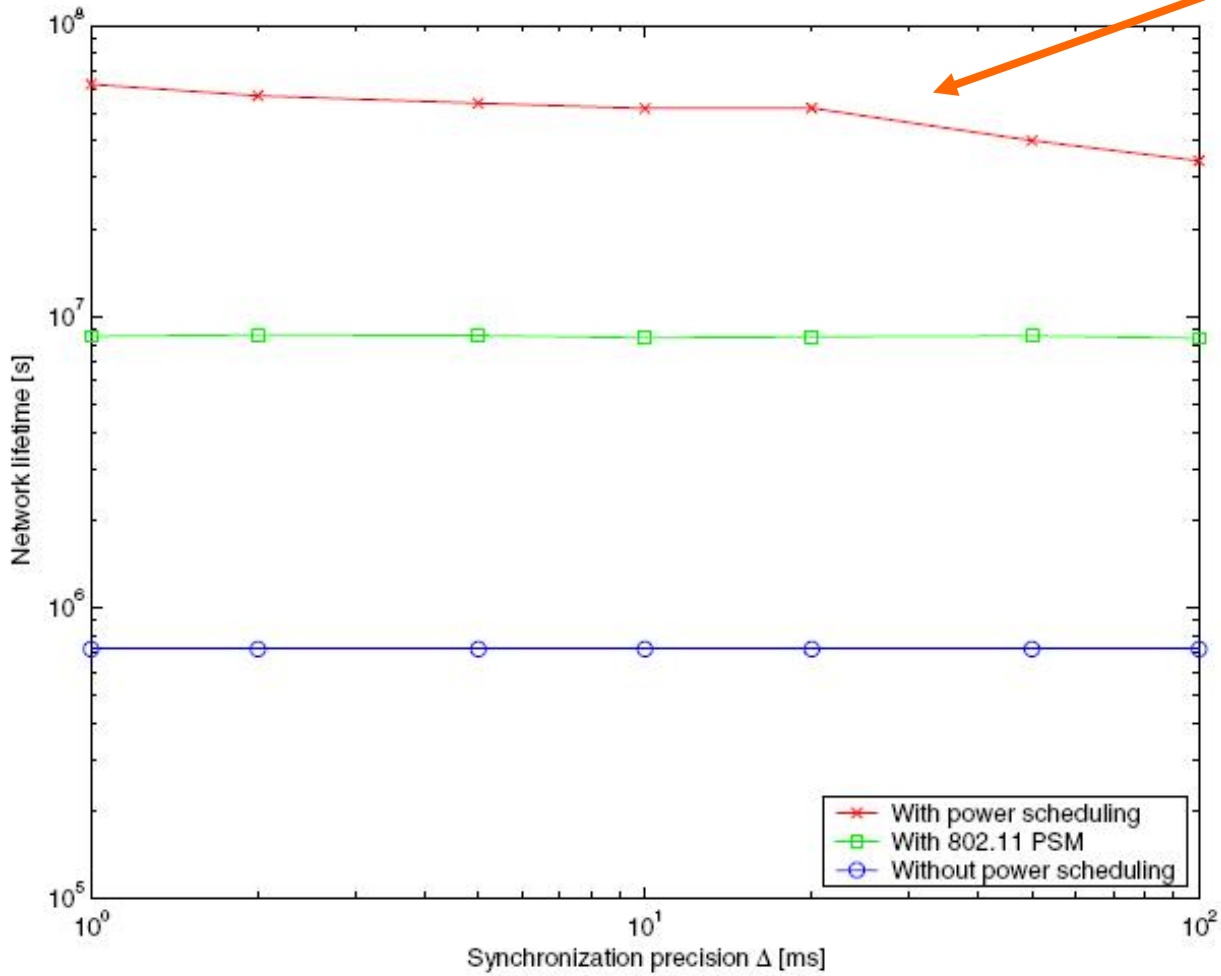


Fig. 10. Dependency of the network lifespans on Δ, the precision of the synchronization algorithm.

Conclusions

- The author proposed a new distributed scheduling algorithm for stationary continuous monitoring sensor networks.
- The algorithm requires the collaboration of both the routing with MAC layers.