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Enhanced Energy Conscious Dynamic Source Routing

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Abstract

Objectives: To propose the new improved energy efficient dynamic source routing protocol. **Methods:** We have used the concept of location based routing so that we can easily find the locations of the nodes. Each and every node can be traced by its GPS signal and we can get the appropriate location of each node, which helps in choosing the intermediate nodes between source and destination. **Findings:** The experimental results show that the proposed protocol has improved the individual node life time and so the whole network life span increases. **Improvement:** This paper offers enhanced energy conscious dynamic source routing for the wireless ad-hoc network.

Keywords: ECDSR (Energy Conscious Dynamic Source Routing), LBR (Location based Routing), MANET (Mobile Ad Hoc Network), RREP (Route Reply), RREQ (Route Request), WRP (Wireless Routing Protocol)

1 Introduction

Network is the collection of devices where they can share resources and having capabilities of data transmission i.e. send and receive any data from any node which is in the network. A Mobile Ad Hoc Network (MANET) is the group of autonomous mobile node which can communicate with each other without using any infrastructure. Because MANET is mobile networks therefore they can change their location and may configure itself accordingly. While connecting with other various networks MANET uses wireless network is shown in Figure 1.

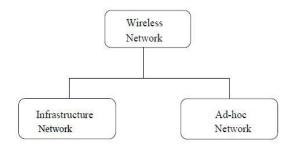


Figure 1. Wireless network categories. 18

The MANET is known as Ad Hoc Network because it does not depend on the pre-existing infrastructure

such as routers and access points used in the wired and wireless network. The network is Ad Hoc because each node in the network behaves like as itself a router and it also have the capability to receive data from other nodes as well forward the data to other nodes in the network. For forwarding the data flooding is used in the Ad Hoc network.⁵

Ad Hoc network is formed by establishing a wireless connection of nodes which depends on the location of the nodes distances among the nodes and their transmitting and receiving power levels.^{6,7}

Ad Hoc Network do not have any fixed topology. In Ad Hoc Network each node behaves as both clients and server to receive or forward the data.

A MANET can also be termed as the infrastructure less network. To discover the shortest and efficient path for the data transmission routing protocols are used such as Ad Hoc on Demand Distance Vector (AODV) routing protocol, Dynamic Source Routing (DSR), Wireless Routing protocol (WRP) etc.^{8,9}

1.1 Protocols

Protocol is the set of rules defined for the particular task. In MANET's there are following three types of the routing protocols are used:-

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1.1.1 Table-Driven (Proactive) Routing

It finds the path between each and every nodes before starting the communication among the nodes. So that when there is a need of communication it may start directly because the path is already found. Therefore it takes no delay to start the communication.^{5,10}

1.1.2 On-Demand (Reactive) Routing

It finds the path between each and every node when there is a need for communication. When the nodes have to communicate they find the path and start communicating. There is no any routing table which may keep routing information. These routing protocols only maintained the information of active routes and uses lazy approach for routing.5,11,12

1.1.3 Hybrid Routing Protocols

It is the combination of both proactive and reactive routing protocol and used to fulfil special requirements such as increase in network size, density etc.5,11

1.2 Energy Consumption in MANET

As in MANET's each node behaves like a router and therefore there is no need of any centralized infrastructure to handle the routing mechanism is shown in Figure 2.

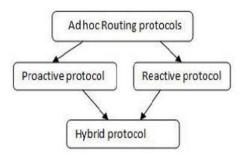


Figure 2. Classification of Routing Protocol.¹⁷

In MANET the location of the nodes is not fixed it means they are mobile or we can say dynamic in nature therefore it is very difficult for each and every node to establish a suitable path between source and destination. And if the path is established in between source and destination then to keep track of that path in regular intervals of time is a tough and complicated job. At the time of communication if any one of the internal nodes has less energy and due to minimum energy level any one of the nodes dies then the whole communication process will get disturbed and the communication is stopped and then again a path between source and destination has to be chosen.

Generally in MANET's for power backup or energy supply, batteries are used which has the limited energy backup and if every time or we can say in a regular intervals of time the nodes have to do the route modification and route maintenance processes then it will consume a lots of energy.

For the energy consumption in MANET's the traditional routing protocols are equally responsible because minimum hop count is the mechanism in which maximum traditional routing protocols are based. It means in between source and destination only that path is selected which have minimum number of intermediates nodes.

If the intermediate nodes are minimum the distance between nodes gets increased and then it will take maximum amount of power for transmission. Due to this the energy while transmitting the data is more than the receiving data and power level of nodes get affected.^{5,13}

1.3 Dynamic Source Routing

DSR is a type of reactive protocol which determines the route from the source to destination only when there is a need of communication. Its routing scheme can be easily optimized. It is based on the concept of source routing.9 If any nodes wants to communicate with other then first it will check in its routing cache that is there any path exist between them if found it start communication else route discovery is started. Here complete route of nodes to the destination is known by the sender itself.11

During the whole routing process the DSR follows following two basic operations:14

1.3.1 Route Discovery

In this route discovery phase the route from source to destination is created whenever communication is required. Firstly the source node check its own routing cache and if route is found then starts communication otherwise follows the following 2 sub processes:15,16

1.3.1.1Route Request

A Route Request (RREQ) message is broadcasted by the source node to its entire neighbouring node when the route is not found in the cache route of source node. The (RREQ) message is attached with the source node's address, destination address and with a unique identification number. So that RREQ may be processed only once by each nodes. Each intermediate nodes keeps broadcasting the RREQ and add their own address to the route record of the packet until it finds the destination node in its own route cache during the RREQ propagation.

1.3.1.2 Route Reply

Destination node generates the Route Reply (RREP) message when is RREQ to it from the same destination address in the RREP packet or by any intermediate node which has routing information in its cache. In RREQ packet the hops sequence are kept updating simultaneously.

1.3.2 Route Maintenance

As MANET is dynamic in nature therefore it uses some mechanisms to maintain the link from source to destination. At a particular time of instance if any participating node gets out of range of its neighbouring node then it may cause network partition.

1.3.3 Benefits and Limitations

The up to date routing information is need not to be maintained by the intermediate nodes because each packet contains the routing decision. Route caching mechanism reduces the route discovery overhead.

Dynamic source routing also have some limitations. As the DSR is also named as the unconventional routing protocol because it does not care about energy related parameters which are important for any mobile ad hoc network. DSR uses the mechanism of minimum hop count and therefore if hops are minimum then the distance between intermediate nodes became larger, so more transmission power is required for the communication. The more the consumption of the battery in the network the less the life span of the nodes and less life span of nodes causes the more partitions in the network.5

1.4 Energy Conscious DSR (ECDSR)

Energy Conscious DSR (ECDSR) selects those paths from source to destination in which intermediate nodes are having the higher energy level. A new path will be chosen to keep communication on without any disturbance if any of the intermediate nodes from source to destination have its energy level equal to the minimum threshold value.¹⁷ ECDSR has following two phases:-

1.4.1 ECDSR Energy Saving Phase

During the route discovery process the energy saving mechanism is used, when the source node wants to communicate with the destination node it selects the most energy efficient path i.e. those path in which intermediate nodes between the source and destination have maximum energy level, so that the communication is possible for the maximum time duration.

The route in DSR is based on the minimum hop between source and destination which is replaced by the most energy conscious path between source and destination.

During route discovery process in DSR if Route Request (RREQ) is received by any node which is not for it or if the node which receives the RREQ is not the destination node then for a certain time of interval that nodes holds the RREQ packet.

Time interval is selected pseudo randomly between 0 to 0.01. Generally 0.01 is observed as the constant broadcast jitter. Nodes keep the packet for that amount of time and then after it broadcast the packet.

But in ECDSR a dynamic kind of jitter for the control packets like RREQ and RREP is used. On the basis of remaining residual power of intermediate nodes different values of jitter is used. The maximum residual power of intermediate nodes leads to the minimum delay on the control packets.

If any of the intermediates nodes from source to destination have energy equal to or less then minimum threshold value than it will not be participate as the intermediate node and also sends an error message to the source. In ECDSR the delay is inversely proportional to the residual battery power.

ECDSR selects the path from source to destination in which the total remaining energy of intermediate nodes is maximum which provides the proper and long-time connection without any disturbance i.e. link break until any of the intermediate nodes get out of range of its neighbouring node.

1.4.2 ECDSR Energy Survival Phase

During the route maintenance process the energy survival is used. DSR never considers the retransmission of packets or link loss caused by the low residual power.

Every time either congestion or node mobility was considered either for route loss or packet loss.

But in ECDSR energy survival method the low residual energy is also considered as the reason for route breakage.

Energy survival phase has one of its major advantages that it saves the nodes from getting completely dead. It means during communication period if any of the intermediate nodes between source and destination has energy equals or less than the minimum threshold energy then it will generate an error message and inform to its neighbour that he is not able to send or receive any of the data packets. And then new route will be discovered for the communication process.

Therefore in ECDSR nodes which have low energy are also alive and can be used in future for any important and necessary communication.⁵

2. Materials and Methods

2.1 Enhanced ECDSR

The primary objective of EECDSR is to lower the energy consumption with the stability of the ECDSR. In EECDSR each and every node can be traced by its GPS signal and we can get the appropriate location of each nodes. Which helps in choosing the intermediates nodes between source and destination? In EECDSR we have used the concept of location based routing so that we can easily find the locations of the nodes. As we know that during the communication between any source and destination there are number of intermediate nodes through which the data packets have to be traversed. And if the information about the location of destination node is available it is easy to select the correct intermediate nodes from source to the destination which will save the time and also the nodes energy. In EECDSR the data packets only move in one direction i.e forward direction the data packets never back track. If source node has to send any message to the destination node first it checks its GPS position and finds the appropriate location of the destination node and with the help of that location it creates a target zone and route request message is only broadcast to the nodes which lies within that target zone.

3. Results and Discussion

3.1 Experimental Results

We have used the MATLAB to perform our experiment. We set up a static network consist of 11 nodes and all the nodes are assigned with a numerical value ranging from 1 to 11.

We have set the different initial battery power of nodes. The nodes having even numbers have 60 joule and nodes having odd numbers have 50 joule of initial energy.

3.2 Evaluation Metrics and Simulation Results

The metrics used to evaluate the performance of the EECDSR and ECDSR routing protocols are energy consumption of nodes, network life time, number of hops used and total energy consumed is shown in Table 1. In the simulation results 1 represents the EECDSR and 2 represents the ECDSR.

Table 1. Simulation parameters value

Sl. No.	Simulation parameters	Value
1	Number of nodes	11
2	Initial energy of nodes1,3,5,7,9,11	50 joule
3	Initial energy of nodes2,4,6,8,10	60 joule
4	rxPower	0.925W
5	txPower	1.43W
6	Sleep power	0.045W
7	Simulation time	60 sec
8	Propagation modal	Two Ray Ground
9	Total energy	600 joule

3.3 EECDSR, ECDSR Results and Comparisons

3.3.1 Energy Consumption of Nodes

From the Figure 3 it is observed that the EECDSR is consuming less energy per node than ECDSR. It will have very high and positive impact on the life time of the network.

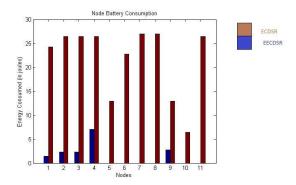


Figure 3. Nodes battery consumption.

3.3.2 Network Lifetime

We have considered network life time as one of the major and important factor while performance analysis. From Figure 4 it is observed that the life time of the nodes has been improved significantly for almost all the nodes.

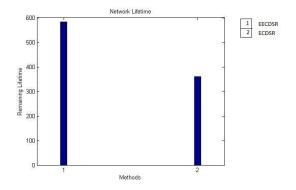


Figure 4. Network lifetime.

3.3.3 Number of Hops Used

From Figure 5 it is observed that the number of nodes in EECDSR reduced to half in comparison with the ECDSR which is helpful to maintain the durability of the network.

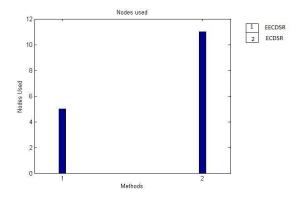


Figure 5. Number of hops used.

3.3.4 Total Energy Consumed

From the Figure 6 it is clearly observed that the EECDSR consumes very less amount of the energy In comparison with the ECDSR.

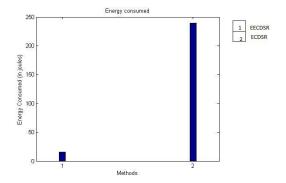


Figure 6. Total Energy consumed.

4. Conclusion and Future Work

In this paper we have designed an Enhanced ECDSR with the ECDSR routing mechanism. The EECDSR is more energy conscious then the ECDSR and it is also found that the per node energy consumption is less in the EECDSR than the ECSDR. EECDSR is not only emerging out to be an energy conscious routing protocol but also proved itself as a better routing protocol then the ECDSR. In all performances metrics EECDSR has shown better results than ECDSR. Our method has improved the individual node life time and so the whole network life span increases with respect to the ECDSR. EECDSR uses the LBR (location based routing) for the selection of intermediate nodes between source and destination. It selects nodes as intermediate nodes between source and destination according to its GPS position and minimizes the energy consumption of nodes as well as network.

This paper has left many scopes for the researchers to extend this work. As we have not considered the mobility of the node, it gives some different results when the same method will be used for the dynamic network.

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