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# Design and Implementation of Wireless Sensor Network by Using OPNET

Madhu Bala [1], Mahesh Singh [2]
Department of Computer Science Engineering, Assistant Professor [2]
A.I.T.M. College Palwal
Haryana - India

**ABSTRACT**
Wireless sensors network (WSN) is the collection of homogenous, self organized nodes known as sensor nodes. These nodes have the event sensing capabilities, data processing capabilities.WSN have unique characteristics like dynamic topology, wireless radio medium, limited resources and lack of centralized administration; as a result, they are vulnerable to different types of attacks in different layers of protocol stack. Each node in a WSN is capable of acting as a router. The necessity for a secure WSN networks is powerfully tied to the security and privacy features. There had been considerable research in the field of increasing the performance of network by using routing protocols. Some attacks affect the network by decreasing the network performance. Previously there had been considerable research in the field of increasing the performance of network by using routing protocols.
In our research work we are improving the performance of network is measured with respect to the QualNET parameters like throughput, retransmission attempts, network load and media access delay. OPNET (Optimized Network Engineering Tool) MODELER 16.0 is used for simulation. In this chapter firstly introduce the basic concepts behind the emerging area of Wireless Sensor Networks (WSN) such as, network components of Wireless Sensor Networks, Mobility models and its standards ,at the same time we also present an overview of the its applications and security challenges.
***Keywords:***— WSNs ,QualNET, Throughput, OPNET, NCTUns

## I . INTRODUCTION

Wireless sensors network (WSN) is the collection of homogenous, self organized nodes known as sensor nodes. These nodes have the event sensing capabilities, data processing capabilities. The components of sensor node are integrated on a single or multiple boards, and packaged in a few cubic inches. A wireless sensor network consists of few to thousands of nodes which communicate through wireless channels for information sharing and cooperative processing. A user can retrieve information of his/her interest from the wireless sensor network by putting queries and gathering results from the base stations or sink nodes. The base stations in wireless sensor networks behave as an interface between users and the network. Wireless sensor networks can also be considered as a distributed database as the sensor networks can be connected to the Internet, through which global information sharing becomes feasible. Wireless Sensor Networks consist of number of individual nodes that are able to interact with the environment by sensing physical parameter or controlling the physical parameters, these nodes have to collaborate in order to fulfil their tasks as usually, a single node is incapable of doing so and they use wireless communication to enable this collaboration.

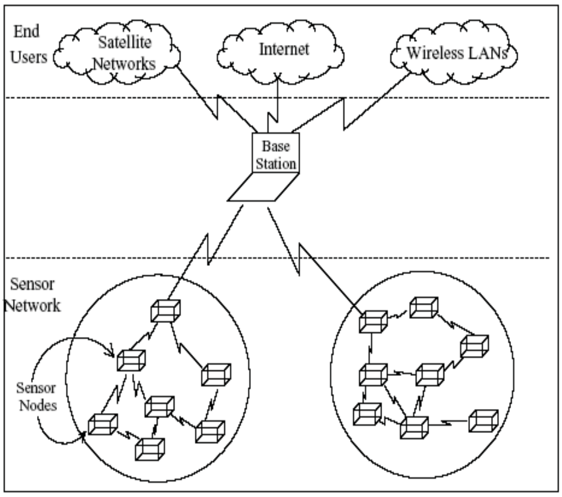


Figure1. Wireless Sensor Network

## II . WIRELESS SENSOR NETWORK MODEL

The major components of a typical sensor network are:

Sensor Field: A sensor field is the area in which the all sensors nodes are placed. Sensor nodes: Sensor node has capabilities of event sensing, data processing and communication capabilities.

Sink: A sink is a sensor node with the specific task of data receiving, data processing and data storing from the other sensor nodes. They serve to reduce the total number of messages that need to be sent, hence reducing the overall energy requirements of the network. Sinks are also known as data aggregation points.

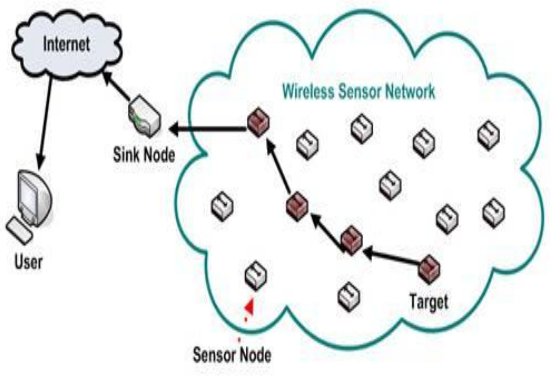


Figure 2: Wireless Sensor network model

Task Manager: The task manager also known as base station is a centralised point of control within the network that extracts information from the network.

# III. LITERATURE REVIEW

Sonam Palden.et al; (2012): In this paper authors proposed a novel energy efficient routing protocol. The proposed protocol is hierarchical and cluster based. In this protocol, the Base Station selects the Cluster Heads (CH). The selection procedure is carried out in two stages. In the first stage, all candidate nodes for becoming CH are listed, based on the parameters like relative distance of the candidate node from the Base Station, remaining energy level, probable number of neighboring sensor nodes the candidate node can have, and the number of times the candidate node has already become the Cluster Head. The Cluster Head generates two schedules for the cluster members namely Sleep and TDMA based Transmit. The data transmission inside the cluster and from the Cluster Head tothe Base Station takes place in a multi-hop fashion. They compared the performance of the proposed protocol with the LEACH through simulation experiments. and observation is that the proposed protocol outperforms LEACH under all circumstances considered during the simulation. As a future scope they state that, the protocol can be enhanced for dealing with mobility of nodes. Even effort can be made to decide the number of clusters dynamically and this may give better scalability to the protocol for dealing with very large wireless sensor networks.

# IV. METHODOLOGY

This section describes the simulation tool used along with the proposed method.

### A. *Simulation tool used:*

Simulation is three phase process which includes the designing of a model for theoretical or actual system followed by the process of executing this model on a digital computer and finally the analysis of the output from the execution. Simulation is learning by doing which means that to understand/ learn about any system, first we have to design a model for it and execute it. To understand a simulation model first we need to know about system and model. System is an entity which exists and operates in time while model is the representation of that system at particular point in time and space. This simplified representation of system used for it better understating. In wireless sensor network there are many simulation tools are used for simulation purpose describe as below:

### *B. Simulation Setup:*

A. **NCTUns:** NCTUns (National Chiao Tung University Network Simulation) is a simulator that combines both traffic and network simulator in to a single module that built using C++ programming language and support high level of GUI support. It is a highly extensible and robust network simulator in no need to be concerned about the code complexity.

B. **NS-2(Network Simulator):** Network Simulator (Version 2), called as the NS-2, is simply an event driven , open source ,portable simulation tool that used in studying the dynamic nature of communication networks. Users is feeding the name of a TCL simulation script as an input argument of an NS-2 executable command ns. NS-2 consists of two key languages one is the C++ and second is the Object-oriented Tool Command Language (OTCL).

C. **OPNET (Optimized network engineering tool):** OPNET is a commercial network simulator environment used for simulations of both wired and wireless networks. It allows the user to design and study the network communication devices, protocols and also simulate the performance of routing protocol. This simulator follows the object oriented modelling approach. It supports many wireless technologies and standards such as,IEEE 802.11 , IEEE 802.15.1, IEEE 802.16, IEEE 802.20 and satellite networks.

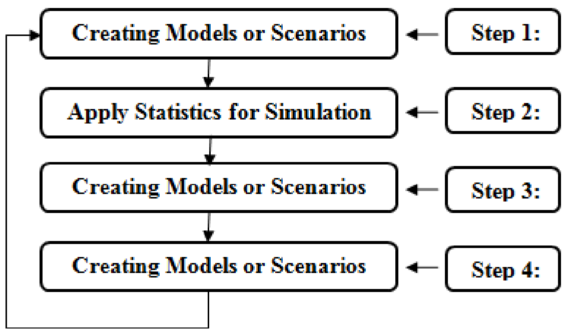

Figure 3: Flow chart of OPNET

Table1: WSN Simulation Parameters

| **Simulation Parameters** | |
|---|---|
| Examined Protocols | OLSR and DSR |
| Number of Nodes | 100,150,200, 250 and 300 |
| Types of Nodes | Static, Mobile |
| Simulation Area | 50*50 KM |
| Simulation Time | 3600 seconds |
| Pause Time | 200 s |
| Performance Parameters | Throughput, Delay, Network load |
| Traffic type | FTP |
| Mobility model used | Random waypoint |
| Data Type | Constant Bit Rate (CBR) |
| Packet Size | 512 bytes |
| Trajectory | VECTOR |
| Long Retry Limit | 4 |
| Max Receive Lifetime | 0.5 seconds |
| Buffer Size(bits) | 25600 |
| Physical Characteristics | IEEE 802.11g (OFDM) |
| Data Rates(bps) | 54 Mbps |
| Transmit Power | 0.005 |
| RTS Threshold | 1024 |
| Packet-Reception Threshold | -95 |

Table 2:WSN Scenario used

| **Scenarios** | **Nodes and Its Types** | **Protocol** |
|---|---|---|
| Scenario 1 | 100 Static Nodes | OLSR |
| Scenario 2 | 100 Static Nodes | DSR |
| Scenario 3 | 150 Static Nodes | OLSR |
| Scenario 4 | 150 Static Nodes | DSR |
| Scenario 5 | 200 Static Nodes | OLSR |
| Scenario 6 | 200 Static Nodes | DSR |
| Scenario 7 | 250 Static Nodes | OLSR |
| Scenario 8 | 250 Static Nodes | DSR |
| Scenario 1 | 100 Mobile Nodes | OLSR |
| Scenario 2 | 100 Mobile Nodes | DSR |
| Scenario 3 | 150 Mobile Nodes | OLSR |
| Scenario 4 | 150 Mobile Nodes | DSR |
| Scenario 5 | 200 Mobile Nodes | OLSR |
| Scenario 6 | 200 Mobile Nodes | DSR |
| Scenario 7 | 250 Mobile Nodes | OLSR |
| Scenario 8 | 250 Mobile Nodes | DSR |

Each scenario was run for 3600 second (simulation time). All the simulations show the required results. Under each simulation we check the behavior of OLSR and DSR. Main goal of our simulation was to model the behavior of the routing protocols. We collected DES (global discrete event statistics) on each protocol and Wireless LAN. We examined average statistics of the delay, network load and throughput for the MANET. A campus network was modeled within an area of 2000 m x 2000 m. The mobile nodes were spread within the area. We take the FTP traffic to analyze the effects on routing protocols. We configured the profile with FTP application. The nodes were wireless LAN mobile nodes with data rate of 11Mbps.

This section describes the simulation tool used along with the proposed method.OPNET modeler v14.5 is extensive and a very powerful simulation tool with wide variety of possibilities. The entire heterogeneous networks with various routing protocols can be simulated using OPNET. High level of user interface is use in OPNET which is constructed from C and C++ source code blocks.

## V. RESULT

A. ***End to End Delay:***: The packet end to end delay is the average time that packets take to traverse in the the network [18, 19]. This is the time from the generation of the packet by the sender node up to their reception at the destination and is expressed in seconds. Hence all the delays in the network are called packet end-to-end delay. It includes all the delays in the network such as propagation delay (PD), processing delay

(PD), transmission delay (TD), queuing delay (QD).It is shown in **figure 4** below..

B. ***Network Load:*** Network load can be described as the total amount of data traffic being carried by the network [18, 19] .When there is more traffic coming on the network, and it is difficult for the network to handle all this traffic so it is called the network load.

C. ***Throughput:*** Throughput can be defined as the ratio of the total amount of data reaches a destination from the source [18, 19]. The time it takes by the destination to receive the last message is called as throughput. It is expressed as bytes or bits per seconds (byte/sec or bit/sec). There are some factors that affect the throughput such as; changes in topology, availability of limited bandwidth, unreliable communication between nodes and limited energy. A high throughput is absolute choice in every network. Throughput can be represented mathematically as in equation (ii).

$$\text{Throughput} = \frac{\text{Number of delivered packets} * \text{packets size} * 8}{\text{Total deuation of simulation}}$$

………… (ii)

D. Total higher layer data traffic (in bits/sec) dropped by the all the WLAN MACs in the network as a result of consistently failing retransmissions. Jammers could affect the network by increasing Data dropped of network as shown in Fig. 6 and 7.

***A.*** **Network Load:** Figure 8 and 9 shows that the network load of the normal network is noted as 22,340 bits/sec and with the jamming nodes in the network it is noted as 25840 bits/sec. The jamming attacker nodes drop the packets and not forwarding the packets for the other nodes. It is shown in **figure 5** below

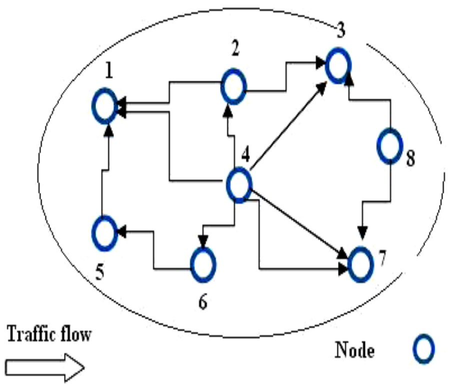


Figure 5: Network Load

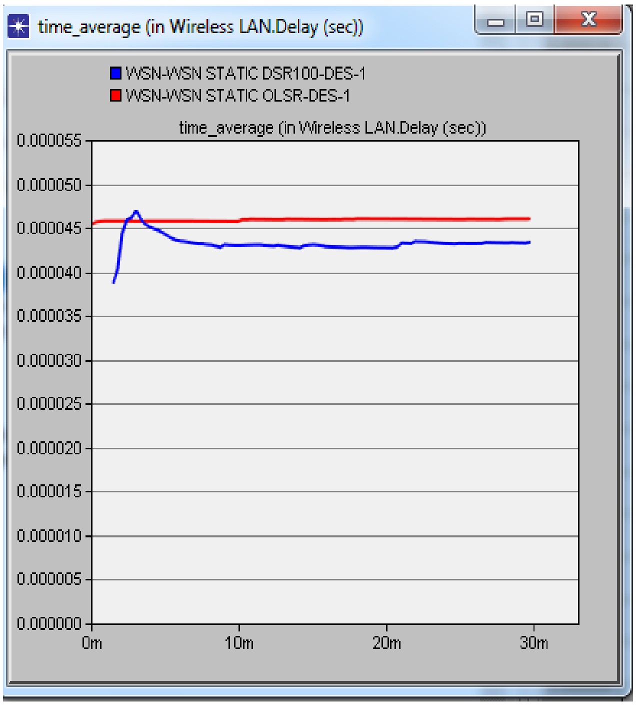


Figure 4: End to End Delay of OLSR and DSR for 100 Static nodes

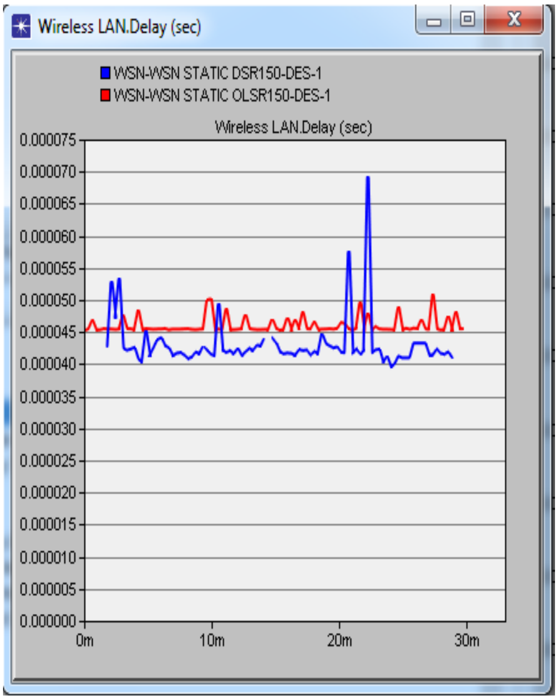


Figure 6: Network load of OLSR and DSR for 100 Static node

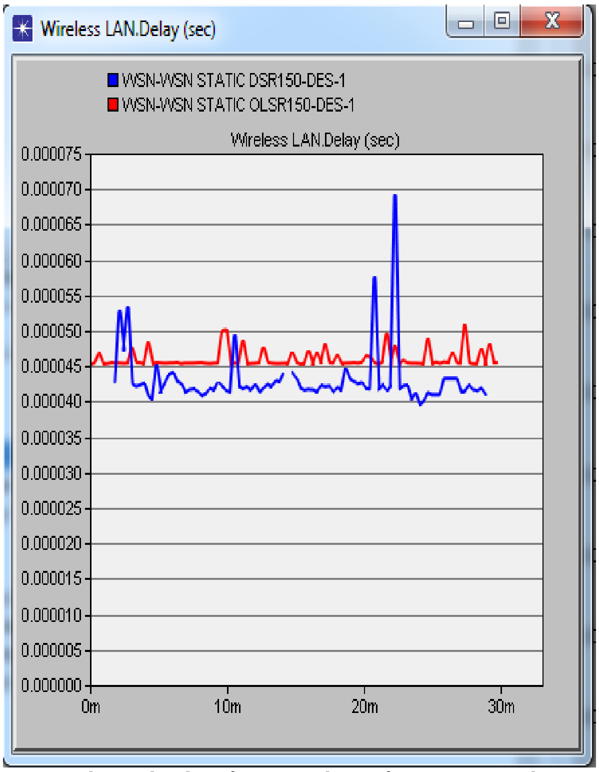


Figure 7: End to End Delay of OLSR and DSR for 150 Static nodes

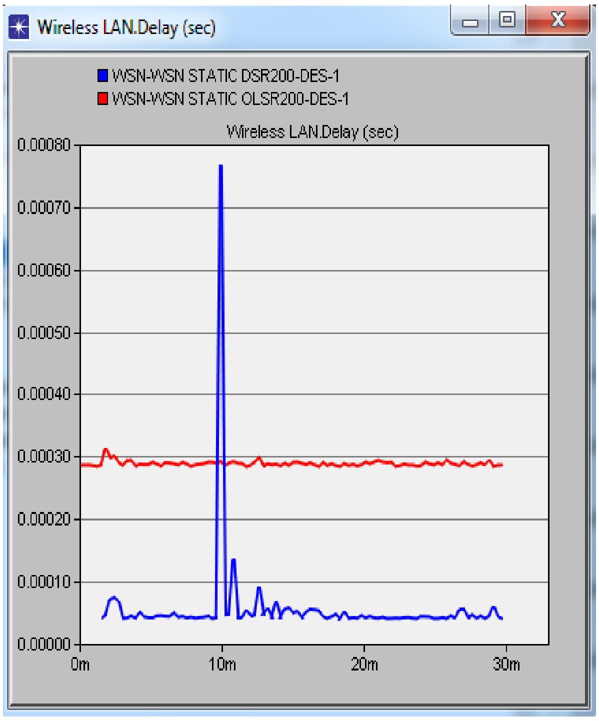


Figure 8: End to End Delay of OLSR and DSR for 200 Static node

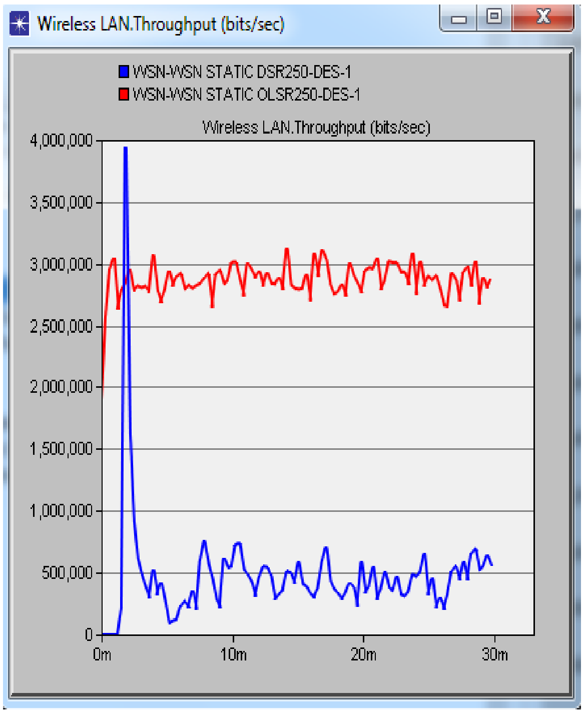


Figure 9: Throughput of OLSR and DSR for 250 Static nodes.

## VI. CONCLUSION

In this study, we have evaluated two routing protocols for their responses to node failure and network scalability with respect to their throughput, packet end-to-end delay and routing overhead as a performance metrics. The selected performance metrics were subjected to identify protocols effectiveness and suitability in terms of reliability and efficient use of network resources for two different type of networks i.e. fixed nodes and mobile nodes networks. Due to the time limitations, our focus was only on the routing protocols during this study. Though, there are many possible directions needed to be explored. The future directions for WSN vary from network structure to, application types to application demands. Different applications have different sensitivity factors. Different network designs have different constraints with respect to varying challenges.

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