ICCSE'21 International Conference on Contemporary approach on revolutionary Science and Engineering, April 9-10, 2021 ISBN: 978-81-910765-1-6

A Contemporary Survey of Energy Efficient Routing Protocol (Manet)

Anita Dorothy.T, Assistant Professor M.E, (anitadorothy@gmail.com)
Suganya. A, Assistant Professor M.E, (sugebalama@gmail.com,)
Manikandan.S, Assistant Professor M.E, (mani.s.5051@gmail.com)
Computer Science and Engineering,
Indra Ganesan College of Engineering,
Trichy , Tamil Nadu, India.

Abstract— **Despite of much exploration action over the previous time on versatile, specially appointed remote organization (MANET), there is a significant testing issue identified with portable hosts/hubs battery power. This is attributable to the common limitations to expand the energy of hubs so it could work for longer time. Additionally, battery power is likewise not adaptable starting with one hub then onto the next hub. The review arranges the energy efficient routing protocols, their usefulness, advantages, constraints lastly the examination of energy efficient routing protocols. The paper intends to help those impromptu organizations, specialists and application designers in choosing proper energy efficient routing protocols for the work**.

Keywords— MANET, energy efficient routing, Battery power.

I. Introduction

Infrastructure less or Mobile Ad Hoc Network (MANET) is a group of multi-hop wireless mobile nodes that communicate with each other without any access point. In conventional infrastructure wireless networks, the nodes that wish to communicate contacts with the access point.

The mobile ad hoc network has many applications-

- Emergency search and Disaster recovery
- Decision making on the battlefield
- Data acquisition operations in terrain etc.

MANET allows anywhere, anytime connectivity. But in MANET many important challenging issues are Dynamic topology, multi hop routing, limited resources (Bandwidth and battery etc.). Nodes communicate over battery constraint and it is having a variable link, power extended and unpredictable topological change.

The use of mobile devices like PDA's, notebooks, laptops have grown up over years, but they have limited their batteries. In MANET, tracking, routing and route maintenance are done by the nodes itself and nodes like a router in the network. This causes additional strain on node batteries thus reducing their network lifetime [1].

Efficient battery management is one of the most challenging problems in mobile ad hoc network. Many researches have been done for energy aware protocols. Efficient energy approach, minimizes energy consumption over the entire network and maximize the network lifetime. These protocols can be generally classified into two categories Minimum Energy Routing Protocols and Maximum network Lifetime routing protocols. Minimum energy routing protocols

[2] search for the most energy-efficient path from the source to the destination and Maximum network lifetime routing protocols [3] tried to balance the remaining battery power at each node when searching for the energy-efficient path. Mobile devices consume power in four mode packet transmission, receiving, idle & sleep and the residual energy. In sleep mode, If they are not in use, there is still a power drain as the transmitting-receiver is continuously receivingsignals [1].

The rest of the paper ordered as follows: Section II Elaborate routing and routing protocols, Section III Related work of energy efficient routing protocols and their metrics, Section IV Gives the analysis of energy efficient routing, Section V Conclusion and Future work

II. ROUTING & ROUTING PROTOCOLS

Routing is a necessary and challenging task for MANET. It is the process of selecting paths in a network and message is routed through host/nodes in the network. Routing in MANETsis difficult since mobility causes frequent network topology changes and requires more robust and flexible mechanisms to search for and maintain routes. When the network nodes move, the established paths may break and the routing protocols must dynamically search for other optimal routes. With a changing topology, even maintaining connectivity is very difficult. In addition, keeping the loop free routes is more difficult when the mobile nodes move. Besides handling the topology changes, routing protocols in MANETs must deal with other constraints, the possibility of different links, caused by different power levels among mobile nodes and other factors such as hostile terrain conditions makes routing protocols more complicated.

A routing protocol specifies how nodes communicate with each other; the choice of the route being done by routing algorithms and here nodes becomes routes.

A. *Categories of Routing protocol*

In a MANET, Routing protocols are usually categorizedas table-driven and on-demand.

In table-driven routing protocols, all the mobile nodes are required to have complete information about the network through their periodic updates. Table-driven routing is also known as a proactive routing maintain routes to all destinations, in spite of whether or not these routes are needed. In sort to maintain correct route information, a node has to periodically send control messages (RREQ). Therefore, proactive routing protocols may waste bandwidth since control messages are sent out unnecessarily when there is no data traffic. Examples of table- driven routing protocols include destination-sequenced distance vector (DSDV) [4] and Optimal Link State routing (OLSR) [5].

In On demand or Reactive routing protocols, It can dramatically reduce routing overhead because they do not need to search for and maintain the routes when there is no data traffic. The route between a source and destination whenever that route is needed, whereas in proactive protocols, we were maintaining all routes. So in reactive protocols we don't need to bother about the routes which are not being used currently. This type of routing is on demand. Discovering the route on demand basis avoids the cost of maintaining routes that are not being used and also controls the traffic of the network because it doesn't send unnecessary control messages which create a significantly large difference between proactive and reactive protocols. Delay in reactive protocols is greater compared to proactive types since routes are calculated when it is required. e.g. Ad-hoc On Demand Distance Vector (AODV)[6][7], Dynamic Source Routing (DSR)[8][9] etc.

B. *Types of Routing Protocol*

Destination-Sequenced Distance Vector Routing (DSDV): It is a table-driven routing scheme. All entries in the routing table contain a sequence number, It is even if a link is there; else an odd number is used. If the number is generated by the destination, and the sender has to send out the next update with this number. Routing information is disseminated between nodes by sending full dumps rarely and smaller incremental updates more frequently [4]. DSDV protocol guarantee gives 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 battery power and a small amount of bandwidth. Whenever the topology changes, a latest sequence number is necessary.

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. Each node uses 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 [5]. No route discovery delay. Allows for differing timer values to be used at differing nodes. Does not include any provisions forsensing of link quality. OLSR uses power and network resources. Requires a reasonably large amount of bandwidth and CPU power.

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 a source routing approach, in which the source specifies the complete route to the destination. The intermediary nodes forward the packets based on the route specified by the source. Each node maintains a route cache, and as long as there is a route to the destination in the cache, no route discovery has to be performed [8]. 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 thepath is invalidated.

Ad hoc On-demand Distance Vector protocol (AODV): AODV is proactive hop by hop routing protocol. AODV overcomes the counting-to-infinity problem of other distance- vector protocols by using sequence numbers on route updates, a technique pioneer by DSDV. AODV is capable of bothunicast 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 and the intermediate nodes store the neighbor's node information corresponding to each flow for data packet transmission. It creates no extra traffic for communication. The connection setup delay is lower. Avoid the counting to infinity problem. Consumes more share of the bandwidth and takes more time to build routes. Intermediate nodes can lead toinconsistent routes.

TABLE I. COMPARISON OF ROUTING PROTOCOLS

Metrics	**Proactive Protocols**		**Reactive Protocols**	
	DSDV	***OLSR***	***DSR***	***AODV***
Unidirectional Link Support	No	Yes	Yes	No
Multicasting	No	No	No	Yes
On-demand Routing Behavior	No	No	Yes	Yes
Loop Freedom	Yes	Yes	Yes	Yes
Sleep Mode	No	Yes	No	No

Metrics	Proactive Protocols		Reactive Protocols	
	DSDV	***OLSR***	***DSR***	***AODV***
Route Discovery and Maintainace	No	No	Yes	Yes
Security	No	No	No	No
Power Conservation	No	No	No	No

III. RELATED WORK OF ENERGY EFFICIENTROUTING PROTOCOL

One important aim of routing protocol is to keep the network functioning as long as possible along with establishing correct and efficient routes between a pair of nodes [10]. This aim can be accomplished by minimizing mobile nodes' energy not only during active communication, but also when they are inactive mode. There are many approaches to minimize the energy in inactive or active mode.

A. Transmission Control Approach

This approach assumes that the nodes have variable transmitting power and reduce the active communication energy by adjusting each node's radio power just enough to reach up to the receiving node. For this, Minimum Energy Broadcasting is used, where the multi hop transmission is used to reach from a specific source to all other nodes in the network while consuming minimum energy [11].

The broadcasting in MANET takes place through flooding. Since the aim of flooding is route discovery, it should be done with minimum communication energy [12].

B. Load Distribution Approach

It is an important approach to optimize active power. Here,the aim is to balance the energy usage evenly among nodes and to maximize the network lifetime by avoiding over- utilized nodes while choosing a routing path [11].

C. Power Aware Routing

1) Efficient Power Aware Routing Protocol (EPAR)

This is on demand routing protocol based on minimizing the power consumption per packet. EPAR identifies the capacity of a node in both residual battery power and the expected energy spent in constantly forwarding data packets over a particular link. Using a mini-max formulation, EPAR selects the path that has the largest packet capacity at the smallest residual packet transmission capacity. EPAR is to minimize the variance in the remaining energies of all the nodes and thereby prolong the network lifetime. Reduces total energy consumption, Decreases the mean delay, and extend the network lifetime [13]. But in which some node operates on limited battery resource & a multi hop routing path and also it does not contain the alternate path in case of link failure.

Disadvantage-Since battery capacity is directly

2) Modified EPAR Protocol

This protocol reduces the energy consumption using the link cost to transmit power control in EPAR in four modes (transmit, receiving, idle & sleep) and residual energy. They added two power value like to set power and max value for packet transmission. In which the cost value depend on packet size or adjustable for small packet choose the short path and for large packet use the long path [14]. But for the large packetthis protocol is not efficient chooses the longer path so network lifetime will be reduced.

3) Efficient Power Routing DSR(EPRDSR) Protocol

EPRDSR selects the bandwidth and a power constraint path are built in to the DSR route discovery process. This is not only extending the lifetime of each node, but also to improve the lifetime of each connection [16].

4) Novel Power Efficient Routing(PER) Protocol

This protocol minimizes the power consumption for operation so that transmission power can be saved. In which instead of reinitializing route discovery process periodically; route discovery is initialized only after transmission of an optimum number of data packets. Hence the optimum value of this number must be chosen carefully depending on the size of the network [17] and the energy level of nodes to avoid routing overhead and maximize the lifetime of the network.

5) Efficient DSR (EDSR) Protocol

In this protocol minimize the energy consumption per packet, minimize maximize the node cost, find the intermediate selfish nodes whose drop the packets and maximize the network lifetime through the route discovery process, in EDSR route discovery, Set and start the timer and destination waits for a specific time after receiving the RREQ packet [15]. It then reply the best path in that timer period and ignore another. According to this protocol destination will wait for the specific time after that RREP packet will send so process will be run for longer time means it is a time consuming process.

D. Battery-cost Lifetime-aware Routing

This is done by either reducing the number of nodes required for routing or by considering battery power at different nodes and route around nodes that have a low level of remaining battery power [12]. There exist a number of 'Battery-cost Lifetime-aware Routing' algorithms [2] that are discussed below:

1) Minimum battery Cost Routing [MBCR] Protocol

It minimizes the total cost of the route. This algorithm minimizes the summation of inverse of remaining battery capacity for all nodes on the routing path. However, since it just minimizes the sum, some nodes may still be overused because a route containing nodes with little remaining battery may still be selected. Since MBCR uses the remaining battery of the nodes as for selecting the route which is quite a goodmethod for selecting the route.

incorporated into the routing protocol, this metric prevents

	Characteristics				
			Min	***Overhe***	

nodes from being overused; thereby increasing node lifetime and the time until the network is partitioned. If all nodes have similar battery power, this metric will select a minimum-hop route. However, because only the sum of values of battery cost is considered, a route nodes with little remaining battery capacity may still be selected.

2) Min-Max battery Cost Routing [MMBCR] Protocol

It is a modification of the MBCR[18]. It attempts to avoid the route with nodes having the minimum battery capacity among all nodes in all possible routes. MMBCR [18] treats nodes more fairly from the standpoint of their remaining battery capacity. Minimum remaining battery capacity nodes are avoided and ones with superior battery capacity are favored when selecting a route. However, more overall energy will be consumed throughout the network since minimum total transmission power routes are no longer favored.

3) Conditional Min-Max battery Capacity Routing [CMMBCR] Protocol

This chooses the route with minimal total transmission power if all nodes in the route have remaining battery capacities higher than a threshold; else the routes that consistof nodes with the lowest remaining power are avoided.

4) Maximum Residual Packet capacity (MRPC) Protocol

It identifies the capacity of the node not just by the residual battery capacity, but also by the expected energy spent in reliably forwarding a packet over a specific link.

5) Power Aware Source Routing (PSR) Protocol

It is an on-demand source routing that uses an accumulative graded cost function. It also uses state of the charge of battery to maximize the lifetime of the MANET.

6) Minimum Total Power Routing (MTPR) Protocol

In MTPR, energy metric [13] is represented by the total energy consumed to forward the packets along the route. In this way, MTPR reduces the overall transmission energy consumed per packet, but it does not directly affect the lifetime of each node. Each node learns the routing paths not only as a source or an intermediate node, but also as an overhearing neighbor node.

Disadvantage –The more nodes involved in routing packets, the larger end-to-end delay. In addition, a route consisting of more nodes is possible to be unstable, because the chances of that intermediate nodes will move away is higher. Hence, from the standpoint of minimum hops, large numbers of nodes are remains in active mode. The route obtained from this algorithm is not attractive

TABLE II. COMPARISON OF ENERGY EFFICIENT ROUTING PROTOCOLS

Protocols	Characteristics				
	Metric	***Max.Life Time***	***Min. Energy Consumption***	***Overhead Ration & End to End Delay***	***Summary***
	battery				e
MTPR	Power	No	No	High	Route Discovery

IV. ANALYSIS OF ENERGY EFFICIENT ROUTINGPROTOCOL

We observe that the existing routing protocols suffered from several problems like network congestion, network wide flooding, bandwidth constraints, delay, greater load on radios,
processing overheads, busy network, selection of route containing nodes with little remaining battery capacity etc. In the existing power aware protocols longer path is selected whereby maximum number of node participates for packet transmission from source node to destination node with minimum number of nodes in the idle mode and maximum number of nodes in the active mode. This will ensure higher energy consumption; while some of the nodes operate on limited energy resources and multipath routing.

V. CONCLUSION & FUTURE WORK

An energy efficient routing protocol is required to choose the energy efficient route from source to destination. Energy efficiency is the main problem of the network. In this paper, we have undergone the survey and classified the energy efficient routing protocols with their methods, benefits and limitations. It is difficult to compare them directly because each method is distinct with different underlying assumptions. Based on the outcomes of analysis, we can develop the energy efficient protocol.

REFERENCES

[1] C. Albert Mo Kin, C. Jharna. “Optimizing power aware routing in Mobile Ad hoc Networks”.

[2] Sheetalkumar Doshi, Shweta Bhandare, Timothy X Brown. “An On- Demand Minimum Energy Routing Protocol for a Wireless Ad hoc Network” Mobile Computing and Communications Review, Volume 6, Number 3.

[3] A Misra and S. Banerjee. “MRPC: Maximizing Network Lifetime for Reliable Routing in Wireless Environments”, Proc. IEEE Wireless Comm. And Networking Conference, March 2002.

[4] C.E. Perkins and P. Bhagwat. “Highly dynamic Destination sequenced distance vector routing (DSDV) for mobile computers”, Proc. Of ACM SIGCOMM’94, 1994.

[5] T. Clausen and P. Jacquet, "Optimized Link State Routing Protocol (OLSR)," RFC 3626, IETF, Oct. 2003.

[6] Charles E. Perkins and Elizabeth M. Royer, “ Ad hoc On-Demand Distance Vector Routing,” in Proceedings of the Second IEEE Workshop on Mobile Computer Systems and Applications in 2009.

[7] C. Perkins, E. B. Royer, S. Das, “Ad hoc On-Demand Distance Vector (AODV) Routing - Internet Draft”, RFC 3561, IETF Network Working Group, July 2003.

[8] D. B. Johnson and D. A. Maltz, "Dynamic Source Routing in Ad Hoc Networks", Mobile Computing, T. Imielinski and H. Korth, Eds. KulwerPubl., 1996, pp. 152-81.

[9] D. B. Johnson, D. A. Maltz, Y.C. Hu, “The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks (DSR)”, IETF MANET Working Group INTERNET Draft, July 2004, work.

[10] Goldsmith AJ, Wicker SB. “Design challenges for energy constrained ad hoc wireless networks”, IEEE Wireless Communications 2002; 9(4): 8– 27.

[11] Pariza Kamboj, A .K. Sharma, “Power aware multicast reactive routing protocol (PAMRRP)”, August 2008.

[12] Intae Kang, P. Radha, “On the lifetime extension of energy-efficient multihop broadcast networks”.

[13] Shivashankar, Suresh H, Varaprasad Golla, Jayanthi, “Designing Energy Routing Protocol with Power Consumption Optimization in MANET”,IEEE 2013.

[14] Shivashankar, Suresh H, Varaprasad Golla, Jayanthi, “Implementing an Energy Aware Issues in MANET by Designing Efficient Routing Protocol”, july 2012.

[15] Shivashankar, Suresh H, Varaprasad Golla, Jayanthi,” Implementing a new power aware routing protocol on existing dynamic source routing protocol for mobile ad hoc network ”, ietdl 2013.

[16] Shivashankar, Suresh H, Varaprasad Golla, Jayanthi,” Importance of on- demand power aware dynamic source routing protocol in mobile ad hoc network ”, ietdl2013.

[17] Shivashankar, Suresh H, Varaprasad Golla, Jayanthi,” Designing An Efficient Routing Protocol In MANETs ”, IJWAMN Nov. 2013.

[18] Z.Qing, T. lang, “An analytical approach to Energy aware hybrid routingfor large scale Mobile Ad hoc Networks”, January 2005.