International Journal of Engineering Research and General Science Volume 3, Issue 1, January-February, 2015
ISSN 2091-2730

Energy Efficient and Reliable Routing with Distributed scheme to Improve Performance and the Life Time of Wireless Ad Hoc Networks

A. Anitha, R. Karthik (Ph. D)
P.G. Student, Assistant Professor, M.E Computer Science and Engineering

SVS College of Engineering

Coimbatore, Tamilnadu, India

anithaantonyraj1@gmail.com

Abstract—An ad hoc network is a decentralized type of wireless network since it does not require any pre existing network infrastructure Since the nodes have limited battery with some degree of capacity, energy administration of a node and entire network is a serious concern in ad hoc wireless networks. Energy administration is an optimization procedure, used to exploit the equipped life span of networks by using energy-efficient routing. The on hand energy aware routing algorithms in ad hoc networks pick a route with a huge number of small-distance hops. Since this type of formulation is based exclusively on the energy depleted in a solitary transmission this can lead to further energy consumption. So that, the proper proposal should comprise the whole energy (including that exhausted for any retransmissions required) exhausted in consistently delivering the packet to its ultimate destination. This paper focuses on finding a new routing scheme which is capable of including energy, link and path reliability factors, as well as packet scheduling scheme to increase network performance and the operational lifetime of the wireless network. The proposed Energy Efficient and Reliable Routing with Distributed scheme (ERD Scheme) selects the path by considers remaining battery capacity and reliability and then it uses packet distribution scheme to the packet within specified deadline. The simulation result shows that the proposed scheme achieves high performance and energy efficiency when compared to the existing system.

Keywords—ad hoc networks, energy aware routing, battery aware routing, energy efficiency, reliability, end-to-end retransmission, hop-by hop retransmission, packet scheduling

INTRODUCTION

Ad hoc wireless networks have acknowledged significant consideration in modern years due to their immediate and cost-effectively deployment and prospective applications such as emergency calamity liberation, armed forces and etc. Ad hoc network is type of wireless network that uses radio waves for their communication and are able to working without any backbone infrastructure. The communication between nodes in network are taken place as follows, if the transmitting nodes are very close to each other, in that case the communication session is achieved either in the course of a single-hop transmission or relaying by intermediate nodes otherwise. In numerous scenarios, wireless routing protocols design requires two necessities that are Energy efficiency to maximize life time and reliability to avoid packet losses.

Organization of energy assets has substantial impact on the ad hoc network since the nodes are constructed by batteries with bounded power. Throughout the transmission, a variety of factors such as desertion, intervention, multi-path effects, and collisions, direct to serious loss rates on wireless links, so that the management of packet losses in wireless network entails essential consequence. Some applications wants end to end reliability obligation, it is compulsory to know how such reliability can be assured in wireless network in an energy efficient manner. In this work we focus the dilemma of energy efficient routing in a wireless ad hoc network that properly handles packet losses in the wireless network. The wireless links are prone to transmission errors, so there is a chance to packet loss at any time, this can be overcome by using the following retransmission schemes.

Hop-by-hop retransmissions- lost packet in each hop is retransmitted by the sender when essential, to make sure link stage reliability. Acknowledgements are sent when receiver receives packet properly

End-to-end retransmissions- here the retransmissions take place only between end nodes that is source and destination nodes, and acknowledgements are sent only by destination node

While finding reliable routes can improve the network quality of the services such as throughput and delay, taking into consideration of the remaining battery energy of nodes in routing can evade nodes from being tired and can ultimately lead to enlarge the operational lifetime of the wireless network. Various proposed energy efficient algorithms [1]-[8] focus on finding energy efficient routes, reliability parameter and life time of network. These algorithms consider either one of these requirements or combination of two but not all three requirements. For example proposed scheme [1] focuses only reliability parameter, [2]-[3] focuses energy efficiency, [2]-[3] focuses prolonging life time and [2]-[3] focuses combination of any of two requirements. We proposed a scheme by considering all these requirements together addition with distributed scheme to improve performance parameters and life time of the wireless ad hoc network.

RELATED WORK

In [4], C. Toh et al. proposed a Conditional Max-Min Battery Capacity Routing (CMMBCR) scheme to exploit the life time of MANET. Max-Min Battery Capacity Routing (MMBCR) is an existing power-aware routing algorithm that addressed the problem of rising the equipped life occasion. MMBCR used Min-Max path selection scheme (it is a method which selects the path that has the uppermost value for its most significant node). Similar to Min-Max route selection method, MMBCR selects the path whose significant node has the uppermost remaining battery energy. In MMBCR, a cost metric C_P links with a particular path P is given by

$$C_P = \min_{\text{node i lies on route P}} \{B_i\}$$

where B_i is the remaining battery capacity of node i lies on path P. The path chosen by P_{MMBCR} is specified by

$$P_{MMBCR} = \max_P \{C_P\}$$

This scheme can evade a node from being tired that is over used. This extends the instance until the first node powers losing and improves the life time before the network is partitioned. On the other hand, these power-aware routing protocols are likely to select longer paths, which enlarge the regular relaying load for every node and consequently decrease of average node life span.

Conditional MMBCR scheme uses lowest energy path if all nodes in the chosen routes have adequate battery capability else it switches from lowest energy path to MMBCR after the battery capability for some nodes goes under a predefined threshold. Conversely, both MMBCR and CMMBCR do not focus the likelihood of error probabilities and changeable broadcast energy costs of links.

In [5], A. Misra et al. proposed a energy aware route finding algorithm called the Maximum Residual Packet Capacity (MRPC) to improve the operational life span of multi-hop wireless networks by taking into consideration of node definite parameters (e.g. remaining battery power) and link definite parameters (e.g. Channel individuality of links)
MRPC identifies the capability of a node by take into account both remaining battery power and probable power exhausted in reliably forwarding a packet over a definite wireless link in wireless network. Similar to *MMBCR*, *MRPC* as well used Min-Max path selection scheme. MRPC selects the path whose significant node (the one with the smallest remaining packet broadcast capability) has the biggest packet capability. Let $C_{i,j}$ be a node link metric for the link (i, j) and is estimated as

$$C_{i,j} = \frac{B_i}{E_{i,j}}$$

where B_i is the remaining battery capability of node and $E_{i,j}$ is the broadcast power required by node i to send out a packet over the link (i, j). Mathematically talking, *MRPC* links with a definite path P, the maximal life span (the utmost number of packets that may be potentially forwarded between source and destination nodes over the route P) $Life_P$ specified by

$$Life_P = \min_{(i,j)\in P} \{C_{i,j}\}$$

The route selected by P_{MRPC} is given by

$$P_{MRPC} = \max \{Life_P | P \in \text{all possible routes}\}$$

Conditional MRPC scheme uses lowest power routing when the $Life_P$ related with the elected route lies over the particular threshold else it switches from lowest energy routing to MRPC
However, these schemes *(MRPC and CMRPC)* lengthen the life span of the network and broadcast a noticeably larger number of packets at superior energy efficiency; these will keep away from lossy links to get better energy efficiency in the occurrence of enlarged network size.

PROPOSED WORK

Network Creation

The topology of a wireless ad hoc network is considered as a graph $G(V, E)$, where V and E are the set of nodes and (edges), correspondingly. Each node assigns unique integer value as their identifier that must be lies between 1 and $N = |V|$. Assume that nodes have only limited battery power. A link between a sending node u and receiving node v in the network is denoted by (u, v). When the received signal strength by v is above a threshold, then there will be a link from u to v. Packet delivery ratio of a link (u, v) to send a packet of length x [bit] is denoted by $p_{u,v}(x)$. The power inspired by a sending node u to pass on a packet of length x bit to a receiving node v by using the wireless link(u, v) is denoted by $\varepsilon_{u,v}(L_d)$ and it is estimated by using the following equation

$$\varepsilon_{u,v}(x) = \left(A_u + \frac{P_{u,v}}{K_u}\right)\frac{x}{r}, \forall x \geq 0, \forall (u, v) \in E$$

The power inspired by the receiving node v to accept and process the packet of length x bit transmitted by sending node u is denote by $\omega_{u,v}(x)$ and it is estimated by using the following equation

$$\omega_{u,v}(x) = \frac{B_v}{r} x, \forall x \geq 0, \forall (u, v) \in E$$

where A_u be the energy necessary to run the processing circuit of the transmitter of node u, $P_{u,v}$ be the communication power from node u to node v. Let K_u be the power efficiency of the power amplifier of node u and it should be lies in the interval $0 < K_u \leq 1$. B_v be the energy necessary to run the receiving circuit of the wireless boundary at node v and r represents the data rate of the wireless link.

Minimum Energy cost Routing

Reliability and energy efficiency of path must be considered in path finding process. In wireless network one interest thing is that, the energy expenditure of a path is interrelated to its reliability. When the routes are with a reduced reliability, then the likelihood of packet retransmission increases. As a result, a superior quantity of power will be inspired per packet due to retransmissions of the packet. Based on this key point about the energy cost of routes and the packet distribution scheme, propose an energy aware reliable routing algorithm for wireless ad hoc network which is called as Energy Efficient and Reliable Routing with Distributed scheme (ERD Scheme).

Energy Efficient and Reliable Routing with Distributed scheme

In [8], J. Vazifehdan et al. proposed Reliable Minimum Energy Cost Routing (RMECR) and Reliable Minimum Energy Routing (RMER) energy aware algorithms for ad hoc wireless network to exploit the network operational life span. RMECR is appropriate for both the network retransmission models. RMECR find the path based on energy efficiency and reliability of link and path, and it also consider the remaining battery capacity to maximize the network life span. The main idea behind this scheme is

- The impact of limited number of retransmission allowed and packet size

- The impact of acknowledgment packets
- Energy utilization of processing elements of transmitter and receiver of processing node.

These points are not addressed in the pioneering studies [1], [2], [3], [4], [5], [6].

At the same time, RMER algorithm selects the path which reduces the total energy consumption for end-to-end packet traversal and does not address the remaining battery energy of nodes. RMER consumes less energy compared to existing energy efficient routing algorithms (e.g., [2]-[7]) and also has better reliability.

We propose a new energy-aware routing algorithm for wireless ad hoc networks called Energy Efficient and Reliable Routing with Distributed scheme (ERD Scheme), which is an extension of previous work RMECR. The proposed scheme is able to enlarge the network life span and is able to find reliable, energy efficient routes concurrently. ERD finds minimum energy cost paths. ERD can reduce the overall energy expenditure in the network by selecting lowest energy cost paths. At the same time it find reliable routes so that the constituent links require less number of retransmissions when there is packet loss. Additionally, ERD Scheme can reduce the end to packet traversal time by using distributed packet scheduling algorithms.

In the proposed scheme, the multi-interfaced mobile router (MMR) packet distribution scheme, distributes packets successfully and fairly on the suitable path using the corresponding network interface. Each network interface is assumed to have a distribution counter coupled with the corresponding traversal path. This distribution counter is used to determine enough capacity to distribute packets on the corresponding traversal path. The weighted capacity is estimated by

$$Weighted\_capacity = Capacity\_unit * Weight$$

The $Capacity\_unit$ in bytes are a useful design parameter and thus can influence on the performance of the proposed scheme. The weight is determined from the estimated available bandwidth of traversal paths. Subsequently, the distribution counter is also decreased by the size of packets being distributed. Consequently, the distribution counter for each network interface is diverse by distributed packets as well as $Weighted\_capacity$

RESULT AND ANALYSIS

In this section, simulations are performed to estimate the proposed scheme. The following tables TABLE I and TABLE II shows the comparison between proposed scheme ERD and existing system RMECR.

TABLE I. ENERGY CONSUMPTION

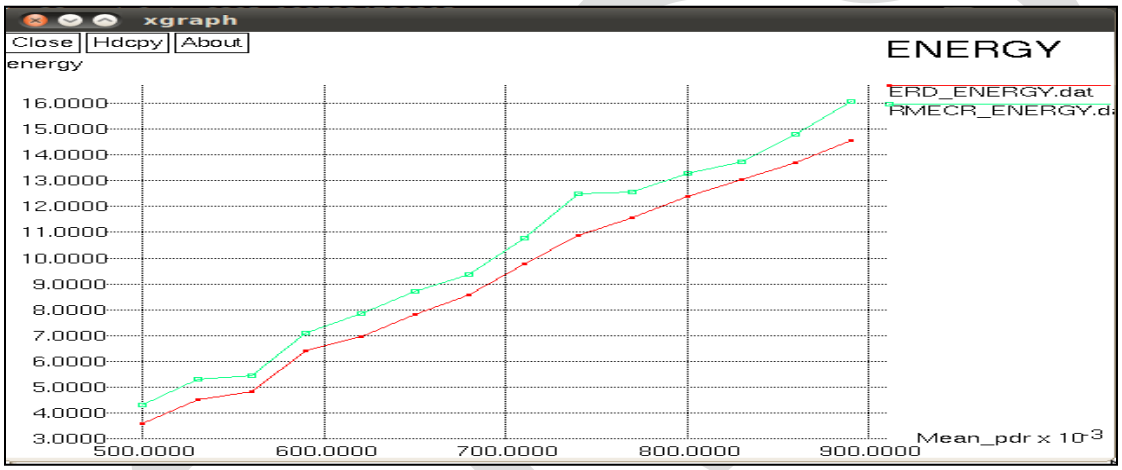
X-axis	**Y-axis**	
Mean_pdr	***RMECR***	***ERD***
0.5000	4.3044	3.6232
0.5899	7.1058	6.3012
0.6799	9.3751	8.9324
0.7999	13.2830	12.2323
0.8900	16.0538	13.55388

TABLE II. RELIABILITY OF PATH

X-axis	**Y-axis**	
Mean_pdr	***RMER***	***ERD***
0.5000	0.2190	0.5072

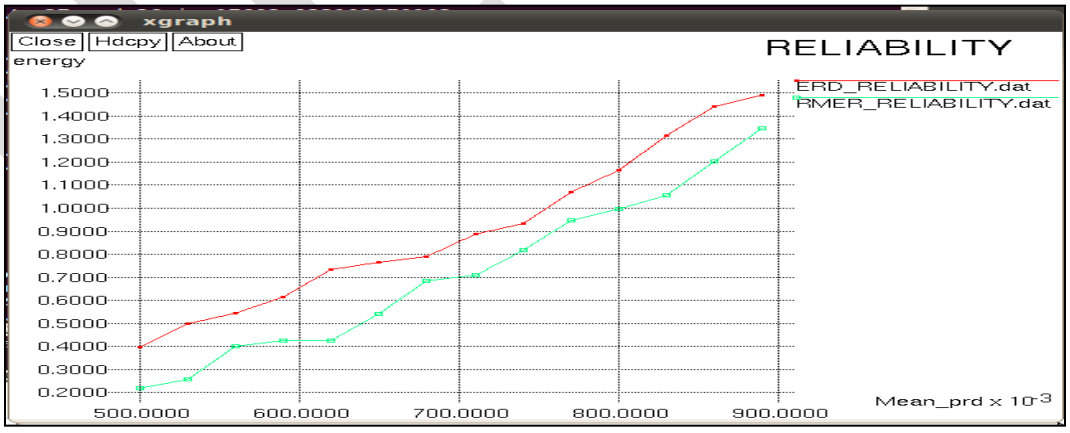
X-axis	Y-axis	
Mean_pdr	***RMER***	***ERD***
0.5900	0.4250	0.7002
0.6800	0.6838	0.8506
0.7700	0.9463	0.9714
0.8900	1.3484	1.2324

The following figure Fig.1 shows that the energy consumption comparison between ERD and RMECR. It clearly shows that the proposed system consumes less energy comparing to RMECR, since it uses packet distribution scheme.



3. Energy consumption

Fig.2 shows the reliability comparison between existing system and proposed system. ERD scheme achieve better reliability compared to RMECR



4. Reliability of Path

CONCLUSION

In this work, we proposed an algorithm for wireless ad hoc networks which is extension of the RMECR. ERD scheme finds minimum energy paths for reliable packet transmission from a source node to a destination node within the deadline.

Our simulation results show that, the proposed ERD scheme can considerably enlarge the operational lifetime of ad hoc networks compared to the similar existing best known algorithms. The proposed scheme further reduces the energy expenditure per packet delivery in the network since it uses distributed packet scheme, which increases the network performance. Additionally, it can select extremely reliable paths.

REFERENCES:

[1] D.S.J. De Couto, D. Aguayo, J. Bicket, and R. Morris, "A High- Throughput Path Metric for Multi-Hop Wireless Routing," Proc. ACM MobiCom, pp. 134-146, 2003.
[2] S. Singh and C. Raghavendra, "PAMAS—Power Aware Multi-Access Protocol with Signalling for Ad Hoc Networks," ACM Computer Comm. Rev., vol. 28, pp. 5-26, 1999.
[3] J. Gomez, A.T. Campbell, M. Naghshineh, and C. Bisdikian,"PARO: Supporting Dynamic Power Controlled Routing in Wireless Ad Hoc Networks," Wireless Networks, vol. 9, no. 5,pp. 443-460, 2003.
[4] C. Toh, "Maximum Battery Life Routing to Support Ubiquitous Mobile Computing in Wireless Ad Hoc Networks," IEEE Comm. Magazine, vol. 39, no. 6, pp. 138-147, June 2001.
[5] A. Misra and S. Banerjee, "MRPC: Maximizing Network Lifetime for Reliable Routing in Wireless Environments," Proc. IEEE Wireless Comm. and Networking Conf. (WCNC '02), pp. 800-806, 2002.
[6] Q. Dong, S. Banerjee, M. Adler, and A. Misra, "Minimum Energy Reliable Paths Using Unreliable Wireless Links," Proc. ACM MobiHoc, pp. 449-459, May 2005.
[7] S. Banerjee and A. Misra, "Minimum Energy Paths for Reliable Communication in Multi-Hop Wireless Networks," Proc. ACM MobiHoc, pp. 146-156, June 2002.
[8] V. Javad, R. Venkatesh, N. Ignas, "Energy-Efficient Reliable Routing Considering Residual Energy in Wireless Ad Hoc Networks",IEEE comm. Trans, on Mobile Computing, vol. 13, no. 2, February 2014