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Prasant Kumar Pattnaik
Department of Computer .Sc.&Engg Bhubaneswar, India, patnaikprasant@rediffmail.com

Rajib Mall
Department of Comp. Sc. & Engg. I.I.T Kharagpur, India, rajib@cse.iitkgp.ernet.in

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An Energy Saving Multi-Directional Routing Protocol for Mobile Ad-hoc Networks

Prasant Kumar Pattnaik
Professor,Department of Computer .Sc.&Engg Bhubaneswar, India
patnaikprasant@rediffmail.com

Rajib Mall
Department of Comp. Sc. & Engg. I.I.T Kharagpur, India
rajib@cse.iitkgp.ernet.in

Abstract- **The limited battery energy is an important consideration in the effective operation of an Ad- hoc network. We propose a protocol named as Energy Saving Multi Directional Routing (ESMDR) that provides a lower energy cost effective routing solution. The performance evaluation of our protocol is carried out using a statistically collected data over Dynamic Source Routing (DSR) and Ad-Hoc On-Demand Distance Vector (AODV) protocol. Analysis exhibits a clear edge over the existing protocol.**

Key Words: Mobile Ad hoc Network, Routing, Flooding, Energy Saving

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I. INTRODUCTION.

A MANET is composed of a group of mobile wireless nodes that form a network independent of any centralized administration. Mobile nodes are battery-operated devices, and conserving battery life is an important objective in effective operation of mobile ad hoc networks since each mobile node performs the routing functions for establishing the connection and transmission of messages (M. Maleki et al. (2002))

Flooding, on the other hand costs high message overhead in route discovery. Most of the routing in MANET uses algorithms similar to flooding in order to discover the route. For instance, AODV (Charles E. Perkins et al (1999)) routing protocol sends request packets to its neighbours, which then forwards the request to their neighbours and so on, until the destination or an intermediate node with a fresh route to the destination is located.

In Dynamic Source Routing (David B. Johnson et al.(2001)) also, a Source initiates route discovery by broadcasting a Route Request packet. Each node receiving the packet forwards it along its all-outgoing links, if it is not a destination or it does not know a route to the destination.

II. ESMD ROUTING ALGORITHM.

A. Assumption:

Each node when enters into the Ad-hoc networks keeps the information about the neighbouring nodes and their relative direction. This information is updated in regular time interval.

Step 1. *Source Searches a path to destination in its neighbourhood.if found then a direct link is established from source to destination and source transmits the data packets.*

Step 2. *If not found the source sends a Route Request packet to those neighbours which are present at its 4 directions ,each separated by 90-degree approximately. Forwarding Directions are decided according to the direction vs concentration[number of nodes in each direction] information available with each nodes.*

Step 3. *Intermediate node again search the intended receiver in its neighbourhood.if found then it send a route reply message to the sender following the same path which has been followed during the transmission of route request path.*

Step 4. *If not found in its neighbourhood then send the route request by appending itself in its route information towards the 4-dirctions where the node concentration [choose those directions where number of nodes are more in those directions]is more. Each of these directions are approximately 90-degree apart.*

Step-5. *Step 3 and 4 are repeated till the route is found to the destination and then a route* *reply packet is backed to the source.*

Step 6. *The source starts sending data packets, after receiving the route reply packet, in that path which is available with the route information found in the route reply packet.*

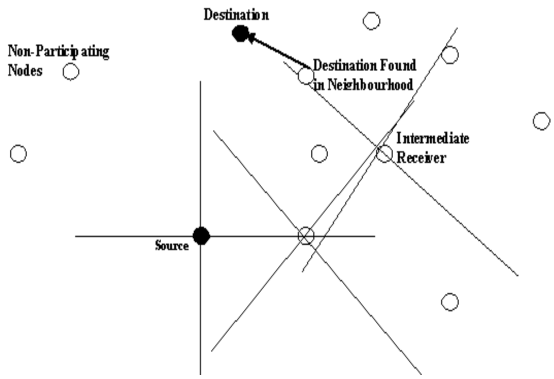


Figure-1:A Typical Scenario of Route Discovery

III. PROBLEM DURING ROUTE DISCOVERY

When a node in the decided path is moved from one location to another location then a new path has to be established. The establishment of another path is to be again decided by using the same ESMD routing algorithm. The following example will demonstrate a typical scenario, when a node in the path is moved from one place to another.

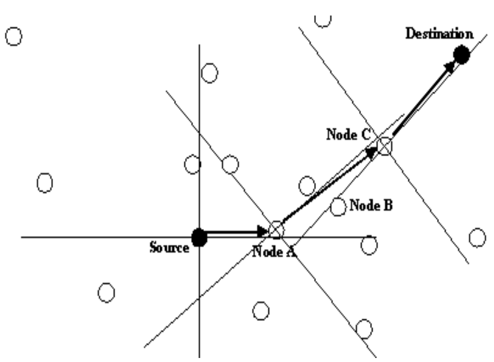


Figure-2:A 1st Snapshot of Route Discovery

In fig-2 source is sending a route request packet along its 4-directions and the route request reaches to node A, again the same route request packet is sent along node A's 4-direction by appending itself in the path information of route request packet. Node C gets the route request packet from node A and which finds the information about destination. But in the very next snapshot node A is moved from its original location to another location as shown in figure given below.

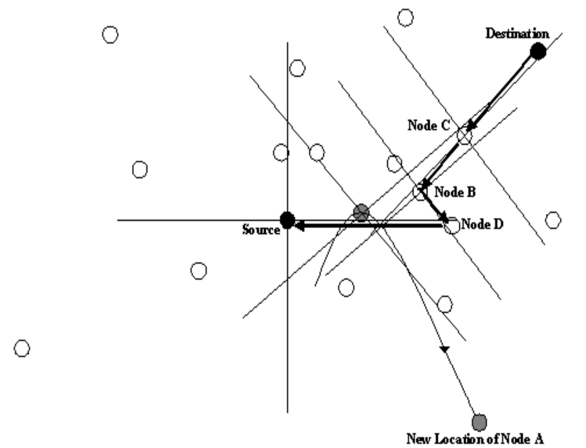


Figure-2:A 2nd Snapshot of Route Discovery

As node C does not get node A, which was appended in the path information of route request packet, so node C tries to find another route to source using ESMD routing algorithm. After getting the information about the source, the new path is followed by node C to source and hence the new path is to be followed during data packet transmission as shown in fig-3.

IV. COMPARATIVE STUDY USING MATHEMATICAL MODEL

Let Ns be the average number of nodes concentrated in a single direction. Let Hc be the number of hop-count required by the source to reach the destination.

So Energy Required for route establishment by the 4-Direction Packet forwarding Scheme is

$$E_{resmd} = \left[\sum_{i=1}^{H_c-1} (4\times N_s)^i + 1\right]\times e_{rp}$$

After getting the route the energy required in data packet forwarding is

$$E_{pesmd} = H_c \times e_p$$

Total Energy required in Energy-Saving Multi-Directional Routing Scheme is

$$E_{esmd} = E_{resmd} + E_{pesmd}$$

$$= \left[\sum_{i=1}^{H_c-1} (4 \times N_s)^i + 1 \right] \times e_{rp} + H_c \times e_p$$

But by route finding techniques the energy consumption will be found out to be

$$E_{rdsr} = N_r \times e_{rp}$$

Where N_r be the number of nodes involved in route finding towards the destination.

Let N_n be the average number of neighbouring nodes for each nodes present in the network. So

$$N_r = \sum_{i=1}^{H_c} (N_n)^i$$

Thus we can Write

$$E_{rdsr} = \left[\sum_{i=1}^{H_c} (N_n)^i \right] \times e_{rp}$$

After getting route the energy required in for data packet is same as that discussed in ESM scheme,i.e.

$$E_{pdsr} = E_{pesmd}$$
$$= H_c \times e_p$$

Total Energy required in DSR technique is

$$E_{dsr} = \left[\sum_{i=1}^{H_c} (N_n)^i \right] \times e_{rp} + H_c \times e_p$$

Again in AODV technique of packet forwarding ,the energy required is

$$E_{aodv} = \left[\sum_{i=1}^{H_c} (N_n)^i \right] \times e_p$$

Thus we know that $e_{rp} < e_p$ and $N_n \geq N_s$ The Last term in E_{resmd} will be in the summation series is $\left[(4 \times N_s)^{H_c-1} \right] \times e_{rp}$ which is less than $\left[(N_n)^{H_c} \right] \times e_{rp}$

V. PERFORMANCE ANALYSIS

The performance analysis is carried out by statistically collected archival data. Here two protocols DSR and AODV are suitably chosen as a comparative model with our proposed protocol. By observation from the graph shown in figure-4 and Figure-5 our proposed protocol gives better result.

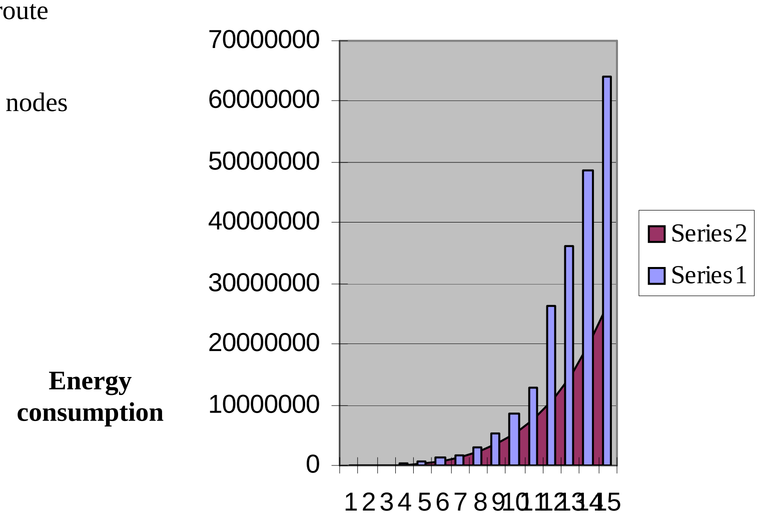
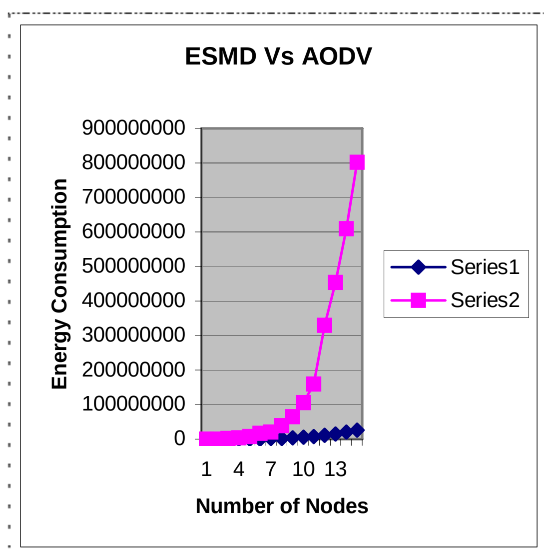


Figure-4:A Comparision Graph between ESMD and DSR



VI. CONCLUSION

We observe that our ESMD protocol saves the significant amount of energy as compared to flooding based routing technology. We are now extending our work to use some probabilistic model so as to find most probable path which minimizes the flooding occurs during route discovery.

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