Energy Efficient Routing Algorithm for Mobile Adhoc Networks – a Survey

J. Nandhini, D. Sharmila

Abstract*— Mobile ad hoc networks are infrastructure-less networks used for communication between two or more nodes without a common access point. There are a number of Routing protocols proposed in the recent scenario. In the case of On-Demand routing, Algorithms such as AODV and DSR were considered as one of the effective method for achieving Quality of service parameters compared to Table Driven method. Establishing correct and efficient routes is an important design issue in MANETs along with Energy Efficiency. Energy based papers proposed in the recent years consider the on-demand routing of AODV and DSR and certain modifications have been applied in order to extract a better energy efficient routing algorithm. This paper is a survey of new and improved energy based routing methods in Mobile Adhoc networks.

Index Terms* — MANET, Energy Efficiency, AODV, DSR, Quality of Service.

I. INTRODUCTION

A Mobile Ad hoc network (MANET) is a self-configuring infrastructure less network of mobile devices connected by wireless links. Adhoc is Latin and means "for this purpose".

Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently. Each must forward traffic unrelated to its own use, and therefore be a router. The primary challenge in building a MANET is equipping each device to continuously maintain the information required to properly route traffic. Such networks may operate by themselves or may be connected to the larger Internet.

Some MANETs are restricted to a local area of wireless devices (such as a group of laptop computers), while others may be connected to the Internet. Because of the dynamic nature of MANETs, they are typically not very secure, so it is important to be cautious what data is sent over a MANET.

The growths of laptops and 802.11/Wi-Fi wireless networking have made MANETs a popular research topic since the mid 1990s. Many academic papers evaluate protocols and their abilities, assuming varying degrees of mobility within a bounded space, usually with all nodes within a few hops of each other. Different protocols are then evaluated based on measure such as the packet drop rate, the overhead introduced by the routing protocol, end-to-end packet delays, network throughput etc.

The nodes participating in the network are powered by limited battery resources; battery depletion can imply network failure. Efficient utilization of battery resources is an important issue. Many protocols have been implemented in order to extend the network lifetime.

These protocols can be generally classified in to two categories: Minimum Energy Routing Protocols [1] and Maximum network Lifetime routing protocols [2]. Minimum Energy routing protocols search for the most energy-efficient path from source to the destination, while Maximum network lifetime routing protocols tried to balance the remaining battery power at each node when searching for the energy-efficient path.

The entire sections of the paper are grouped as follows: Section I gives an overview about Mobile Ad Hoc Networks. Section II elaborates about routing & routing protocols in MANET. Section III presents the survey of existing energy based routing protocols. Section IV concludes the paper.

II. ROUTING IN MANET

Routing is the process of selecting paths in a network along which to send network traffic. A routing protocol is a protocol that specifies how routers communicate with each other, disseminating information that enables them to select routes between any two nodes on a computer network, the choice of the route being done by routing algorithms. A routing protocol shares this information first among immediate neighbors, and then throughout the network [3]. This way, routers gain knowledge of the topology of the network.

A. Classification of Routing Protocols

A.1. Proactive Routing Protocols: A proactive routing protocol is also called "table driven" routing protocol. Using a proactive routing protocol, nodes in a mobile ad hoc network continuously evaluate routes to all reachable nodes and attempt to maintain consistent, up-to-date routing information. Therefore, a source node can get a routing path immediately if it needs one. Examples are Wireless Routing Protocol (WRP), the Destination Sequence Distance Vector (DSDV) and the Fisheye State Routing (FSR).

A.2. Reactive Routing Protocols: Reactive routing protocols for mobile ad hoc networks are also called "on-demand" routing protocols. In a reactive routing protocol, routing paths are searched only when needed. A route discovery operation invokes a route-determination procedure. The discovery procedure terminates either when a route has been found or no route available after examination for all route permutations. Examples are Dynamic Source Routing (DSR) and Ad hoc On- demand Distance Vector routing (AODV)

A.3. Hybrid Routing Protocols: Hybrid routing protocols are proposed to combine the merits of both proactive and reactive routing protocols and overcome their shortcomings. Proper proactive

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routing approach and reactive routing approach are exploited in different hierarchical levels, respectively. Examples are Zone Routing Protocol (ZRP), Zone-based Hierarchical Link State routing (ZHLS) and Hybrid Ad hoc Routing Protocol (HARP).

B. Types of Routing Protocol

B.1. Dynamic Source Routing protocol (DSR): It is an on-demand protocol designed to restrict the bandwidth consumed by control packets in ad hoc wireless networks by eliminating the periodic table-update messages required in the table-driven approach. It is source routing protocol, in which the source specifies the complete route to the sink. The intermediate nodes forward the packets based on the route specified by the source. It maintains a route cache, and as long as there is a route to the sink in the cache, no route discovery has to be performed [4]. The route cache can contain multiple paths to a node and the choice of route to a destination is based on selection criteria. When a used link is broken a route error message is sent back to the source and the path is invalidated.

B.2. Destination-Sequenced Distance Vector Routing (DSDV): It is a table-driven routing scheme. Each entry in the routing table contains a sequence number, the sequence numbers are generally even if a link is present; else, an odd number is used. The number is generated by the destination, and the emitter needs to send out the next update with this number. Routing information is distributed between nodes by sending full dumps infrequently and smaller incremental updates more frequently [5]. DSDV protocol guarantees loop free paths. Extra traffic is avoided. DSDV maintains only the best path instead of maintaining multiple paths to every destination. This protocol requires a regular update of its routing tables, which uses up battery power and a small amount of bandwidth. Whenever the topology of the network changes, a new sequence number is necessary.

B.3. Optimized Link State Routing Protocol (OLSR): It is a proactive link-state routing protocol, which uses hello and topology control (TC) messages to discover and then disseminate link state information throughout the mobile ad-hoc network. Individual nodes use this topology information to compute next hop destinations for all nodes in the network using shortest hop forwarding paths. Routes to all destinations within the network are known and maintained before use. No route discovery delay. Allows for differing timer values to be used at differing nodes. Does not include any provisions for sensing of link quality. OLSR uses power and network resources. Requires a reasonably large amount of bandwidth and CPU power.

B.4. Ad hoc On-demand Distance Vector protocol (AODV): AODV is a distance-vector routing protocol. AODV avoids the counting-to-infinity problem of other distance-vector protocols by using sequence numbers on route updates, a technique pioneered by DSDV. AODV is capable of both unicast and multicast routing.

Technical description: It employs destination sequence numbers to identify the most recent path. The major difference between AODV and DSR is that DSR uses source routing in which a data packet carries the complete path to be traversed. However, in AODV, the source node and the intermediate nodes store the next-hop information corresponding to each flow for data packet transmission. It creates no extra traffic for communication. The connection setup delay is lower [6]. Avoids the counting to infinity problem. Consumes more share of the bandwidth and takes more time to build routes. Intermediate nodes can lead to inconsistent routes.

III. ENERGY BASED ROUTING IN MANET

One important goal of routing protocol is to keep network functioning as long as possible along with establishing correct and efficient routes between pair of nodes [7]. This goal can be accomplished by minimizing mobile nodes' energy not only during active communication but also when they are inactive. Transmission power control and load distribution are two approaches to minimize the active communication energy, and sleep/power-down mode is used to minimize energy during inactivity. This section presents a set of energy aware routing protocols and their performances are an analyzed in mobile scenarios.

A. QoS Based Power Aware Routing [8]: Vinay Rishiwal et al proposes a routing algorithm based on energy stable QoS constrained end to end path. The selected route is energy stable and satisfies the bandwidth constraint of the application. The protocol Q-PAR is divided in to two phases. In the first route discovery phase, the bandwidth and energy constraints are built in into the DSR route discovery mechanism. In the event of an impending link failure, the second phase, a repair mechanism is invoked to search for an energy stable alternate path locally.

The protocol considers only energy stability for local reconstruction of the routes to avoid packet loss and costly global reconstruction. The protocol is able to enhance the network lifetime delay repair due to energy depletion of nodes and significantly improve the overall efficiency of packet delivery. However a priori estimation of the bandwidth and admission control to ensure bandwidth availability between wireless links is required to ensure the performance of the protocol.

B. Energy Efficient Cluster Based Routing protocol for MANETs [9]: Seyed-Amin Hosseini-Seno et al proposes Cluster based routing. This protocol divides the nodes of the Adhoc network into a number of overlapping or disjoint 2-hop diameter clusters in a distributed manner. Each cluster chooses a head to retain cluster membership information.

The node with a lowest ID among its neighbors is elected as the Cluster Head (CH). Each node maintains a Neighbor Table and a Cluster Adjacency Table. Neighbor Table is a conceptual data structure that it employs for link status sensing and cluster formation. Cluster Adjacency Table keeps information about adjacent clusters for Adjacent Cluster Discovery. These tables are updated by the periodic Hello Messages (HM). In CBRP, routing is based on source routing. Cluster structure is exploited to minimize the flooding traffic during route discovery phase. Furthermore, certain uni-directional links are discovered and used, thus it is increasing the network connectivity.

In Route Discovery, only cluster heads are flooded with Route Request Packets (RREQ) in search for a source route. Each cluster head node forwards an RREQ packet only once and it never forwards it to a node that has already appeared in the recorded route. It proactively acquires its intra cluster topology information through the exchange of HELLO messages and

reactively acquires the route information inter cluster.

One manner for saving energy in cluster based ad hoc network is all of member node except gateways node can goes to sleep mode when they are in idle mode. In this method only CHs and gateway nodes are active for any communication in other words the backbone of the network every time is active to any communication. If a node be idle for t1 sec send a packet to CH for goes to sleep. If this node received an ACK form the CH, it goes to sleep state for t2 second. Every node has an internal clock which reset with putting to sleep state. After t2 sec the node wakes up automatically. Since, clusters heads and gateway nodes are alive during the network life; delay time is not very high in this implementation. It defines an idle timer which shows the time that node was in idle state and sleep timer which shows the time that node was sleep. Thus Energy efficiency is achieved in cluster based routing as compared to AODV.

C. Energy Efficient Real Time Multicast Routing in Adhoc Networks [10]: Bulent Tavli et al presents Multicasting through Time Reservation using Adaptive Control for Energy efficiency (MC-TRACE), an energy-efficient real-time data multicasting architecture for mobile ad hoc networks. MC-TRACE is a cross-layer design, where the medium access control layer functionality and the network layer functionality are performed by a single integrated layer. The basic design philosophy behind the multicast routing part of the architecture is to establish and maintain an active multicast tree surrounded by a passive mesh within a mobile ad hoc network. Thus, the MC-TRACE multicast backbone is a condensed passive mesh woven around a highly pruned tree. Although tree- and mesh-based multicasting techniques have been used separately in existing multicasting architectures, this method integrates and reengineers of the tree and mesh structures to make them highly energy efficient and robust for real-time data multicasting in mobile ad hoc networks. Energy efficiency is achieved by enabling the nodes to switch to sleep mode frequently and by eliminating most of the redundant data receptions. MC-TRACE provides superior energy efficiency while producing competitive QoS performance and bandwidth efficiency.

D. Energy Efficient Routing protocol based on AODV [11]: Annapurna P. Patil et al proposes Energy efficient Routing protocol based on AODV with considering two different Energy cost metric. The energy metric combined are Transmission power and remaining energy capacity. During route discovery from the source to the destination the energy values along the route are accumulated in the RREQ packets. At the destination or intermediate node (which has a fresh enough route to the destination) these values are copied into the RREP packet which is transmitted back to the source. The source alternates between the maximum remaining energy capacity route and minimum transmission route every time it performs route discovery.

E. Energy Efficient Location Aided Routing Protocol for Wireless MANETs [12]: Mohammad A. Mikki proposes EELAR protocol for MANETs based on Location Aided Routing. EELAR makes significant reduction in the energy consumption of the mobile nodes batteries by limiting the area of discovering a new route to a smaller zone. In EELAR a reference wireless base station is used and the network's circular area centered at the base station is divided into six equal sub-areas. At route discovery instead of flooding control packets to the whole network area, they are flooded to only the sub-area of the destination mobile node. The base station stores locations of the mobile nodes in a position table. Thus, control packets overhead are significantly reduced and the mobile nodes life time is increased.

F. PEER Protocol [13]: Dr.R.K.Chauhan et al proposes Model and Protocol for Energy- Efficient Routing over Mobile Adhoc Networks. Analytical model is used to track the energy consumption due to various factors and Progressive routing protocol is used to improve the performance during path discovery and in mobility scenarios. PEER is cost based energy – efficient routing protocol. In cost based routing protocol, the total cost of all the links on each available path between the source node and the destination node were calculated, and a minimum cost path were selected. This protocol run over 802.11 MAC and derives the link cost. There are two mechanism involved in this protocol as path discovery scheme and path maintenance scheme. The protocol is tested under static scenario and mobility condition. This protocol performs better with reduced overhead and path setup delay in both static and mobility conditions.

IV. CONCLUSION & FUTURE WORK

In this paper the characteristics of Mobile Ad hoc Networks, their application areas and also the routing in Mobile Ad hoc networks are discussed. The classification of routing protocols, the different types of routing protocols used in Mobile Ad hoc Networks, their advantages & disadvantages are also seen. Energy based routing protocols proposed by various authors are discussed in this paper with regard to Power aware routing, Cluster based routing, Location aided conditions and Progressive Routing in both static and mobility conditions. Network connectivity seems to be the important criteria for better routing of packets. This is achieved by designing an energy efficient protocol that reduces energy consumption during active and passive stages along with conventional routing protocols.

REFERENCES

1. S.Doshi, S.Bhandare, and T.X. Brown. “An On-Demand Minimum Energy Routing Protocol for a Wireless Adhoc Network” ACM Mobile Computing and Comm. Rev., Vol. 6, No. 3, July 2002.
2. A.Misra and S.Banerjee. “MRPC: Maximizing Network Lifetime for Reliable Routing in Wireless Environments”, Proc. IEEE Wireless Comm. And Networking Conference, March 2002.
3. Changling Liu, Jorg Kaiser. “A Survey of Mobile Ad Hoc network Routing Protocols”, Global Telecommunications Conference, 2008.
4. J. Broch, D. Johnson and D. Maltz. “The Dynamic Source Routing Protocol for Mobile Adhoc Networks (DSR)”, IETF Internet Draft, July 2004.
5. C.E. Perkins and P. Bhagwat. “Highly dynamic Destination sequenced distance vector routing (DSDV) for mobile computers”, Proc. Of ACM SIGCOMM’94, 1994.
6. Nitiket N Mhala1 and N K Choudhari. “An Implementation possiblites for AODV in real world”, International Journal of Distributed and Parallel Systems (IJDPS) Vol.1, No.2, November 2010.
7. Goldsmith AJ, Wicker SB. “Design challenges for energy constrained ad hoc wireless networks”, IEEE Wireless Communications 2002; 9(4): 8–27.
8. Vinay Rishiwal, S. Verma, and S.K.Bajpai. “QoS Based Power Aware Routing in MANETs”, International Journal of Computer Theory and Engineering, Vol. 1, No. 1, April 2009.

9. Seyed-Amin Hosseini-Seno, Tat-Chee Wan, Rahmat Budiarto. "Energy Efficient Cluster Based Routing Protocols for MANETs", International Conference on Computer Engineering and Applications, 2011.
10. Bulent Tavli and Wendi B. Heinzelman. "Energy Efficient Real Time Multicast Routing in Mobile Adhoc Networks", IEEE Transactions on Computers, Vol. 60, No. 5, May 2011.
11. Annapurna P Patil, Dr K Rajani kanth, BatheySharanya, M P Dinesh Kumar, Malavika J. "Design of Energy Efficient Routing Protocol for MANETs based on AODV", International Journal of Computer Science Issues, Vol. 8, Issue 4, No 1, July 2011.
12. Mohammad A. Mikki. "Energy Efficient Location Aided Routing Protocol for Wireless MANETs", International Journal of Computer Science and Information Security Vol. 4, No. 1 & 2, 2009.
13. Jinhua Zhu and Xin Wang. "Model and Protocol for Energy – Efficient Routing over Mobile Adhoc Networks", IEEE Transactions on Mobile Computing, Vol. 10, No. 11, November 2011.

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