Energy aware issues of routing protocols in Mobile Ad hoc Network

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***Abstract* – A MANET is group of wireless devices which forms a self- configured network. There is no predefined administration; mobile nodes make communication over wireless links. Nodes have limited battery power due to which this wireless communication is concerned with energy. In Ad-Hoc routing, energy conservation of any node is very important. In this paper we basically analyzed energy efficient protocols in MANET. One recently proposed routing protocol is preemptive DSR. It exemplifies the energy conservation methods to enhance the routing protocol effectiveness. The energy conservation is achieved in the medium access control layer. It deals with the proposed energy preservation scheme. It describes the interaction of routing overhead and energy conservation and it deals with the routing overhead minimization. It computes the remaining and required energy of communication node and it estimates the conserved energy level. In paper [1] author showed that the energy efficient performance of PDSR is better than the existing DSR, and they showed this by some performance metrics like packet delivery ratio and end to end delay.**

***Keywords* - MANET, Energy efficiency, PDSR**

I. INTRODUCTION

A mobile ad-hoc network (MANET) is an structure-less, self- managed collection of nodes which are mobile in nature connected by wireless links in which all nodes functions as a mobile router and as whole forms an arbitrary topology. The nodes organize themselves arbitrarily and free to move anywhere, thus the MANET structure changes frequently and unpredictably.

In any network, nodes can be both the source and destination; however in MANETs any node can also act as the intermediary node, responsible of packet forwarding and receiving to and from the neighboring nodes. And because of this participation of intermediate nodes, energy is consumed by these middle nodes as well even though they are not the actual sender and receiver. The current routing system is based on single route routing-between a source and a destination however in a well-established network there may be multiple path possible between source and destination. This idea of multipath routing gives the edge to source node of choice between multiple paths at any instance. In Ad-hoc network the nodes are operated on the basis of battery and have energy resources limitation. That is why energy efficiency is a key concern in determining whole network system lifetime. The remaining battery power of the nodes gives idea about lifetime of that particular node as well as of the overall network. Under some circumstances, MANET has to be established in outside or rival areas. This makes it very difficult to again charge and replace the batteries. Therefore, it is desirable to preserve the energy-decadency level as minimum as possible to escape regular battery replacement.

To store the minimum transmits power of the links in any route an energy level link cache is used. After combining minimum transmits power for the link and the packet size a cost function is created by which energy cost of any link is computed. The route which has minimum energy cost is chosen by applying Dijkstra's algorithm.

Battery consumptions and throughput are two critical problems in MANET. In arbitrary topology of MANET few nodes may relay more traffic in compared to other nodes, because of their positions in MANETs, such node consumes their reserve energy faster than the others. If traffic will be high it will lead to packet loss, radio jamming and delay. Battery consumption leads to an earlier node failure, partitioning of the network and route reliability downfall.

In routing process of some existing routing algorithm, some nodes are chosen in such a way that they always take participation in packet forwarding and so resulting in their early death. Such routing algorithms do not consider the energy available with the nodes. So routing paths is chosen in such a way that distribution of energy consumption is equal among the nodes for packet transfer in the path so that no node expires due to the battery power consumption.

A. Characteristics of Ad hoc network:

- Dynamic topologies- As network topology may change regularly because of its dynamic nature; nodes are free to move anywhere.
- Fluctuating link capacity- Due to decrement in node's battery power link capacity may vary at times.
- Energy-constrained operation- Due to energy requirement some nodes in ad hoc network may

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need batteries, and we have to save the battery power of that node for long network life.

- Restricted physical security- Ad hoc networks are more likely to have physical security threats than fixed wired networks.
- Multi-hop packet forwarding- For any message when a source node and destination node is out of range, the MANETs are capable of multi-hop routing.

B. Applications of MANETs:

Ad-hoc networking can be applied anywhere, where, there is less or no communication infrastructure or the existing infrastructure is expensive or inconvenient to use.

Some of the typical application includes:

- Device Networks- The networks of device support the wireless connections between various mobile devices so that they can communicate.
- Commercial Sector- Ad-hoc can be used in rescue operations for disaster relief efforts like in floods, fire, or earthquake etc.
- Collaborative Work- Sometimes people do need to have outside meetings to cooperate and exchange information on a given assignment. To create such networks MANET can be very useful.
- Military Battlefield- MANET supports tactical network for military communications like information network between the soldiers, vehicles, and military information head quarter.
- Data Networks-We can exchange data between mobile devices with the support of MANET to the network.
- Personal Area Network (PAN) -Short-range MANET can simplify the intercommunication between various mobile devices (such as a laptop, a PDA, and a cellular phone).Complex wired cables are replaced with wireless connections. The PAN is potentially a promising application field of MANET in the future pervasive computing context.

C. Performance metrics for energy routing protocols:

As different applications have different needs, the services required by them and the associated energy parameters differ from application to application. The following are some metrics commonly used by applications to specify energy requirement to the routing protocol-

- Delay- The packet end –to-end delay is the time of generation of packet by the source up to the destination accepting that packet. So this is the time taken by a packet to go across the network.
- Network Load- When there is more traffic coming on the network, then it is very difficult for the network to handle all this traffic and so it is called the network load. The efficient network can easily wraps with large traffic coming in, and to make a very good network, many techniques have been introduced.
- Packet Delivery Fraction (PDF) - PDF is known as the data packets delivered to the destinations to those generated by the CBR sources.
- Throughput- Throughput is defined as the ratio of the total amount of data that reaches the receiver from the source to the time taken by the receiver to receive the last packet.

D. Protocols in Manet

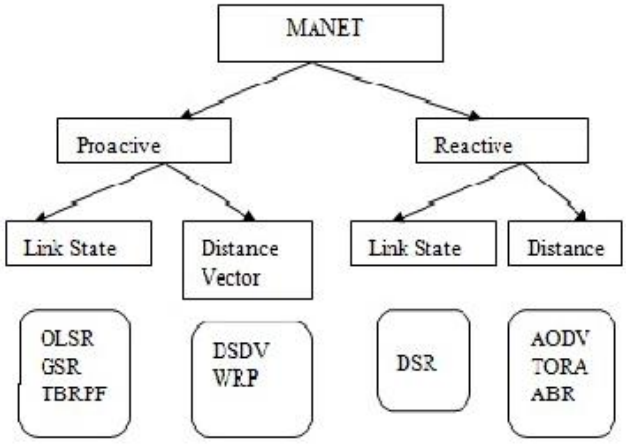

Fig. 1 A category for ad hoc routing protocols

One important proactive routing protocol is Optimized Link State Routing (OLSR), the working of OLSR is as below:

OLSR has its name due to its proactive nature. To get information about their neighbours, the nodes get knowledge of topology being used in the network by topology control (TC) and hello packets. Packets are forwarded by only multipoint relay (MPR) nodes rather than by every node. Before using any link, source and destination node are well established. Every node contains a routing table; these routing tables create higher routing overhead for OLSR compared to other reactive routing protocols. It decreases the delay for route discovery.

In OLSR, before the starting delivery of packet, Hello messages are sent periodically to the neighbour nodes in order to determine the status of link. Suppose X and Y are neighbours, Hello messages are sent to node Y by node X

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and if the message is successfully received by node Y then this link is called asymmetric. This is also true for node Y if it sends a Hello messages to node X. The information of neighbouring nodes is contained by Hello messages. After the symmetric connections are established a minimum number of MPR nodes are selected to broadcast TC messages at a predetermined interval. The information of selected MPR nodes is contained by TC messages. The calculations of routing are also handled by TC messages.

There is one important reactive protocol Dynamic Source Routing (DSR), here is working of DSR:

The DSR has on-demand characteristics and based on source routing, in which the source of the packet determines the complete sequence of nodes through which to forward the data packets. Because routing decision is taken by source there is no need to maintain the routing information by the intermediate hops and so it is different from link-state routing and table driven routing. The DSR protocol has **route discovery** and **route maintenance** mechanisms that work together in the Ad Hoc network.

Route discovery is the mechanism in which before sending the packet to destination, source node first check the route cache to confirm whether the route information already exist or not. If there is a route which is not expired, it will consider that route to send data packet otherwise it will initiate route discovery by broadcasting a request for route. In this route request packet there is an address of source and destination node and a unique request id.

Route maintenance is used to detect the availability of network topology during forwarding a packet to destination. At the time of packet transmission each node is responsible to detect, if its next hop is broken. When the link break is found by a node, a route error packet is returned to the originator node. Then originator deletes that link from the route cache where the error has occurred.

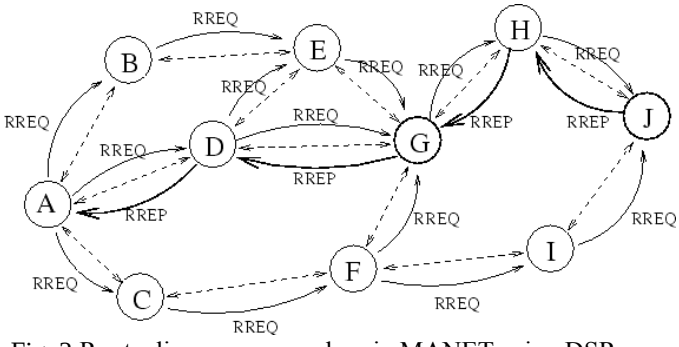

Fig. 2 Route discovery procedure in MANET using DSR

II. RELATED WORK

Different routing protocols have already been proposed to improve the routing performance. Every routing performance has different behaviour than others for improving and maintenance the performance.

In general routing protocols are classified into two categories:

Table driven or proactive protocols maintains coherent and up-to-date routing information from each node to the rest of node in the network in the form of routing table regardless of the need of such routes. Distance vector based routing protocols such as Destination-Sequence distance vector (DSDV), and the link state routing protocols, such as optimized Link State Routing (OLSR) are two types of proactive routing protocols.

On demand or reactive protocols create requests for new routes only when requested by a source node. Data forwarding is based on two main techniques: Source routing, such as Dynamic Source Routing (DSR), and Hop-by-hop routing, such as Ad hoc On-Demand Distance vector (AODV).

Parameter	Table driven	On-demand
Availability of Routing information	Immediately from route table	After a route discovery
Route updates	Periodic Advertisements	When requested
Routing overhead	Proportional to the size of the network regardless of network traffic	Proportional to the number of communicating nodes and increases with increased node mobility.

TABLE 1.Comparison of Table driven and on demand

In [1] Ramesh et.al has explained the performance of Energy Efficient Preemptive Dynamic Source Routing (EE-PDSR) protocol. Initially, the energy control and the performance of EE-PDSR protocol are described. They clearly explained the minimum energy node selection process for EE-PDSR. Then they successfully calculated the node energy level in the selected communication path. They explained the relation between the energy conservation and the routing overhead and also it explained the routing overhead reduction algorithm. And after simulation of comparative performance of PDSR and DSR it clearly shows that the energy efficient performance of PDSR is better than existing DSR.

In [2] Karim El Defrawy et.al proposed a Localized Energy Aware Routing (LEAR) protocol which is based on DSR but modifies the route discovery procedure for

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balanced energy consumption. In LEAR, a node will decide whether to forward route request message or not depending on its residual battery power. To extend the lifetime of each node and to use the battery fairly the concept of a threshold is used by Conditional max-min battery capacity routing (CMMBCR) protocol.

In [3] Shanmugavel et.al have offered and considered three cross-layer designs among physical layer, medium access control layer and network(routing) layer using received signal strength(RSS) as cross-layer relation parameter for energy conservation, rejection of unidirectional link and reliable route formation in mobile ad hoc networks.

In [4] Utkarsh et al. proposed An Energy Saving Ad hoc Routing (ESAR) algorithm in which the actual distance between the source to destination and also minimum available battery power of a node in the path is considered to derive the best path for packet delivery. Backup paths are also stored in case the best path is found suitable no more. The simulation results in this paper shows that the proposed ESAR algorithm attains better network life time when the delay in packet transmission is not compromised.

In [5] Ajay et al. compared the energy consumption in AODV and DSR and concluded that AODV lacks in performance than DSR if energy consumption only due to routing packets is considered. At low speed DSR performed better while at high speed AODV showed an improvement because at high speed the route cache becomes useless which results in more route discovery in DSR, hence it increases the overheads and energy consumption. Considering the total energy consumed by the nodes when varying the sources, DSR performed better than AODV due to cache. The increment in energy here is due to increase in routing packets which in turn increases with the increase in sources.

In [6] Ahvar *et al.* simulated and compared the performance of LAR, DSR and AODV. The key findings from this experiment suggest that LAR is better in energy consumption in high density network. DSR resulted in best energy consumption for low density network. AODV generated higher amount of energy even than DSR in high density network.

In [7] Jin-Man Kim et al. proposed an enhanced AODV routing protocol, which is slight modification to improve the network lifetime in MANET. By applying energy mean value algorithm which considerate node energy-aware, network lifetime is maximized for the AODV protocol. As there is fast increment in the number of applications which use Ad hoc network, is the reason in the development of algorithms which consider energy efficiency as the cost metric.

In [8] Yumei et al. proposed a multipath routing protocol for MANETs, called Maximal Minimal residual energy (MMRE)- Ad Hoc On- Demand Multipath Distance Vector (AOMDV), which extends the AOMDV routing protocol. The key point of this protocol is to find the minimal nodal residual energy of every route in the process of choosing path and accordingly sort multi-route by descending nodal residual energy. Suppose any new route comes with greater nodal residual energy then it is reselected to forward rest of the data packets. It can balance particular node's battery power utilization and hence enhance entire network's lifetime.

In [9] Zeng Wenli et al. proposed a new mechanism of energy aware routing called EAODV, which is based on the AODV protocol. Here a backup routing mechanism is adopted. In this new mechanism, the route which spends less energy and owns larger capacity is selected by synthetic analysis.

In [10] Sandip Vijay et al. proposed method called as Energy Efficient Network (EEN), which carefully selects "Backbones, connectors and controllers" from the given network. Energy Efficiency Network backbones stay alert continuously and perform multi-hop packet and switching routing while others nodes in the network remain in power saving mode and periodically check whether they can be backbone node or not. They checked the energy efficiency of their algorithm on the basis of network lifetime.

In [11] Duy Ngoc Pham et al. proposed another technique named as Expanding Ring Search (ERS), used to minimize the number of RREQ packets, so that the nodes only relay necessary packets and discard all duplicate packets to reduce overheads and to use energy efficiently by using the Time To Live (TTL) mechanism. They proved their result on the basis of reduced overhead and energy consumption in the network.

In [12] Kwan- Woong Kim et al. comes with another idea named as Local Route Change Algorithm (LRCA). The main objective of this approach was to reduce route failure due to dead nodes which consumes all the battery life. If any node has low battery then this technique provides ability of changing routes to neighbouring nodes

And then focus on route discovery to minimize power consumption or effective power distribution before some of intermediate nodes fail due to their battery. They proved their result by showing decrement in number of lost packets.

III. CONCLUSION

In order to ease communication within a MANET, an effective routing protocol is required to discover routes between mobile nodes. Energy efficiency is one of the main issues in MANET, especially in designing a routing protocol. In this survey paper, we analysed and classified a

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number of energy aware routing schemes. Some of these papers mainly deal with the problem of maximizing the network lifetime of a MANET, i.e. the time period during which the network is fully working. In paper [1] author showed that the energy efficient performance of PDSR is better than the existing DSR, and they showed this by some performance metrics like packet delivery ratio and end to end delay. We can further analyse PDSR on the basis of network load factor because traffic will be low in network as nodes will be in sleep state in their idle time. We will further go into deep aspects of pre-emptive DSR algorithm and will try to minimize overhead further, and will discuss on some other performance metrics other than end to end delay and packet delivery fraction.

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