DESIGN AN ENERGY EFFICIENT DSDV ROUTING PROTOCOL FOR MOBILE AD HOC NETWORK

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ABSTRACT

As the nodes are rely on batteries or exhaustive energy sources for power and drop out within an ad hoc network, since energy sources have a limited lifetime. As the power availability is one of the most important constraints for the operation of the ad hoc network. In this paper, we present performance evaluation and verification for energy efficient DSDV (EEDSDV) [1] routing protocol for MANET and simulate the result with the help of the performance matrices like End to End Delay and Packet Delivery Ratio. The EEDSDV uses variant transmission energy approach to overcome the problem of more energy consumption for transmission and receiving messages in DSDV. Our simulation results of EEDSDV show the consumption of energy is less over DSDV routing protocols.

KEYWORDS: *Ad hoc Network, DSDV, EEDSDV Routing, Transmission Energy.*

I. INTRODUCTION

Wireless Network can be broadly classified into two part wireless mobile network and wireless ad hoc network which is a self-configuring infrastructure less network of mobile devices connected by wireless, and having the advantages and facilities in various types' of applications such that disaster recovery, battle field communication and law enforcement operations which demanded for setting up a network in no time. Mobile ad-hoc networks can operate in a standalone fashion or could possibly be connected to a larger network such as the Internet [2]. Source and destination nodes are communicate with each other over multiple hops when no other networking infrastructure is available. For routing of the data packets into MANET there are mainly proactive routing protocol used i.e. DSDV [3], FSR [4], and reactive protocol i.e. DSR [5], TORA and hybrid protocol e.g. ZRP [6]. There are various energy constrained based protocol such as Flow Augmentation Routing (FAR) [7], Online Max-Min Routing (OMM) [8], and Power aware Localized Routing (PLR) [9] protocols and survey papers such as [10,11] which is based on transmission power control approach whose main aim is to minimize the total transmission energy but avoid low energy nodes. In this paper in the continuation of our proposed protocol energy efficient DSDV routing protocol (EEDSDV) [1] we implement and simulate EEDSDV with the help of NS2 and verify the result. Modification of DSDV into energy efficient routing protocol (EEDSDV) is performed by controlling the transmission energy of node and provides energy efficient routing which consumes less energy. We consider the DSDV protocol which was developed by C. Perkins and P. Bhagwat in 1994[3]. DSDV is a table-driven routing scheme for ad hoc mobile networks based on the Bellman-Ford algorithm. It helps in solving the routing loop problem. The routing table entry contains a sequence number, if a link is present the sequence numbers are generally even; else, an odd number is used. The number is generated by the destination, and the intermediate hops need to send out the next update with this number. Routing information is distributed between nodes by sending full dumps not in a frequently manner and smaller incremental updates sending more frequently. On reception of these update messages; the neighboring nodes checks for the sequence number, if new sequence number is greater than or equal to the old sequence number and hop count is less then updating in routing table performed, Otherwise, ignore the update message.

Rest of the paper is organized as follows, section 2 describes literature survey and after that our proposed work is given in section 3 and then in section 4 we present simulation results. Finally in section 5 gives conclusion and future scope presents in section 6.

II. LITERATURE REVIEW

DSDV protocol is not so much concerned with energy consumption as it is table driven. There have been a lot of research work has been done for the improvement of the proactive as well as reactive protocols. But there was least concentration on DSDV protocol modification.

In the paper [12] author proposed a novel routing tree, as the Quality of service routing is challenged in the normal routing strategy and having problem of link breakage, congestion and energy consumption and namely gives novel routing tree as an Energy-Efficient Traffic-Aware Detour Tree, which is constructed completely in a bottom-up fashion, with the consideration of traffic pattern and residual energy and routing shows higher throughput than other detour trees, leading to a better routing performance. But there still exist some mechanism like if we apply both the tree construction method such as top down & bottom up considering traffic pattern & residual energy of network through which the routing may be fast and topology of the network may be constant which leads to better performance.

Paper [13] Eff-DSDV overcomes the problem of stale routes and larger size network having larger number of nodes. For the given stale route problem author have devise an algorithm indicating that the performance evaluation of the given solution is superior as compared to original DSDV under the performance evaluation parameters. Although the author gives the stale route problem the protocol is still challenged by the communication time failure and security issues as it is not feasible to receive a late coming packet because it is worst than not receiving the message in time and if packet is coming late then there are following measures are affected i.e. more energy consumption, large numbers of control packets are required which leads to congestion as well as quality of service affected.

In [14] author have focuses on an approach for energy conservation as well as reducing packet storming within the routing protocol of the ad-hoc network by the use of sending and receiving sleep mode sleep and wake up message.

Many improved form of algorithm have been suggested in DSDV due to limitations like -

1. Doesn’t support Multi path Routing.
2. Wastage of bandwidth
3. Difficult to maintain the routing table’s advertisement for larger network. Each and every host in the network should maintain a routing table or advertising. But for larger network this would lead to overhead, which consumes more bandwidth.
4. Difficult to determine a time delay for the advertisement of routes.

As per the literature survey on energy consumption aspect of nodes in a network we have found that in DSDV protocol there are following problems exists which are -

- The large number of route replies in DSDV because route reply is sent through all the available routes leading to unnecessary congestion & waste of energy (battery power).
- Each node uses constant power to forward the packet or to transmit the packet. Irrespective of the distance between adjacent nodes, each node transmits with a constant power which takes more battery power.

III. PROPOSED WORK

We consider the energy constraint in MANET. By the use of Variant Transmission Energy Approach we implement an efficient energy management in DSDV and modify DSDV into EEDSV. From the baseline evaluation of the most protocol of MANET we come to the conclusion that DSDV which is having the problems like-

- In the existing DSDV, the large number of route replies in DSDV because route reply is sent through all the available routes leading to unnecessary congestion & waste of energy (battery power).
- In existing DSDV, each node uses constant power to forward the packet or to transmit the packet. Irrespective of the distance between adjacent nodes, each node transmits with a constant power which takes more battery power.

3.1. Energy Efficient DSDV (EEDSDV) Routing

In wireless network's architecture energy saving will be done at different layer [15]. There are different methods are used to save power at different layers. To deal with the above stated problem in DSDV we proposed Energy Efficient DSDV (EEDSDV) Routing Protocol. Our proposed protocol at network layer uses mechanism of unicasting on behalf of multicasting or broadcasting for the purpose of route reply as well as data transmission from source to destination is performed by nodes transmission energy, which is tuned according to distance.

In EEDSDV before the actual route request all the available route (path) is provided by the network node by taking the route labeled with most recent sequence number. Route Request is sent to the destination via multihop network with specified network size and number of node. Whereas Route Reply is sent via the route through which the destination received the first Route Request, because it is the most active route for the particular source-destination pair at the moment of sending the request.

At the time of Route Reply in EEDSDV one more strategy have used in our proposed protocol that is the calculation of distance between two nodes in the selected path by means of the time taken by Route Reply message known as Trip Time. The Trip Time (TT) is the time calculated by sending a route reply message from the local node to the remote node. Calculation is performed at the time of route reply where destination node inserts current time in the route reply message header and transmitted it to the immediate previous node at the selected path. Immediate previous node takes this header time and subtracts this time by his current time which is obviously higher than header time and store the result in the cache. Again the former node inserts own current time and transmits it to immediate previous node. Following the same procedure the time is calculated at the selected path from destination to source. Doing so, time at each node in the selected path is calculated. After the calculation of time at each node, for the estimation of distance from destination node to source will have to be calculated in ad hoc network according to the formula below, as the return time measured by sending a packet from the local node to the remote node is known as *Round Trip Time (RTT)*. The formula below is used for the estimation of RTT in wireless LAN, which is also presented in [16] as,

$$RTT = 2 \times distance/c$$

Where $c \approx 3 \times 10^8$ *m/s (*speed of light*)*, while the distance is the length of local node to the remote node. So from above equation, for one way distance, we can calculate the distance as,

$$Distance\ (d) = TT * c \quad where\ c \approx 3 \times 10^8\ m/s.$$

The *c* is the speed of light, while the distance (d) is length of the neighboring nodes in the selected path from source to destination.

In such way all the link distance is available at each node in the selected path. After the calculation of distance at each node, appropriate data transmission energy is calculated at each node which will be discussed in section 3.2.

When the link failure happened due to mobility or due to nodes become dead having less energy. By using single hop route request and acknowledgement protocol creates a temporary link through a neighbor which has a valid route to the desired destination. The temporary link is created by sending one-hop RREQ and ROUTE-ACK messages. The intermediate node upon finding the next hop broken link broadcasts a one-hop RREQ packet to all its neighbors. In turn, the neighboring nodes returns the ROUTE-ACK if it has a valid route to the destination. For route update time an additional entry is there in each entry of the routing table. This update time is embedded in the ROUTE-ACK packet and is used in selecting a temporary route. In case of receiving multiple ROUTE-ACK with the same number of minimum hops, ad hoc host node chooses that route which has the latest update time.

3.2. Energy Consummption Reduction Mechanism in DSDV

Mechanism corresponds to determining the appropriate data transmission energy at each node in a path, through which communication data can suitably be transmitted. Before the estimation of transmission energy previously we have to determine the distances among each hop through source to destination as discussed in section 3A.

By this distance how much energy is required to transmit the data packet is calculated which is bitterly tuned according to the distance.

Before starting of the Route Request we assume a specified threshold energy used at the time of route request and route request considers only those nodes which are having the energy greater than the specified threshold energy and We are assuming that each node having a larger energy source so that it can transmit the data packet.

EEDSDV Routing strategy is used to determine the variant transmission energy in which once the distance between the two nodes is determined and stored in the corresponding cache of the node. The Variant Transmitted Energy (VTE) is determined using the following formula at every hop by which it can transmit the data suitably. Variant Transmission Energy (VTE) can be calculated by

$$\text{Variant Transmission Energy (VTE)} = (a*d^4) + c;$$

Where'd' is the distance between two adjacent nodes, and 'a' and 'c' are arbitrary constants where c = 30e-13 mW and a = 6.35e-9 mW, as

$$a=Pr*k;$$

In which Pr is minimum Signal Received Energy or Channel Sensing Energy and is equal to 7.94e-10mW & k =8. We can say that transmitted energy is directly proportional to distance (d); finally we transmit the packet by their desired energy to reach next hop which is tuned according to the distance between two nodes. Thus data transmission from source to destination is performed by nodes transmission energy, which is tuned according to distance.

3.2.1. Estimation of energy consumption in DSDV

A mobile node consumes its battery energy not only when it actively send or receive packets but also when it stays idle listening to the wireless medium for any possible communication requests from other nodes. Thus energy based routing protocols either in the active communication energy required to transmit and receive data packet or the energy during inactive periods. If we calculate the active communication energy of DSDV protocol in terms of transmission energy which is used for the total transmission energy required to deliver the data packets from source to the destination. DSDV routing protocol is based on the uncontrolled transmission energy i.e. Constant Transmission Energy (CTE). In a CTE approach minimum constant transmission energy is used by all the nodes of the network to transmit and receive packet .Let the Constant Transmission Energy (CTE) at each node is equal to 3.97e-6 mW.

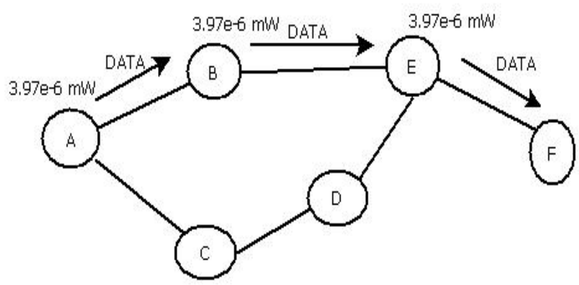

Figure 1. Energy Consumption in DSDV

Let us take a topology of 6 nodes A, B, C, D, E and F as shown in figure 1. Here data transmission performed through the route ABEF. So the total Constant Transmission Energy (CTE) required to transmit the data packet from source to destination is equal to the energy consumed by number of nodes involve in communication from source to destination.

i.e. the Total Constant Transmission Energy (CTE) consumption during data transmission =1.19e-5mW.

3.2.2. Estimation of energy consumption in EEDSDV

If the transmission energy is controllable transmission energy (i.e. Variant Transmission Energy), it is more energy efficient to transmit packet using intermediate nodes [1]. In our proposed protocol the required Variant transmission energy (VTE) the communication between two nodes has super linear dependence on distance 'd' as transmission energy is directly proportional to distance (d);

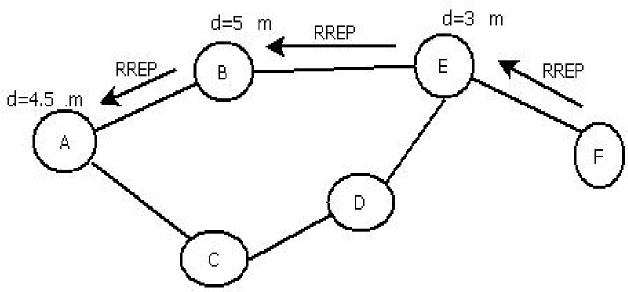

Figure 2. Distance info when Route Reply

According to the proposed mechanism distance d is calculated at each node as shown in figure 2. Therefore Variant Transmission Energy (VTE) between node A and B whose distance is 4.5cm can be calculated at the node A as:

$VTE_{AB} = 6.35e\text{-}9\ mW * (4.5)^4 + 30e\text{-}13\ mW$

$= 2.6e\text{-}6\ mW$

The Variant Transmission energy between nodes B and E whose distance is 5.0 cm can be calculated at the node A as:

$VTE_{BE} = 6.35e\text{-}9\ mW * (5)^4 + 30e\text{-}13 mW$

$= 3.97e\text{-}6\ mW$

Similarly,

$VTE_{EF} = 6.35e\text{-}9\ mW * (3)^4 + 30e\text{-}10 mW$

$= 5.14e\text{-}7\ mW$

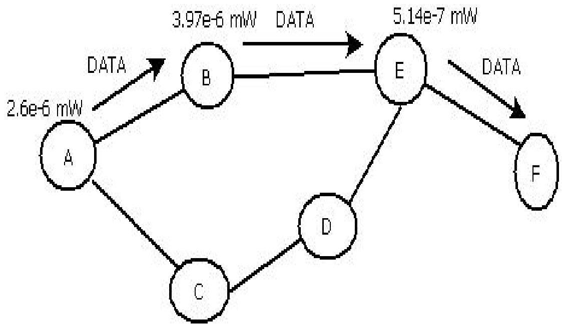

Figure 3. Data Transfer in EEDSDV

I.e. the Total energy consumption during data transmission from A to F in EEDSDV as shown in figure 3

= 1.175e-5 mW

So the percentage decrease in overall energy consumption in between DSDV & EEDSDV

= (total energy consumption in DSDV- total energy consumption in EEDSDV) * 100 / total energy consumption in DSDV

= (1.19e-5 – 1.17e-5)*100/1.19e-5

= 1.68 %

IV. Simulation Results and Analysis

To simulate our proposed routing protocol we have used NS2 [17, 18] version 2.31. The primary reason for choosing NS2 is its free availability for research and support of a multi-hop wireless environment & second reason is their citations in most of the studies in the literature where researchers have used NS2 as their simulation environment. During modification we have consider the parameters as stated in Table 1. We have considered performance matrices which are Packet Delivery ratio, End to End Delay and finally compare the consumption of Energy of DSDV by EEDSDV.

Table1. Simulation Metric Table

Matrices	Dimension
Channel Type	Wireless Channel
Area (meter)	400*400
Antenna type	Omni Antenna
No. of Nodes	15
Minimum Transmission Energy	3.97e-6 mW
Minimum Signal Received Energy	7.94e-10mW
Data Rate	30kbps
Periodic Update	10-12 sec

4.1. End To End Delay

The delay experienced by a packet from the time it was sent by a source till the time it was received at the destination. End to End Delay considers all possible delays caused by buffering at MAC layer during queuing delays, and propagation and transfer times of data packets. This is the average overall delay for a packet to traverse from a source node to a destination node. So, Average-End-to-End-Delay of routing protocol is calculated as:

Avg. End-to-End Delay $=\sum T_t / P$ Where $T_t = (T_d - T_s)$ and

Td = Time when packet received at destination,

Ts=Time when packet created by source, and

P =Total Packet

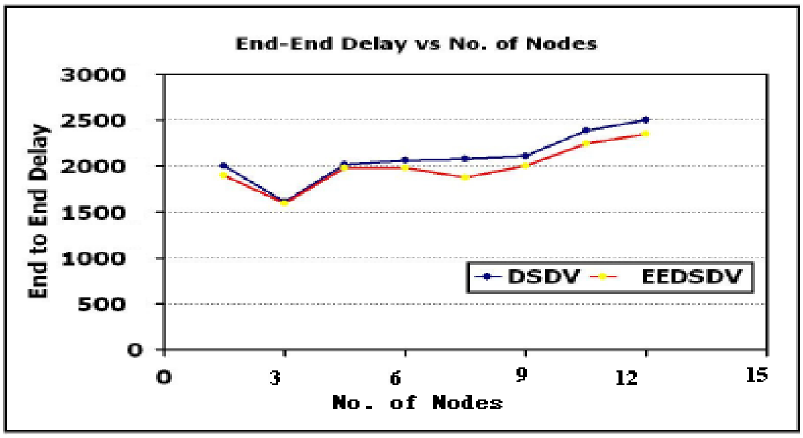

Figure 4. End to End Delay Vs Number of Nodes.

Figure 4 shows the End to End Delay for the two protocols as a function of the number of nodes. X - Axis of the graph shows number of nodes used for simulation and Y– axis shows End to End Delay for the two protocols. The performance of EEDSDV is better than DSDV protocol for varying number of nodes especially between 3 and 9 nodes as shown in figure but for 3 nodes End to End Delay for both the protocols are same and for 5 number of nodes there is a slight difference in both protocol. After that the performance of EEDSDV is better than DSDV protocol because of using the temporary routes in the EEDSDV the packet latency naturally is bound to decrease.

4.2. Packet Delivery Ratio

It is the percentage of ratio between the number of packets sent by sources and the number of received packets at the sinks or destination.

PDR = $\sum_i$ [No. of received packet at sink $_i$ / No. of packet sent by source $_i$]*100

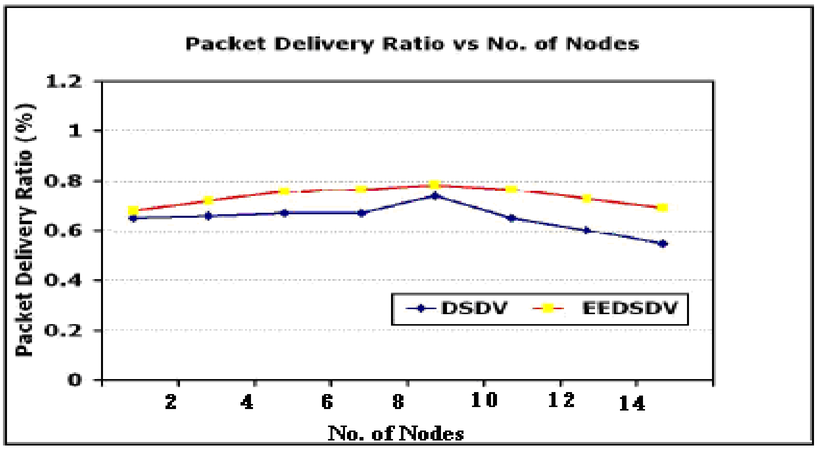

Figure 5. Packet Delivery Ratio Vs Number of Nodes.

Figure 5 show the graph of the two protocols as a function of the number of nodes. X - Axis of the graph shows number of nodes used for simulation and Y– axis shows packet delivery ratio. It can be seen from the graph that the performance of EEDSDV is better than the regular DSDV. It may observe that for 15 nodes the packet delivery ratio of DSDV protocols is up to almost 70% and decreasing after 8 nodes to 15 nodes whereas for EEDSDV packet delivery ration for the 15 node is more than 75 % for the same scenario.

4.2.1. Energy Consumption in DSDV and EEDSDV

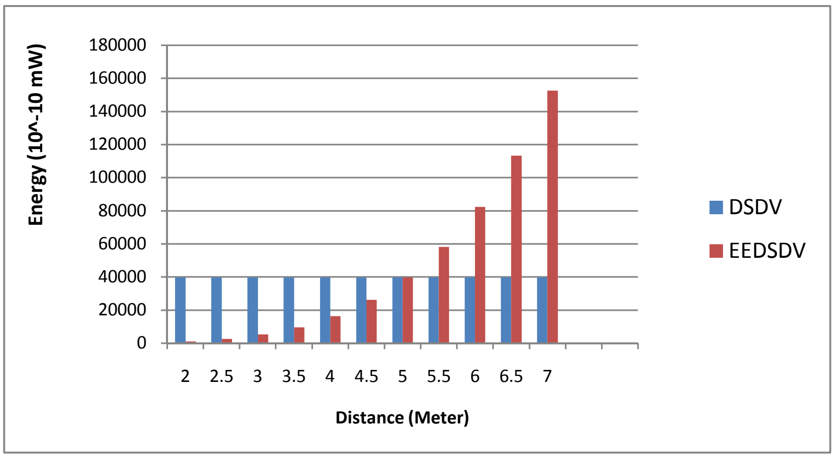

Figure 6. Energy consumption Vs Distance

The comparison of DSDV and our proposed routing Protocol EEDSDV are shown in figure 6. We consider x-axis as distance in (meter) and y-axis shows energy consumption in mW. Then the comparison between both the protocols DSDV and EEDSDV are performed. In the baseline evaluation of Regular DSDV protocol we have seen in Figure 6 that consumption corresponding to the distances in basic DSDV routing protocol have same level of energy consumption and consumed energy is not bother by distance due to constant power used at each node in network. For forwarding the packet or to transmit the packet and according to DSDV draft, each node uses 3.97e-6 mW energy. we have seen that irrespective of the distance between adjacent nodes each node transmits with a constant power i.e. for the different distance 2 meter, 3 meter, 4.5 meter & 5 meter, the consumption of energy is same that is 3.97e-6 mW.

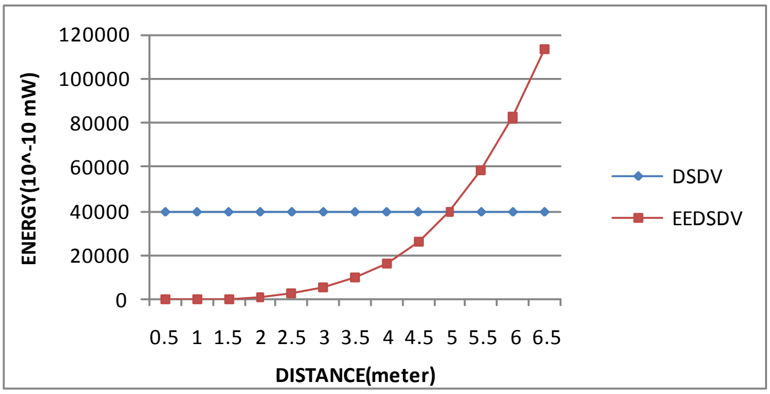

Figure 7. Energy Consumption Vs Distance

But for our proposed routing protocol EEDSDV for the purpose of data transmission, consumption of energy used is controlled (VTE) energy according to distance i.e. for EEDSDV the transmission energy is tuned according to the distance between transmitting node and receiving node. For different distances different energy is consumed. As for the different distance 4.5 meter, 5 meter, 3 meter & 2 meter the consumption of energy is 2.603e-6, 3.97e-6 mW, 5.143e-7mW, and 3.21e-8mW respectively. So energy consumption is varied according to distance.
We can also understand this energy consumption by the figure 7, in which for DSDV a constant level of energy consumption for different distances have shown whereas for EEDSDV energy consumption varied for different distances.

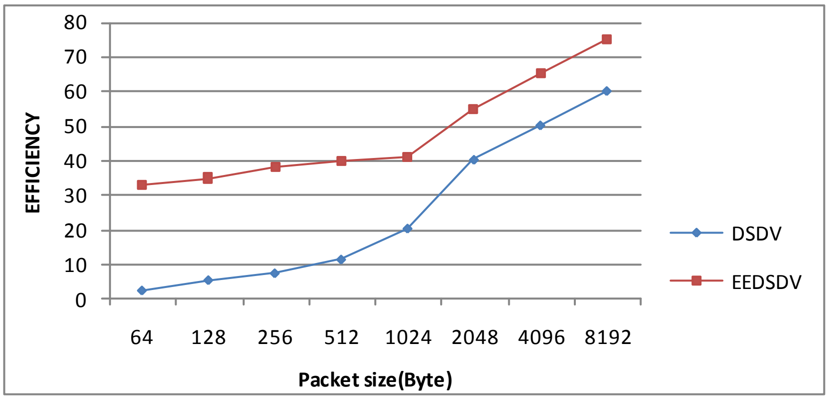

Figure 8. Efficiency Vs Packet Size.

In figure 8 Efficiency of DSDV & EEDSDV for the different packet sizes is shown. For the 64 byte packet size efficiency of DSDV is 2 whereas efficiency of EEDSDV is quite higher for the same packet which is 33. For sizes greater than 1024B, there is no considerable difference between the two protocols although EEDSDV operates slightly better.
In this section, we discussed he metrics used for our proposed EEDSDV approach

- Mainly based on avoidance of unwanted route replies & variant transmission energy approach leads to decreasing end to end delay.
- Control packets generated in the network also reduced and packet delivery ratio increases.
- Our modifications make the data transmission better and the average percentage energy saved per node is found to be better than the original consumption.

V. CONCLUSION

In this paper, we discussed and verify an Energy efficient DSDV routing protocol with the help of performance metrics. As DSDV used constant transmission power to transmit and receive messages where as our proposed routing Protocol used variant transmission power. Our results, shows that there is less energy consumption when we used EEDSDV routing protocol as compared with DSDV routing protocol. Mainly based on variant transmission energy approach and avoidance of unwanted route replies leads to decreasing end to end delay and increase in packet delivery ratio as well as control packets generated in the network is reduced. The average percentage energy saved is found better than the original consumption.

VI. future work

Quality of Service guarantee is one very obvious offshoot of our proposed algorithm is to provide. With the routing protocol scalability could be an issue as we discussed earlier due to the increase in size of the history table as well as the routing updates with the increase in number of nodes in the network. This is another area, which can be worked upon. In implementing the routing protocol, we had fixed the periodic update intervals at 10 and 12 seconds for constant and variant energy control approach. It would be interesting to see at what periodic intervals the energy aware routing algorithm give best performance results.

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