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Performance Evaluation of Bellman-Ford, AODV, DSR and DYMO Protocols using QualNet in 1000m×1000m Terrain Area

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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. In addition, WSNs often operate under strict energy constraints, and therefore reducing energy dissipation is also an important issue. In this paper we discuss various protocols like Bellman-Ford, Ad-Hoc on-Demand Routing (AODV), Dynamic Source Routing (DSR), Dynamic MANET On-demand Protocol (DYMO) and compare various parameters like Average End-to-End Delay (sec.), Residual Battery Capacity (mAhr), and Throughput (bits/sec.), Output Received at CBR Server.

Keywords— Wireless sensor networks, Routing Protocols, Energy efficiency, Qualnet 5.2.

I. 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. 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].

Energy efficiency is a basic requirement for network operations [4]. Fig. 1 illustrates the WSN architecture. First, all sensor nodes are pre-deployed in the monitored area, with the observer then sending the relevant monitoring commands to specific targets. All the nodes are connected to one wireless -subnet and then we apply applications on some nodes and then we make some of them are coordinator and one is the PAN-Coordinator which collects the data from other nodes.

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 [5].

In wireless network, routing protocols play an important role in managing the formation, configuration, and maintenance of the topology of the network [6].

Power management is an important issue in wireless sensor networks (WSNs) [7] 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.

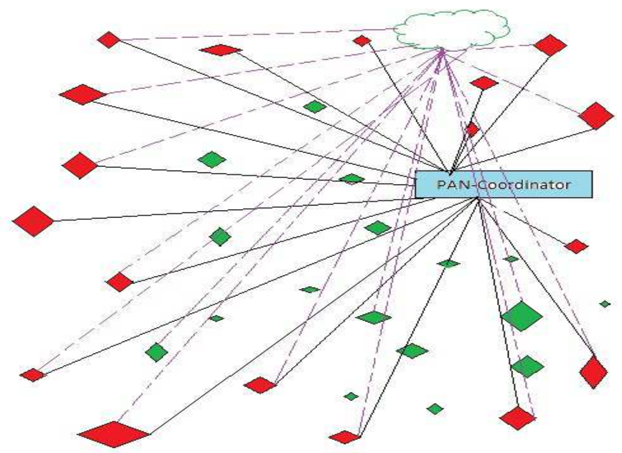

Fig. 1 WSN Architecture

In this Paper we discuss various protocols like Bellman-Ford, Ad-Hoc on-Demand Routing (AODV), Dynamic Source Routing (DSR), Dynamic MANET On-demand Protocol (DYMO) and compare various parameters like Average End-to-End Delay (sec.), Residual Battery Capacity (mAhr), and Throughput (bits/sec.), Output Received at CBR Server.

The rest of the paper is organized as follows. A brief overview of the Protocols is given in Section 2. Related work is presented in Section 3. Then the Network Simulation is discussed in Section 4. Next, in Section 5, Simulation Results are presented. Finally, we conclude the paper in Section 6.

II. BRIEF THEORY

Taxonomy of Protocols as shown in Fig. 2 and detailed description is given below:

In **uniform protocols** there is no hierarchy in network, all nodes send and respond to routing control messages at the same manner.

In **non-uniform protocols** there is an effort to reduce the control traffic burden by separating nodes in dealing with routing information. Non-uniform protocols fall into two categories: protocols in which each node focuses routing activity on a subset of its neighbors and protocols in which the network is topologically partitioned [8].

Topology-based protocols use the principle that every node in a network maintains large-scale topology information. This principle is just the same as in link-state protocols.

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Destination-based protocols do not maintain large-scale topology information. They only may maintain topology information needed to know the nearest neighbors.

Proactive protocols, which are also known as table-driven protocols, maintain all the time routing information for all known destinations at every source [9].

In on-demand i.e. in **reactive protocols** the route is only calculated on demand basis. That means that there is no unnecessary routing information maintained.

Type of Cast

Another type of classification can be done via, type caste property. i.e, whether they use

- Unicast
- Geo-cast
- Multicast
- **Unicast:** Unicast forwarding means one to one communication. i.e, one source transmits data packets to a single destination.
- **Geo-cast:** The main aim of Geo-cast is to deliver the data to a group of nodes situated inside a specified geographical area [10].
- **Multicast:** Multicast means one to many i.e, when a node needs to send same data to multiple destinations.

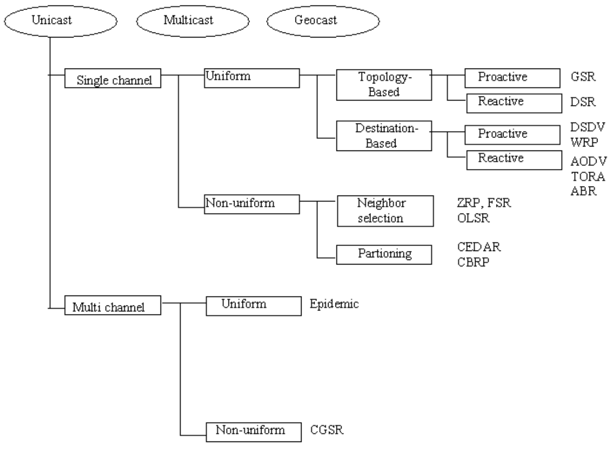

Fig. 2: Taxonomy of Protocols

Bellman-Ford Routing Protocol

Bellman-Ford Routing Algorithm, also known as Ford-Fulkerson Algorithm, is used as a distance vector routing protocol. Routers that use this algorithm have to maintain the distance tables, which tell the distances and shortest path to sending packets to each node in the network. The information in the distance table is always updated by exchanging information with the neighbouring nodes.

Destination Based Routing:

Ad-Hoc on-Demand Routing

AODV is a modification of the DSDV algorithm. When a source node desires to establish a communication session, it initiates a path-discovery process to locate the other node. The source node broadcasts a RREQ packet with its IP address, Broadcast ID (BrID), and the sequence number of the source and destination [11]. While, the BrID and the IP address is used to uniquely identify each request, the sequence numbers are used to determine the timeliness of each packet.

Uniform Routing:

Dynamic Source Routing (DSR):

DSR is a reactive uniform routing protocol that uses a concept called source routing [12]. Each node maintains a route cache where it lists the complete routes to all destinations for which the routes are known. A source node includes the route to be followed by a data packet in its header. Routes are discovered on demand by a process known as route discovery. When a node does not have a route cache entry for the destination to which it needs to send a data packet, it initiates a route discovery by broadcasting a route REQUEST or QUERY message seeking a route to the destination.

DYMO (Dynamic MANET On-demand Protocol)

The Dynamic MANET On-demand (DYMO) protocol is a reactive routing protocol being developed within IETF's MANET working group. Typically, all reactive routing protocols rely on the quick propagation of route request packets throughout the MANET to find routes between source and destination. While this process typically relies on broadcasting, route reply messages that are returned to the source rely on unicasting.

III. RELATED WORK

Parma Nand *et al.* [13] simulated three routing protocols (AODV, DSR and DYMO) in IEEE 802.11 using Qualnet 5.0.2 Network Simulator.

Parameter	Value
Area	1500×1500
Simulation Time	90,120, 200 sec
Channel Frequency	2.4 Ghz
Data rate	2.Mbps
Path Loss Model	Two Ray Model
Mobility Model	Random-Way Point
Packet size	512 bytes
Physical Layer Radio type	IEEE 802.11b
MAC Protocol	IEEE 802.11
Antenna Model	Omni-directional

Table 1.Simulation Parameters

IV. 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 [14].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 1000m × 1000m as flat area. The entire area is further divided into 100 square shaped cells. Simulation time we have used is 450s. 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) connections are 20.The entire connection set up has been done randomly. In this we use the concept of RFD and FFD. Then we further make the coordinator and PAN Coordinator whichever we have mentioned in Table 1. That's why the Packet size reduces to 70 bytes because it only supports up to 128 bytes.

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.
2. End-to-End Delay: A specific packet is transmitting from source to destination and calculates the difference between send times and received times.

We want to compare the parameters they used in their simulation from the Table 1 to Table 2 which is shown below:

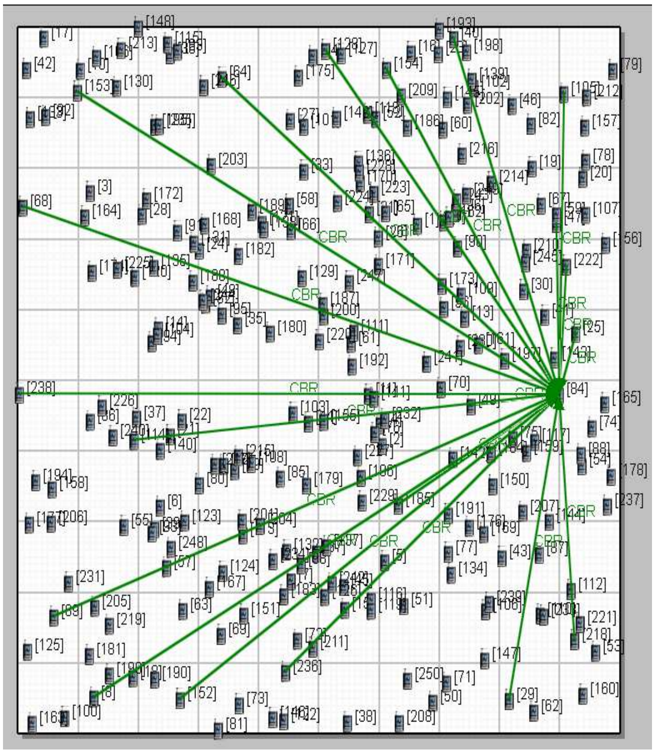

Fig. 3 Simulation Scenario

V. 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 [15]. 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, have obtained the following results. The results are shown as under in the form of various analyses from Fig.4 to Fig.16.

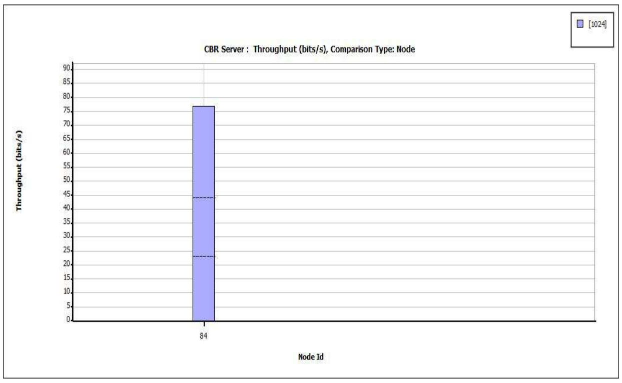

Fig. 4 Throughput at CBR Server using Bellman-Ford

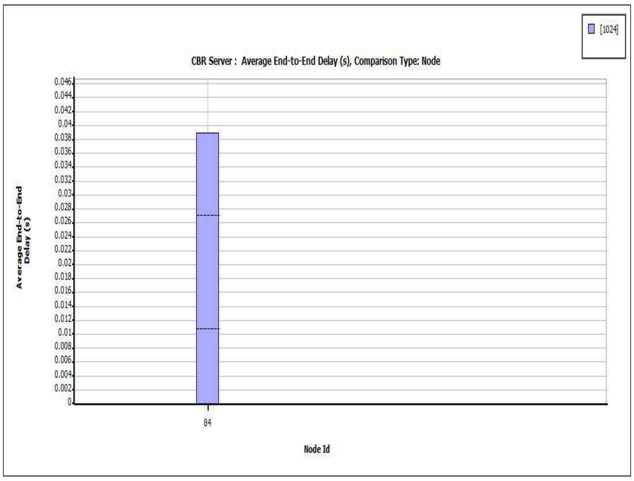

Fig.5 Average End To End Delay

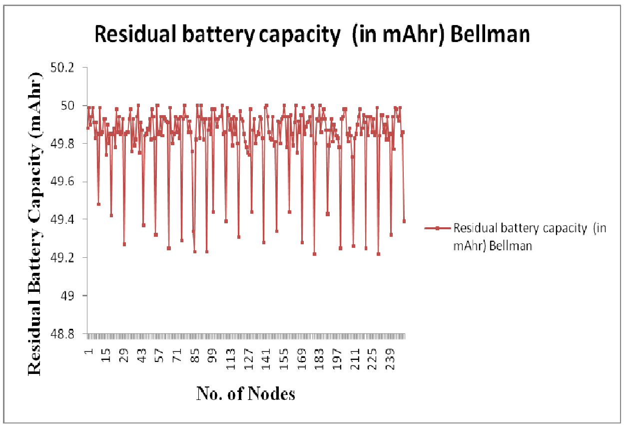

Fig. 6 Residual Battery Capacity

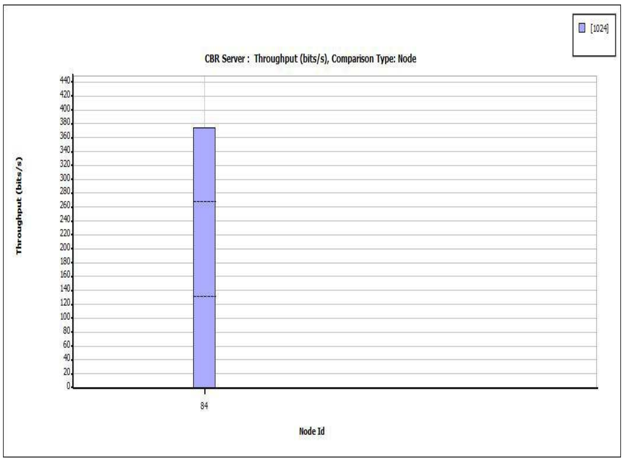

Fig. 7 Throughput at CBR Server using AODV

Parameters	Bellmanford	AODV	DSR	DYMO
Area Size (Flat Area)	1000m×1000m	1000m×1000m	1000m×1000m	1000m×1000m
Attitude Range Above & Below Sea Level	1500m	1500m	1500m	1500m
Simulation Time	450 sec.	450 sec.	450 sec.	450 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	CBR	CBR
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	Bellmanford	AODV	DSR	DYMO
No of Nodes	250	250	250	250
Number of CBR	20	20	20	20
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 Co-ordinator (FFD)	1	1	1	1
Co-ordinator (FFD)	25	25	25	25
RFD's	225	225	225	225
Residual Battery Capacity (mAhr)	49.83	49.59	49.52	49.80
Output Received at CBR Server	3	3	3	20
Average End-to-End Delay (sec.)	0.0390211	1.66038	13.3153	28.6776
Throughput (bits/sec.)	77	375	232	564

Table 2. Simulation Parameters

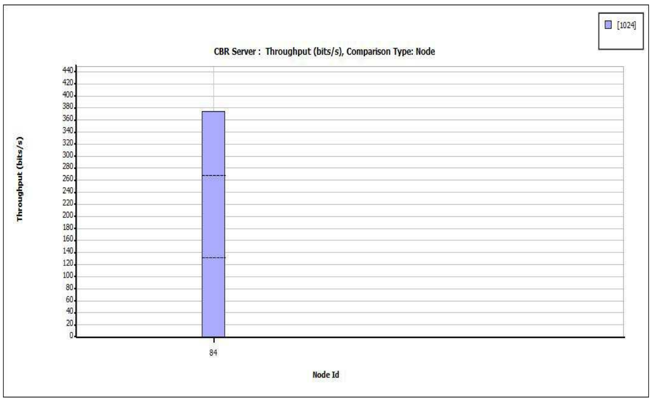

Fig. 7 Throughput at CBR Server using AODV

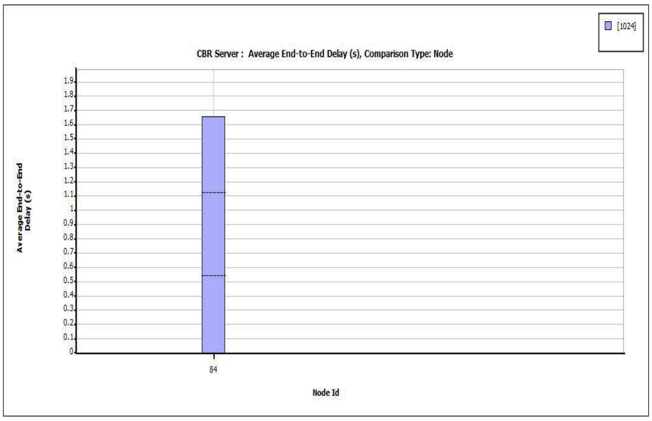

Fig. 8 Average End To End Delay

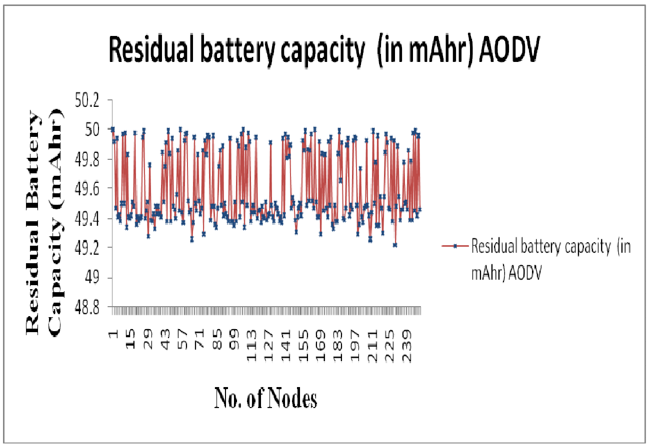

Fig. 9 Residual Battery Capacity

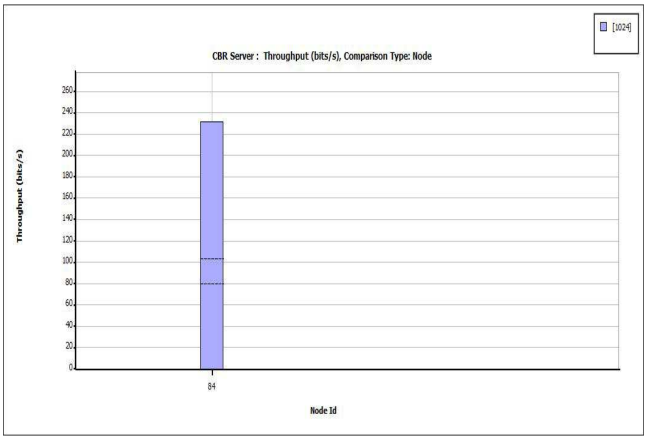

Fig. 10 Throughput at CBR Server using DSR

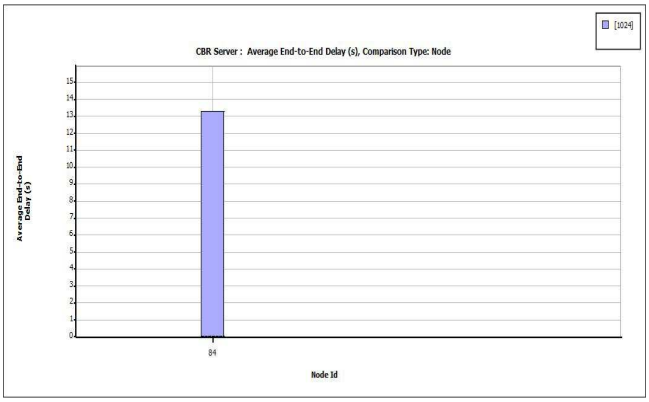

Fig. 11 Average End To End Delay

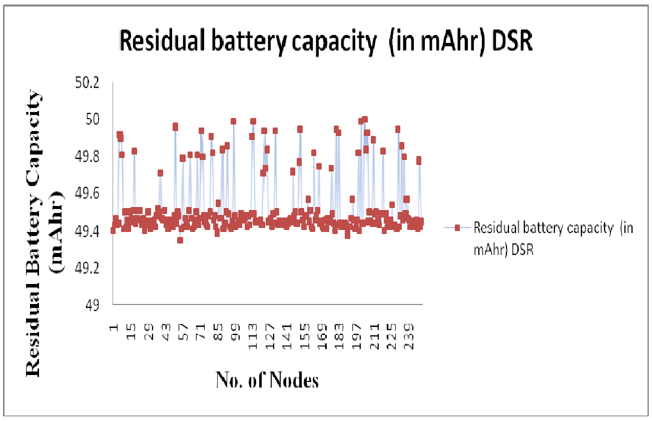

Fig. 12 Residual Battery Capacity

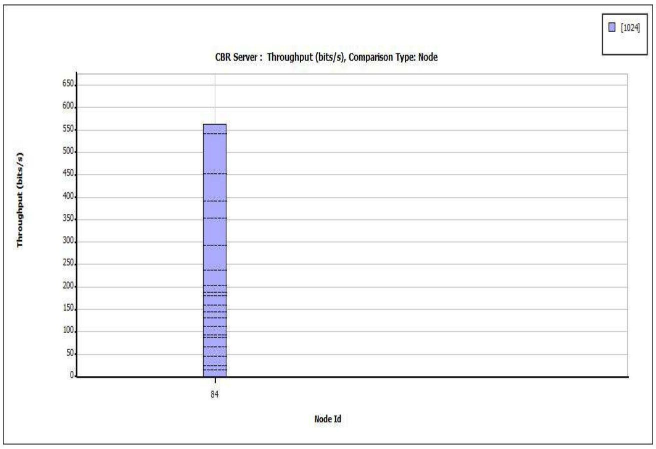

Fig. 13 Throughput at CBR Server using DYMO

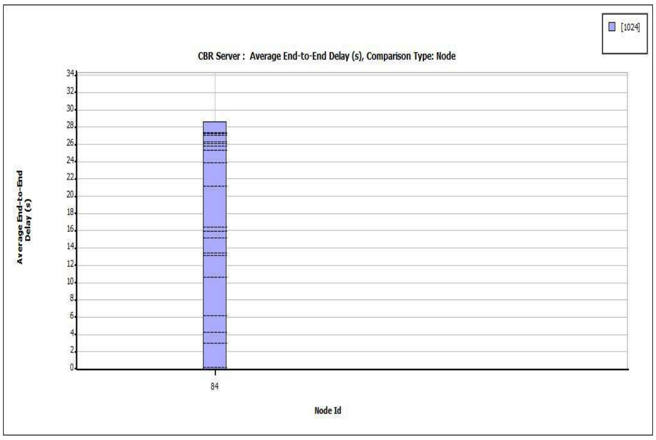

Fig. 14 Average End To End Delay

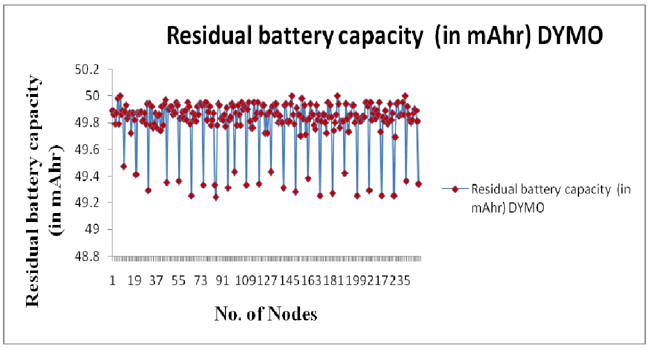

Fig. 15 Residual Battery Capacity

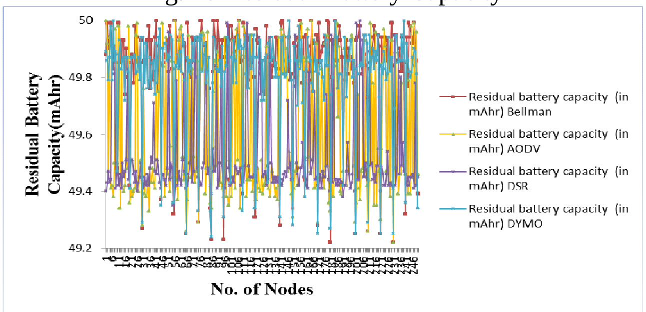

Fig. 16 Comparison of Residual Battery Capacity of all the Protocols

VI. CONCLUSION

We have plotted different parameters for various protocols in Fig. 4 to Fig. 16 and tabulated them in Table 2 and compared the parameters like Residual Battery Capacity (mAhr), Output Received at CBR Server, Average End-to-End Delay (sec.) and Throughput (bits/sec.) for the routing Protocols like Bellman-ford, AODV, DSR and DYMO. From the Table 2, we conclude that DYMO is better in terms of energy efficiency, throughput and output received at server but we have to compromise with average end-to-end delay.

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