Topology Comparision in Wireless Sensor Network MAC Protocol

Divya Jain[1], Ashish Jirapure[2],Nitin Pathak[3],Apeksha Murkute[4]
1 *Dept. of E. T.C. Engineering*, P. C. E , Nagpur, India
jaindivya.26@gmail.com
2 *Dept. of E. T.C. Engineering*, P. C. E , Nagpur, India
ashish_jirapure@rediffmail.com
3 *Dept. of E. E., M.I.E.T.*, Gondia, India
hi.pathak1@gmail.com
4 *Dept. of E. T.C. Engineering*, P. I. E. T., Nagpur, India
apeksha_murkute@rediffmail.com

Abstract— **A Wireless Sensor Network comprises of number of nodes distributed over an area to collect information. The sensor nodes communicate among themselves through the wireless channel and forward the collected data to its one-hop distant neighboring node. These nodes are normally battery operated. But as these nodes are placed in such conditions that charging or replacing battery of these nodes are nearly impossible, energy consumption becomes a major factor. Here we are creating a network once with Sensor-MAC (SMAC) and again with Sensor-MAC with sleep schedule. After simulating these networks in different topologies network of SMAC-L is found to give better results in life time and energy consumption when compared to network of SMAC.**

***Keywords*—Global Sleep Schedule, Medium Access Control Protocol, Sensor-MAC (SMAC), Sensor-MAC with sleep schedule (SMAC-L). Wireless Sensor Network**

I. Introduction

As the name explains Wireless Sensor Network is nothing but a network of sensors which are used to sense different conditions. These collected data is sent to the destination via different nodes. The nodes in the network communicate among themselves to pass the data to destination. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance. They are now used in many industrial and civilian application areas, including industrial process monitoring and control, machine health monitoring, environment and habitat monitoring, healthcare applications, home automation and traffic control.

Each node in a sensor network is typically equipped with a radio transceiver or other wireless communications device, a small microcontroller, and an energy source, usually a battery. A sensor node might vary in size from that of a shoebox down to the size of a grain of dust. The cost of sensor nodes also varies greatly depending on the size of the sensor network and the complexity required of individual sensor nodes. Size and cost of sensor nodes decides such as energy, memory, computational speed and bandwidth.[1]

In the network created for this paper each node can communicate with its one-hop distant node only. The distance between each node is 250 meters.

II. CHARACTERISTICS OF WSN

The unique characteristics of WSN as stated in [2] include:

- Power consumption constrains for nodes using batteries or energy harvesting.
- Ability to withstand harsh environmental conditions.
- Ability to cope with node failures.
- Mobility of nodes.
- Dynamic network topology.
- Communication failures.
- Scalability to large scale deployment.
- Unattended operation.
- Easy to use.

III. energy consumption in mac protocol

Here we are trying to make a network of sensors such that they are more energy efficient and has a longer life span. In this concern we must know that in sensors where the energy is consumed.

Usually the sensors are battery operated. As they are deployed in such areas the replacing or recharging battery is almost impossible efficient energy consumption becomes a major factor.

Generally we think that most of the energy consumed would be in sending and receiving the data. But in reality transmission of data consumes same amount of energy as that in idle state i.e. it consumes very less energy. Greater part of energy consumed is actually wasted in different forms. As cited in [3] the energy wastage is caused in:

- **Collision:** The first one is the collision. When a transmitted packet is corrupted due to interference, it has to be discarded, and the follow-on-retransmissions increase energy consumption. Collision increases latency also.

- **Overhearing:** The second is overhearing, meaning that a node picks up packets that are destined to other nodes.

- **Packet Overhead:** The third source is control packet overhead. Sending and receiving control packets consumes energy too, and less useful data packets can be transmitted.

Idle Listening: The last major source of inefficiency is idle listening i.e., listening to receive possible traffic that is not sent. This is especially true in many sensor network applications. If nothing is sensed, the sensor node will be in idle state for most of the time. The main goal of any MAC protocol for sensor network is to minimize the energy waste due to idle listening, overhearing and collision.

IV. SMAC PROTOCOL

A detailed description of SMAC can be found in [4] here we are having a brief over look of it. We have already learnt how energy is wasted in MAC layer. In SMAC the nodes follow an active-sleep schedule to save energy. In [5] detail of modified SMAC is given namely SMACL. In this the node goes off to sleep for a particular span of time and then become active again for particular time. The node generally goes to sleep when it is not involved in transmission of data. We know that a node consumes same amount of energy whether it is involved in transmission or when it is idle. So when the node is not involved in transmission it turns off its radio and goes to sleep so that energy is saved. Each node follows a particular active-sleep cycle.

In details of MAC layer we study that its frame format consists of SYNC packets, Ready-to-Send (RTS) and Clear-to-Send (CTS). The node decides its sleep schedule and then broadcast it in the network so that others nodes can come to know about it. As the nodes go to sleep chances of collision reduces hence energy wastage due to collision is also reduced.

V. SIMULATION ANALYSIS

Here we have designed a network of 25 nodes first with 25 SMAC nodes and then with 25 SMACL nodes. The topologies designed are Matrix topology and Random topology. All the nodes in the network follow the same duration of active and sleep schedule. We have used network Simulator 2 NS-2 for its simulation. The expected result was a less consumption and longer life span of SMACL network. A few parameters for this simulation are listed below.

A. Parameters

The parameters as cited in [5] are:

a) *SMAC/SMACL Parameters:* The duty cycle used here is 10%. It is the maximum range NS2 provides. Duty cycle determines the energy depletion rate.

b) *Radio Parameters:* Omni directional antenna of range 1.5 meters is used about the node. The radio module is 914 MHz Lucent Waveland DSSS radio interference.

c) *Network Topology:* the distance between the adjacent nodes is 250 meters. The node can communicate with its one-hop distant neighbour node only.

d) *Traffic Model:* Every non base station node keep sending a 512 bytes packet to the base station every 200 second.

e) *Energy Model:* The base station used in simulation has infinite energy. The default Energy model of wireless node in NS2 is used in simulations. The different levels of Energy consumption for different operations are defined in the following:

- Idle state: 0.05 watt
- Sleep state: 0.001 watt
- State transition from sleep to idle: 0.2 watt
- Transition time (sleep to idle): 0.5 sec
- Receive power: 0.3 watt
- Transmit power: 0.6 watt

B. Simulation

All the nodes in the designed network follow the same sleep schedule. They have the same active duration and sleep duration. When any node wants to transmit data it broadcast the SYNC packet. Then it tracks the shortest path to the destination node and starts sending data through that path. The nodes can transmit data to its one hop distance neighbor only. The nodes that are involved in transmission of data remain active till the complete transmission while other nodes follow their sleep schedule. If there is some node whose sleep time is about to start but it is receiving data and it is not the destination node then that node will go to sleep only after it has transmitted the received data. Hence its sleep schedule changes. The node then broadcast its schedule so that al the neighboring node can update the schedule.

VI. RESULT

The simulation results of network with the above stated parameters shows that the life time of nodes in random topology is better than that of matrix topology. Figure 1 and 2 shows the energy graph of nodes in matrix topology without sleep schedule and with sleep schedule respectively. Figure 3 and 4 shows the energy graph of nodes in random topology without sleep schedule and with sleep schedule respectively. Figure 5 and 6 shows the comparative graph of Throughput of generating packet Vs simulation time of matrix and Random topology without sleep schedule and with sleep schedule respectively.

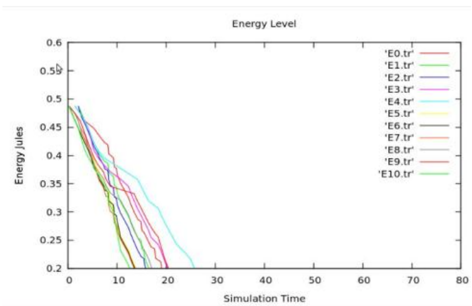

Figure 1: Energy graph of Matrix topology without sleep schedule.

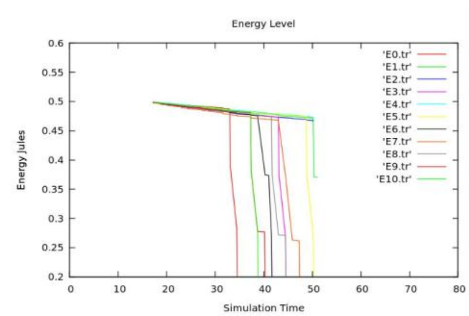

Figure 2: Energy graph of Matrix topology with sleep schedule

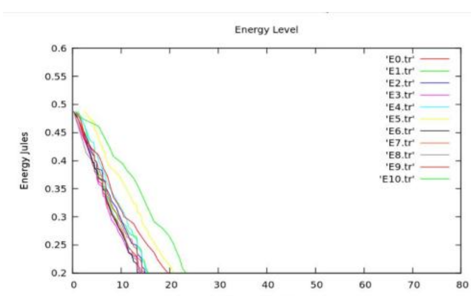

Figure 3: Energy graph of Random topology without sleep schedule

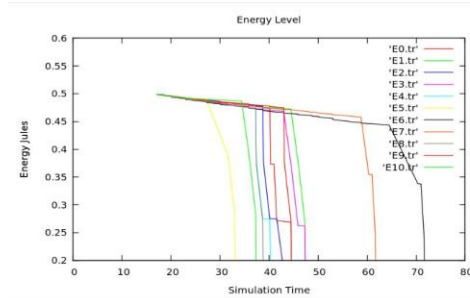

Figure 4: Energy graph of Matrix topology without sleep schedule

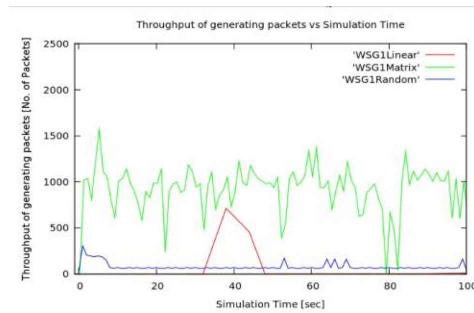

Figure 5: Throughput of generating packets Vs Simulation time without sleep schedule.

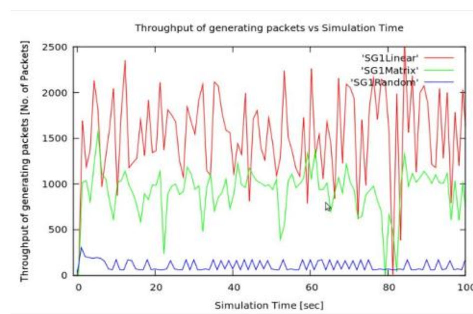

Figure 6: Throughput of generating packets Vs Simulation time with sleep schedule.

VII. CONCLUSION

In this paper, we have seen the impact of sleep schedule in SMAC protocol in both random and matrix topology. Our simulation results as seen in graph shows that energy consumption of node with sleep schedule is very less as compared to node without sleep schedule. The throughput of generating packet is also much better of node with sleep schedule.

References

[1] http://en.wikipedia.org/wiki/Wireless_sensor_network

[2] Akyidiz, I.F., Wang, X, "A Survey on Wireless Mesh Network" *IEEE Radio Communication*, **volume**, 43, Sep 2005.

[3] Rajesh Yadav, Shirshu Varma, N. Malaviya, "A Survey of MAC Protocols for Wireless Sensor Networks" *Ubicc Journal*, **volume**, 4, Number 3, August 2009.
[4] Wei Ye, John Heidemann, Deborah Estrin, "medium Access Control with Coordinated, Adaptive Sleeping for Wireless Sensor Networks" *USC/Information Sciences Institute*, January 2003.
[5] Zhang, Lei, Ghosh, Somnath, Veeraraghavan, Prakash, Singh, Samar. "An Energy Efficient Wireless Sensor MAC Protocol with Global Sleeping Schedule" *In Computer Science and its Application, 2008. CSA '08. International Symposiu*, October 2008.