National Conference on "Advanced Technologies in Computing and Networking"-ATCON-2015
Special Issue of International Journal of Electronics, Communication & Soft Computing Science and Engineering, ISSN: 2277-9477

Designing an efficient power aware routing algorithm based on existing Dynamic Source Routing (DSR) Protocol

P. P. Khatri **Dr. R. V. Dharaskar** **Dr. V. M. Thakare**

***Abstract* — MANET consists of devices that run on batteries, having limited amount of energy and due to its self-configuring and dynamic nature, all operations are performed by the node itself. However, if any new technology and advancement are introduced in the MANET then the overhead of computation will also be performed by the individual nodes. All these computation will consume a lot of battery energy during the process of communication. In such scenario, DSR routing protocol is considered as base protocol and some modification are applied on it which acts into an efficient power aware DSR. In this paper, DSR is considered because it is one of the protocol which does not take into account energy, and once the dedicated path is established between source to destination then it will keep sending through that path until the link is broken. Whereas proposed DSR not only act as an energy efficient routing protocol but also shows an energy survival instinct. It establishes a path from source to destination where packet transmission can be sent for a longer period of time through the nodes having high level of residual battery power. So, the number of packet drops and retransmission can be reduced. Hence, the proposed method enhances the performance of the networks as well as enhances the network life time as compared to the traditional DSR with a higher ratio. It performs significantly well in high mobility by using much less overhead than any other existing energy efficient routing protocols.**

***Key Words* — DSR protocol, energy, MANET, power-aware**

I. INTRODUCTION

A MANET usually consists of battery-powered mobile devices (nodes) which will become useless once their limited power is depleted, leading to degradation of network performance, network partition, or potential network collapse. As a result, the energy is an important resource that needs to be preserved in order to extend the lifetime of the network [1],[2],[8]. To improve the performance and lifetime of the network, dynamic resource and power management must be deployed. The majority of energy-efficient routing protocols for MANETs try to reduce energy consumption by means of an energy-efficient routing metric used in the routing table computation instead of the minimum-hop metric.

The first approach for energy-efficient routing is known as 'minimum total transmission power routing (MTPR)'. This mechanism uses a simple energy metric, represented by the total energy consumed to forward the information along the route. Thus, MTPR reduces the overall transmission power consumed per packet, but it does not directly affect the lifetime of each node (because it does not take into account the available energy of network nodes). However, minimizing transmission energy only differs from shortest-hop routing. If nodes can adjust transmission power levels then multiple short hops are more advantageous from an energy point of view than a single long hop[3].

As each mobile node in a MANETs performs the routing function for establishing communication among different mobile nodes the ''death'' of even a few of the nodes due to power exhaustion might cause disconnect of services in the entire MANETs. So, Mobile nodes in MANETs are battery driven. Thus, they suffer from limited energy level problems. Also the nodes in the network are moving if a node moves out of the radio range of the other node, the link between them is broken. Thus, in such an environment there are two major reasons of a link breakage.

- Node dying of energy exhaustion
- Node moving out of the radio range of its neighboring node [4].

So, besides using energy efficiency in each node the remaining energy must be balanced in all nodes in order to prevent any node from stop working too early [5]. The multicast algorithms are used to reduce the power and bandwidth consumption over the network [6].

In this paper, an efficient power aware DSR technique is introduced which is basically an improvement on DSR protocol. The metric used in the proposed DSR technique measures the stability of the network based on two factors. The routing decisions at each node lead to the multiple paths, which are node-disjoint. Thus, this technique is expected to provide highly stable, reliable and robust node-disjoint paths. As the paths are node-disjoint, energy drain rate of the nodes is expected to be less and hence longer lifetime. Also the paths are selected on the energy constraints of the nodes. They are the ones with higher capacity. Thus, the proposed technique prolongs the network lifetime by using the path cost and energy level of nodes.

II. DSR PROTOCOL

The Dynamic Source Routing protocol (DSR) is designed specifically for use in multi-hop mobile ad hoc networks. It is very simple and efficient routing protocol. One advantage of using DSR is that, there is no need of sending periodic router updates as sender itself knows the complete route of nodes to the destination. DSR uses source routing algorithm where each data packet consists of total routing information from source to destination. Each node in DSR maintains a cache which has route information from source to destination. DSR includes two phases: Route discovery and Route maintenance.

A. Route Discovery

Route discovery phase is initiated whenever a node wants to communicate to destination node which isn't in the transmission range of source node, therefore source node must obtain a route to the destination. Before initiating route discovery mechanism sender node must check for route in its route cache, if no route is found in its route cache then it proceeds as follows:

– First source node creates a route request (RREQ) packets containing the address of sender node as well as of destination node. Then it broadcast this RREQ to all its neighbors.

– After receiving RREQ the neighbor nodes consult route cache to find a route to the destination otherwise these neighbor nodes first add their address to the header and then broadcast the route request to their neighbors, and this goes on until route request reaches the destination node. If a node already processes a particular route request, then it ignores the new received RREQ by checking its sequence number.

B. *Route Reply*

When the destination node receives the route request this procedure is executed by a node:

– Destination node adds the new route to its route cache for future use.

– Destination node adds its address to the header of DSR packets.

– And destination node replies with route reply (RREP) which is unicast along the path contained in the header.

C. *Route Maintenance*

After forwarding the packet, sender node also confirm that whether the packet is correctly received or not, since ad hoc networks are highly dynamic in nature so it may happen that the topology of the network is changed because of the node mobility so there may be some situation where sender node doesn't receive the acknowledgement of packet. In this case sender node resends the packet until it reaches to a predefined value of attempts. Whenever this resend value reaches to the predefined value sender node consider the link as broken, then first it deletes all the routes containing that link from its route cache and after that sender node generates a route error (RERR) message to inform the intermediate node as well as source node about the link failure. Intermediate node also delete all the route containing this route and this process continues until the route error packet reach to the source node which launch a new route request or find a new route.

D. *Route Cache*

The route cache is used to store frequently used routes in order to avoid unnecessary new route discovery mechanism which takes lot of network resources. So whenever a new route is discovered it is saved in the route cache for future use. A node can also update its route cache from route request and route error messages.

Though the DSR protocol has many advantages; it does have some drawback, which limits it performance in certain scenarios. The various drawbacks of DSR are as follows:-DSR does not support multicasting. The data packet header in DSR consists of all the intermediate route address along with source and destination, thereby decreasing the throughput. DSR sends route reply packets through all routes from where the route request packets came. This increases the available multiple paths for source but at the same time increases the routing packet load of the network. Current specification of DSR does not contain any mechanism for route entry invalidation or route prioritization when faced with a choice of multiple routes. This leads to stale cache entries particularly in high mobility [4].

III. Related Work

Energy consumption is a crucial design concern in mobile ad hoc networks. In recent years, many energy efficient routing protocols have been developed. To utilize device heterogeneity, Liu et al.,[1] designed a novel power-aware routing protocol named DELAR that incorporates nodal residual energy information and nodal load status to save energy. This cross-layer designed framework achieves energy conservation from multiple facets, including power-aware routing, transmission scheduling and power control. Moreover, the novel notion of "mini-routing" is introduced into the data link layer and an Asymmetric MAC (A-MAC) scheme is proposed to support the MAC-layer acknowledgements over unidirectional links caused by asymmetric transmission power levels between powerful nodes and normal nodes. A multi-packet transmission scheme is also presented to improve the end-to-end delay performance striking a good balance between energy efficiency and other network performance metrics.

F. De Rango et al.,[2] proposed a novel routing strategy that tries to account for link stability and for minimum drain rate energy consumption. In order to verify the correctness of the proposed solution a bio-objective optimization formulation has been designed and a novel routing protocol called Link-stability and Energy aware Routing protocols (LAER) is proposed. This novel routing scheme improves the performance in terms of node selection with higher link duration. It has the capability to better discriminate the node behavior associated not only with the current node condition but also with the history of link lifetime.

Most of the routing protocols select the best path using hop count parameter. Nguyen et al.,[5] proposed a protocol called routing dual criterion (RDC) that uses energy parameter besides hop count parameter to select best path. . It balances energy of nodes in the network thereby increasing the lifetime and throughput of the network.

Varaprasad et al.,[6] introduced a new multicasting algorithm for MANETs that considers residual energy while forwarding the data packets. It extends the lifetime of nodes and network without degrading the network throughput.

As Mobile Ad-hoc Networks (MANET) are consisting of nodes that have limited battery power so the energy efficiency is taken as one of the primary metrics of interest. Gautam et al.,[7] proposed a technique for minimizing energy conservation within the routing protocols of the ad hoc network called, Modified Energy Saving Dynamic Source Routing (MESDSR) that efficiently utilizes the battery power of the mobile nodes for increasing the lifetime of the network. Heenu et al.,[8] analyzed several power aware routing algorithms based on DSR as conventional routing protocols do not consider the power budget where the routes between nodes are built merely by the shortest path routing algorithm. Shiva et al.,[9] performed surveys and classified numerous energy efficient routing mechanisms proposed for wireless infrastructure-less networks. The paper also presented detailed comparative study of larger number of efficient/power aware routing protocols in MANETs.

IV. EXISTING METHODOLOGY

A. *Efficient DSR (EDSR)*

EDSR [3] maximizes the network lifetime by minimizing the power consumption while establishing path with the help of modified DSR considering stability from all aspects. The lifetime of the network can be reduced primarily by two causes. First, the node moving out of the radio range can lead to link breakage. Secondly, the node can be drained of its energy leading to network partitioning. The metric used in the proposed technique (EDSR) measures the stability of the network based on two factors. The routing decisions at each node lead to the multiple paths, which are node-disjoint. Thus, this technique provides highly stable, reliable and robust node-disjoint paths. As the paths are node-disjoint, energy drain rate of the nodes is expected to be less and hence longer lifetime. Also the paths are selected on the bandwidth constraints. They are the ones with higher capacity. Topology control is another approach, in which the transmission power is adjusted to achieve energy efficiency.

B. *Efficient Power Aware Routing (EPAR)*

EPAR [4] deals with the problem of maximizing the network lifetime of a MANET, i.e. the time period during which the network is fully working. It is basically an improvement on DSR. In contrast to conventional power aware algorithms, EPAR identifies the capacity of a node not just by its residual battery power, but also by the expected energy spent in reliably forwarding data packets over a specific link. Using a mini-max formulation, EPAR selects the path that has the largest packet capacity at the smallest residual packet transmission capacity. This protocol has ability to handle high mobility of the nodes that often cause changes in the network topology. Three ad hoc network routing protocols (EPAR, MTPR, and DSR) are evaluated in different network scales, taking into consideration the power consumption. Indeed, the proposed scheme reduces the total energy consumption and decreases the mean delay, especially for high load networks, while achieving a good packet delivery ratio.

V. ANALYSIS AND DISCUSSION

EDSR [3] protocol behaves better than the DSR and MTPR, the two main actual reactive protocols. The EDSR protocol performs well in high mobility by using much less overhead than the two others mentioned before. The MTPR, DSR and EDSR techniques consider the stability of the network from all aspects. The network lifetime of EDSR protocol is increased as compared to the MTPR and DSR protocols with different pause times. Thus, EDSR protocol performs well in terms of average node lifetime and packet delivery ratio when compared with the MTPR and DSR protocols.

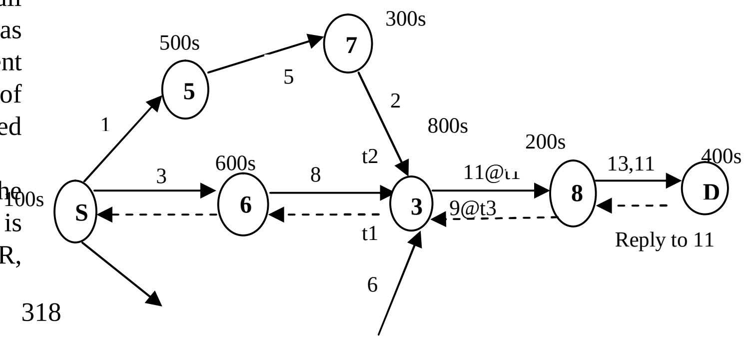
EPAR [4] protocol has ability to handle high mobility of the nodes that often cause changes in the network topology. It is evaluated with three ad hoc network routing protocols (EPAR, MTPR, and DSR) in different network scales, taking into consideration the power consumption. It shows that the consumed power of a network using the DSR protocol increases rapidly while that of EPAR based network shows stability with increasing number of nodes. The end to end delay operating EPAR protocol increases slowly as compared to MTPR based network showing a gentle increase with increasing number of pause time. Energy is uniformly drained from all the nodes and hence the network life-time is significantly increased. However, for medium and large ad-hoc networks the DSR performance proved to be inefficient but EPAR and MTPR produced good results in terms of throughput.

VI. PROPOSED METHODOLOGY

Power aware schemes make routing decisions to optimize performance of power or energy related evaluation metrics. The route selections are made solely with regards to performance requirement policies, independent of the underlying ad-hoc routing protocols deployed. Therefore, the power aware routing schemes are transferable from one underlying ad hoc routing protocol to another, the observed relative merits and drawbacks remain valid. There are two routing objectives for minimum total transmission energy and total operational lifetime of the network that can be mutually contradictory.

A. Route discovery and Maintenance in efficient power aware DSR

The objective for the proposed DSR is to forward the packet through those nodes which are having higher level of energy at a given time. The main aim of power aware EDSR is to minimize the variance in the remaining energies of all the nodes and thereby prolong the network lifetime. In the traditional DSR during route Discovery process if any node receives a Route Request (RREQ) which is not meant for it or if the node is not the final destination then it keeps the packet for a certain time interval and chooses the path with the minimum number of hops. However, for proposed DSR, the path chosen is based on energy of nodes along with path cost.. The idea behind this protocol is to introduce the delay dynamically for the control packet like RREQ and RREP (Route reply) on the basis of residual battery power of the intermediate nodes. The more will be the residual power the less will be the delay.
Following Fig. 1 represents the power-aware routing mechanism with the RREQ and RREP packets in the efficient DSR protocol.



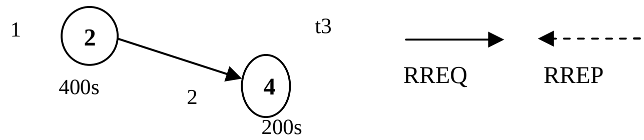


Fig.1 Routing mechanism in efficient power aware DSR protocol

The RREQ broadcast is initiated by the number of sources. The intermediate nodes can reply to the RREQ packet from cache as in the DSR protocol.
If there is no cache entry, receiving a new RREQ packet an intermediate node does the following:

1. Node starts the timer.
2. Keeps the path cost in the header as minimum cost. Then it adds its own cost to the path cost in the header and broadcast to the neighboring nodes.
3. On receiving duplicate RREQ packet, an intermediate node re-broadcasts it only if the timer for that RREQ packet has not expired but with the maximum energy level of nodes (i.e. node lifetime).
4. Destination also waits for a specific time after the first RREQ packet arrives. It then replies to the best path consisting of the timer value and maximum energy level, in that period and ignores others.
5. The destination node sends RREP packet along the path consisting of nodes having maximum energy.
6. Finally, the new path cost in the header is less than the minimum cost. The path cost is added to the RREP packet and is stored in cache by all nodes that hear the RREP packets.

VII. Possible Outcome And Result

Efficient power aware DSR is basically an improvement on existing DSR. This technique improves packet delivery ratio and throughput thereby increasing the lifetime of network. However, the proposed technique may outperform the traditional energy efficient algorithms as it considers two factors i.e, the path cost and energy level of nodes. Also, it performs well in high mobility by using much less overhead than any other existing energy efficient routing protocols.

Conclusion

This paper mainly deals with the problem of maximizing the network lifetime of a MANET, i.e. the time period during which the network is fully working. This efficient power aware DSR technique considers the stability of the network from all aspects. The metric used in the proposed technique (efficient power aware DSR) measures the stability of the network based on two factors. The routing decisions at each node lead to the multiple paths, which are node-disjoint. Thus, this technique is expected to provide highly stable, reliable and robust node-disjoint paths. As the paths are node-disjoint, energy drain rate of the nodes is expected to be less and hence longer lifetime. Also the paths are selected on the energy constraints of the nodes. They are the ones with higher capacity. Thus, the proposed efficient power aware DSR technique prolongs the network lifetime by using the path cost and energy level of nodes. Load balancing approach is also used to avoid over utilized nodes. The future work can also include designing routing algorithms by adding congestion considerations and studying the energy efficiency of routing protocols from QoS provisioning. The actual implementation of proposed technique can be done in future. This work can be extended to include the amount of energy consumed by mobility models by varying node density, traffic load, number of sources, transmission range and the network size.

References

[1] Wei Liu, Chi Zhang, Guoliang Yao and Yuguang Fang, "DELAR: A Device-Energy-Load Aware Relaying Framework for Heterogeneous Mobile Ad Hoc Networks", *IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS*, Vol. 29, No. 8, September 2011.
[2] Floriano De Rango, Francesca Guerriero and Peppino Fazio, "Link-Stability and Energy Aware Routing Protocol in Distributed Wireless Networks", *IEEE TRANSACTIONS ON PARALLEL AND DISTRIBUTED SYSTEMS* ,Vol. 23, No. 4, pp. 713-726, April 2012.
[3] Shivashankar, Golla Varaprasad, Suresh Hosahalli Narayanagowda, "Implementing a new power aware routing algorithm based on existing dynamic source routing protocol for mobile ad hoc networks", *IET Networks*, Vol. 3, Issue No. 2, pp. 137-142, August 2013.
[4] Shivashankar , Hosahalli Narayanagowda Suresh, Golla Varaprasad, and Guruswamy Jayanthi, "Designing Energy Routing Protocol With Power Consumption Optimization in MANET", *IEEE Transactions on Emerging Topics in Computing* , Vol. 2, Issue No. 2, pp. 192-197, June 2014.
[5] T.D Nguyen, V.D Nguyen, T.T Nguyen, T.H Pham, N.T Nguyen, Wakasugi Koichiro,"Routing Dual Criterion Protocol", *ICUIMC(IMCOM)'13*,January2013.
[6] G. Varaprasad and R.S.D Wahibandhu,"New power-aware multicast algorithm for mobile ad hoc networks", *IEEE POTENTIALS*, pp. 32-35, March 2013
[7] Shipra Gautam and Rakesh Kumar," Modified Energy Saving DSR Protocol for MANETs" *International Journal of Electronics and Computer Science Engineering(IJECSE)*,Vol. 1,No. 4,pp.1982-1992
[8] Heenu and Pooja Narula, "Survey on Power Aware Routing in Multi-Path DSR", *International Journal of Advanced Research in Computer Science and Software Engineering"(IJARCSSE)*, Vol. 4, No. 4, pp. 67-70, April 2014.
[9] Shiva Prakash, J.P. Saini, Ajeet Kumar Gautam, S.C. Gupta,"Literature Review and General Consideration of Energy Efficient Routing Protocols in MANETs", *International Journal of Advanced Research in Computer Science and Software Engineering"(IJARCSSE)*, Vol. 3, No. 12, December 2013.

Author's Profile

Payal P. Khatri
Student of ME II year, PG Department of Computer Science and Information Technology, SGBAU University, Amravati, Maharashtra, India.
(e-mail: payalkhatri23@gmail.com)

Dr. R. V. Dharaskar
Professor and Head, PG department of Computer Science and Engineering, G. H Raisoni College of Engineering, Nagpur, Maharashtra, India.
(e-mail: rvdharaskar@yahoo.com)

Dr. V. M. Thakare
Head of department of PG department of Computer Science and Information Technology SGBAU University, Amravati ,Maharashtra, India.
(e-mail: vilthakare@yahoo.co.in)