Qos Analysis Of Different Routing Protocols In Multi-Clustering Using Qualnet

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Abstract— Wireless sensor networks (WSNs) offer much promise for target tracking and environmental monitoring. While many WSN routing protocols have been proposed to date, most of these focus on the mobility of observers and assume that targets are fixed. However, in reality, many applications require for sensing data to be propagated from multiple mobile targets to multiple mobile observers. In addition, WSNs often operate under strict energy constraints, and therefore reducing energy dissipation is also an important issue. Clustering in wireless sensor networks (WSNs) is an important technique to ease topology management and routing. Clustering provides an effective method for prolonging lifetime of a WSN. In this paper we discuss the performance of two protocols like Dynamic Source Routing (DSR), Dynamic MANET On-demand Protocol (DYMO) using CBR (Constant Bit Rate) and Traffic-Gen for Multi-Clustering technique and compare various parameters like Average End-to-End Delay (sec.), Residual Battery Capacity (mAhr), No. of packets received at Coordinator, Average End-to-End Delay at PAN Coordinator (sec.) and Throughput at PAN Coordinator (bits/sec.).

Keywords: Wireless sensor networks, Multi-clustering, Routing Protocols, Energy efficiency, Qualnet 5.2.

1. INTRODUCTION

A wireless sensor network (WSN) is composed of a large number of sensor nodes that are densely deployed in the monitoring region communicating over radio waves. These kinds of networks are very flexible and attractive for many practical applications such as natural disaster recovery [1], habitat monitoring, target tracking [2]. Due to the limited and non-rechargeable energy provision, the energy resource of sensor networks should be managed in a smart way to extend the lifetime of network [3].

Typically, a sensor node is a tiny device that includes three basic components: a sensing subsystem for data acquisition from the physical surrounding environment, a processing subsystem for local data processing and storage, and a wireless communication subsystem for data transmission. In addition, a power source supplies the energy needed by the device to perform the programmed task. This power source often consists of a battery with a limited energy budget. In addition, it could be impossible or inconvenient to recharge the battery, because nodes may be deployed in a hostile or unpractical environment [4]. Recently, unattended wireless sensor network (UWSN) has become a subject of attention in the security research community of sensor networks [5-9]. In the unattended settings, a sensor is unable to communicate to sinks at will or in real time. Instead, it collects data and waits for an explicit signal to upload accumulated data to sinks (or mobile sinks). On the other hand, the sensor network should have a lifetime long enough to fulfill the application requirements. Fig. 1 illustrates the WSN architecture.

In many cases a lifetime of the order of several months, or even years, may be required. Therefore, the crucial question is: "how to prolong the network lifetime to such a long time?" Broadly there are two methods of enhancing the lifetime of the battery: 1) Clustering and 2) Time scheduling. This paper probes the clustering mechanism.

First, all sensor nodes are pre-deployed in the monitored area, with the observer then sending the relevant monitoring commands to specific targets [10]. As soon as one or more of the sensor nodes senses the target stimulus in their monitored area, one of the nodes (known as the "source") immediately reports back the relevant data, such as location and temperature, to the observer (known as the "sink") via a wireless channel to a laptop or hand-held mobile device [11]. The data can also be sent to other users for further analysis and data mining. Consequently, the dissemination of sensing data from the source to the sink is a fundamental function of WSN.

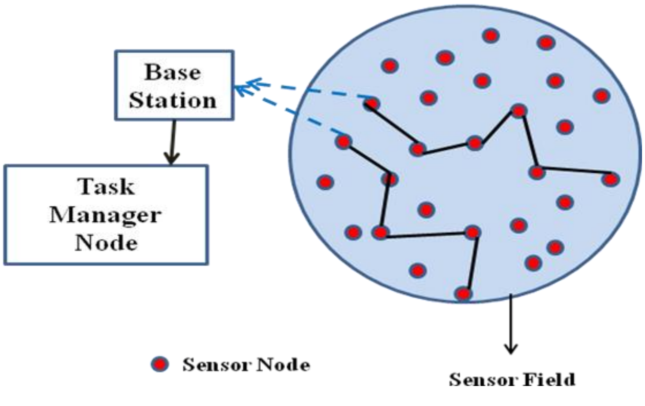

Fig. 1 WSN Architecture

IEEE 802.15.4 focuses on low-rate and low-power solutions for reliable wireless monitoring and control. It is specifically designed for discrete data sent occasionally [12].

In WSN, there are thousands of sensors that send a huge amount of messages simultaneously which should be handled and treated efficiently. When a base station wants to get information, it should have an efficient and a real-time response. Routing protocols play an important role in managing the formation, configuration, and maintenance of the topology of the network [13].

In recent years, the issue of WSN dissemination has been widely studied, with Faheem *et al.* presenting three patterns for recognizing sink mobility [14]. One of these patterns: random mobility - is easily applicable to sink movements and is therefore the most commonly adopted [15, 16, 17, and 19]. However, random mobility requires continuous location updates and reroutes, which results in higher levels of wireless transmission collisions and energy consumption [14].

Power management is an important issue in wireless sensor networks (WSNs) [18] because wireless sensor nodes are usually battery powered, and an efficient use of the available battery power becomes an important concern specially for those applications where the system is expected to operate for long durations. This necessity for energy efficient operation of a WSN has prompted the development of new protocols in all layers of the communication stack.

In this paper we discuss the performance of two protocols like Dynamic Source Routing (DSR), Dynamic MANET On-demand Protocol (DYMO) using CBR (Constant Bit Rate) and Traffic-Gen for clustering technique and compare various parameters like Average End-to-End Delay (sec.), Residual Battery Capacity (mAhr), No. of packets received at Coordinator, Average End-to-End Delay at PAN Coordinator (sec.) and Throughput at PAN Coordinator (bits/sec.).

The rest of the paper is organized as follows. In section 2 we give brief overview about Ad-hoc Routing Protocols, Multi-Clustering and Traffic Generators. Related work is briefed in section 3. Network Simulation is discussed in Section 4. Simulation results are presented in Section 5. Finally, we conclude the paper in Section 6.

2. BRIEF THEORY

Ad-hoc routing protocols

Ad-hoc routing protocols can be divided into three categories, Proactive (Table driven) routing protocol, Reactive (On demand) routing protocol and Hybrid routing protocol. Fig. 2 shows classification of Ad-hoc routing protocols.

2.1. Proactive (Table-Driven) Routing Protocols

Proactive Routing Protocols [20] maintain information continuously. Typically, a node has a table containing information on how to reach every other node and the algorithm tries to keep this table up-to-date. Changes in network topology are propagated throughput the network.

2.2. Reactive (On-Demand) Routing Protocols

On demand protocols [20] use two different operations to Route discovery and Route maintenance operation. In this routing information is acquired on-demand. This is the route discovery operation. Route maintenance is the process of responding to change in topology that happen after a route has initially been created.

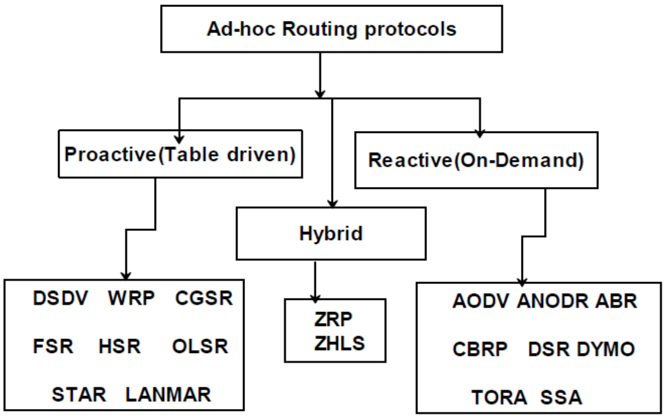

Fig. 2 Classification of Ad-hoc Routing Protocols

2.3. Hybrid Routing Protocols

Hybrid Routing Protocols are new generations of protocol, which are both are Proactive and Reactive in nature. Most hybrid protocols proposed to date are zone based, which means that the network is partitioned or seen as a number of zones by each node. Normally, Hybrid routing protocols for MANETs exploit hierarchical network architectures.

Dynamic Source Routing (DSR):

The Dynamic Source Routing protocol (DSR) [21] is a simple as well as efficient routing protocol which is designed specifically for the use in different multi-hop wireless ad hoc networks of various mobile nodes. All the network nodes cooperate to forward multiple packets for each other for allowing communication over a lot of “hops” between nodes not directly within the wireless transmission range of one another. As all the mobile nodes in the network may join or leave the network through movement, and as the wireless transmission conditions such as sources of interference change and hence the routing is automatically determined as well as maintained by the DSR routing protocol. Since the number or the sequence of intermediate hops required to reach any destination may alter at any time, the resulting network topology may be quite affluent and rapidly changing.

DYMO (Dynamic MANET On-demand Protocol)

The Dynamic MANET On-Demand (DYMO) protocol [22] is a simple and fast routing protocol for multi-hop networks. It discovers uni-cast routes among DYMO routers within the network in an on-demand fashion, offering improved convergence in dynamic topologies. The basic operations of the DYMO protocol are route discovery and route management.

2.4 Multi-Clustering

Wireless Sensor Network (WSN), provides versatile computing platforms for the applications such as environmental monitoring and military field surveillance. The WSN deployed in these applications are usually faced with harsh environments which makes it very hard or impossible to recharge their node batteries. So it is necessary to fabricate specific protocol for WSN to enable its nodes to efficiently utilize their energy. A distributed multiple clustering policy, in which the nodes are chosen to act as cluster heads(CHs) in certain probability is applied, that enables the self organization of large numbers of nodes. These cluster heads constitute the routing infrastructure and aggregate data from their neighbouring non-cluster nodes. Among the cluster heads, the one with more residual energy is picked out to be the coordinators [23]. The cluster heads does not need to transfer information directly to the base station(PAN Coordinator) but to the super node (Coordinators) through which the information will be transferred to the base station.

Advantages of Multi-Clustering in WSNs

The advantages of Multi-Clustering are that it enables bandwidth reuse thus can improve the system capacity [24]. Due to the fact that within a cluster, all the normal nodes send their data to the CHs so energy saving is achieved by absence of flooding, multiple routes, or routing loops. Due to the fact that clustering enables efficient resource allocation and thus help in better designing of power control and other advantage is due to the fact that any changes of nodes behaviour within a cluster affect only that cluster but not the entire network, which will therefore be robust to these changes.

2.5 Traffic Generators

A Traffic Generator models the traffic which behaves in a predefined structure and scheduled manner [25]. It sends the demand to transmit the traffic payload regardless of the state of the agent being attached at a specific time and interval. The following two traffic generators are used for the analysis:

1. Constant Bit Rate (CBR): CBR traffic Generator creates the payload which is fixed in size and the generation of packet interval is fixed. This UDP-based client-server application sends data from a client to a server at a constant bit rate.

2. Traffic-Gen**.**: A random distribution-based traffic generator. This is a flexible UDP traffic generator that supports a variety of data size and interval distributions. It also supports quality of service (QoS) parameters [26].

3. RELATED WORK

Samer A. B. Awwad *et al.* proposed CBR-Mobile protocols that are evaluated using MATLAB and compared to LEACH-Mobile and AODV protocols [27] and the parameters of evaluation considered are given in Table 1.

Parameter and models	**Value**
Network(Field) Size(L*W)	50 x 50 m
Number of sensor nodes(N)	100, 120,140
Location of the sink node	(25,25)
Sensor nodes deployment	Random deployment
Sensor ID	1-140
Maximum transmission range	19 m
Percentage of cluster head	5%
Percentage of mobile sensor nodes	0-90%
Data size	2000 bits
Mobility model	Random waypoint model with Speed(1-10) m/s
Radio model	Two-Ray Ground model
NEW_MEMBERSHIP_ REQUESTERS database	Initially is empty
ALTERNATIVE_SHEDULE	Reverse order of original schedule
Battery	Initial capacity is assumed to be constant
Traffic model	CBR traffic for periodic data generation
Queuing model	FIFO with Drop Tail Queue Mechanism

Table 1.Simulation Parameters

Megha Rastogi *et al.* focuses on routing protocols like AODV, DSR and DSDV as well as different traffic generators and their overall performance under different scenarios like Packet Delivery Ratio, Throughput using Simulating Software NS2 (Network Simulator 2) version 2.35 [28] has been evaluated.

4. NETWORK SIMULATION

This Section enables us to analyze temporal assessment of Different routing protocol under the specified terrain conditions in wireless sensor networks.

4.1 Simulation Scenario

We have chosen Qualnet version 5.2 over Windows platform for our simulation studies. Qualnet is a discrete event simulator. It is equally capable of simulating various wired or wireless scenarios from simple to complex conditions. In the simulation model, there are 250 nodes and all of these are connected to one wireless station. The terrain condition we have set as 500m × 500m as flat area. The entire area is further divided into 100 square shaped cells. Simulation time we have used is 500s. All the nodes we have assumed as dynamic one. The type of wireless propagation model is Two Ray ground propagation. The numbers of constant bit rate (CBR) and TRAFFIC generator connection are 16. The entire connection set up has been done randomly. In this we use the concept of Reduced Functional Device (RFD) and Full Functional Device(FFD). Then we further make the Coordinator and PAN Coordinator. The Packet size reduces to 70 bytes because it only supports up to 128 bytes. Here different clusters are created and all nodes are divided among these clusters. We make Base station as PAN Coordinator and all cluster-heads as Coordinators. Table 2 gives all the parameters.

4.2 Simulation Scenario Parameters

1. Throughput: Throughput is the average rate of successful data packets received at destination. It is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second.

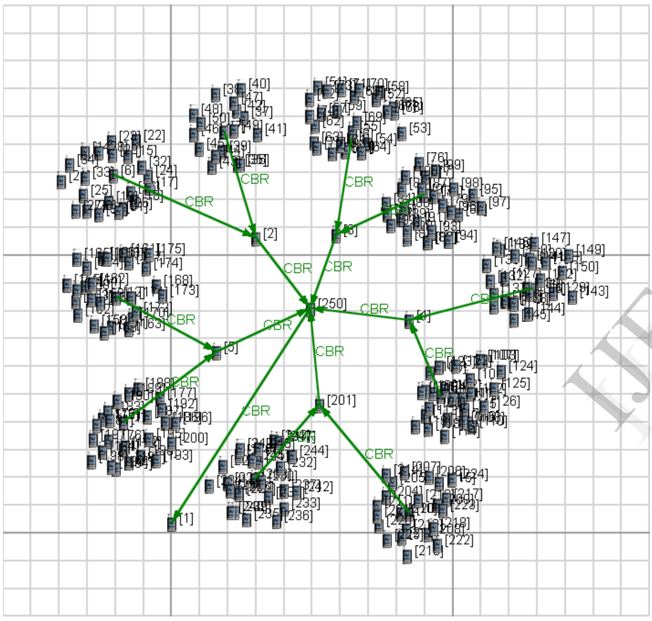

Fig. 3 Simulation Scenario with CBR

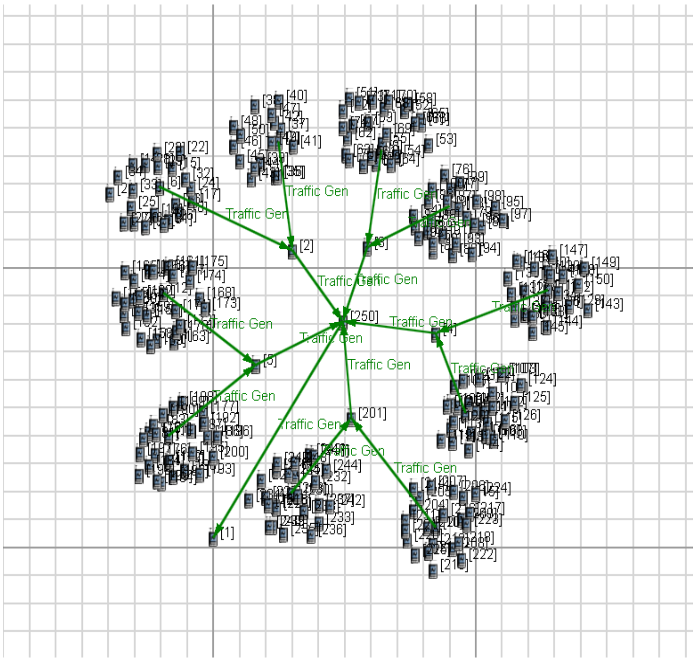

Fig. 4 Simulation Scenario with Traffic Gen.

2. End-to-End Delay: A specific packet is transmitting from source to destination and calculates the difference between send times and received times. Delays due to route discovery, queuing, propagation and transfer time are included in the delay metric. We want to compare the parameters they used in their simulation from the Table 1 to Table 2 which is shown below:

5. SIMULATION RESULTS

In this research, we did the simulation for the performance analysis of Different routing protocols using the Qualnet 5.2 which is developed by Scalable Network Technology [29]. Qualnet 5.2 provides a comprehensive environment for designing protocols, creating and animating network scenarios, and analyzing their performance. On the basis of the above mentioned simulation scenario and parameters we have obtained the following results. The results are shown from Fig.5 to Fig.35.

	CBR		Traffic Gen.	
Parameters	**DSR**	**DYMO**	**DSR**	**DYMO**
Area Size (Flat Area)	500m×500m	500m×500m	500m×500m	500m×500m
Attitude Range Above & Below Sea Level	1500m	1500m	1500m	1500m
Simulation Time	500 sec.	500 sec.	500 sec.	500 sec..
Wireless Propagation Model	Two Ray	Two Ray	Two Ray	Two Ray
Node Placement	Random	Random	Random	Random
Energy Model	MicaZ	MicaZ	MicaZ	MicaZ
Traffic Type	CBR	CBR	Traffic Gen.	Traffic Gen.
Data Source Distribution	100 square cells	100 square cells	100 square cells	100 square cells
Mobility Model	None	None	None	None
MAC Protocol	MAC802.15.4	MAC802.15.4	MAC802.15.4	MAC802.15.4
Network protocol	IPv4	IPv4	IPv4	IPv4
Routing protocol	DSR	DYMO	DSR	DYMO
No of Nodes	250	250	250	250
Number of CBR	16	16	16	16
Mobility	None	None	None	None
No. of Channels	1	1	1	1
Channel Frequency	2.4GHz	2.4GHz	2.4GHz	2.4GHz
Packet Size (bytes)	70	70	70	70
No. of times Experiment simulated	1	1	1	1
Battery Model	Enabled	Enabled	Enabled	Enabled
Battery Model	Linear	Linear	Linear	Linear
Battery Charge Monitoring Interval	1 sec.	1 sec.	1 sec.	1 sec.
Full Battery Capacity (mAhr)	50	50	50	50
PAN Coordinator (FFD)	1	1	1	1
Coordinator (FFD)	16	16	16	16
RFD's	233	233	233	233
Residual Battery Capacity (mAhr)	49.895	49.866	49.901	49.893
No. of Packets Received at Coordinator	48	463	728	673
Average End-to-End Delay at PAN Coordinator (sec.)	10.7525	0.726633	0.963411	0.462878
Throughput at Pan Coordinator (bits/sec.)	38	54	48	60

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Table 2. Simulation Parameters

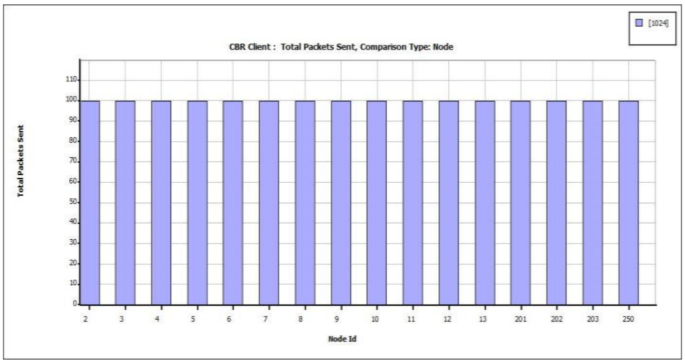

Fig. 5 DSR Input

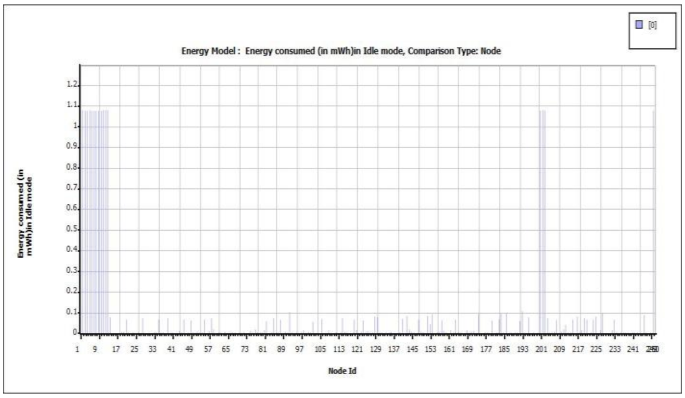

Fig. 6 Energy Consumed in Idle Mode (DSR)

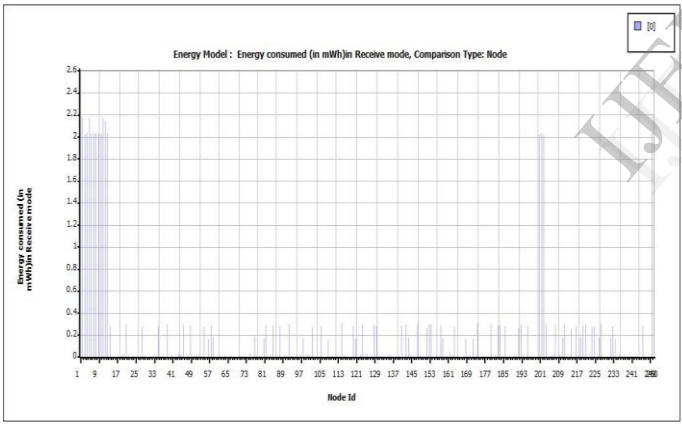

Fig. 7 Energy Consumed in Receive Mode (DSR)

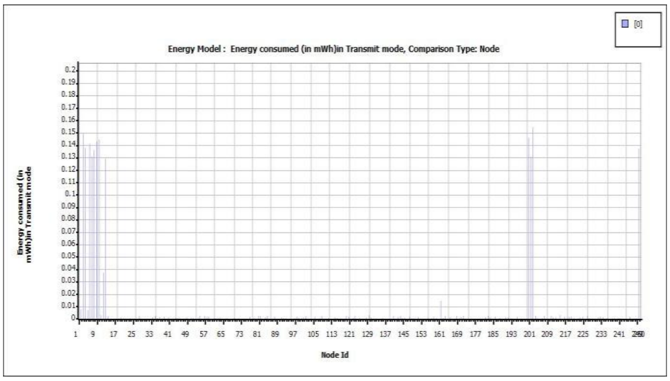

Fig. 8 Energy Consumed in Transmit Mode (DSR)

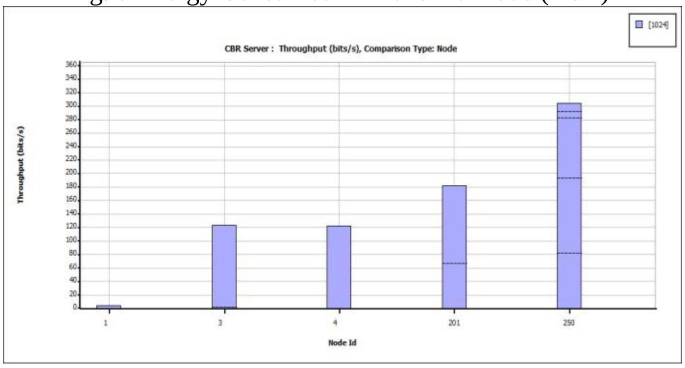

Fig. 9 Throughput at CBR Server (DSR)

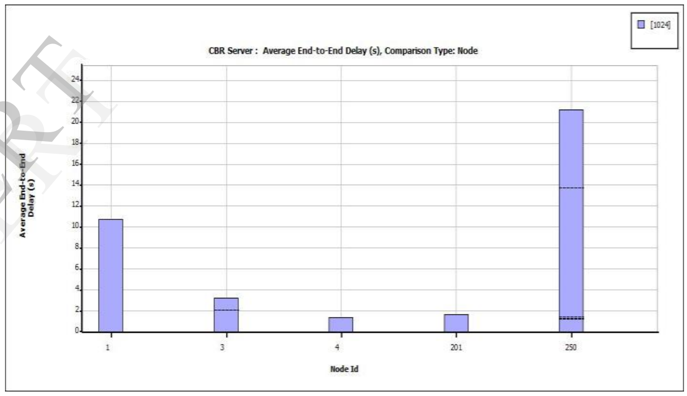

Fig. 10 Average End To End Delay (DSR)

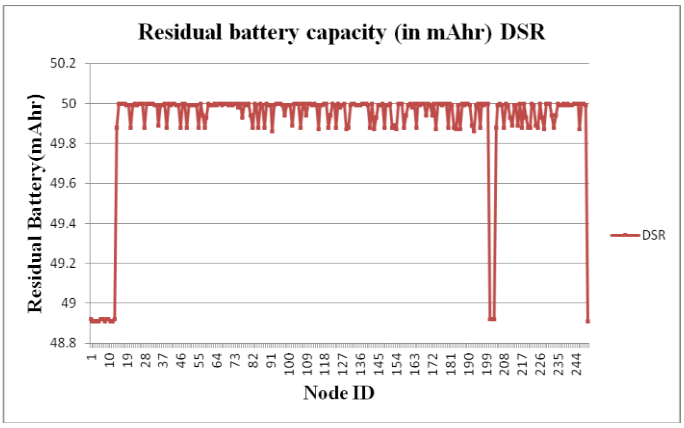

Fig. 11 Residual Battery Capacity (DSR)

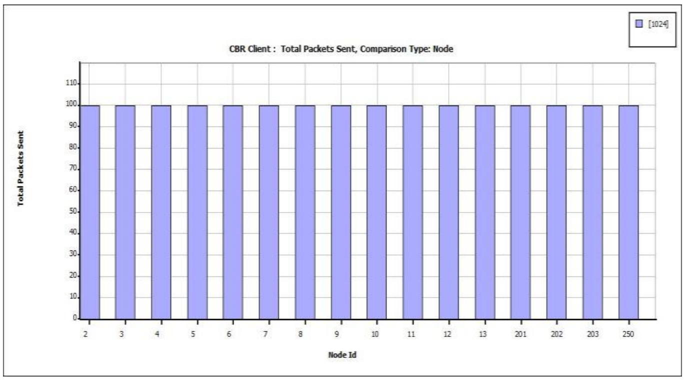

Fig. 12 DYMO Input

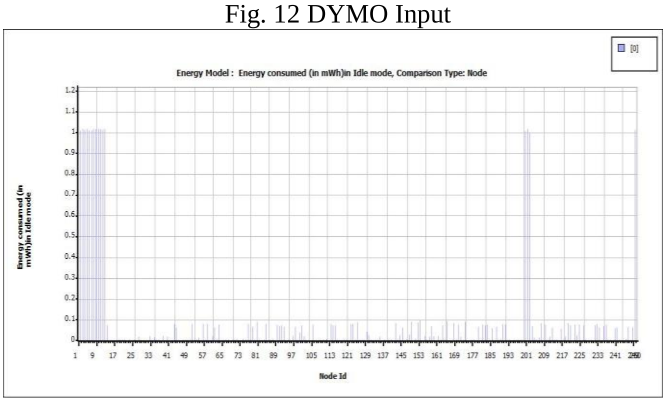

Fig. 13 Energy Consumed in Idle Mode (DYMO)

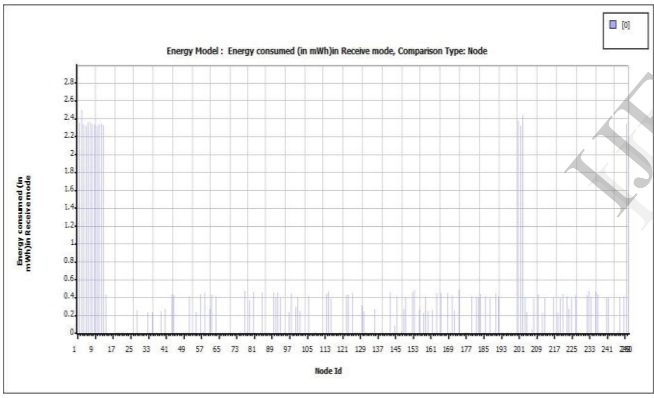

Fig. 14 Energy Consumed in Receive Mode (DYMO)

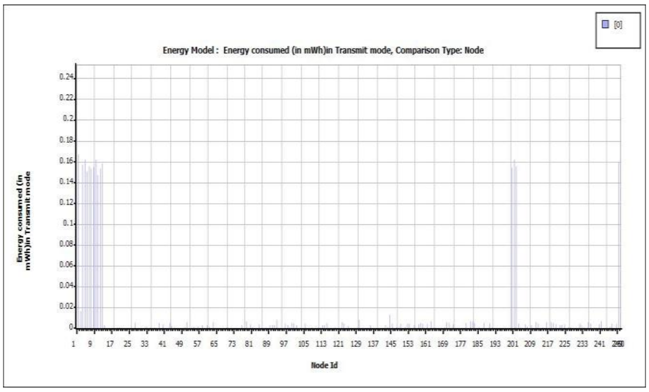

Fig. 15 Energy Consumed in Transmit Mode (DYMO)

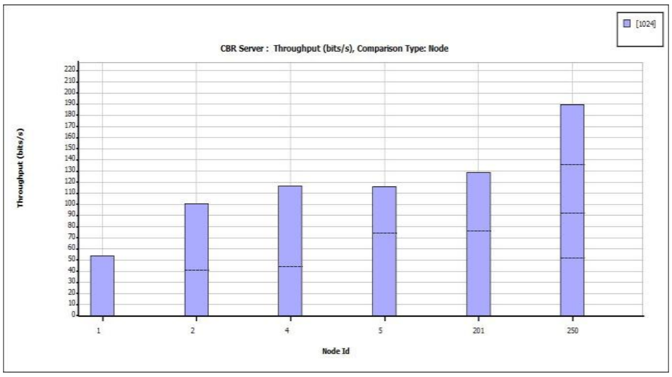

Fig.16 Throughput at CBR Server (DYMO)

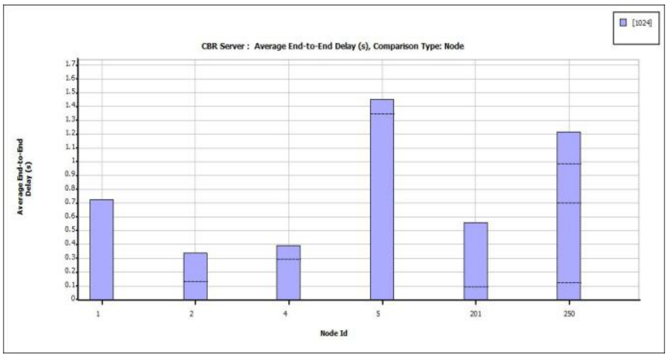

Fig. 17 Average End To End Delay (DYMO)

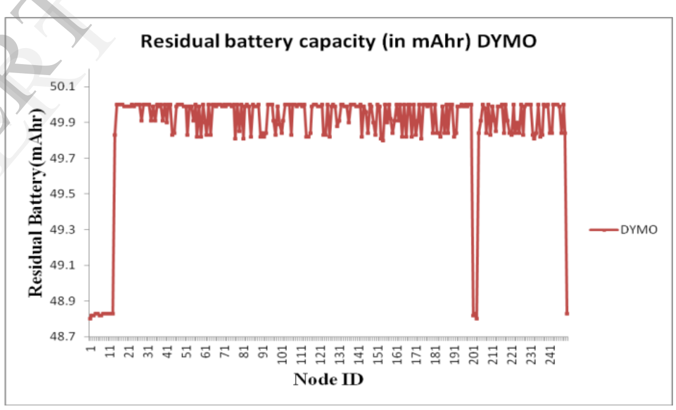

Fig. 18 Residual Battery Capacity (DYMO)

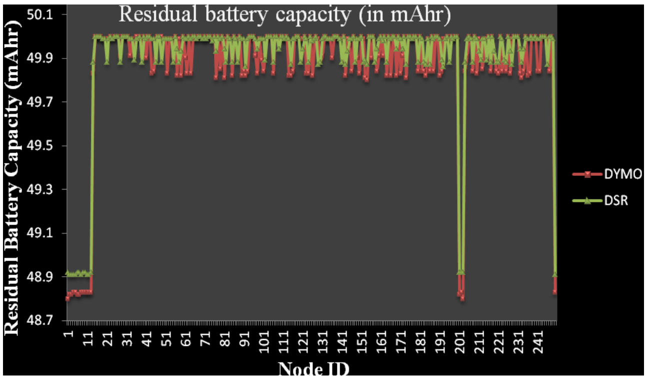

Fig. 19 Comparison of DSR and DYMO at CBR server

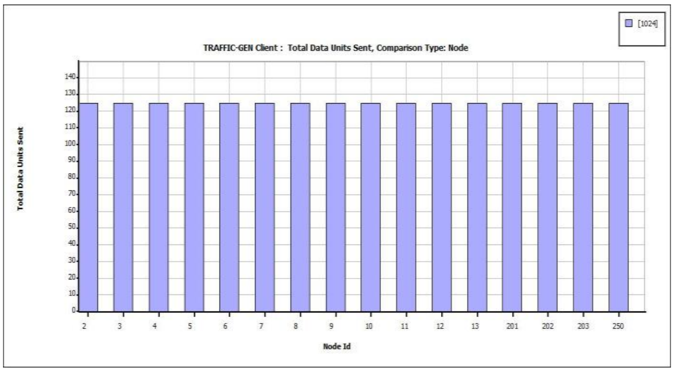

Fig. 20 DSR Input

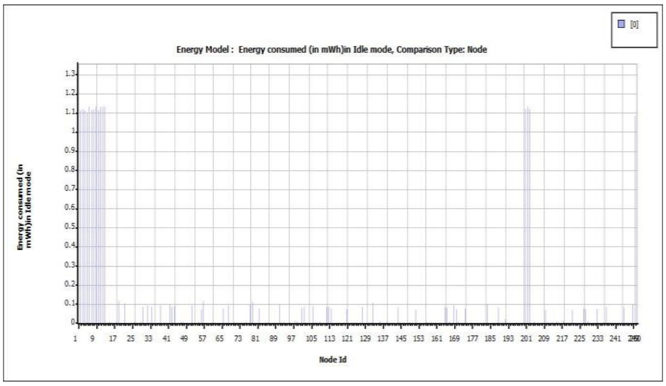

Fig. 21 Energy Consumed in Idle Mode

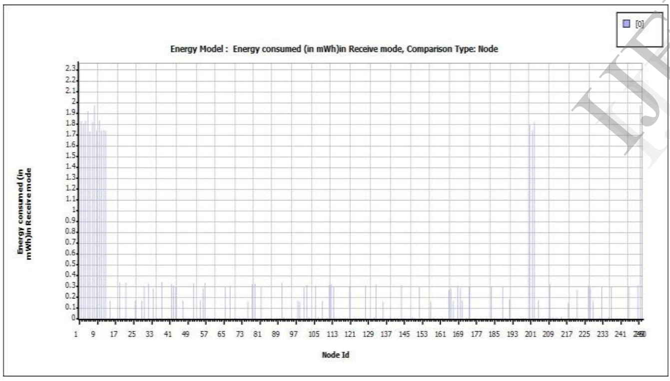

Fig. 22 Energy Consumed in Receive Mode

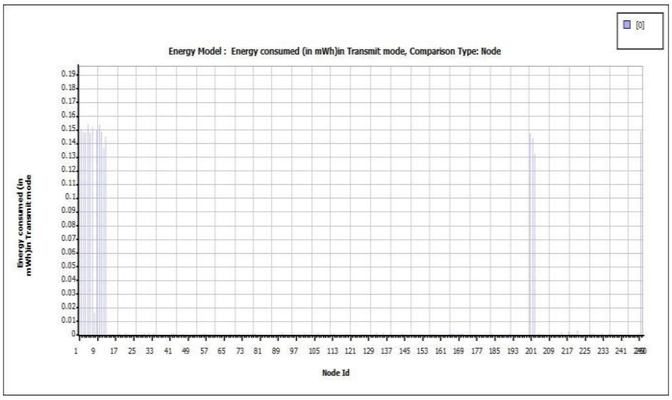

Fig. 23 Energy Consumed in Transmit Mode

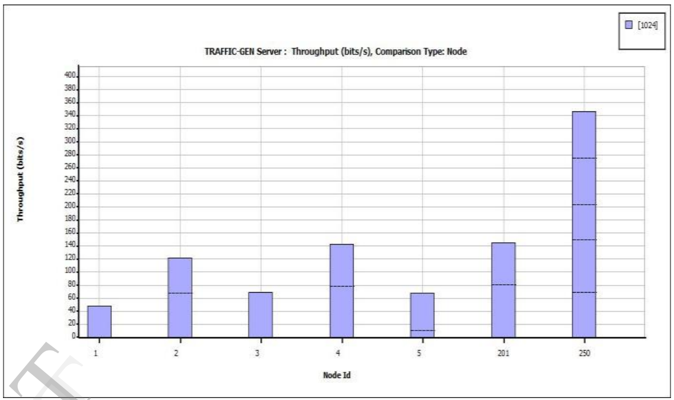

Fig. 24 Throughput at CBR Server

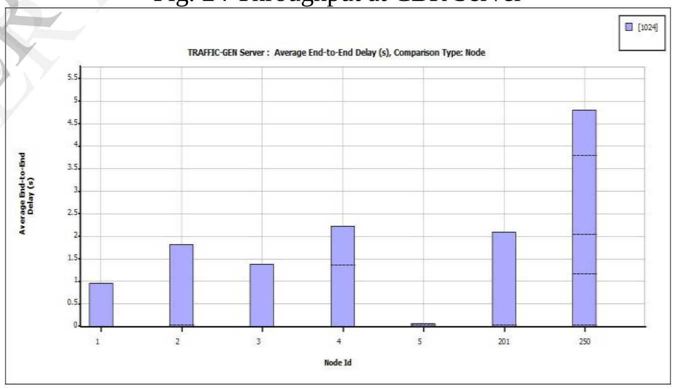

Fig. 25 Average End To End Delay

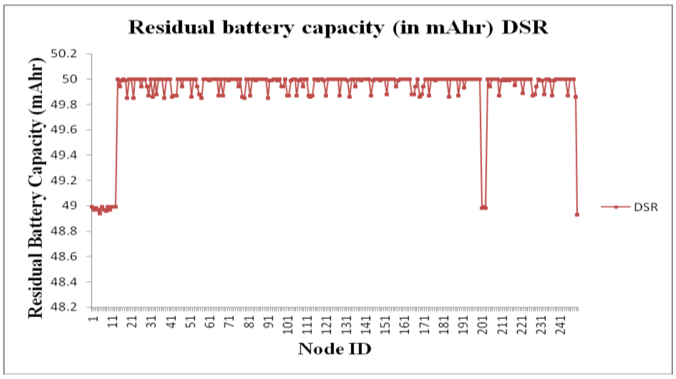

Fig. 26 Residual Battery Capacity (DSR)

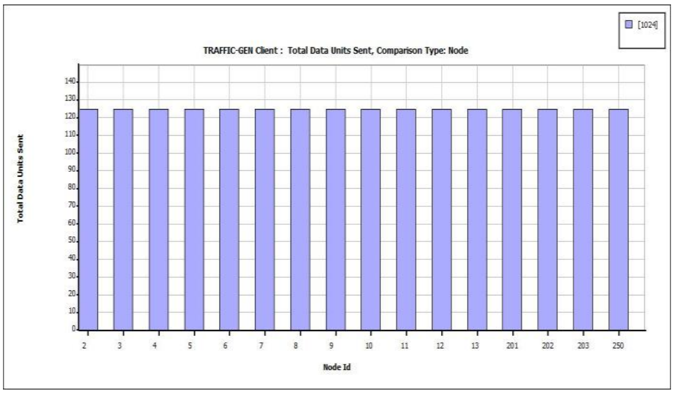

Fig. 27 DYMO Input

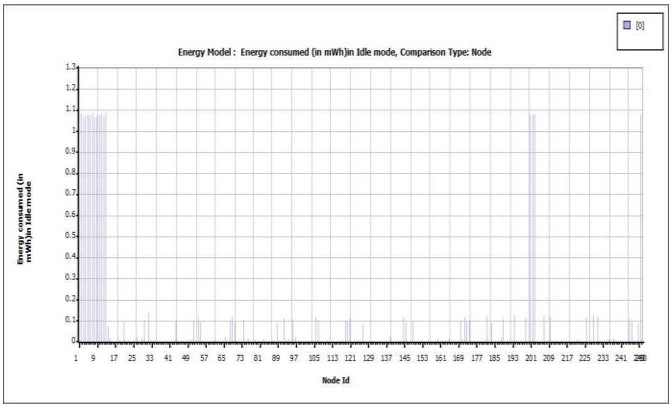

Fig. 28 Energy Consumed in Idle Mode

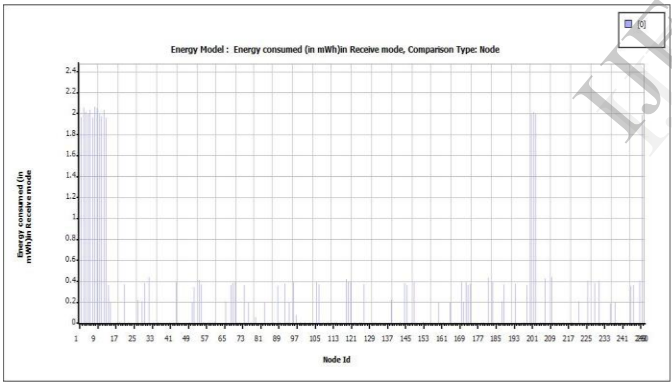

Fig. 29 Energy Consumed in Receive Mode

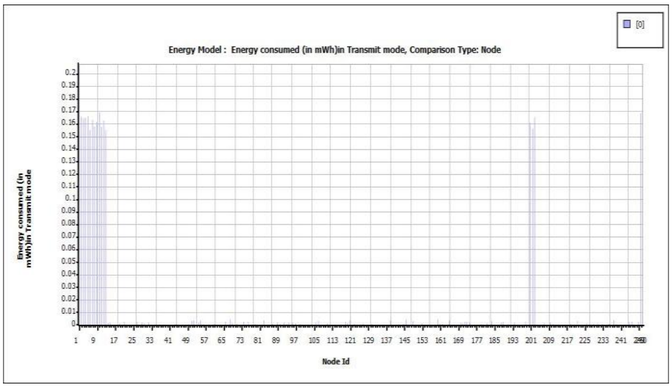

Fig. 30 Energy Consumed in Transmit Mode

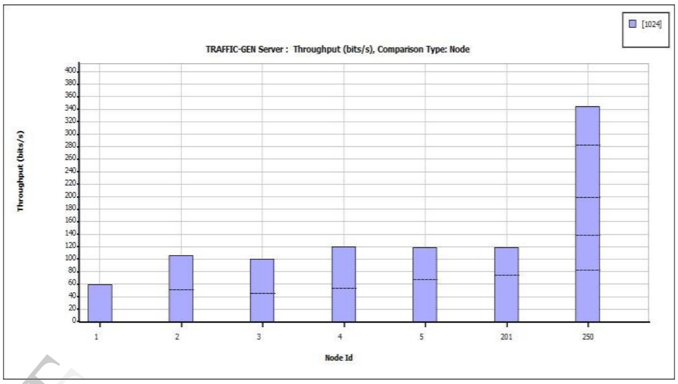

Fig. 31 Throughput at CBR Server

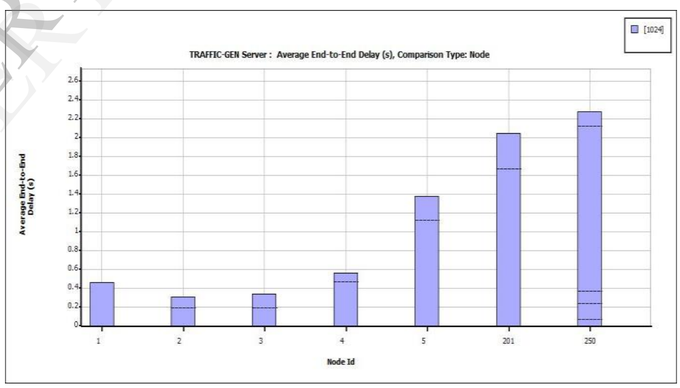

Fig. 32 Average End To End Delay

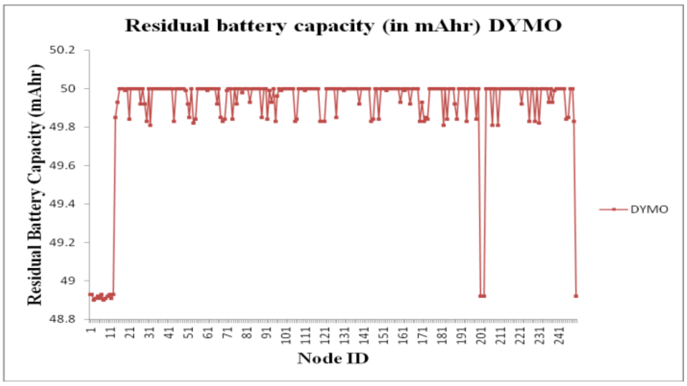

Fig. 33 Residual Battery Capacity (DYMO)

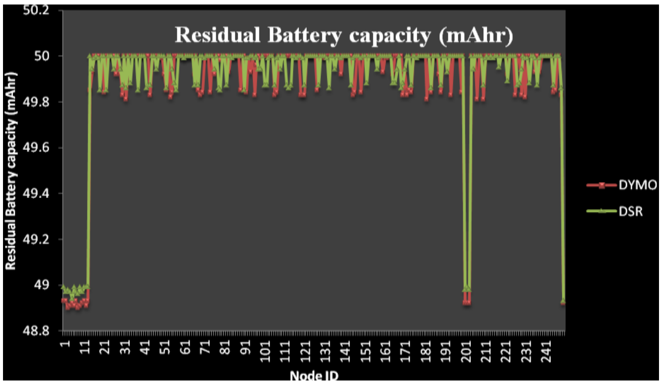

Fig. 34 Comparison of DSR and DYMO at Traffic- Gen.

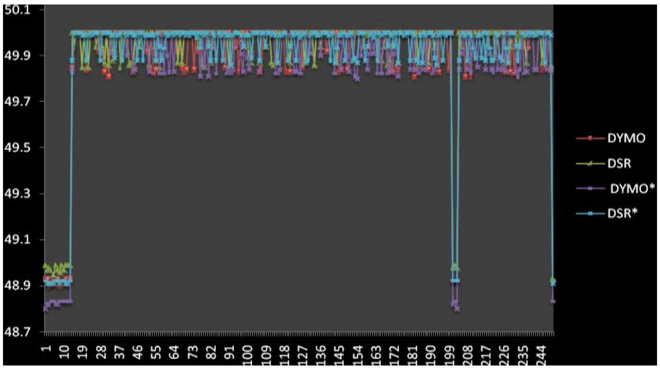

Fig. 35 Comparison of Residual Battery Capacity of DSR and DYMO using CBR and Traffic-Gen.

6. CONCLUSION

We have plotted different parameters for various protocols from Fig. 5 to Fig. 35 and tabulated them in Table 2 and compared the parameters like Residual Battery Capacity (mAhr), No. of packets received at Coordinator, Average End-to-End Delay at PAN Coordinator (sec.) and Throughput at PAN Coordinator (bits/sec.) for the routing Protocols like DSR and DYMO using CBR and Traffic-Gen. From the Table 2, we conclude that in DYMO 1) No. of packets received at Coordinator and Throughput is higher, 2) Average end to end delay at PAN Coordinator is less using CBR as well as Traffic-Gen. The Residual Battery Capacity is approximately similar in both cases when simulated for 500s. By increasing the simulation time it could be possible to obtain better analysis of residual battery capacity.

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