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A Review on Energy Efficient Dynamic Source Routing Protocol for Mobile Ad Hoc Networks

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Abstract— Dynamic Source Routing protocol (DSR) has been accepted Itself as one of the distinguished and dominant routing protocols for Mobile Ad Hoc Networks (MANETs). From various performance analysis and results, it is shown that DSR has been an outstanding routing protocol that outperforms consistently than any other routing protocols. But it could not pervade the same place when the performance was considered in term of energy consumption at each node, energy consumption of the networks, energy consumption per successful packet transmission, and energy consumption of node due to different overhead. Because, DSR protocol does not take energy as a parameter into account at all. And as MANET is highly sensible towards the power related issues and energy consumption as it is operated by the battery with the limited sources, needed to be used efficiently, so that the lie time of the network can be prolonged and performance can be enhanced. This paper presents a comprehensive summery of different energy efficient protocols that are based on the basic Mechanism of DSR and enlightens the effort and commitment that has been made since last 10 year to turn the traditional DSR as energy efficient routing protocol.

Keywords— Wireless ad-hoc network, DSR, GEAR, LEAR, EESDSR, TPBDDS, MEDSR

I. INTRODUCTION

Ad Hoc Network is a multi-hop wireless networks which is consist of autonomous mobile nodes interconnected by means of wireless medium without having any fixed infrastructure. It's quick and easy deployment in a situation where its highly impossible to set up any fixed infrastructure networks, has increased the potential used in different applications in different critical scenarios. Such as battle fields, emergency disaster relief, conference and etc. A mobile ad hoc network [MANET] [1, 2, 3, 4, 7] can freedom to Move any direction not like fix base station. One of the important challenges of MANET is power constraint. The mobile ad hoc networks are operated on battery power. And the power usually gets consumed in mainly two ways. First one is due to transmitting of data to a desired recipient. Secondly, mobile node might offer itself as an intermediate forwarding node in the networks. The power level of the node is also getting affected while any route is established between two end points.

Therefore, various energy efficient routing protocols have been proposed to increase the lifetime of the nodes as well as lifetime of the networks, so that communication can be carried out without any interruption. This article provides as well as analyzes different energy efficient routing protocols designed for ad hoc wireless networks which are only based on the mechanism of traditional DSR routing protocol.

II. ROUTING PROCESS IN AD HOC NETWORKS

In MANET [1, 2, 3, 4, 6,7] routing is a process of establishing a route and then forwarding packets from source to destination through some inter mediate nodes if the destination node is not directly within the range of sender node. The route establishment itself is a two steps process. First one is the Route Discovery where it finds the different routes from same source to destination. Second, the Route Selection, where it selects a particular route among all routes found for the same source to destination. Traditional protocols and data structure are available to maintain the routes and to execute it by selecting the path that is having minimum distance from source to destination where the minimum distance is in term of minimum hop count.

A . Existing ad hoc routing protocols

Depending upon the mechanisms, they have been classified. Routing update mechanism are divided into two types.

- Table driven or Proactive Protocols
- On Demand or Reactive Protocols

1. Table driven or proactive protocols

Proactive Protocol as the name signifies, each node keeps all routing information to every other nodes in the network by maintaining one or more routing tables. These routing formations get updated periodically in the table to maintain the latest view of the networks. Some of the existing table driven protocols are DSDV, DBF, GSR, WRP, ZRP and many

more. This article does not cover all these table driven protocols as it is focused on DSR and different modification made on DSR protocols.

2. Reactive or on demand routing protocols

Here the protocols are On – Demand routing protocols [8, 12] do not update the routing information periodically as there is no routing table present for keeping routing information. Each node has route cache rather than routing table where it keeps all latest paths from source to destination. Rather a path is obtained when it is to establish a communication path between a source to a destination. Some of the example of on demand routing protocols are DSR, AODV, TORA, ABR etc

III. Dynamic Source Routing Protocol

Dynamic Source Routing (DSR) [9, 10] is a simple and efficient routing protocol designed specification for use in multi-hop wireless ad hoc mobile networks. DSR is one of the important routing protocols that are used for mobile ad hoc networks as much energy efficient routing protocols are designed based on its mechanism. It finds the route from source to destination only when the source initiates route discovery process. This protocol is totally on demand. This protocol also makes self-configuring. Basically the protocol is composed of two mechanisms, Rote Discover and Route Maintenance and these two mechanisms work together to allow nodes to discover and maintain the source route to any destination node in the a hoc networks.

- Route Discovery
- Route Maintenance

A. Benefits and Limitation

As the entire route is contained in the packet header, there is no need of having routing table to keep route for a given packets. The caching reduce the number of control message being sent, reducing overhead.

But DSR is not scalable to large networks. The other drawback of DSR is selecting the path for routing on the basis of minimum hop counts. As it selects the path of having minimum hops count, lesser will be the number of intermediate nodes, more will be the distance between each pair of nodes.

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IV. ENERGY EFFICIENT ROUTING PROTOCOLS

The energy efficient routing protocols [6, 11] play a Significant role in mobile ad hoc networks as the nodes are dynamic in nature and each node can participate in routing the data packets. In such scenario, efficient routing protocols are needed for Ad Hoc networks, especially when there are no routers, no base stations and no fixed infrastructure. So establishing the correct and efficient routes between the a source and destination is not the ultimate aim of any routing protocols, rather to keep the networks functioning as much as possible with less battery consumption at each node, should also be the objective of any routing protocols.

These goals can be accomplished by minimizing mobile node's energy during both the active as well as inactive communications. Active communication is when all the nodes of the route are participating in receiving and forwarding of data. Minimizing the energy during active communication is possible through two different approaches:

- Transmission power Control
- Load distribution

These metrics are helpful while determining energy efficient routing path instead of considering shortest path like in the traditional DSR protocol use. These metrics are:

- Energy consumed per packet
- Time to network partition
- Variation in node power level
- Cost per packet
- Maximum node cost

By using these metrics we can determine the overall energy consumption for delivering a packet, which is known as Link cost. In other word, link cost is the transmission energy over the link.

V. REVIEWED WORK

A. Global Energy Aware Routing (GEAR) Protocol

We have discussed that the Route Request is propagated towards the destination via multiple intermediate nodes. In Global Energy Aware (GEAR), along with the route request it piggybacks the remaining battery power as well as its identity and broadcast it to its neighbor nodes. When the destination nodes receive these different route request (RREQ) from the same source, then it selects the best route on the basis of high remaining/residual battery power out of the all received RREQ. But it does not guarantee the selected path is the best path always Apart from the above problem GEAR is associated with two major problems, one is incapable to use the route cache and the other one is blocking property. Because the individual node is not having any power related information in its route cache which induces traffic surge

due to the flood of the RREQ. Where as the other problem is to manipulate the waiting time of the various RREQ from the same source node in order to select the best route by the destination node. Because prior to select the best route it waits until it receives all RREQ messages along all possible routing paths On the other hand too long time may affect the average response time.

B. Local Energy Aware Routing (LEAR) Protocol

Localized Power Aware Routing (LEAR) Protocol [14] is based on DSR routing mechanism. The basic idea of LEAR is to consider only those nodes for the communication which are willing to participate in the routing path. "Willingness" is the special of parameter used in the modified DSR to find the route. The new parameter can be determined by the Remaining Battery Power (Er). If it is higher than a "threshold Value (thr)", then the node will be considered for the route path and 'Route Request' is forwarded, otherwise the packet is dropped. It means only when the intermediate nodes will have good battery levels then only the destination will receive route request message. So the first message that arrives at the destination will be considered to follow an energy efficient as well as reasonably shortest path.

An interesting situation arises when a single intermediate node of a total route has lower battery power level than its threshold value (Er < Thr), a route request is simply dropped. To avoid this situation, the source will resend the same route with an increased sequence number. When any intermediate node receives this same route request message, again with larger sequence number it adjusts (lower) threshold value to continue forwarding.

As the LEAR is mean to estimate the energy consumption and the balance across all mobile nodes, the result from the simulation shows that it has achieved the balanced energy consumption across all nodes successfully which is 35% more than that of DSR.

LEAR routing protocol not only achieves balanced energy consumption based only on local information but also removes the blocking property of GAER. Other than that it has also an advantage of being its simplicity characteristic and being integrated easily into existing ad hoc routing algorithm without affecting the other layers of protocol stack.

Energy Saving Dynamic Source Routing (ESDSR) Protocol

Energy Saving Dynamic Source Routing (ESDSR) protocol [15] is another modified DSR protocol which is aimed to prolong the network life time by using basic two approaches of power consumption, one is transmission power control approach and the second one is load balancing approach. In the first phase it decides the route based on the load balancing approach and in the second phase it dynamically adjusts the transmitting power at every node before it transmits packet.

When the following cost is maximize then only a source node finds the route R(t):

$C(R,t) = \max (Rj (t))$ …….. (1) $Rj (t) = \min (Ei / Pti)$ ……(2)

Where Rj (t) is called the minimum expected lift time at time "t" or the path j. So while selecting the path it selects the path which is having maximum of minimum expected life time among different possible path. Then each node calculates the minimum transmitting power in order to send the packet to it's next neighbor node. This minimum transmitting power is calculated in the following way:

$Pmin = Ptx + Precv + Pthreshold$ …(3)

Where Ptx is the transmitting power to send the packet, Precv is the receiving power of the node at which it receives the packet, required threshold power of the receiving node for successful reception of data. Each node maintains a power table where the required transmitting power of that node and it transmits the packet at that power.

ESDSR is implemented by considering various parameters like total numbers of data packets reached at the destination, energy consumption per packet, number of dead nodes and outperforms better than DSR routing protocol irrespective these different parameters

C. Topology Control Based Power-Aware and Battery Life-aware DSR (TPBDSR) Protocol

It is realized later that the topology control has serious effects on the system performance in various ways. It can affect the traffic carrying capacity as well as can have the contention for the medium. Topology Control Based Power-aware Battery Life-aware DSR (TPBDSR) [18] uses simple pure distributed control where each node adjust its transmitting power through certain range of neighbor that are given with some number. If the node find it's neighbor within or beyond certain range then the transmitting power is getting adjusted. In other word, we can say that the transmitting power gets adjusted according to their neighbor node's position in the network topology which may change dynamically. This strategy also limit the power adjustment period which is denoted by h second, where the value of h may vary with mobility character of the networks.

1. The Operation in Intermediate nodes:

As TPBDDSR has to adjust the transmitting power, it requires Transmitting Power Value Field (TTP) and Least Battery Value field (LBP) which have to be attached with the Route request Packet. Every time the node k receives the route request packet (RREQ) ,then the new value of TTP has to be updated.

So, TTPNew = TTPold + TTPk and if Bk < LBPold then
LBPnew = Bk

Where Bk = Fk/ Rk(t),

Fk = Full battery Capacity of the node, Rk = remaining Battery capacity of the node k at time t.

2. The Operation in the Destination Node:

DSR basically accepts the first packet that has come through the shortest path and hence it discards other subsequent request packets. But TPBDSR accepts multiple route requests. It does that with some additional rules. The moment first route request arrives at the destination; it sets a timer and wait for a more route request packets containing other path's information. And selects the best path among all the paths it has in list.

Simulation result shows that the TPBDDSR have much longer life time of nodes than the traditional DSR and EEDSR. As the scenarios of the experiment changes the result may vary, hence it's still difficult to say which one is best between TPBDDSR and EEDSR. But certainly TPBDSR gives better results than DSR.

D. Minimum Energy Dynamic Source

Routing Protocol (MEDSR) Minimum Energy Dynamic Source Routing Protocol (MEDSR) [19] has done one of the finest attempts to make DSR more as an energy aware routing protocol. The whole MEDSR approach is based on two mechanisms:

- Route Discovery
- Link Power Adjustment

The route Discovery process itself is classified into two sub processes.

- Route Discovery mechanism using low power level
- Route discovery mechanism using high power level

1. Route Discovery mechanism using low power level:

In this process of route discovery when source node S has some packets to send, then it sets a minimum level transmitting power for all the nodes. So the route packet will be broadcasted to only re within the range of the minimum level of transmitting power. The route reply is sent back to the nodes that are within the small range of transmitting power level from the destination node. The moment, the intermediate node will receive the route reply, it will calculate the minimum power for itself. The minimum transmitting power level for any node can be calculated as

Pmin =Ptx-Prec +Pth

Where Ptx=Transmitting Power of Destination

Prec=Receiving Power of the node that has received th route reply

Pth= Threshold receive power for successful reception of the packet. And it will keep continuing at each node until the route reply is received by the source. Once the route reply reaches at the source, the source sets the transmitting power.

2. Route Discovery mechanism using High Power Level:

High power route discovery is just same as the low power route discovery. The only difference is that instead of setting up the low transmitting power, it sets high transmitting power while sending route request. This process is highly needed for route discovery, especially when no path is found due to unreachability by setting the transmitting power low. So to overcome this problem high power routing is also mandatory.

MEDSR uses two levels of powers; the network connectivity is highly maintained and results less network partition. The result also depicts that when the network size is small the energy saving per data is maximum in MEDSR as compared to DSR, almost 55% high which indeed turning out to be an efficient routing protocol.

VI. Conclusion

In this review paper we have discussed, main problem that is energy consumption in MANET. As the traditional routing mechanisms like minimum hop count produces not only overheads in the networks but also consume more power in the networks during the communication. And hence it is required to have some any energy efficient routing protocols to be designed in order to overcome this problem. As there are many energy efficient routing protocols exist, it is very difficult to compare them directly since each method has different assumptions and has different means to achieve the goals. If we consider the traffic density or node density in the network which are also responsible of power consumption in a node, can be solved by using distributed load balancing approach in the networks. DSR routing protocol has provided the basic for any energy efficient routing protocols where by modifying its structure of control packet and considering some new energy matrices power consumption can be reduced.

This paper has also expounded few energy efficient routing protocols which are explicitly based on the DSR routing protocol. These protocols have proved the traditional DSR can also be acted as an energy efficient routing protocol. Because DSR is considered as one of the unconventional routing protocol which does not concerned about energy consumption at all. This paper has also revealed that a single routing protocol cannot stand strongly against the major constraint of MANET that is power consumption until it is integrated with some other techniques like power consumption, load balancing, transmission control, multi path routing and many more. Using all these techniques node can surely turning out be an efficient solution for energy constraint.

It is very difficult to conclude which one of the protocol is the best among all energy efficient routing protocols, because all these protocols are based on different methodologies, performances matrices, different implementation environments and different techniques. But all these protocols have proved that they are better than the DSR routing protocol. Still many scopes are there in DSR to add on new functionally and to modify the basic mechanism of DSR as an Energy Efficient Routing protocols.

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