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Traffic Generator Based Power Analysis of Different Routing Protocol For Mobile Nodes in Wireless Sensor Network Using Qualnet

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ABSTRACT

A sensor network is a system that consists of thousands of very small stations called sensor nodes. The communication between nodes is done in a wireless approach, and thus, the name of wireless sensor networks. The service lifetime of such sensor nodes depends on the power supply and the energy consumption, which is typically dominated by the communication subsystem. There has been growing interest in the WSN applications where traffic and mobility is the fundamental characteristic of the sensor nodes. The most important advantage of this traffic generator model is that it can be applied to all one and two dimensional traffic scenarios where the traffic load may fluctuate due to sensor activities. During traffic fluctuations the novel Optimized grids and random placed nodes algorithm can be used to re-optimize the wireless sensor network to bring further benefits in energy reduction and improvement in QoS parameters. To validate our traffic generator model, we compare (1) simulation of results using the QualNet simulation platform with and without our mobility for the IEEE 802.11 DCF, (2) In this paper power analysis comparison of three Routing Protocols AODV, DSR & OLSR is done by using traffic generator based model and changing the nodes mobility using QualNet 5.0 Simulator. The metrics used for performance evaluation are Average Jitter, Throughput, End-to- End delay and power consumption model to evaluate power consumption in all modes in wireless network protocols.

***Keywords* -** Wireless sensor network, Power model, Mobility, QualNet Simulator 5.0, Routing Protocols

I. INTRODUCTION

Wireless ad-hoc networks are also known as "networks without a network" since they do not use any fixed infrastructure. Participating nodes in these networks are usually battery operated, and thus they contain access to a limited amount of energy [1]. Frequently, once nodes are deployed, their batteries cannot be easily recharged. Sensor network nodes are a typical example as some of them have very limited battery life; moreover, once deployed, a sensor network may be left unattended for its entire operational lifetime. This is due to the fact that sensor networks may be deployed in wide, remote, inaccessible areas. The energy-constrained nature of ad hoc networks in general and sensor networks in particular, calls for protocols that have energy efficiency as a primary design goal. Research on power-aware protocols has been very active and spans multiple layers of the protocol stack. As a result, several energy-efficient medium-access control (MAC) and routing protocols have been proposed [2].

In order to evaluate and compare power-aware protocols in terms of their energy efficiency as well as assess the effectiveness of cross-layer mechanisms to achieve energy savings, accurately accounting of the energy consumed by data communication activities is crucial. Such accounting must be as close to reality as possible, taking into consideration all radio states, i.e., energy spent not only while transmitting and receiving a packet, but also while in idle, overhearing, or sleep modes. Furthermore, most current simulators do not automatically measure energy consumption, leaving it up to the protocol designer to explicitly write code to account for it. And, clearly, depending on the layer of the protocol stack, energy consumption accounting can become quite cumbersome and inaccurate [3] [4].

This is accomplished by explicitly accounting for low-power radio modes and considering the different energy costs associated with each possible radio state, i.e., transmitting, receiving, overhearing, idle, sensing, and sleeping. For example, in, the graphical model presented for energy consumption in IEEE 802.11 single-hop wireless networks is compared to the accounting provided by QualNet. We also evaluate the energy consumption of AODV OLSR and DSR [3].

A. MOBILITY MODEL

Mobility models are used for simulation purposes when new network protocols are evaluated.

The Random waypoint model was first proposed by Johnson and Maltz. It is a random mobility model used to illustrate the movement of mobile users, and how their location changes with time. It is one of the most popular mobility model to evaluate Mobile ad hoc network (MANET) routing protocols, because of its simplicity and wide availability. Using this model, the mobile nodes move randomly and freely without any restriction i.e. source to destination, speed and direction are all chosen randomly and independently of all other nodes [5] [6].

B. POWER MODEL

In the power consumption of some network interface cards (NICs) was measured when used by different end-user devices. They also report on transport- and application-level strategies to reduce energy consumption by NICs. Later, reported detailed energy consumption measurements of some commercially-available IEEE 802.11 NICs operating in ad hoc mode. Along the same lines, assessed the impact of transmission rate; transmit power, and packet size on energy consumption in a typical wireless network interface. In most previous measurements, however, the focus was on the characterization of energy consumption during the many modes of operation of a NIC (transmit, receive, idle, etc.). In power consumption model for sensor networks consisting of three components sensor, computation and communication cores is proposed in this paper [5].

C. TRAFFIC GENERATORS

A Traffic Generator model is the traffic which behaves in a predefine configuration and scheduled manner. 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 traffic generators are taken into consideration for the analysis which also supports QoS parameter.

- File Transfer Protocol (FTP)
- Constant Bit Rate (CBR)
- Variable Bit Rate (VBR)
- FTP/Generic
- Lookup
- Traffic-Gen
- Super-Application
- VoIP

The remainder of this paper is organized as follows. Section 2 reviews related work. In Section 3, we describe system description for implementation of energy consumption. Brief descriptions of routing protocols are presented in Section 4. Results comparing MAC protocols, namely S-MAC and 802.11, and routing protocols, namely AODV, OLSR and DSR, are presented in Section 5 and our concluding remarks and directions for future work in Section 6.

II. RELATED WORK

An energy-aware simulation model, which considers a network consisting of multiple nodes, where each node is composed by a local request queue, a microprocessor, an external request queue, another processor, a service queue and a service provider is describe in. All components are random variables. The total energy consumption on a node is the sum of the energy spent by node components, energy consumption for transmitting a data packet, and energy consumption for receiving a data packet. Although the model considers energy spent with processing and buffering requests, the radio model is quite simple and does not include a low-power radio mode, which is crucial for development of power-aware protocols [7].

A simple energy model is introduced in to evaluate power-aware protocols in the LEACH project. LEACH (Low-energy Adaptive Clustering Hierarchy) is a clustering-based protocol that uses randomized rotation of cluster-heads to evenly distribute the energy load among the sensors in the network. In the energy model, the energy spent on transmission is given by the energy dissipated by the radio electronics and the power amplifier, while the energy spent by the receiver is given by the energy dissipated by the radio electronics [5] [7].

Since the energy necessary to amplify the signal depends on its attenuation, and the attenuation depends on the distance, the energy dissipated by the radio electronics is proportional to d^2 for short distances and to d^4 otherwise. Using this same energy model, examine the energy consumption in a wireless sensor network with two distinguished organizations: single layer versus clustered.

In, energy consumption in ad-hoc mobile terminals is modeled using the Advanced Configuration Power Interface, or ACPI, an open standard that allows computer systems to implement motherboard configuration and power management functions. ACPI was used to measure energy consumption due to transmission/ reception. The resulting energy consumption model includes two states: high consumption state, where the host receives and transmits, and low consumption state, where the node receives or is in idle. Thus results from different efforts cannot be compared directly.

A graphical model to predict energy consumption in saturated IEEE 802.11 single-hop ad hoc networks under ideal channel conditions is presented in. The energy consumption predicted by the model is then compared to the accounting provided by QualNet. Important results from this work include the following: (1) contrary to what most previous results indicate, the radio's transmit mode has marginal impact on overall energy consumption, while other modes (transmit, receive, idle, etc.) are responsible for most of the energy consumed; (2) the energy cost to transmit useful data increases almost linearly with the network size; and (3) transmitting large payloads is more energy efficient under saturation conditions [8] [10].

III. SYSTEM DESCRIPTION

We develop a scenario using QualNet 5.0; software that provides scalable simulations of Wireless Networks to analyze the performance of different routing protocols in wireless sensor network with CBR application.CBR is the data traffic that keeps bit rate same throughout the process. In this scenario there are 40 nodes placed within 1500*1500 m^2 area. Node 1 is a Full Function device and acts as a Pan Coordinator & rest of the nodes are reduced function device. CBR application is used between source nodes 1 & destination nodes 5,10,15,20,25,30,35 &40 respectively. Random waypoint mobility is used as a Node movement model. Simulation is done by varying the Mobility of nodes and the results are analyzed using different protocols [14].

The number of packet Performance evolution of the AODV, DSR and OLSR protocol is implemented on the QualNet 5.0 with the following considerations. The following parameters are considered as shown in table 1.

TABLE I

Parameters require for Traffic Generator Based

Parameters	Value
QualNet	5.0
Channel Type	channel/wireless channel
MAC type	IEEE 802.11
Antenna Type	Omni-directional Antenna
Network Layer	LL
Network Layer	PHY wireless
MAC protocol	Mac/802.11
Network interface type	Physical/ Wireless Phy
No of Nodes	40
Radio-propagation model	Two Ray Ground
Topological area	1500 x 1500 sq. m
Simulation time	300 sec.
Energy Model	MICA-MOTES
Routing protocols	DSR, AODV and OLSR
Initial energy of a Node	1000.0 Joules
Radio type	802.11b Radio
Packet Reception Model	PHY 802.11b Reception Model
Data Rate	10 Mbps
Mobility Model	Random Way Point
Pause Time	30 sec.
Battery Model	Linear Model

Power analysis of different routing protocols.

The node is moving in the random motion in the area of 1500x1500 m^2. When comes in specific transmission range it starts transmission between the different nodes. Here it is shown that the packet is transmitting. When overlapping of that & specific range is finish stops data transmission. The figure 2 showed the output [15] [18].

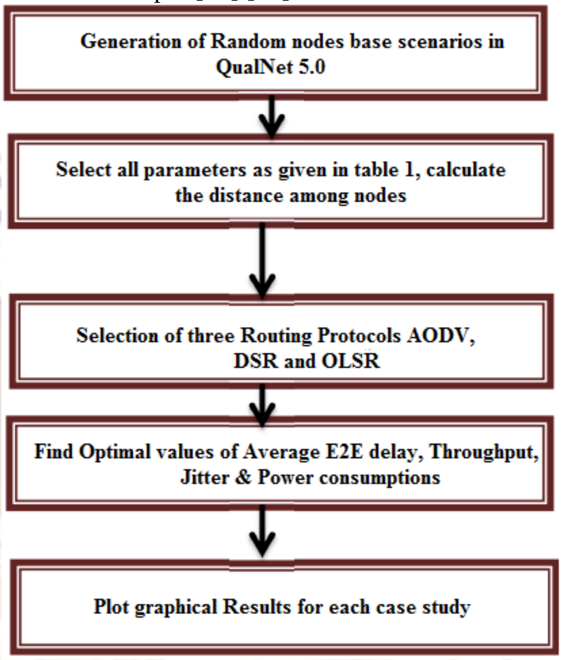

Figure 1 Block Diagram for the Simulation of networks of size 1 to 40 nodes for the chosen routing protocols.

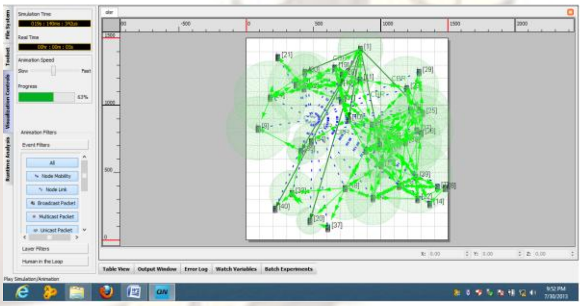

Figure 2 shows the snapshot of OLSR wireless routing protocol taking table 1 parameters.

IV. DISCRIPTION OF ROUTING PROTOCOLS

A. AODV: A REACTIVE ROUTING PROTOCOL IN WSNS

AODV is an "on demand routing algorithm based routing protocol", means that it establishes paths only upon demand by source nodes. It maintains these paths as long as they are needed. Nodes do not participate in active path neither maintain any routing information nor participate in any periodic routing table exchange. AODV established path based on route request- route reply mechanism [12].

AODV uses source sequence number and

destination sequence number to resolve the freshness of routes. To find a new route, AODV proceed by broadcasting the route request (RREQ) packet. If the neighboring nodes which receiving the RREQ has no route information regarding the destination after that it will further broadcast RREQ packet in the network otherwise it will send answer by the route reply (RREP) packet to the sender from which RREQ is received. RREQ contains source address, source sequence number, broadcast_id, destination address, destination sequence number, and hop count as shown in Figure 3.

Type	**Reserved**	**Hop Count**
broadcast_id		
Destination IP Address **Destination Sequence Number**		
Source IP Address **Source Sequence Number**		

Figure 3 Structure of an RREQ packet

The immediate node which receive a RREQ, keeps a forwarding pointer (next hop) towards source to destination. This process continues "go back up to the source" is looped by all nodes that participated in this path discovery mechanism. When the RREP reaches the source, the route is ready, and the initiator can use it. A neighbor that has communicated at least one packet during the past active timeout is considered active for this destination. An active entry in the routing table is an entry that uses an active neighbor. An active path is a path established with active routing table entries. A routing table entry expires if it has not been used recently. In this main content that AODV uses the route expiration technique, where a routing table entry expires within a specific period, after which a fresh route discovery should be initiated [9] [10] [11].

B. Dynamic Source Routing (DSR)

Dynamic Source Routing (DSR) [17] protocol is specifically designed for multi-hop ad hoc networks. The difference in DSR and other routing protocols is that it uses source routing supplied by packet's originator to determine packet's path through the network instead of independent hop-by-hop routing decisions made by each node. The packet in source routing which is going to be routed through the network carries the complete ordered list of nodes in its header through which the packet will pass. Fresh routing information is not needed to be maintained in intermediate nodes in design of source routing, since all the routing decisions are contained in the packet by themselves.

DSR protocol is divided into two mechanisms which show the basic operation of DSR. The two mechanisms are:

- Route Discovery
- Route Maintenance

When a source node wants to send a packet to destination node, the route to destination node is obtained by route discovery mechanism. In this mechanism the source node broadcasts a ROUTE REQUEST packet which in a controlled manner is flooded through the network and answered in the form of ROUTE REPLY packet by the destination node or from the node which has the route to destination. The routes are kept in Route Cache, which to the same destination can store multiple routes. The nodes check their route cache for a route that could answer the request before re-propagation of ROUTE REQUEST. The routes that are not currently used for communication the nodes do not expend effort on obtaining or maintaining them i.e. the route discovery is initiated only on-demand. The other mechanism is the route maintenance by which source node S detects if the topology of the network has changed so that it can no longer use its route to destination. If the two nodes that were listed as neighbors on the route moved out of the range of each other and the link becomes broken, the source node S is notified with a ROUTE ERROR packet. The source node can use any other known routes to the destination or the process of route discovery is invoked again to find a new route to the destination [12].

C. Optimize Link State Routing (OLSR)

OLSR is a proactive routing protocol for mobile wireless networks. The protocol inherits the stability of a link state algorithm and has the advantage of having routes immediately available when needed due to its proactive nature. OLSR is an optimization over the classical link state protocol, tailored for mobile ad hoc networks [16].

OLSR minimizes the overhead from flooding of control traffic by using only selected nodes, called MPRs, to retransmit control messages. This technique significantly reduces the number of retransmissions required to flood a message to all nodes in the network. Secondly, OLSR requires only partial link state to be flooded in order to provide shortest path routes. The minimal set of link state information required is that all nodes, selected as MPRs, must declare the links to their MPR selectors. Additional topological information, if present, may be utilized e.g., for redundancy purposes [17].

OLSR may optimize the reactivity to topological changes by reducing the maximum time interval for periodic control message transmission. Furthermore, as OLSR continuously maintains routes to all destinations in the network, the protocol is beneficial for traffic patterns where a large subset of nodes are communicating with another large subset of nodes, and where the [source, destination] pairs are changing over time. The protocol is particularly suited for large and dense networks, as the optimization done using MPRs works well in this context. The larger and more dense a network, the more optimization can be achieved as compared to the classic link state algorithm.

OLSR is designed to work in a completely distributed manner and does not depend on any central entity. The protocol does not require reliable transmission of control messages: each node sends control messages periodically, and can therefore sustain a reasonable loss of some such messages. Such losses occur frequently in radio networks due to collisions or other transmission problems.

Also, OLSR does not require sequenced delivery of messages. Each control message contains a sequence number which is incremented for each message. Thus the recipient of a control message can, if required, easily identify which information is more recent - even if messages have been re- ordered while in transmission [13] [17].

V. RESULT ANALYSIS

A. *Throughput:*

Throughput is the average rate of successful message delivery over a communication channel. Throughput is usually measured in bits per second (bits/sec), and sometimes in data packets per second or data packets per time slot. High throughput is always desirable in a communication system.

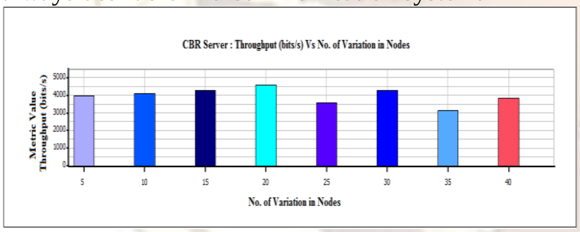

Figure 3 Graphs for Throughput (AODV)

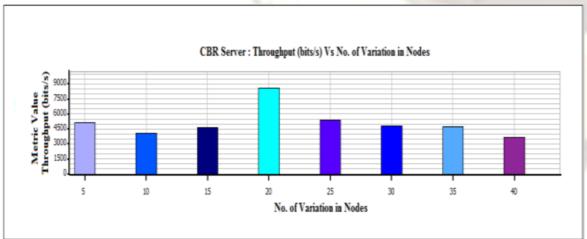

Figure 4 Graphs for Throughput (DSR)

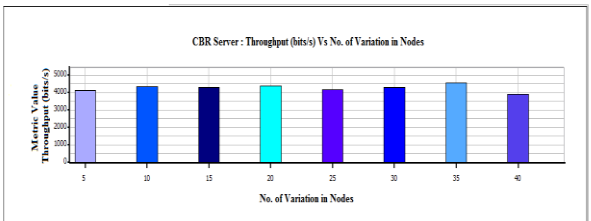

Figure 5 Graphs for Throughput (OLSR)

The above graphical shows that throughput increases with increase in node mobility and is maximum in case of AODV & minimum for OLSR as lot of control overhead is associated due to their proactive nature.

B. *Average Jitter Effect:*

Signifies the Packets from the source will reach the destination with different delays. A packet's delay varies with its location in the queues of the routers all along the path between source and destination and this position can vary randomly. It is observed that the performance of AODV protocol is superior then DSR and OLSR.

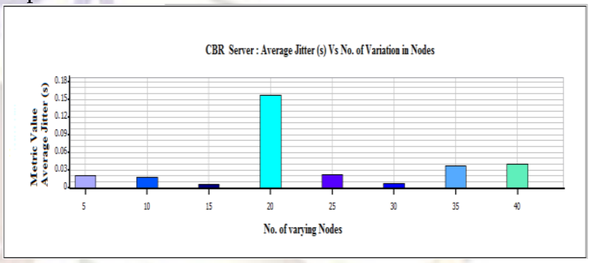

Figure 6 Graphs for Average Jitter (AODV)

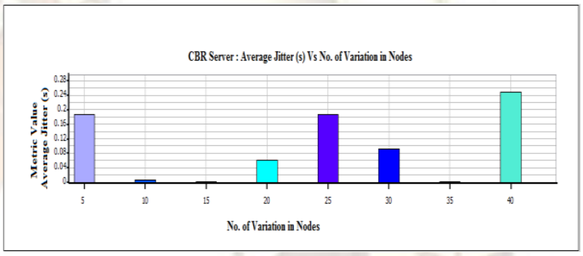

Figure 7 Graphs for Average Jitter (DSR)

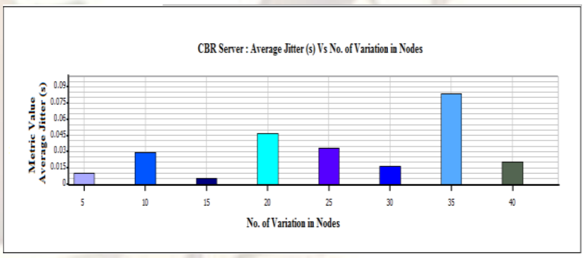

Figure 8 Graphs for Average Jitter (OLSR)

Figure shows graphical representation of Jitter decreases with increase in node mobility and is high for OLSR and is lowest for DSR with less node mobility but increases with increase in node mobility and intermediate for AODV & DSR.

C. *End-To-End Delay:*

Average End to End Delay signifies the average time taken by packets to reach one end to another end (Source node to Destination node).

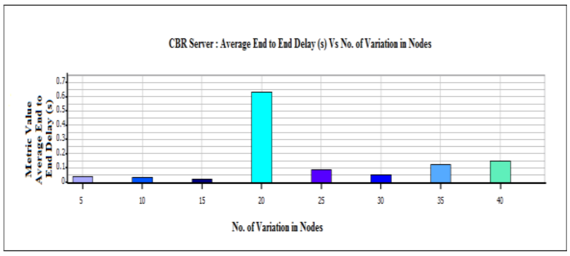

Figure 9 Graphs for Average End to End Delay (s) (AODV)

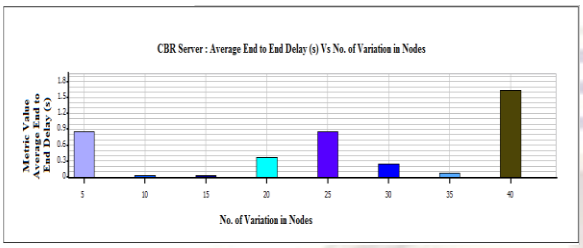

Figure 10 Graphs for Average End to End Delay (s) (DSR)

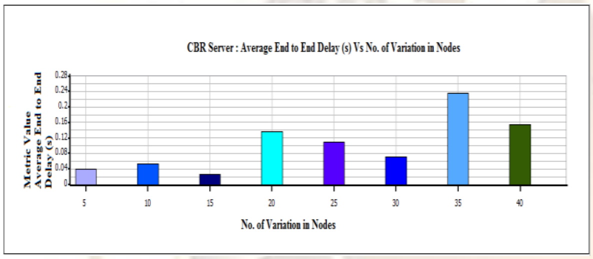

Figure 11 Graphs for Average End to End Delay (s) (OLSR)

Above graphical shows that DSR & AODV performed better than OLSR. OLSR has highest delay while OLSR has lowest delay due to regular update of routing table.

D. Routing Power:

Routing Power is calculated by using the formula

Routing Power (RP) = (Throughput / Avg. End-to-End Delay)

E. Power Consumption Mode:

The mobile nodes in wireless sensor network are connected to other mobile nodes. These nodes are free to transmit and receive the data packet to or from other nodes and require energy to such activity. The total energy of nodes is spent in following modes: (1) Transmission Mode (2) Reception Mode (3) Idle Mode and. These modes of power consumption are presented in graphical mode:

f. Energy Consumed in Transmit mode:

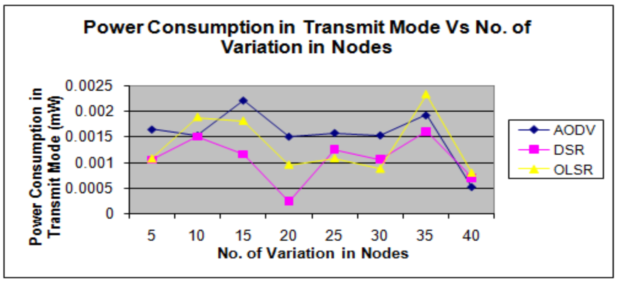

Figure 12 Energy consumed in Transmit mode

F. Energy Consumed in Receive Mode:

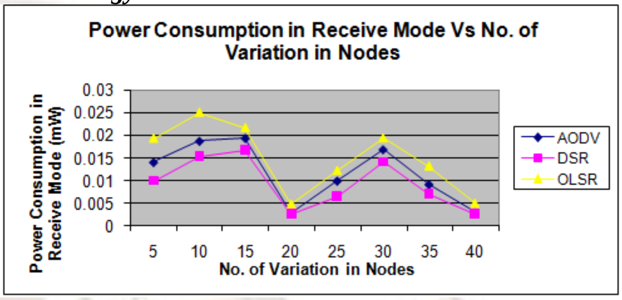

Figure 12 Energy Consumed in Receive Mode

G. Energy Consumed in Idle Mode

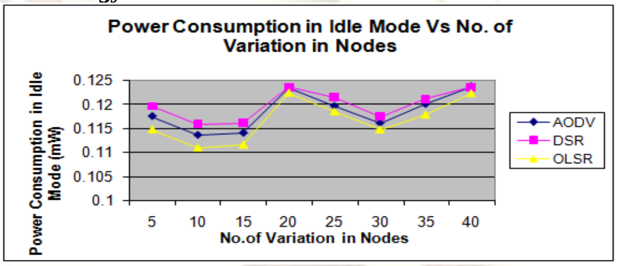

Figure 12 Energy Consumed in Idle Mode

VI. CONCLUSION

The Routing algorithms under the analysis have been simulated and their performance is being analyzed. Under the CBR, VBR and traffic generator based power source the entire routing algorithm performed well and produced over 70% throughput under different pause time from the above graphical results, we obtain some conclusion that in Random waypoint mobility model with CBR and traffic generator AODV gives maximum throughput followed by DSR and OLSR gives the worst results in terms of throughput as it always needs to keep update of whole networks information. Jitter & end to end delay is lowest for OLSR & highest for AODV than DSR. Comparative analysis shows that AODV protocol has the advantage over DSR in a number of key areas but is held back by its proprietary nature and costs. Power saving at routing protocols level is much easier as to evaluate through graphical representation shown above.

We strongly believe in future work that analyzing and criticizing the current routing techniques and their performance can expose new open issues and also be used to either enhance the existing routing schemes or to develop and design of optimal route selection for new routing solutions.

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