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Energy and Power Aware Stable Routing Strategy for Ad hoc Wireless Networks based on DSR

Mr. Nirav Bhatt[1], Dr. Dhaval Kathiriya[2]

[1]*Reaserch Scholar, School of Computer Science, RK University, Rajkot*
[2]*Director IT, Anand Agricultural University, Anand*

Abstract: **-In ad hoc wireless networks, nodes are mobile, and there is no any fixed infrastructure. So the nodes in the network forward messages on behalf of other nodes which are not within the transmission range of each other. Here we proposed a routing strategy based on DSR that enhance the performance by analyzing the residual energy and transmission power at each node in the network. In ad hoc networks nodes running on batteries, so they are having limited amount of energy because here all operations are performed by node itself. In such scenario we attempt to make some modifications in basic DSR in terms of energy and transmission power saving and try to make our protocol stable for the network. In our propose strategy, it establish a route between source to destination and then select the route for transmit the data where route can stay for the longer period of time based on the residual energy of each node. It also considers the transmission power and adjust the transmission power based on the distance between two nodes. We have evaluated our propose strategy in ns-2.34 and evaluate various parameters and they are improved as compared to the basic DSR.**

Keywords**—Ad hoc wireless networks, DSR, SEDSR, Residual Energy**

I. INTRODUCTION

Ad hoc networks are wireless networks of mobile nodes without having any fixed infrastructure for communication between nodes. The nodes which are within the range of each other can communicate without the need of central point. Each node in the network can act as a router as well as host for multi hop fashion. The nodes in the network forward messages on behalf of other nodes which are not within the transmission range of each other. So the availability of each node is equally important and if any single node becomes failure then it can greatly affect on the overall operations and performance of the network. When any node contributes actively in transmission process in multi-hop fashion, more energy will consumed throughout transmission [12]. In ad hoc networks where each node is mobile, there has been accelerating energy crisis. In such scenario we have considered Dynamic Source Routing (DSR) protocol as our base and then we attempt to make some modifications on it. We have considered DSR protocol because it is one of the protocols which do not take energy into account and once the dedicated path is established between sources to destination then it will keep sending through that path until the link is broken due to any of the intermediate node dies out of energy or the transmission is not completed. Basic DSR considered the shortest path, select the route with minimum hop count and start transmission through that route. But to establish the correct and efficient routes from a source to destination is not the decisive aim of any routing protocols, rather to keep the routes and hence the networks functioning as long as possible without any interruption and with less battery consumption at each node.

These goals of routing strategy can be accomplished by minimizing mobile node's energy during the active communications in the networks. Active communication is when all the nodes of the route are participating in receiving and forwarding of data on behalf of other nodes. But DSR is a protocol that does not take energy as a parameter into account.

Dynamic source routing protocol offers a number of potential advantages over conventional routing protocols such as distance vector in an ad hoc network. Source routing is a technique in which the source node determines the entire sequence of nodes through which a packet has to pass. The source node puts the list of addresses of all nodes in the header of the packet, so that the packet is forwarded to the destination through those specified nodes.

II. BASIC DSR PROTOCOL

Basic DSR protocol consists two main phases: Route Discovery and Route Maintenance. During the first phase it finding out the route for the source and then starts transmission of data packets on that route. While during the second phase it is used to resolve the route break or any other issues if finds during data transmission [1].

A. *Route Discovery*

In the network, when any node has data to send, so First it starts the route discovery to the destination. Source node initiates with broadcasting a packet RREQ – Route Request.

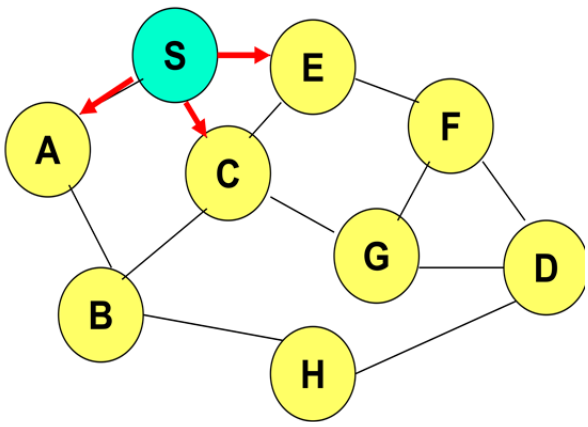

Fig. 1: Broadcasting of RREQ

When RREQ arrived at any node, it checks whether the route of destination is exists in cache or not. It route is exists then sent to the source. Otherwise each intermediate node forwards the RREQ towards destination. Each node forwards RREQ only once based on pure flooding. Finally RREQ reaches at destination node. Destination node when received RREQ, generate Route Reply packet RREP and formed a reverse path. Destination node sent the RREP back to the source through the reverse path. Destination node sent RREP only to the route from where it received first RREQ. When Source received RREP, it record the route store it in its cache. Now source consider the route as the shortest and start transmission of data packets through that route.

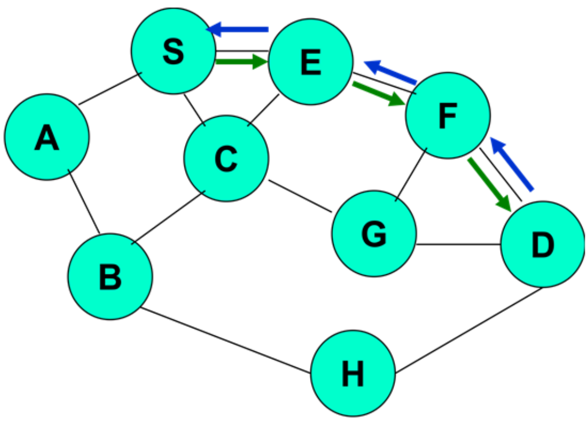

Fig 2: Formation of route & data transmission

B. Route Maintenance

Route maintenance is done by the use of route error packets RERR and acknowledgments. RERR packet is send by a node to the source when the data link layer met a fatal transmission trouble. When a RERR packet is received, the erroneous hop is removed from the node's route cache and all routes that contain that hop are truncated at that point.

Each node transmitting a packet is responsible for confirming that the packet has been received by the next hop along the source route. If none exists, DSR specific software takes the responsibility to sent back an ACK. When retransmissions of a packet in a node arrive at a maximum number, a Route Error Packet (RERR) is sent from the node back to the source, identifying the broken down link and Source eliminate that route entry from the routing table, and find out another route so starts a new route discovery process [3].

III. Proposed Energy & Power Saving Routing Strategy Based On Dsr

The proposed routing strategy also consists two phases Route Discovery and Route Maintenance. The Route Maintenance is mostly worked same as in normal DSR. In Route Discovery it considers the energy-level of each node and then selects the route which are having highest energy-level among all the available routes. During data packet transmission it also considers the transmission power in terms of signal strength [2]. The proposed strategy is not used maximum transmission power that is mostly 1.5 W in normal DSR for 250 meter distance.

During Route Discovery process, source node broadcast the route request packets RREQ to the all neighbors. Each neighboring node when received RREQ, it checks for the duplication and if it is first time then simply forwards RREQ towards of destination node. RREQ finally arrived at destination from multiple routes. Now destination node generates Route Reply packet RREP, inserts its own residual energy to RREP.

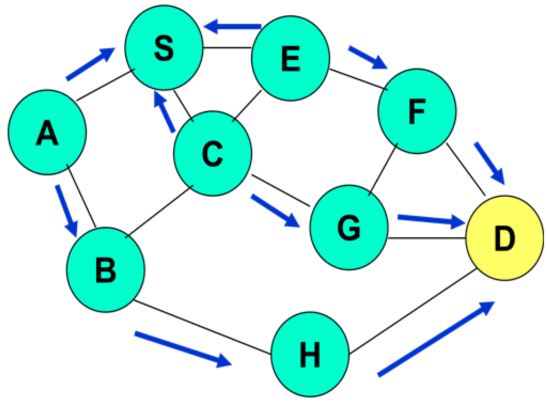

Fig. 3: RREQ arrived at destination node

Now the behavior of destination node and DSR is changed here. Destination node formed a reverse path, sent it to all the routes from where it received RREQ unlike basic DSR (in basic DSR, it sent only one RREP from where first RREQ received). RREP is arrived at each intermediate node. Now the intermediate node compares its residual energy with some threshold value. If residual energy is greater than the threshold value then it participates in route discovery otherwise it simply discards RREP and not to forward it [7]. The algorithms performed at destination node and at intermediate node are described by following pseudo codes:

Pseudo Code 1: Performed at source node: -

```
DSR::gen_Pkt (Packet *P)
{
        if P is RREQ then
                Broadcast RREQ
                Wait for RREP
        end if
        if P is Data then
                start transmission through the route with
                highest energy-level
        end if
}

DSR::recv_Pkt(Packet *p)
{
        if P is RREP then
                calculate the average_energy_level for
                each,
                select the route with highest level,
                store other routes
        end if
}
```

Pseudo Code 2: Performed at destination node: -

```
DSR::recv_Pkt (Packet *P)
{
        if P is RREQ then
                generate RREP
                inserts res_energy into RREP
                send RREP
        end if
        if P is Data then
                process P
        end if
}
```

Pseudo Code 3: Performed at each intermediate node: -

```
DSR::recv_Pkt (Packet *P)
{
        if P is RREQ then
                forward it
        end if
        if P is RREP then
                if res_energy <= Threshold then
                        discard RREP
                else
                        insert res_energy in RREP,
                        calculate distance from
                    sender of RREP,
                        calculate signal strength,
                        forward RREP
                end if
        end if
        if P is Data then
                adjust signal strength based on distance,
                transmit P
        end if
}
```

Each intermediate node also calculates the distance from the sender of RREP and also calculates the signal strength required for data transmission. In ad hoc wireless network distance and signal strength (transmission power) have some relations; it is shown by following equation [5, 7].

$$p_r = k \cdot \frac{p_t}{d^4}$$

Where,

p_r = receiving power (in terms of signal strength)

p_t = transmission power (in terms of signal strength)

d = distance between two nodes in the route

k = constant

Calculating the transmission signal strength by using following equation based on distance (d) and received signal strength [5, 7].

$$p_t` = p_r \,.\, k \,/\, d^4$$

After calculating the distance from the sender of RREP and calculating the transmission power required for that, intermediate node forwards RREP to the direction of source node. Each intermediate node performs the same thing as described in the pseudo code – 3.

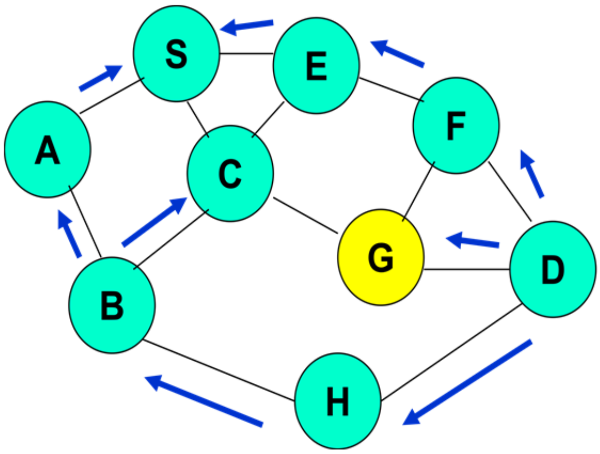

Fig. 4: Sending of RREP by Destination

In Fig. 4, where destination node D generates the RREP and send back to each reverse path from where it received RREQ, so here it sent back to F, G and H nodes respectively. But as shown in Fig. 4, node G, is not having residual energy greater than the threshold value, so it simply discards the RREP and cannot forward to source. While other two nodes node F and node H is having enough energy so they calculate the distance and transmission power according to the pseudo code – 3 and forwards RREP towards the source node. Finally source node received RREP from multiple paths with energy value of each intermediate node. Source node calculates the average energy-level of each node. Source node selects the route with highest energy-level among all available routes and start data packet transmission through that route. Source node stores other routes as back up inside the cache so; they can be used in future if required.

In our example we can find the route <S, E, F, D> with highest energy-level. So source node starts the transmission of data packet through that route while keeping other route <S, A, B, H, D> as back up in the cache.

During data transmission, source sends the data packet to the first intermediate node in the route. At intermediate node, it adjusts the signal strength according to the distance of next node in the route and then forwards the data packet with only required transmission power.

IV. SIMULATIONS

All the simulations were run on the Network Simulator ns – 2.34 [9]. The all the modifications were made to the normal DSR code written for the ns – 2.34. I have tested with 50 nodes network in a field size of 2000 X 2000 sq. m area with 1000 seconds of simulation time. Node movement was modeled using the Random Waypoint model [14].

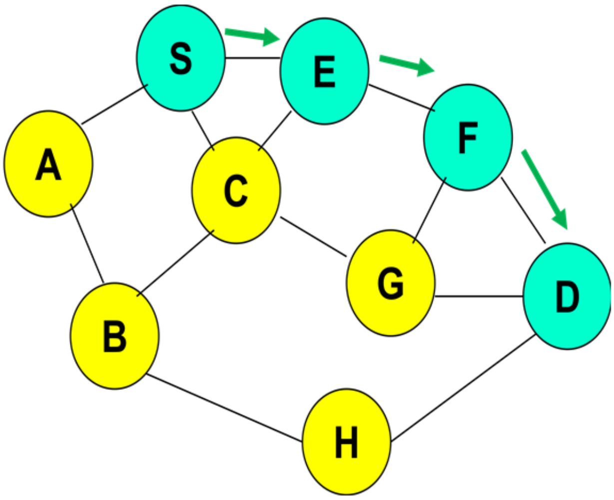

Fig. 5: Source Starts the Transmission

This model is characterized by two parameters: the maximum speed and the PAUSE TIME. Each node arbitrarily selects a destination and a speed, where the speed value is consistently dispersed among 1m/sec and the maximum velocity. The node then moves to its selected destination at the selected velocity. Once it reaches the destination, it stops for a random pause time. The pause time is consistently dispersed between 0 and PAUSE TIME. The node ultimately selects a new destination and speed, and repeats the previous steps. The simulation environments and other details that we have considered during the simulation are described in bellow table. The whole simulation is performed to evaluate the basic DSR with our proposed routing strategy.

Parameter	Values
Pause Time (sec)	0, 1, 2, 5, 10, 15
Speed (m / sec)	1, 2, 5, 10, 15, 20
Max. Connection	20
Transmission Range	250m
Bandwidth	2Mbps
Mobility Model	Random way out
Packet Size	64 Bytes
Packet Rate	4 Packets / Sec
No. of Nodes	50
Initial Energy	100 J.

Table 1: Simulation Setup – ns 2.34

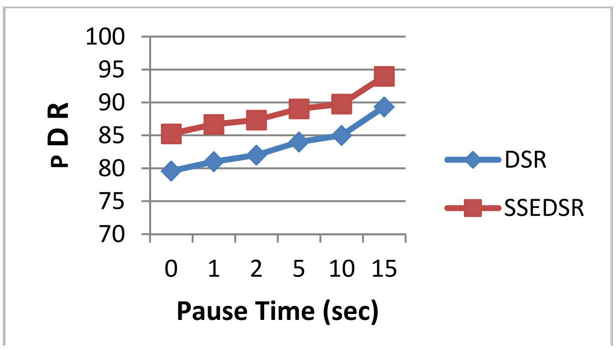

Fig. 6: Packet Delivery Ration V/s Pause Time

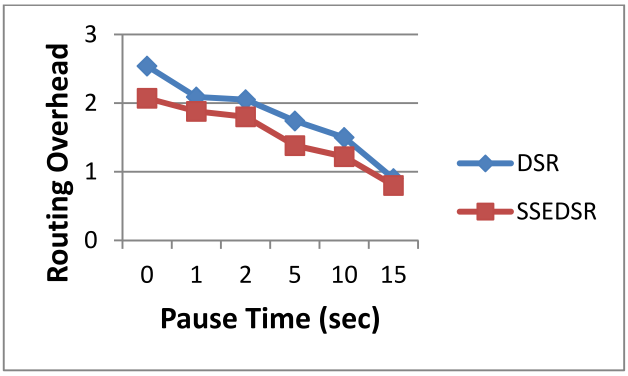

Fig. 7: Routing Overhead V/s Pause Time

Fig. 6, 7 and 8 represents the comparison of basic DSR and our proposed routing strategy in terms of Packet Delivery Ratio, Routing Overhead and Delay respectively with reference to pause time. From Fig. 6, we can say that in our proposed routing strategy, the Packet Delivery Ratio increased and provides improved performance compare to basic DSR.

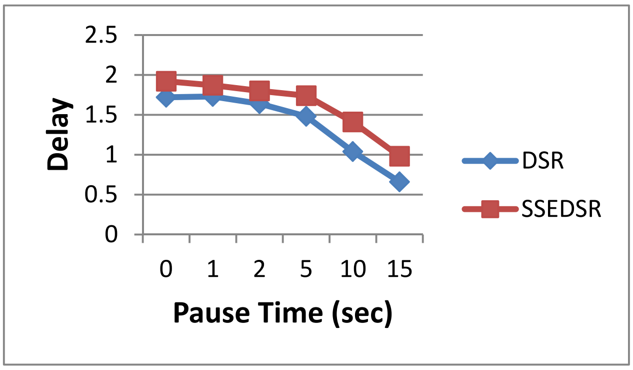

Fig. 8: Delay V/s Pause Time

From fig. 8, we can say that the E2E delay has a little increased in our proposed routing strategy compared to basic DSR. Because in our proposed routing strategy, we have calculated energy-level, transmission power and distance at each intermediate node, so it takes some more delay.

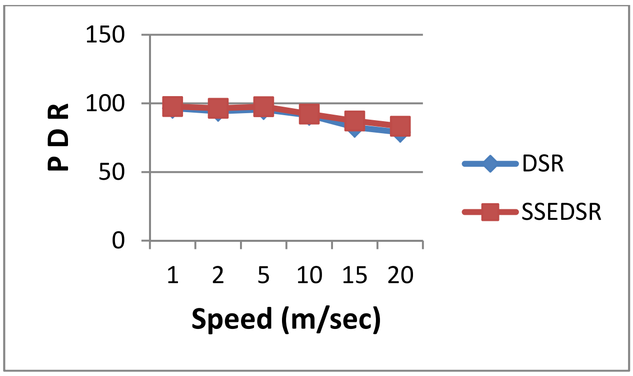

Fig. 9: PDR V/s Speed

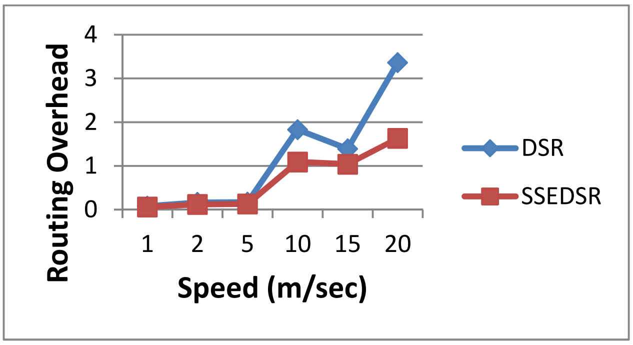

Fig. 10: Routing Overhead V/s Speed

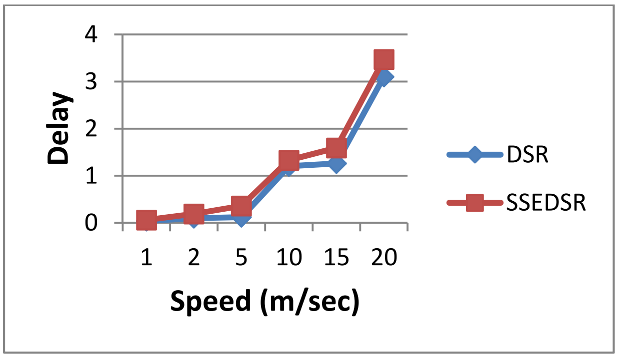

Fig. 11: Delay V/s Speed

The proposed routing strategy is based on reactive and mostly used basic routing protocol DSR in ad hoc wireless networks. The proposed strategy works based on energy consumption. After testing various results during simulations, we can say that our proposed routing strategy provides improved performance than the basic DSR. In our proposed routing strategy we have achieved to increase the Packet delivery Ratio and decrease the Routing Overhead with the drop of a little increasing in E2E Delay. It also consumes the transmission power, means not utilized the maximum transmission power but it is adjusted according to the distance of next hop in the route.

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