A Study on Energy Consumption in Mobile Adhoc Network

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ABSTRACT
A Mobile Ad-hoc Network (MANET) is a collection of mobile nodes communicating and cooperating with each other without any pre-determined topology. The mobile node in the network operates not only as a host but also as a router in forwarding packets to other mobile nodes in the network. Each node contains a limited resource constraint such as battery power, bandwidth, etc. Since nodes are dynamic, energy drains quickly. Energy consumption and selecting an efficient path between source and destination are the major challenges in this type of network. Lots of approaches have been proposed in developing an energy efficient route. This paper presents some of the latest approaches that provide an energy efficient route in delivering the packets from source to destination and also enhance the lifetime of the network.

Keywords
MANET, Energy Efficient route survey, Network Lifetime

1. INTRODUCTION
Mobile Adhoc NETwork (MANET) is an autonomous network formed by connecting mobile routers through wireless links [1]. The routers are dynamic and hence the network topology changes frequently. The routers in the network communicate wirelessly in a self-organised manner. This type of network is widely used in the area where there is no other wireless communication infrastructure present or where such infrastructure cannot be used. All nodes in such networks are mobile, so energy is one of the most important and vital issues for those ones.

Many approaches have been developed in consuming the energy and also in improving the lifetime of the network [2]. But routing algorithm plays an important role in finding an energy efficient route because routing algorithm decides which node has to be selected for communication. An example of MANET is shown in figure 1.

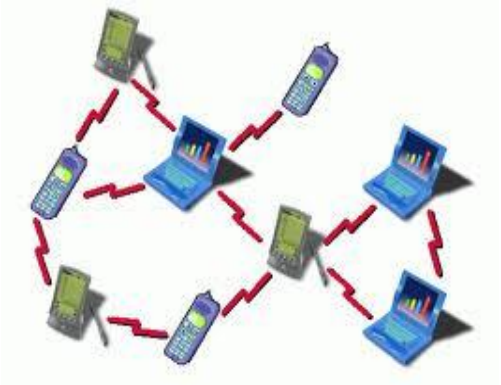

Fig 1: Mobile Ad hoc Network [3]

The nodes in the network depend on their battery power during transmission of packets. The energy drain of a particular node depends upon the transmission energy of a node, data packet size send through the particular node and queue status of a node. Queue status of a node overcomes the congestion problem which wastes the network energy unnecessarily.

The rest of the paper is organized as follows. Section 2 presents the challenges in MANET. Section 3 briefly describes routing protocols in MANET. Section 4 presents related work involved in MANET. Section 5 describes and classifies energy efficient algorithms for MANET. Section 6 provides conclusion.

2. CHALLENGES IN MANET
Since there are limited resources available in MANET, there are lots of challenges [4] [5] faces by this architecture and are categorized as follows:

1) **Limited bandwidth:** Wireless links usually have lower capacity compared to wired networks.
2) **Dynamic topology:** Nodes in the network moves freely, thus the network changes dynamically and changes rapidly at unpredictable times.
3) **Routing Overhead:** Since nodes in the network are movable routes to the destination changes often. So, some stale routes are formed which leads to unnecessary routing overhead.
4) **Battery constraints:** Since the devices are portable, charging at work place are not possible. So all devices are fitted with battery power
5) **Security threats:** The nodes in the network are connected through wireless links, so security for the data is quite a challenge in this type of network.

3. ROUTING PROTOCOLS IN MANET
Routing protocols are the set of standards or rules. Routing is the process of selecting the paths in the network to send the network traffic. There are three types of routing protocols: Proactive protocol, Reactive protocol and Hybrid protocol. The protocols are selected depend upon the network capability.

3.1 Proactive Protocol
In proactive protocol, each node in a network maintains routing information about the entire network topology. The routing tables are updated periodically [6]. Each node broadcast the messages to the entire network whenever there is a change in the network topology. Hence, additional overhead cost occurs due to the updation of routing table periodically. Finally this leads to degradation of throughput in the network. Destination Sequenced Distance Vector (DSDV), Optimized Link State

Routing protocol (OLSR) are some of the examples of proactive routing protocol [7].

3.2 REACTIVE PROTOCOL

In reactive protocol, the routing process is initiated whenever there is a demand. If the source wants to send message to destination, first it will broadcast the Route Request (RREQ) packet to all other neighbors. An intermediate node then checks whether it has route to destination or not in its routing table. If it has a route then the RREQ packet is send to the destination through that route and Route Reply (RREP) is send to the destination else an intermediate node will broadcast the RREQ to its neighbors and the process continues until RREQ packet reaches the destination [8]. Dynamic Source Routing (DSR), Ad-hoc On Demand Routing (AODV) and Associativity Based Routing (ABR) protocols are some of the examples of reactive routing protocol. In DSR, the entire routing information is maintained in the packet header [9] whereas in AODV source routing is not present.

3.3 HYBRID PROTOCOL

Hybrid protocol invokes the advantages of both proactive protocol and reactive protocol [10]. Zone routing protocol is an example of hybrid protocol. In this protocol, the inter zone network uses reactive protocol and the intra zone network uses proactive protocol.

4. RELATED WORK

Many works have been done in MANET to provide a robust and secure communication. Since mobile nodes are portable, security for data packets are not clear [11]. Since MANETs are mainly used in the battle field, recovery areas etc., data send through the network should not be known to the attackers. So the number of approaches and algorithms has been developed in providing a secure and reliable communication. The energy consumption of the mobile nodes is also high due to the dynamic nature of the network. Since nodes in the network have limited resource constraints energy drains quickly in case of high dynamic, network overload etc. Hence improving the lifetime of the network becomes a major challenge in today's network.

5. LITERATURE REVIEW

Energy efficient routing protocol (EER) [12], overcomes the issues arising during the route maintenance process. The failure of any node in the route when the transmission of data packet is in progress leads to the degradation of the Quality of Service (QoS). To overcome this issue energy efficient routing protocol selects the route based upon the maximum bandwidth, minimum load, maximum energy and minimum hop count between source and destination. When a node's energy level falls below the threshold route maintenance process is initiated by sending a Route Error (RERR) message to its predecessor node. The predecessor node searches for an alternate route in its final route table. If the route is found the predecessor node informs the source and other intermediate node about the alternate route by sending RERR message. Else, informs that no such path is available that doesn't contain sinking node.

Maximum Energy Level Ad Hoc Distance Vector (MEL-AODV) protocol selects the energy efficient route using residual energy of each node involved in the path. The source wishes to send data packets to destination initiate the route request process. A new field known as accumulated energy is added into the RREQ. When the intermediate node receives the RREQ packet, it updates the accumulated energy field by its residual energy. At the destination the total energy of each route is calculated. Then the accumulated energy field of all the routes are compared. The route having the highest accumulated energy is selected as the best route and the RREP is send along the particular path. Then the source sends the data packets through that path [13].

Energy based multipath routing (E-AOMDV), takes the amount of energy left at the neighboring nodes in selecting one route from multiple paths route. The overall percentage of load from each path is calculated based on the processing capability of executed route and the processing capability of all existence routes [14].

An Energy Saving Ad Hoc Routing (ESAR) algorithm selects an energy efficient path by considering an actual distance between the source and destination along with minimum energy available in the path. When the source wants to send data packets to destination it initiates a route discovery process. Upon receiving the first Route Request (RREQ), the destination waits for đt time period to collect more routes through paths. After the time period, all the paths are stored for the selection of best paths. The cost of the each path stored is calculated based on the formula available in [15]. The path minimum cost is selected as an energy efficient path.

Energy Efficient Maximum Lifetime Ad-hoc Routing (EEMLAR) [16] protocol also calculates the residual energy of each node but at the destination the optimization function is used to calculate the energy efficient path instead of comparing with other routes.

Initially threshold value for both signal strength and residual energy is set. At each intermediate node, the signal strength and residual energy are compared with threshold value. Based on the comparison reliability count value is incremented. In destination, by calculating and comparing the reliability factor for each path the best route to the destination is selected. The protocol used is signal strength and energy aware routing [17].

The method AODV-Sleep [18] changes the mode of the node to sleep if its energy level reaches the minimum threshold value. Before going to the sleep mode, it checks the remaining energy of the neighboring node. If the energy of neighbor node is greater than 50 then the routing table updation is performed on the node and the new route is established through that node.

Energy Efficient Enhanced AODV Routing protocol selects the path based upon the residual energy, traffic density and the stability of the node until the time T. The route reply is send along the corresponding paths. Source node calculates the power loss level by subtracting the received energy from the transmitting energy of the particular path. Then the data packet is send along the path having low power loss level [19].

Network coding increases the communication efficiency by combining the information at intermediate nodes but it fails to consider the power drain and delay. To overcome this problem Mobility Based Minimal Network Coding (MBMNC) algorithm [20] is proposed. When a new packet arrived at particular it checks the sequence number to avoid duplication. If it is not duplicate, then it checks for the information header in the packet. If the information header is available and the destination for two packets, say p1 and p2 are same then two packets will be encoded else the packet is transmitted.

Efficient Power Aware Routing Protocol (EPAR) [21] identifies the best path using Mini-Max formulation. Destination node selects the path with maximum lowest hop energy. But the mobility prediction of the node is not considered. In Efficient Power and Life Aware Routing (EPLAR) protocol [22], the mobility prediction of the route is also considered and finds an efficient path to destination.

The Transmission Energy (TE) of each node is also used to calculate the energy efficient path. Each node checks whether the residual energy of the node is less than the transmission energy or not. If it is less than TE then the node will broadcast the request to neighboring nodes and change the mode to sleep. Otherwise it is involved in the route to destination. At destination the total transmission energy of the route is calculated. The energy efficient route is selected on the basis of minimum total transmission energy of the path [23].

The Intelligent energy efficient routing protocol [24] proposes a SPAN algorithm. SPAN algorithm selects "coordinators" from the network. The coordinators are selected based upon the remaining energy level. Only the coordinators are combined to form a route to the destination. The remaining non-coordinators nodes are put to sleep mode. The network is selected with high coordinator node to ensure better communication. The algorithm is analyzed for both heterogeneous and homogeneous network. If the network doesn't contain as many coordinator nodes as possible then this algorithm will not suits. The ant colony optimization algorithm [25] is used to find the shortest path from source to destination.

Many routing algorithms have been developed to provide an energy efficient route. To make a congested free network an Energy Efficient Routing (EER) algorithm [26] considers queue occupancy as one parameter. The queue status of a node ensures efficient delivery of the data packets. The node does not provide service to only one source destination pair; it may deliver data packets from many sources. So if the queue status of the node is high it will simply discard the route request message.

The lifetime prediction of a node can also be used to improve the lifetime of the network. The lifetime of a particular node is selected based upon the last N values of residual energy. The lifetime of the nodes except source and destination are calculated using the formula in [27]. The route request message with minimum cost is accepted by an intermediate node and then forwards to neighboring nodes. At destination, the route having minimum total cost is selected as energy efficient route.

The broadcast overhead in AODV and DSR are reduced by using expansion ring search algorithm. But still some redundant broadcasts are available in Expanding Ring Search (ERS) algorithm which cause overhead wasted energy and increased collisions in the network. This problem is solved with the help of overhearing scheme [28]. The overhearing scheme is divided in to two methods such as collecting local topology and reducing the overhead of pure flooding. In the first method, source node broadcast a route request to all nodes within K-hop neighbors and collects the local topology information. If there is no route to destination then the ring is increased and again the same process is repeated. Some nodes participated in the first search can be silent by applying reducing the overhead of pure flooding. Thus, this process will increase the overall lifetime of the network by reducing the broadcast overhead.

An alternative approach to expanding ring search algorithm is Blocking Expanding Ring Search (BERS). Instead of TTL sequence, a new control packets such as stop_instruction and a hop number is used which reduces an energy consumption during route discovery process. The main difference between the TTL sequence-based ERS and BERS is that route discovery process resumes at any appropriate intermediate nodes rather than source node at each node [29]. The two stop signals are used in BERS. One is RREP which is send by any route node to source and the other is stop_instruction which is send by source to all other nodes in the network. The waiting time for RREP message is twice the hop number. An enhanced version of BERS ie. BERS* [30] is similar to BERS, except it requires intermediate node to wait for only half amount of the waiting time. This speeds up the overall route discovery process compared to BERS.

Table 1. Comparison of existing protocols

Protocols	Energy Consumption	Delay	Packet Delivery Ratio
EER	High	Low	High
MEL-AODV	High	High	Moderate
E-AOMDV	Moderate	Low	High
ESAR	High	High	Medium
AODV-SLEEP	High	High	Low
MBMNC	Low	Low	High
EPAR	High	High	Low
IMPROVED AODV	High	Low	High
ERS	High	Low	High

6. CONCLUSION

A Mobile Ad-Hoc network (MANET) consists of a self-organizing, autonomous and self-operating nodes which communicates directly with the nodes in a wireless range or indirectly through other nodes in the network via dynamically computed multi-hop route. The dynamic nature of the network consumes lot of power and energy compared to fixed network. Thus, energy consumption is one of the major issues in MANET. In this paper, the various methods for conserving energy are discussed. To conserve the active communication energy, the transmission power control and load balancing approaches are used. The sleep/power-down mode approach focuses on reducing the energy during the idle state. So the main concern for conserving power of nodes and increasing the lifetime of network is to consider the energy of a route before sending the data.

7. REFERENCES

[1] Deepthy J, Nishanth Krishnan, "Performance Improvement Of Energy Aware And Adaptive Routing Protocols For Manets – A Survey", International Journal of Research in Engineering and Technology, Volume: 03 Special Issue: 01, March 2014.

[2] Shruti Verma, Pushpa Singh, "Energy Efficient Routing in MANET: A Survey", International Journal of Engineering and Computer Science, Volume 3 Issue 2 February, 2014

[3] http://www.google.co.in/

[4] Gaurav Sachan, D. K. Sharma, Karishma Tyagi, Abhimanyu Prasad, "Enhanced Energy Aware Geographic Routing Protocol in MANET: A Review", International Journal of Modern Engineering Research (IJMER), Vol.3, Issue.2, March-April. 2013.

[5] Aarti, Dr. S. S. Tyagi. "Study of MANET: Characteristics, Challenges, Application and Security Attacks", IJARCSSE, Volume 3, Issue 5, May 2013.

[6] Surendra H. Raut, Hemant P. Ambulgekar, " Proactive and

Reactive Routing Protocols in Multihop Mobile Ad hoc Network" , IJARCSSE, Volume 3, Issue 4, April 2013.

[7] Ravneet Kaur, "Energy Efficient Routing Protocols in Mobile Ad hoc Network based on AODV Protocol", IJAIEM, Volume 2, Issue 1, January 2013

[8] Lata Lohani,, Arun Kumar, Srinivas Arukonda, "A Survey on Power Aware Routing in Manet", International Journal of Advanced Research in Computer Science and Software Engineering, Volume 3, Issue 4, April 2013.

[9] Sunil Taneja and Ashwani Kush, "A Survey of Routing Protocols in Mobile Ad Hoc Networks", International Journal of Innovation, Management and Technology, Vol. 1, No. 3, August 2010

[10] Harjeet Kaur, Varsha Sahni, Dr. Manju Bala, "A Survey of Reactive, Proactive and Hybrid Routing Protocols in MANET: A Review", International Journal of Computer Science and Information Technologies, Vol. 4 (3), 2013.

[11] Pradeep Rai, Shubha Singha, "Review of MANET's Security Aspects and Challenges", IJCA Special Issue on "Mobile Ad-hoc Networks", MANETs, 2010.

[12] Supriya Srivastava, A.K. Daniel, R. Singh and J.P. Saini, "Energy-Efficient Position Based Routing Protocol for Mobile Ad Hoc Networks", 2012 International Conference on Radar, Communication and Computing (ICRCC), December, 2012. pp.18-23.

[13] P.S.Karadge, Dr.S.V.Sankpal, "A Performance Comparison of Energy Efficient AODV Protocols In Mobile Ad Hoc Networks", IJARCCE, vol.2, Issue 1, January 2012.

[14] Bhavna Sharma, Shaila Chugh, Vismay Jain, "Energy Efficient Load Balancing Approach to Improve AOMDV Routing in MANET", 2014 Fourth International Conference on Communication Systems and Network Technologies, IEEE, 2014.

[15] Utkarsh, Mukesh Mishra and Suchismita Chinara, "ESAR: An Energy Saving Ad Hoc Routing Algorithm for MANET", IEEE- Fourth International Conference on Advanced Computing, December 13-15, 2012.

[16] Mrs.Shilpi Jain, Mrs.Sourabh Jain, "Energy Efficient Maximum Lifetime Ad-Hoc Routing", IRACST, volume 2 , No 4 , August 2012.

[17] P.Srinivasan, K.Kamalakannan, "Signal Strength and Energy Aware Reliable Route Discovery in MANET", IJCNS, volume 1, Issue 4, 2012.

[18] Tripti Nema, Akhilesh Waoo, P.S.Patheja, Dr.Sanjay Sharma, "Energy Efficient Adaptive Routing Algorithm in MANET with Sleep Mode", IJACR, volume 2, Number 4, Issue 6, December 2012.

[19] R.Rajeshkanna , Dr.A.Saradha, "Energy Efficient Enhanced AODV Routing Protocol for Maximize the Lifetime of Mobile Ad Hoc Networks", IJCTA, volume 4, sep 2013.

[20] Saravanan.K, Venkatalakshmi.B, "Mobility Based Minimal Network Coding (MBMNC) Algorithm For Mobile Ad-Hoc Network", 2013 International Conference on Recent Trends in Information Technology (ICRTIT), IEEE 2013.

[21] Haseena K.S, Sheena Anees, Neela Madheswari. "Power Optimization Using EPAR Protocol In MANET", IJISET, vol 1, Issue 6, July 2014.

[22]Anuja.M, Jaya shree.S, Gobinath.S, Mrs.R.M.Bhavadharini, "Maximizing the Network Lifetime of MANET Using Efficient Power and Life Aware Routing Protocol", IJARCET, Volume 3, Issue 3, March 2014.

[23] Anjum Asma, "Energy Efficient Routing Algorithm for Maximizing Network Lifetime of MANETs", International Journal of Innovative Research in Computer and Communication Engineering", Vol.1, Issue 8, October 2013.

[24] Dr.Annapurna Patil, Saunhita Sapre, "Intelligent Energy Efficient Routing Protocol based on Biological Agents for MANETS", IJETAE, volume 4, Issue 7, July 2014.

[25] WANG Ya-li, SONG Mei, WEI Yi-fei, WANG Ying-he, WANG Xiao-jun, "Improved ant colony-based multi-constrained QoS energy-saving routing and throughput optimization in wireless Ad-hoc networks",Science Direct, 21(1): 43–53, February 2014,

[26] MD. Manowarul Islam, MD Ashraf Uddin, Ali Newaz Bahar, A.K.M Kamrul Islam, MD. Selim Al Mamun, "Energy Efficient Routing Mechanism for Mobile Ad Hoc Networks", IJCSE, volume 3, No.01, Jan 2014.

[27] Morteza Maleki, Karthik Dantu, and Massoud Pedram, "Lifetime Prediction Routing in Mobile Ad Hoc Networks", March 2007

[28] Ngoc Duy Pham, Hyunseung Choo, "Energy Efficient Expanding Ring Search for Route Discovery in MANETs", IEEE, 2008.

[29] Incheon Park, Jinguk Kim, Ida Pu, "Blocking Expanding Ring Search Algorithm for Efficient Energy Consumption in Mobile Ad Hoc Networks", IEEE proceedings.