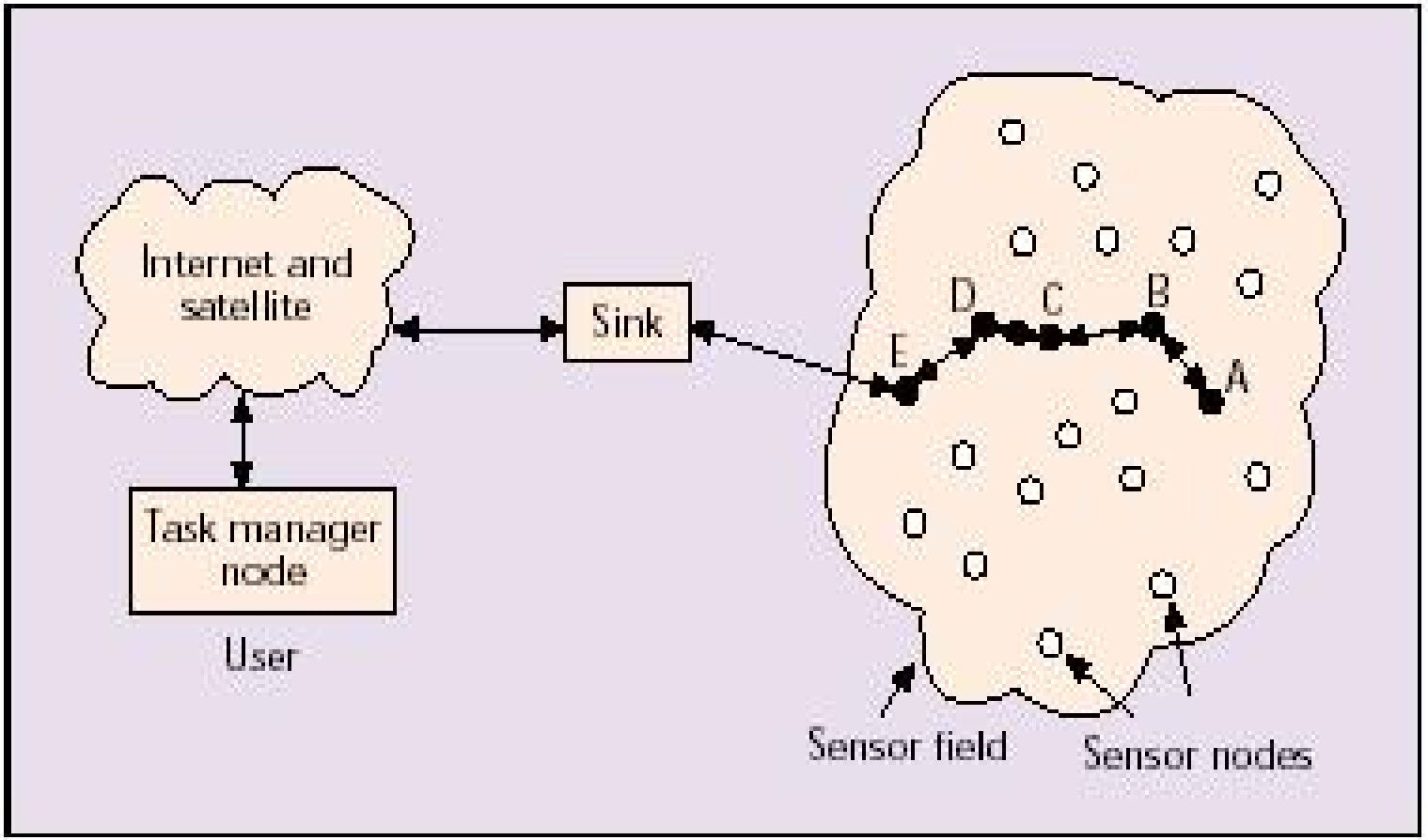
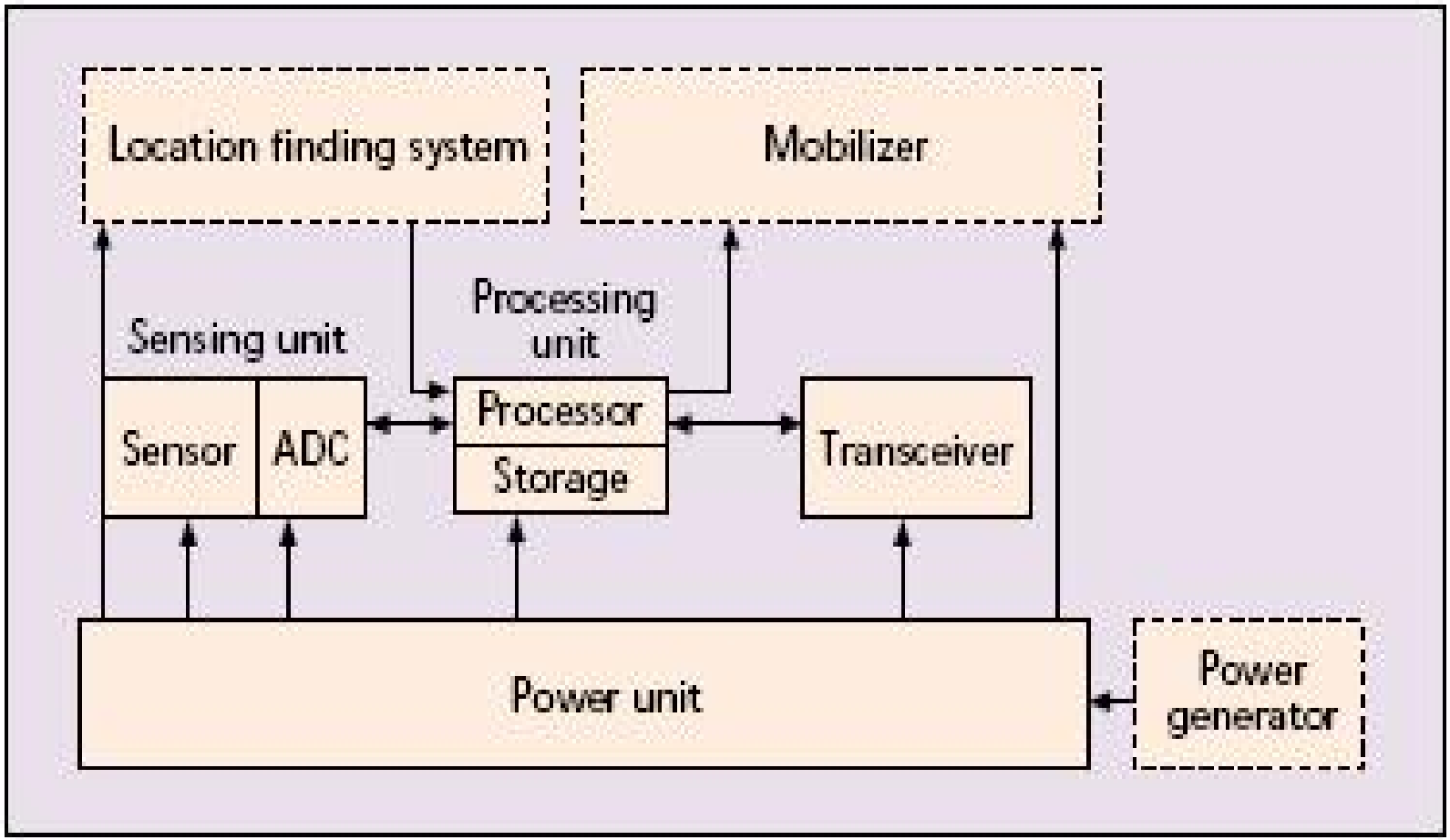
A solar-aware wireless sensor network based on low energy adaptive clustering hierarchy

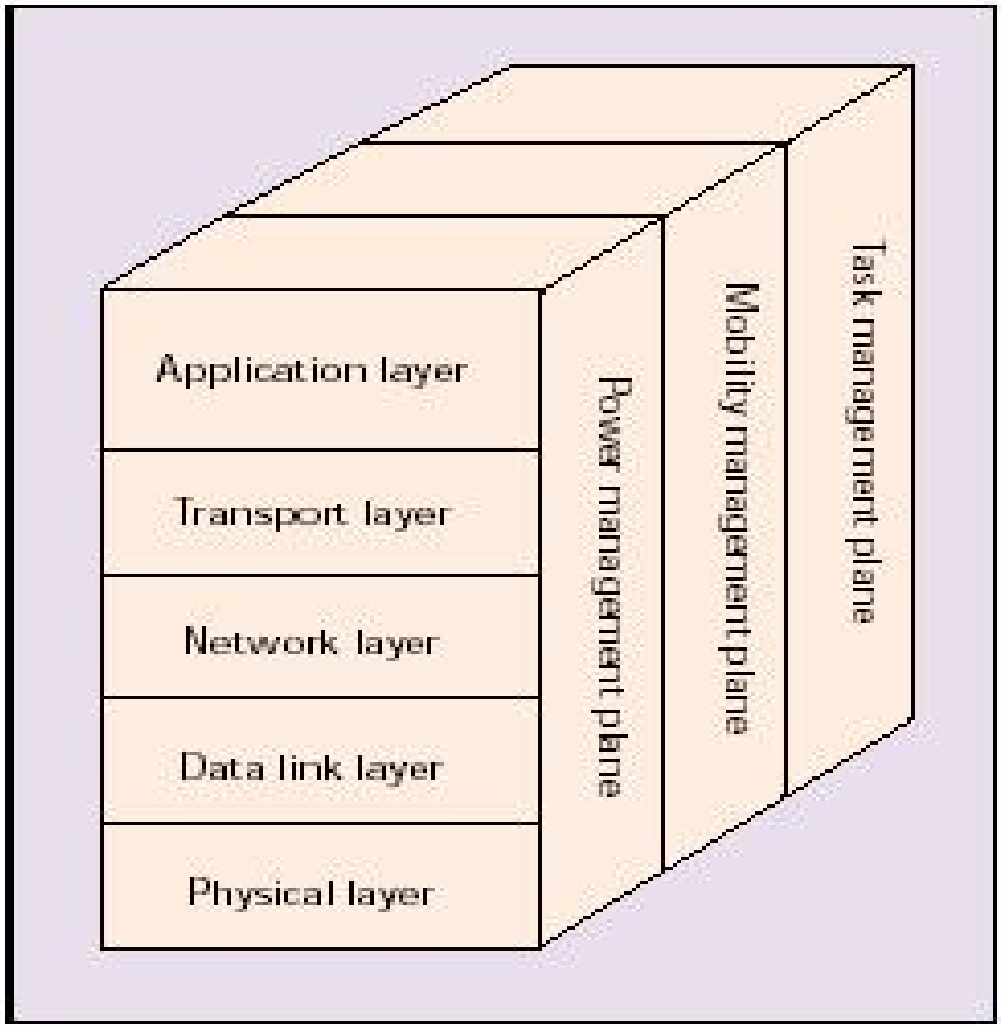
An Overview of Wireless Sensor Netw ork



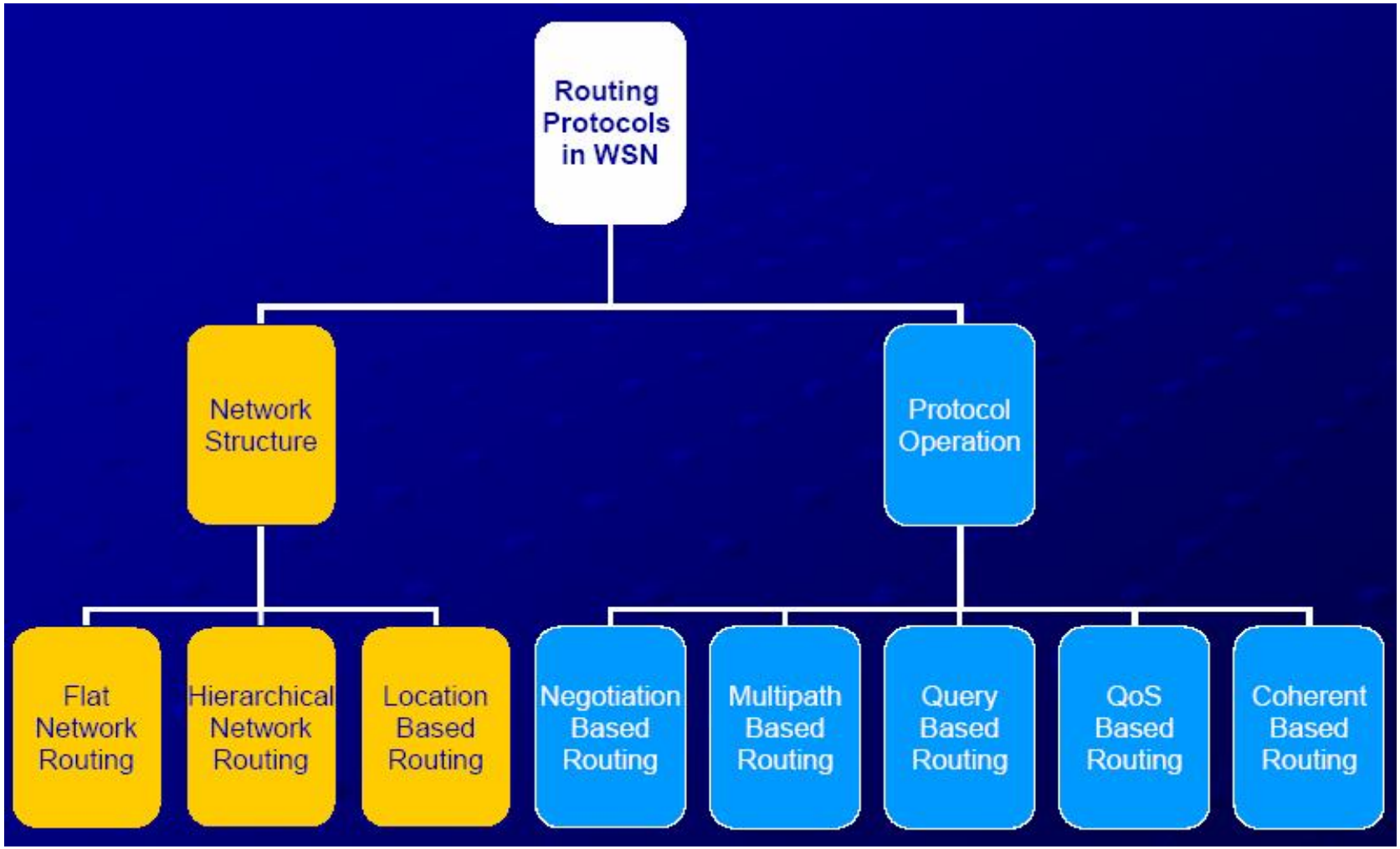
The components of a sensor node



Sensor Networks Communication Architecture



Network Layer Routing Protocols



Hierarchical Based Routing Protocol

- When sensor density increases single tier networks cause
  - Gateway overloading
  - Increased latency
  - Large energy consumption

  To allow the system to cope with additional load and to be able to cover a large area of interest without degrading the service, networking clustering has been pursued in some routing approaches.

Hierarchical Based Routing Protocol

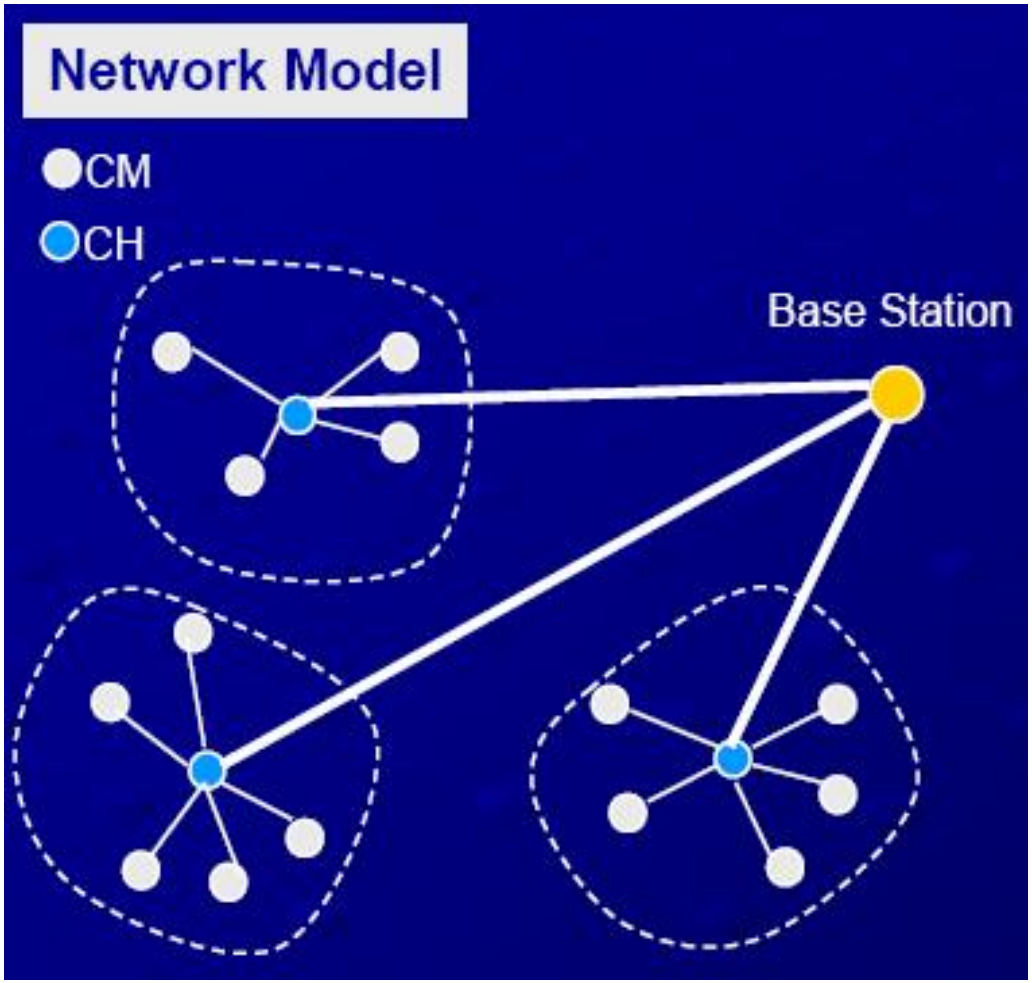
- Uses Multi - hop communication within a cluster
- Performs data aggregation and fusion on data to reduce number of transmitted messages to the sink
- Maintain the energy reserves of nodes efficiently

Examples

- **LEACH** – Low-Energy Adaptive Clustering Hierarchy
- Power-Efficient GAthering in Sensor Information Systems (**PEGASIS**)
  - Hierarchical PEGASIS
- Threshold sensitive Energy Efficient sensor Network protocol (**TEEN**)
  - Adaptive Threshold TEEN (**APTEEN**)
- Energy-aware routing for cluster-based sensor networks
- Self-organizing protocol

Low-**E**nergy **A**daptive **C**lustering **H**ierarchy **(LEACH)**

- Randomized, adaptive, self-configuring cluster formation;
- Localized control for data transfer;
- Low-energy media access control;
- Data compression and aggregation process



LEACH Algorithm Details

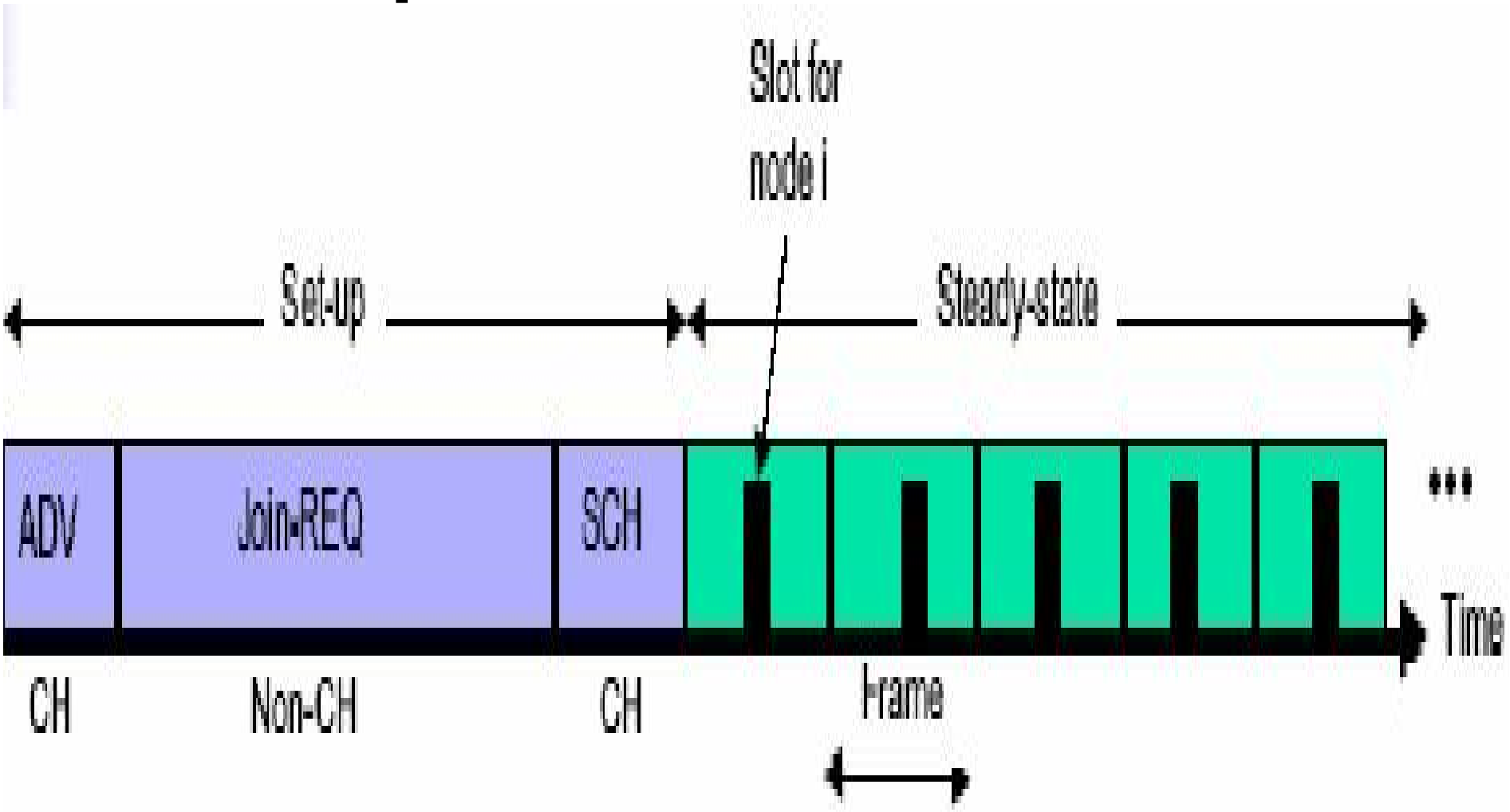
Set-up Phase

- Cluster-head advertisement
- Cluster set-Up
- Transmission schedule creation

Steady-state Phase

- Data transmission to cluster heads
- Signal processing (Data fusion)
- Data transmission to the base station

Two phases that describe the operation of LEACH



Solar-aware LEACH [sLEACH]

- use of renewable energy sources such as solar power prolong the lifetime of a sensor network
- letting nodes powered by solar energy to perform the most energy demanding tasks
- choosing solar-powered nodes as clusterheads is feasible and energy savings

Thus LEACH can be extended to become solar aware, a new version of **LEACH**, **sLEACH**

Solar-aware LEACH [sLEACH]

- Sensor nodes transmit their remaining energy level and position to the base station. They also transmit their solar status (if a node is powered by solar energy or by battery).

- Solar-driven nodes that have a high remaining energy level have a high chance of becoming cluster head. Clusterheads, chosen by the base station remain as clusterheads for a certain time called round.

OMNeT++, Discrete Event Simulator

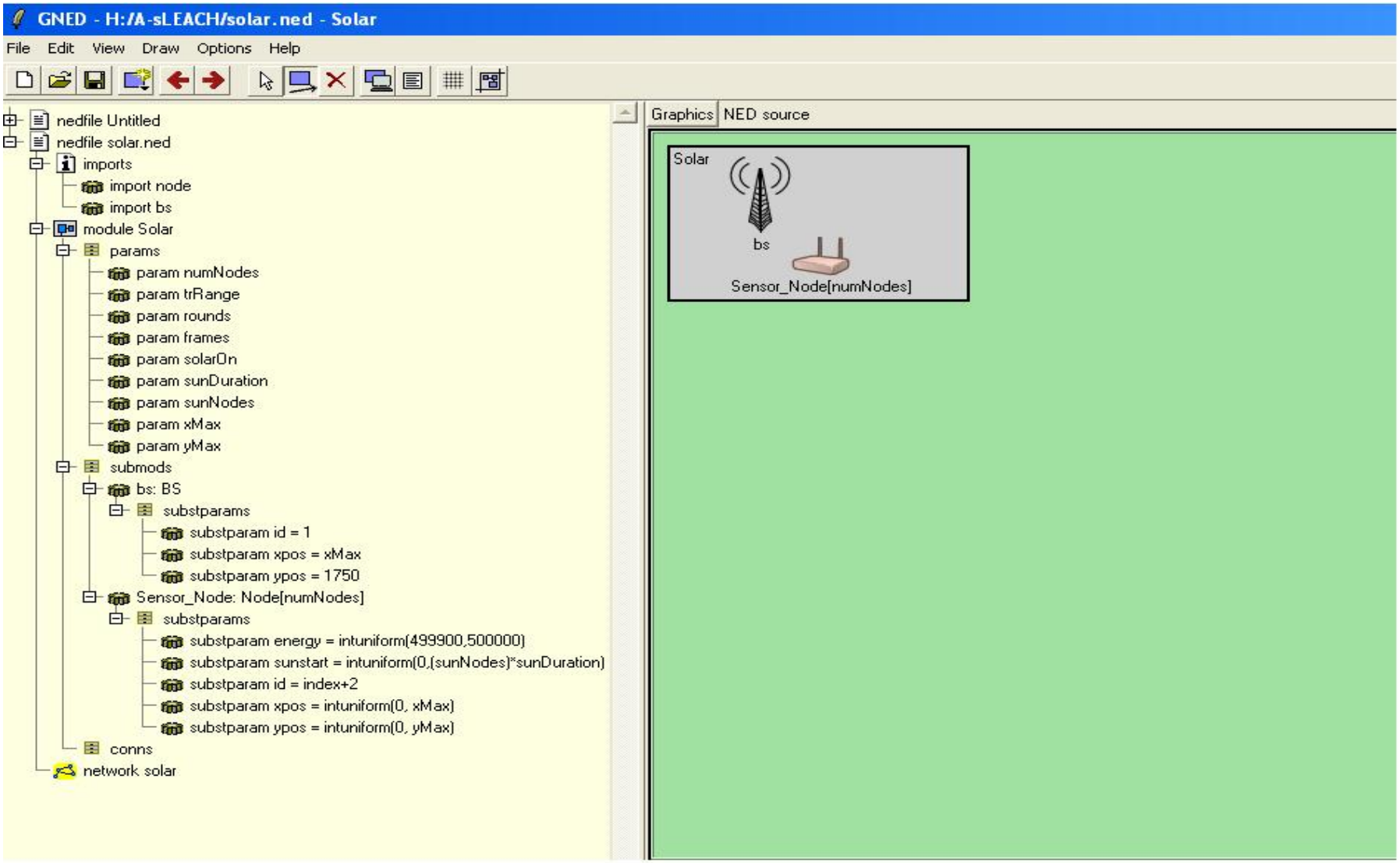
- Allow the design of modular simulation models
- Object-oriented approach allows flexibility in the simulation kernel
- Offer an extensive simulation library
- Model components are compiled and linked with the simulation library and one of the user interface libraries to form an executable program
- Simulation kernel uses C++ to be embedded in larger applications
- Models are built with **NED** and **omnetpp.ini** and do not use scripts

Building Simulation Programs

An OMNeT++ simulation model physically consists of the following parts:

- NED language topology description(s). These are files with the .ned suffix.
- Message definitions, in files with .msg suffix.
- Simple modules implementations and other C++ code, in .cpp files on Windows

Network Description File (. ned) Window

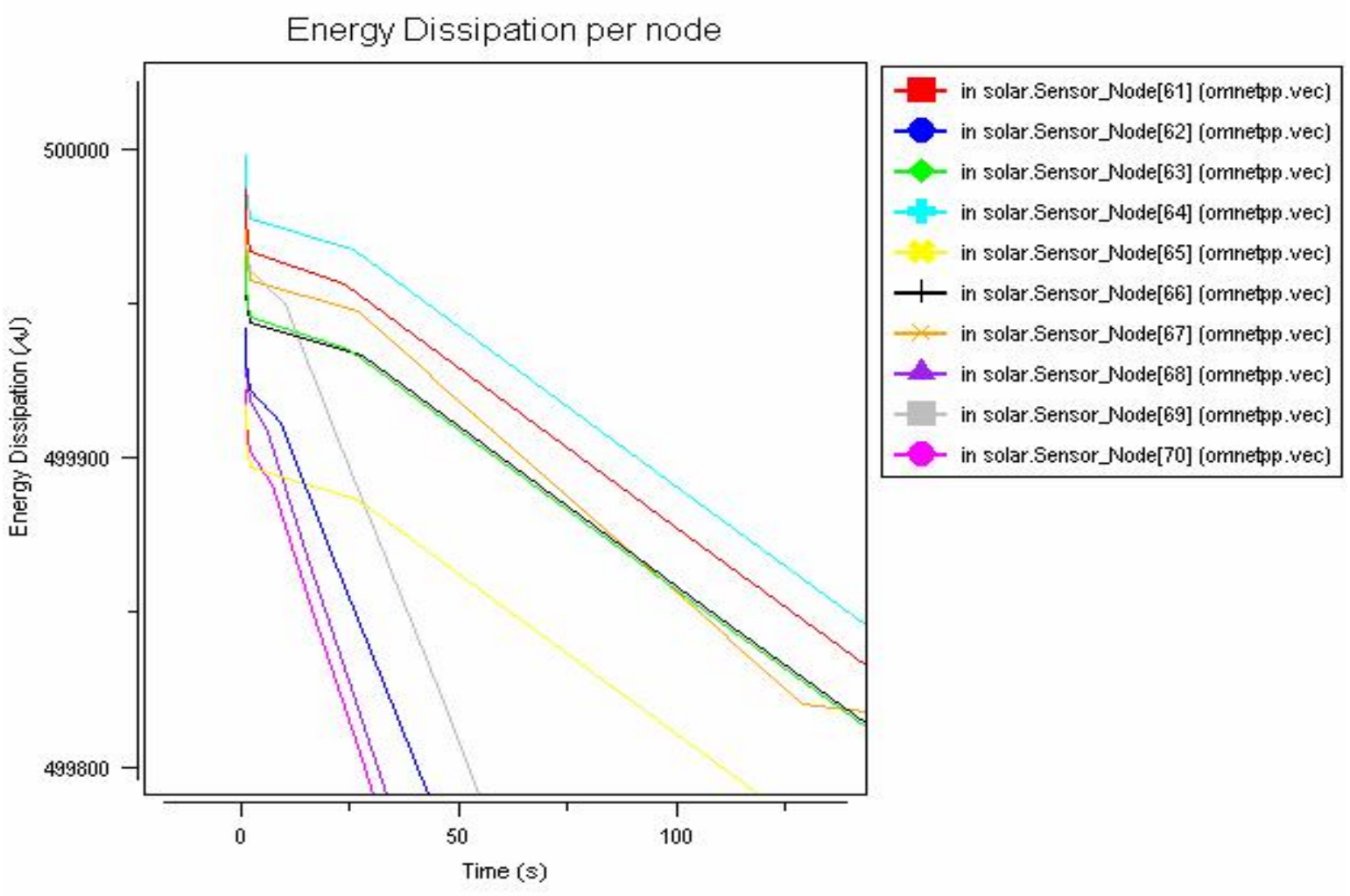


Setting Module Parameters in the Configuration File: omnetpp.ini

- solar.trRange = 190;
- solar.numNodes = 100;
- solar.xMax = 1000;
- solar.yMax = 1000;
- solar.rounds = 280;
- solar.frames = 10;
- solar.solarOn = 1;
- solar.sunDuration = 600;
- solar.sunNodes = 5;

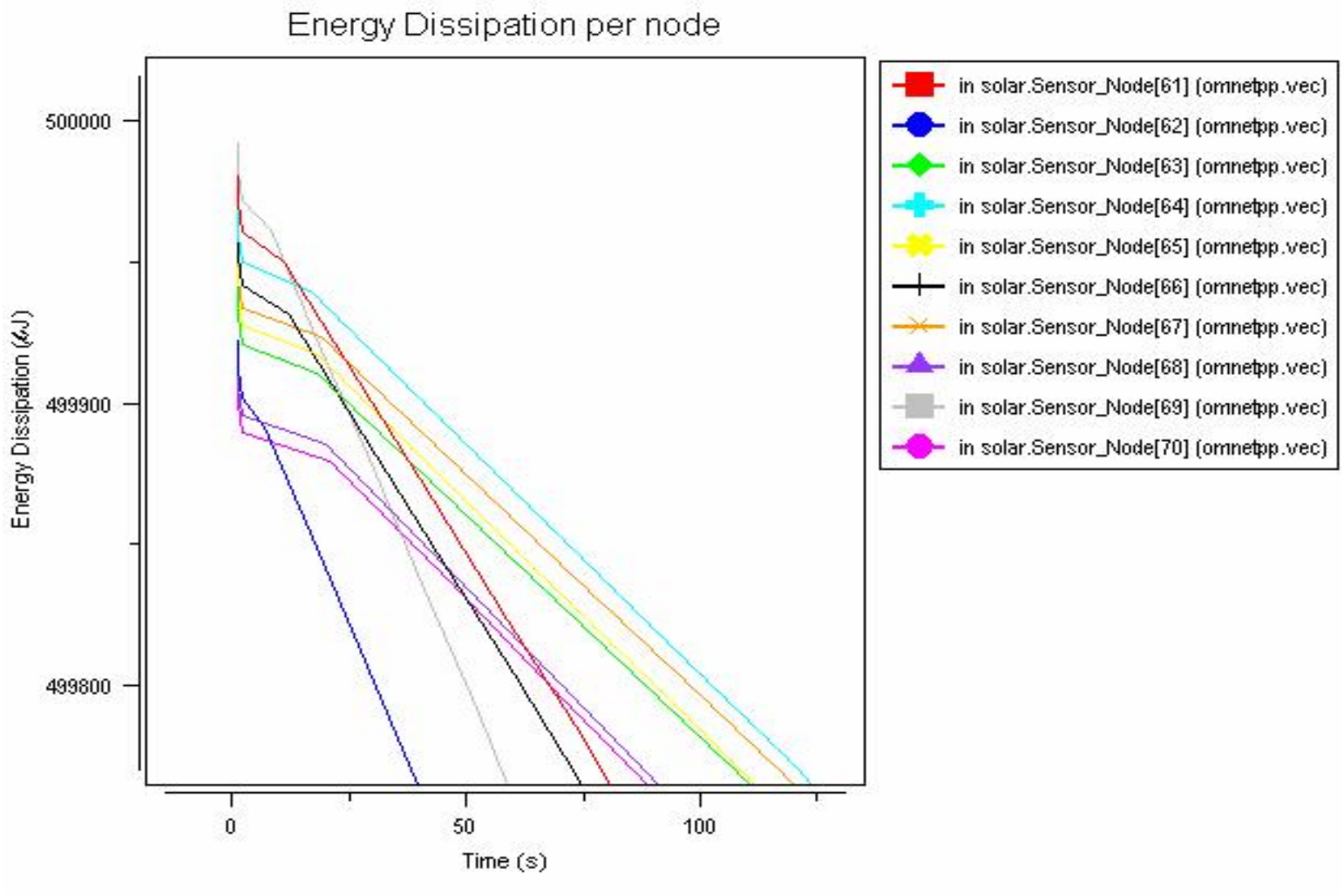
Model of Scenario for Simulation

Analyzing Simulation Results



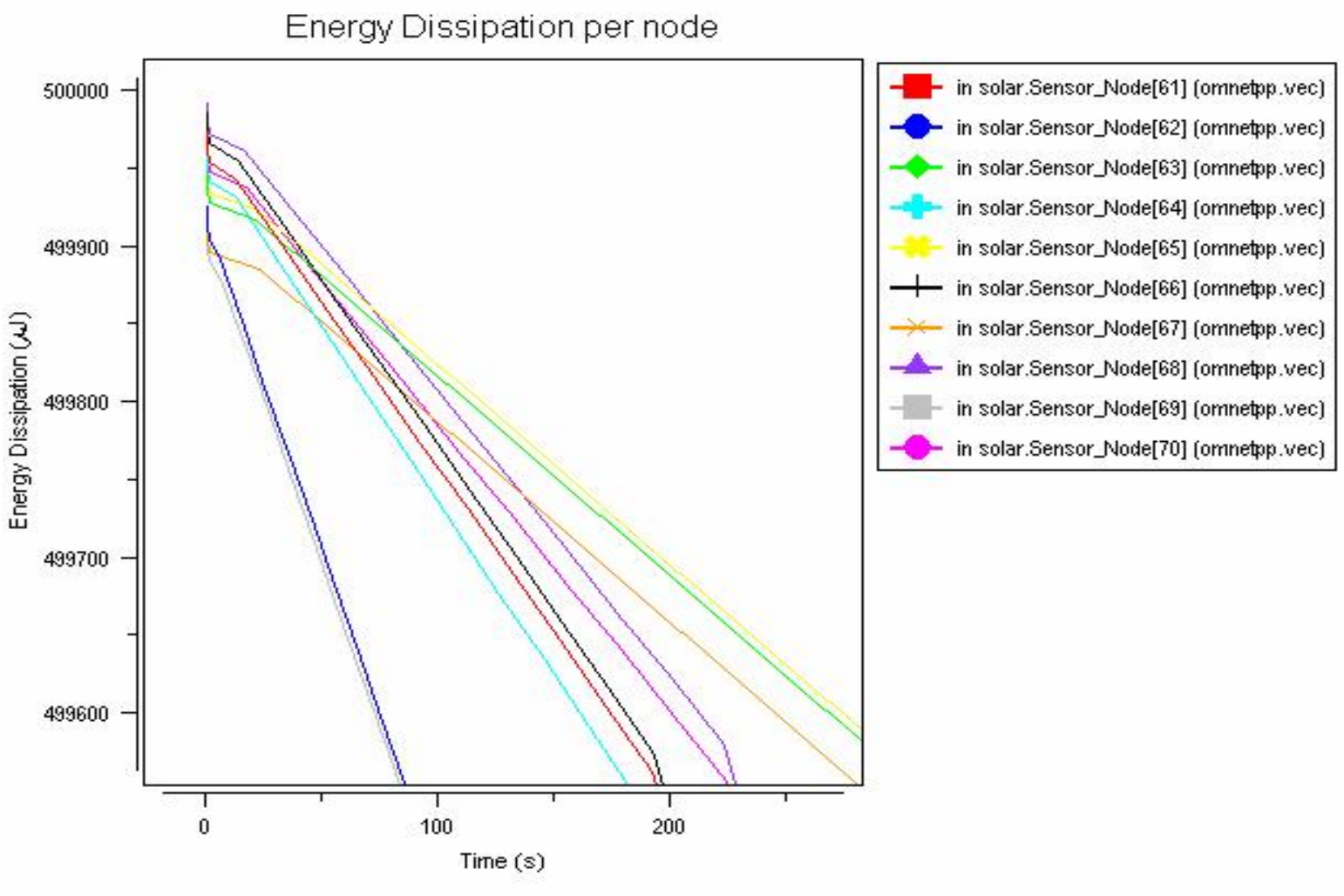
Simulation results w ith sunDuration=600

Analyzing Simulation Results



Simulation results w ith sunDuration=1200

Analyzing Simulation Results



Simulation results w ith sunDuration=2400

Output scalars are used to compare designed netw ork model behavi or under various parameter settings w hich is show n in the follow ing

Frames 10, Sun -Duration 600

solar.sunNodes	5	10	15	25
Å solar on	120F/142H	144F/157H	152F/173	162F/168H
Å solar off	104F/118H	107F/124H	117F/113H	133F/146H

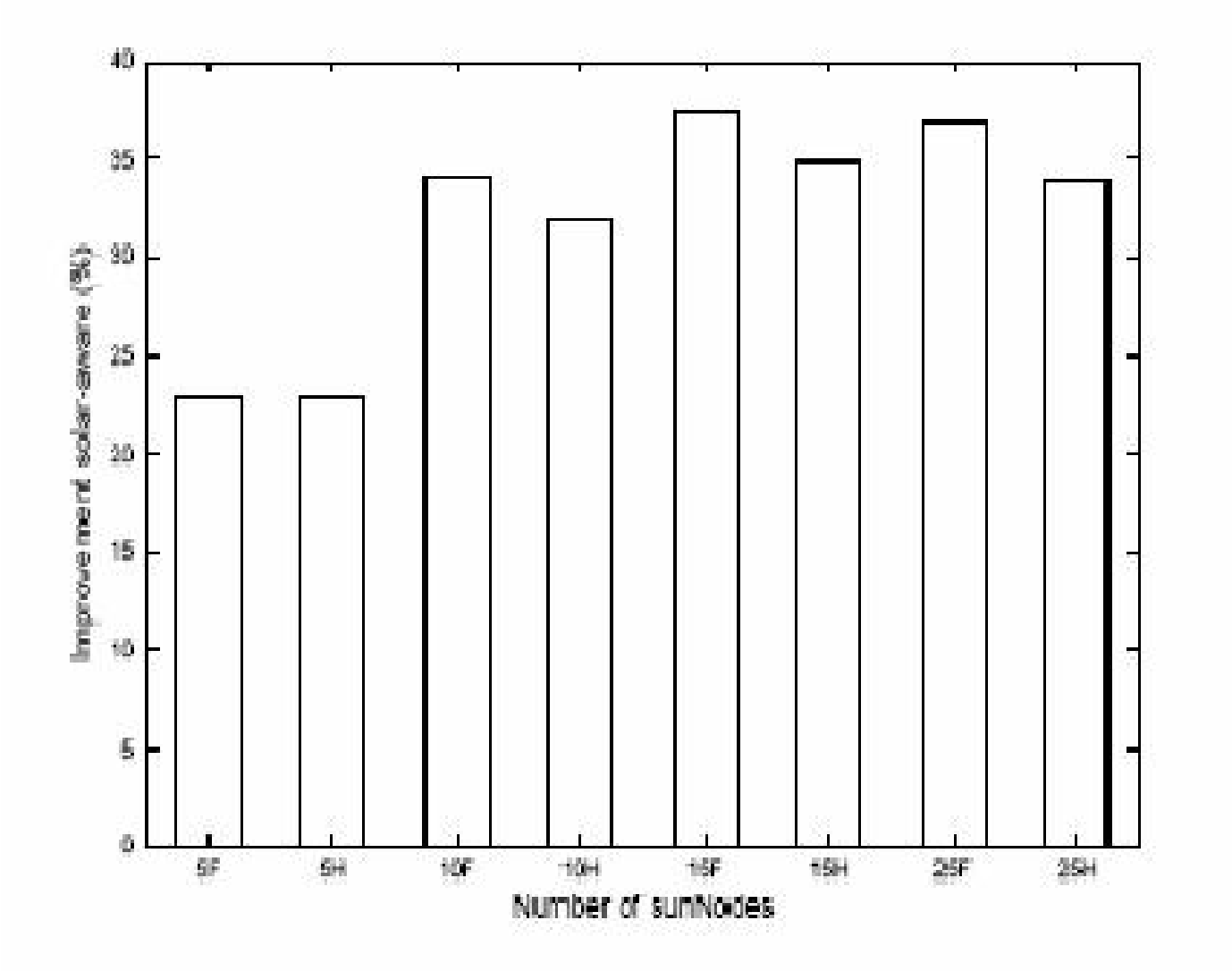
Frames 10, Sun -Duration 1200

solar.sunNodes	5	10	15	25
Å solar on	128F/150H	159F/176H	165F/193H	192F/211H
Å solar off	107F/123H	120F/139H	129F/142H	136F/159H

Frames 10, Sun -Duration 2400

solar.sunNodes	5	10	15	25
Å solar on	140F/155H	170F/190H	188F/199H	213F/235H
Å solar off	110F/127H	132F/146H	147F/165H	160F/177H

Improvement of solar-aware LEACH over the standard LEACH protocol



A solar aware sensor network has been presented. The network model has been verified through experimentation and found

- For longer sun-Duration the energy dissipatio n per node decreases with respect to time.
- When the node is solar powered, the number of rounds (until the first node dies) increase with increased sun-Nodes.

These features led to design solar-aware LEACH [sLEACH]. So, letting sensor nodes powered by solar energy to perform the most energy demanding tasks in sensor networks significantly extends the lifetime of sensor networks.

THANK YOU ALL