ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 10, October 2013

Design of Novel Protocol to Increase Network lifetime in MANETs

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Abstract: The objective of this research work is to extend the network lifetime, balance the power consumption among mobile nodes and increase the throughput of the networks. The wireless mobile adhoc network consists of various mobile and battery-powered wireless devices, such as PDAs, laptops and cellular phones. These wireless personal devices form the network in an adhoc way to let devices communicate with each other. Power consumption of network interfaces can be significant. With battery technology lagging behind, the batteries on wireless personal devices can only last a few hours for work. This paper provides a suite of efficient power-aware algorithms and schemes for routing in wireless network. Nodes in a Mobile Ad hoc Network (MANET) have limited battery power. In a MANET, if a mobile node continuously transmitting the data packets, more battery power consumed by that node, obviously that node energy level is insufficient for data packet transmission and becomes critical node or dead node and result is connection failure in network. The aim of this paper is to minimize the consumption power for operation so that transmission power can be saved. In this work, we have considered three routing protocols such as Destination-Sequenced Distance-Vector (DSDV) & Minimum Maximum Battery Cost Routing (MMBCR) and our proposed novel Efficient Power Routing (EPR) protocol which increases the lifetime of the network by efficiently minimizing the power consumption. From the simulation results, it is observed that our proposed protocol gives improved network lifetime, packet delivery ratio and less end to end delay as compared to MMBCR and DSDV protocols.

Keywords: DSDV, MMBCR, network lifetime, power aware

I. INTRODUCTION

MANET is an autonomous system of mobile routers connected by wireless links. The routers are free to move randomly and organize themselves arbitrarily; thus, the network's wireless topology may change rapidly and unpredictably. Such a network may operate in a stand-alone fashion, or may be connected to the larger Internet. Since the need to conserve energy so that battery life is maximized is important, it is obvious that energy efficient algorithms should be implemented in place of the conventional routing algorithm. In this paper we have proposed a new power efficient routing protocol which increases the network lifetime.

The majority of energy efficient routing protocols for MANET try to reduce energy consumption by means of an energy efficient routing metric, used in routing table computation instead of the minimum-hop metric. This way, a routing protocol can easily introduce energy efficiency in its packet forwarding. These protocols try either to route data through the path with maximum energy bottleneck, or to minimize the end to end transmission energy for packets. However, minimizing transmission energy only differs from shortest-hop routing if nodes can adjust transmission power levels, so that multiple short hops are more advantageous, from an energy point of view, than a single long hop. In 802.11 we do not have access to this capability, so that, in a fixed transmission power context, this metric corresponds to a Shortest Path routing.

Routing protocol DSDV uses proactive “table driven” routing, while EPR and MMBCR use reactive “on-demand” routing. Protocol DSDV periodically updates its routing tables, even in cases when network topology doesn’t change. MMBCR protocol has inefficient route maintenance, because it has to initiate a route discovery process every time network topology changes. Both protocols, EPR and MMBCR, use route discovery process, but with different routing mechanisms. In particular, MMBCR uses routing tables, one route per destination, and destination sequence numbers as a mechanism for determining freshness of routes and route loops prevention. On the other hand, EPR uses power aware source routing and route caching, and doesn’t depend on any periodic or time-based operations. Generally, we can conclude that in low mobility and low load scenarios, all three protocols react in a similar way, while with mobility

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or load increasing EPR outperforms MMBCR and DSDV routing protocols. However, there are many other challenges to be faced in routing protocols design.

II. SOME OF THE PREVIOUS RELATED WORK

In a MANET each node is willing to forward data for other nodes, and the determination of which nodes forward data is made dynamically based on the network connectivity. Packets are routed from sender node to destination node through neighbor MANET nodes. Routing protocols can be classified into two categories: topology-based routing and position-based routing [1]. Topology-based routing protocols [2,3], which are originally used in wired networks, depend on the link information to make routing decisions. However, the topology of a MANET changes too frequently to be updated timely. Maintaining a routing table [4] at each node consumes a significant amount of energy in wireless devices. To avoid maintaining routing tables, position-based routing protocols are proposed [5, 6]. In general, this type of protocol can achieve high flexibility and low energy dissipation [7].

DSDV is a pro-active, table-driven protocol based on the distributed version of the classical Bellman Ford algorithm [8,10,1114]. Each mobile node stores a routing table that contains information about all the possible destinations in the network. Each entry in the routing table is marked with a sequence number assigned by the destination node and contains information like the number of hops required to reach the destination and the next hop on the path to the destination. The route labeled with the latest sequence number is always used to avoid stale routes. In case, two updates have the same sequence number, the route with the minimum number of hops to reach the destination is used. Routing table updates are propagated periodically across all nodes to maintain table consistency. Thus, in spite of the high communication overhead, a node is always forced to learn of the shortest hop route to the destination. DSDV fits under the minimum weight path routing category.

MMBCR mechanism considers both the total transmission energy consumption [9,12] of routes and the remaining power of nodes. When all nodes in some possible routes have sufficient remaining battery capacity, a route with minimum total transmission power among these routes is chosen.

Since less total power is required to forward packets for each connection, the relaying load for most nodes must be reduced, and their lifetime will be extended. However, if all routes have nodes with low battery capacity (i.e., below the threshold), a route including nodes with the lowest battery capacity must be avoided to extend the lifetime of these nodes with MMBCR applied.

III. THE PROPOSED PROTOCOL

A. *Basic Assumptions*

There has been much work discussing the power metric for multi-hop wireless transmissions in equation (1). To transmit a packet from node *a* to node *b* in a MANET, the energy consumption is usually modeled as

$$E= e+ \xi d_{(a,b)}^{n} \quad \text{----------------------(1)}$$

where $d_{(a,b)}$ is the distance between node *a* and node *b*, *n* is the propagation loss coefficient, which is a constant determined by the transmission media, $\xi d_{(a,b)}^{n}$ accounts for the radiated energy necessary to transmit over a distance of $d_{(a,b)}$, and *e* is the energy utilized in the transceiver.

To accurately model energy dissipation in battery-powered devices, discharging loss (ς) should be included in the power metric for multi-hop wireless transmissions. We therefore introduce a more accurate energy consumption metric that includes discharging loss ς\

$$\text{E}= \text{e}+ \xi d_{(a,b)}^{n} + \varsigma \quad \text{--------------(2)}$$

For the energy dissipation in today's wireless devices, ς is a significant amount of energy. Each device is assumed to be discharged at a current *I* during its entire lifetime.

- EPR is designed to dynamically facilitate power awareness in MANET routing. EPR is independent of specific routing protocols. It enables routing protocols to set up routing paths from a battery power each mobile nodes. In addition, we design an enhanced prioritized EPR for time sensitive applications in MANETs. The objective of EPR is to guarantee the end-to-end routing connections with a set of measurable attributes, in terms of routing delay, packet delivery ratio and network lifetime.

- EPR, a mobile node decides whether to process a RREQ depending on its residual battery capacity *E* . Let *E* be the energy consumed at the traditional nodes for every successful data packet transmission in the absence of a relay node and *ER* denote the energy consumed when the mobile nodes are deployed. The performance gain is then computed as $\frac{E-E_R}{E}$. If *E* is higher than the threshold battery power, the mobile node forwards the RREQ packet, otherwise, it drops the RREQ. Hence, when the RREQ arrives at the destination, it contains a route with all intermediate nodes with satisfying energy levels.

- As *E* for mobile nodes decreases with time, the value of threshold battery power should be adjusted adaptively to identify energy-rich mobile nodes and energy poor ones dynamically. If a source node does not receive any RREP within a specified time for its out-going RREQ message, the source will send a duplicated RREQ with a different sequence number.

- When an intermediate node receives the duplicated RREQ, it adjusts (or reduces) its threshold battery power to allow forwarding to continue.
- Each mobile node can save its inactivity energy by switching the mode of operation of its radio into sleep/power-down mode or simply turns it off when there is no data traffic.
- This leads to considerable energy savings, especially when the network is with low data traffic load. However, it requires well-designed routing protocols to provide data delivery guarantee because partial mobile nodes turning into sleep mode may impair route discovery time and packet delivery.

The following algorithm illustrates the Route Discovery process.

B. *Route Discovery Algorithm*

Step 1: Source node S.

- Creates the RREQ packet with field values set as SA=S, DA= D, Seq.No= I, TTL= T, Hops=H, BW=0, Min_energy = Initial energy;
- Broad cast the RREQ packet to next neighbor node whose BWth >= BW.

Step 2: If the intermediate node will receive the RREQ packet.

- The Min_energy field in RREQ is updated by initial energy.
- Forward the RREQ packet to node 2.
- Calculate Node's Residual energy.
- This Residual Energy value is compared with Min_energy value in Routing table. The route is selected on the basis of Min_energy >= R_{energy} and BWth > = BW. Otherwise the link between Node1 and Node2 are unavailable.

Step 3: If the node receiving the RREQ packet in D, then the node D.

- Generates the RREP packet for uni-casting to source. The bandwidth field of the RREP packet is updated with the cumulative bandwidth of the path and Energy field should be updated by cumulative Energy.
- D uni-casts all the node disjoint paths back to the source node S.

C. *Route Selection*

When the RREQ receives at the neighbour node, it forwards a RREP packet back to the source. Otherwise, it rebroadcasts the RREQ. If they may receive a processed RREQ, they discard the RREQ and do not forward it. If RREQ of multiple paths are received at source node, it stored by the hop count value. In MMBCR the route is selected on the basis of minimum number of hops. But the EPRDSR protocol select the best path by sorting multi-route in descending order of nodal residual energy and bandwidth and the data packets are forwarded by using the maximal nodal residual energy.

D. *Route Maintenance*

In case the energy value is less than the threshold value minimum energy then link is broken, an Route Error message (RERR) is sent back to the previous node to indicate the route breakage. If node receives this RERR message, it informs to the source node then it starts route discovery procedure again.

E. *ROUTE DISCOVERY*

In route discovery procedure, the EPR builds a route between source to destination using a route request and route reply query cycle. When a source node wants to send a packet to destination for which it does not already have a route, it forward a RREQ packet to all the neighbours across the network. The performance of EPR is improved by adding energy model parameters in RREQ packet, two additional fields are added in the RREQ header information such as bandwidth and energy constraints. In EPR routing discovery process, the source node in the network sends the extended RREQ message to the destination node through number of intermediate nodes.

At the initial stage the source node's initial energy is entered into minimum energy field, the residual energy is computed at every node in the network. This residual energy is compared with minimum energy field of RREQ packet. If this value is less than the minimum energy field, then it replaced by residual energy. While selecting the best path, the minimum energy should be kept as the lowest among all the nodes in this route. Once the RREQ packet is received by the destination node, the node will produce RREP packet and send back to the source node. RREP packet is also included two additional fields Bandwidth and minimum energy, the RREP packet records the routing information from the source to destination. The duplicate packet ID is received by the destination node, and then it responds with a maximum of RREP packets to the source node.

IV. PERFORMANCE EVALUATION

A. *Simulation Set-up*

The intermediate nodes forward packets between the sender and the receiver. In this topology only one traffic flow exists in the network. Constant bit rate (CBR) traffic is generated at a rate of 50 packets per second. Each packet is 1000 bytes in length, resulting in a data rate of 0.4 Mbps.

In this paper, we have studied effect of mobility and varying number of mobile nodes of packet delivery ratio, average

ISSN (Print) : 2319-5940
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end to end delay and network lifetime metrics. NS-2 simulator is used in this simulation. 100 mobile nodes are used and area of ad hoc network is 1000 X 1000. We run all simulations for 1000 seconds. When we consider node movement, random waypoint model is used with two factors: (a) maximum speed and (b) pause time. Our simulation environment and the simulation models are summarized in Table 1.

Table 1: Simulation parameters list

Network Simulator	NS-2.33 Version
Network Size	1000x1000
Number of Mobile Nodes	100
Signal Processing Model	Two – ray ground
Transmission range	250m
MAC layer	IEEE-802.11G
Routing Protocols	EPR, MMBCR and DSDV
Mobility Model	Random way
Traffic Model	CBR
Data Packet size	512 bytes

B. *Network Performance Metrics and discussion of results*

Data packet delivery ratio: Defined as the total number of data packets received by all destination nodes over the total number of data packets sent by all source nodes in the network.

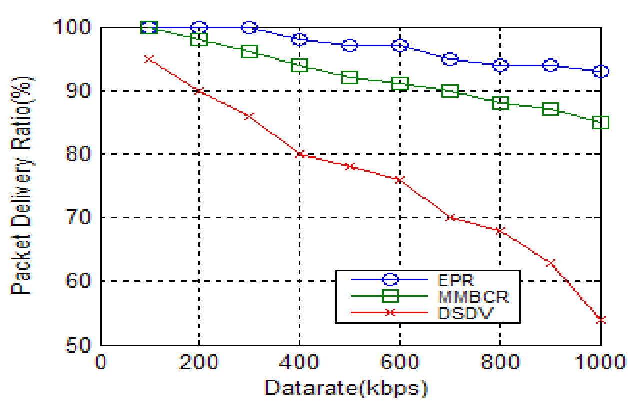

Fig. 1: Comparison results of PDR with EPR, DSDV and MMBCR

Obtained results show characteristic differences in performance between considered routing protocols, which are the consequence of various mechanisms on which protocols are based. Although we carried out simulations with 10to 100 sources. EPR and DSDV, achieve high values of PDR, which means they are efficient protocols from the point of delivering packets to their destination shown in fig. 1.

For EPR and MMBCR protocols, PDR is independent of mobility and number of sources, while DSDV has approximately the same PDR under low mobility. EPR and MMBCR protocols deliver over 90% of packets for all considered values of pause time and maximum movement speed. Since DSDV protocol uses a table driven approach of maintaining routing information, it isn't adaptive to the route changes that occur under high mobility as EPR and MMBCR protocols are.

End-to-end delay: Calculates the average time from a data packet is generated at the source node till this data packet is received at the destination node. The power metric used in these protocols considers only the radiation dissipation of the energy during routing. This is a rather rough metric and might not precisely model the energy dissipation in MANETs.

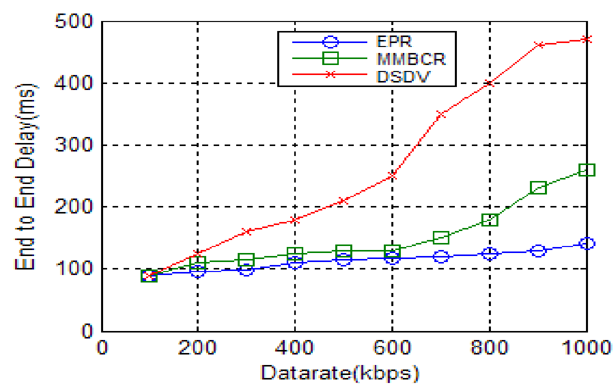

Fig. 2: Comparison results of End to End Delay with EPR, DSDV and MMBCR

Analyzing average end to end delay, we come to the conclusion that EPR protocol outperforms MMBCR and DSDV protocols shown fig. 2. In other words, a route discovery process has to be activated, because MMBCR is a routing protocol that has no available route when needed. Because of inefficient route maintenance, average end to end delay is the largest for MMBCR. On the other hand, DSDV protocol proactively holds routes to all destinations in its table, regardless of topology changes. However, EPR protocol has the best performances, because it doesn't depend on periodical activities, and it uses source routing and route caching, but also maintains multiple routes per destination. It excels especially in low mobility scenarios, which means that in cases when network topology is stable, routes are not stale and that results in the best performances under consideration. When a network contains a small number of sources or node's sending rate is low, MMBCR and DSDV protocols have a similar average end to end delay as EPR, especially when node mobility is low.

C. *Power consumption*

International Journal of Advanced Research in Computer and Communication Engineering
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We believe that delay should be given the highest priority when dealing with data packets over the wireless network. On the other hand, many researchers have focused and emphasized on saving power of the node battery to last for longer time and a lot of researchers. In this work, we also minimize power to an extent that it does not degrade improved delay performance.

Fig.3 illustrates the energy related performances in the simulations. In all three cases, EPR consumes the least energy compare to MMBCR and DSDV. The energy consumed by overhearing is significant. None of the routing methods considered adequately address this issue. We can modify the routing protocols by considering the overhearing during the route discovery phase. However, with node mobility, it is hard to estimate the overhearing cost. Thus, an energy efficient MAC protocol may be a more feasible solution

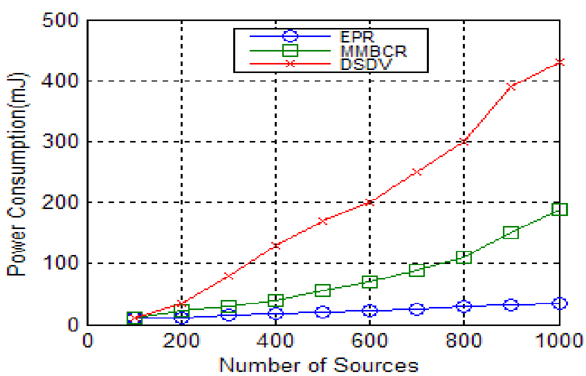

Fig. 3: Comparison results of power consumption with EPR, DSDV and MMBCR

Network lifetime: Fig. 4 shows the network lifetimes with different number of dead nodes. We can see that power awareness can greatly increase the network lifetime. Also note that the rate of lifetime increase is higher with lower node density.

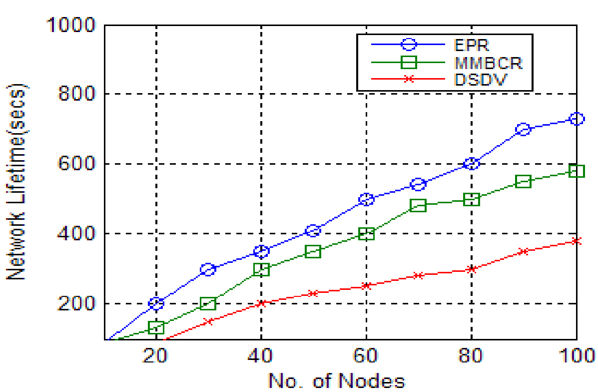

Fig. 4: Comparison results of Network lifetime with EPR, DSDV and MMBCR

For example, in the comparison between EPR, MMBCR and DSDV, the lifetime can be increased by 44% with 65% nodes, and increased by 0 to 100 nodes. This is because that a network with lower density is more likely to have an insufficient number of nodes as routers to construct routing paths. EPR can carefully budget node energy dissipation and preserve more alive nodes. Therefore, a lower density network benefits more from such battery power saving and its rate of lifetime increase is higher than that of a higher density network.

CONCLUSION

A novel power aware EPR election policy has been proposed. This novel features allows energy node to be preserved for longer time. We surveyed energy efficient routing protocols for AMNETs. Our contribution in this paper is a framework to derive benchmarks for the overall energy consumption in mobile ad hoc networks. Results from this paper showed that network lifetime is a significant issue for the performance of a multi-hop ad-hoc network. Overall, the findings show that the energy consumption and packet delivery ratio in small size networks did not reveal any significant differences. In particular, the performance of EPR, MMBCR and DSDV in small size networks was comparable. But in medium and large size networks, the EPR and MMBCR produced good results and the performance of EPR in terms of packet delivery ratio, network lifetime and power consumption is good in all the scenarios that have been investigated.

REFERENCES

[1] Arwa Zabian and Ahmed Ibrahim, "Power Saving Mechanism in Clustered Ad-Hoc Networks", Journal of Computer Science, Vol. 4, No. 5, pp.366-371, 2008.

[2] C.-K. Toh, "Maximum battery life routing to support ubiquitous mobile computing in wireless ad hoc networks," *IEEE Communications Magazine*, vol. 39, no. 6, pp. 138–147, June 2001.

[3] D.Kim, J. Garcia-Luna-Aceves, K. Obraczka, J.-C. Cano, and P. Manzoni, "Routing mechanisms for mobile ad hoc networks based on the energy drain rate," *IEEE Transactions on Mobile Computing*, vol. 2, no. 2, pp. 161–173, 2003.

[4] A.Michail and A.Ephremides, "Energy-efficient routing for connection oriented traffic in wireless ad-hoc networks," *Mobile Networks and Applications*, vol. 8, no. 5, pp. 517–533, 2003.

[5] Jang-Ping Shew, Kun-Ying Hsieh and Yao-Kun Cheng, "Distributed transmission power control algorithm for wireless sensor networks", Journal of Information Science and Engineering Vol. 25, pp.1447-1463, 2009.

[6] Sunil Tanejaa, Ashwani Kushb, Amandeep Makkarc, and Bharat Bhushand, "Power Management in Mobile Adhoc Network" International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies, Vol. 2, No. 2, pp.45-53, 2011.

[7] P. O. Tariq, F. Greg & W. Murray, "On the Effect of Traffic Model to the Performance Evaluation of Multicast Protocols in MANET", Proceedings of the Canadian Conference on Electrical and Computer Engineering, pp. 404–407, 2005.

[8] B. Wang and S. K. S. Gupta, "On Maximizing Lifetime of Multicast Trees in Wireless Ad hoc Networks", Proceedings of the IEEE International Conference on Parallel Processing, 2003.

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 10, October 2013

[9] R. Vaishampayan, J.J. Garcia-Luna-Aceves, “Energy Efficient and Robust Multicast Routing in Mobile Ad Hoc Networks”, Proceedings of the IEEE International Conference on Mobile Ad-hoc and Sensor Systems, 2004.
[10] G. Girling, J. Li Kam Wa, P. Osborn, R. Stefanova, “The Design and Implementation of a Low Power Ad Hoc”, Journal of Global Research in Computer Science, Vol.3. No.5, pp. 46-50, 2012.
[11] V. Rishiwal, M. Yadav, S. Verma, S. K. Bajapai, “Power Aware Routing in Ad Hoc Wireless Networks”, Journal of Computer Science and Technology, Vol. 9, No. 2, pp. 101-109, 2009.
[12] K. Wang, Y.-L. Xu, G.-L. Chen, and Y.-F. Wu, “Power-aware on-demand routing protocol for manet,” in *ICDCSW ’04: Proceedings of the 24th International Conference on Distributed Computing Systems Workshops - W7: EC (ICDCSW’04)*. Washington, DC, USA: IEEE Computer Society, 2004, pp. 723–728.
[13] J.-C. Cano and D. k. Kim, “Investigating performance of power aware routing protocols for mobile ad-hoc networks,” in *Mobiwac’02: International Mobility and Wireless Access Workshop*, Oct 2002, pp. 80 – 86.
[14] N. Usop, A. Abdullah, and A. Abidin, “Performance Evaluation of AODV, DSDV & DSR Routing Protocol in Grid Environment,” *International Journal of Computer Science and Network Security IJCSNS*, vol. 9, No. 7, pp. 261-268, July 2009.

BIOGRAPHY

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