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Comparative Study of Energy Efficient Routing Algorithms in Mobile Ad-hoc Networks

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Abstract *— Mobile ad-hoc Networks (MANETs) is a wireless network which comprises of set of wireless mobile nodes. These nodes are infrastructure-less as well as devoid of central administration. Important issues in MANET are link failure, power failure of node, limited bandwidth, and limited transmission power. To overcome these problems energy efficient protocol has become a very interesting and important research area. Energy consumption is a vital issue because routing is based on nodes battery lifetime and it's efficiency to maintain the network. So routing decisions must be such that critical nodes does not exhaust and network lifetime and route reliability increases. In this paper, we investigate the different protocols proposed to resolve the issue of energy consumption of routing nodes in MANET. We provide parameterized study of energy efficient protocols. Main aim of the study is to explore the ideas for innovators and researchers to design more energy efficient routing protocols.*

Keywords- AODV, DSR, MANET, OLSR, TORA, Energy efficient protocols, Routing nodes, Network lifetime

I. INTRODUCTION

MANET is an infrastructure-less, dynamic type of automatically configuring network of linked nodes. MANET – Mobile adhoc network configures self-organizing network in which different wireless nodes dynamically communicate with each other without central control. In this type of network there is not any available connection of mobile nodes with the base stations. Only aim is transmission of data for the communication between two parties. All the nodes in MANET behaves as router for packet transmission but separate routers are used in wired networks which transmit packets by maintaining proper routing table. Sender node when sends information to a destination node, a collection of nodes is also employed in between. The information is send out in totally different hop that's why they are conjointly known as multi-hop, wireless distributed network. In MANETS nodes can act both as hosts and routers. Bandwidth and processing power is always a constraint in MANET, Different links have different capacity. The operations performed on MANETs are also in energy constraints and frequent routing updates are also available. The energy efficient routing is the most important criteria for MANETs, since mobile nodes will be powered by batteries with limited capacity. Overall network lifetime is affected by power failure of a mobile node and its ability to forward packets. This paper compares and classifies energy-efficient routing mechanisms proposed for MANETs. A mobile node consumes its battery energy when it actively sends or receives packets and when it stays idle listening to the wireless medium for any possible communication requests from other nodes. Thus, energy-efficient routing protocols minimize either the active communication energy required to transmit and receive data packets or the energy during inactive periods. All these traditional protocols and techniques performed with decreased efficiency that was of no use. Thereafter many proactive, reactive and hybrid protocols were introduced in MANETs . Still energy efficiency was a big problem during the use of proactive, reactive and hybrid protocols so energy economical routing is necessary customary for MANETs[5]. As mobile nodes supercharged by batteries have limited capability in extent, if mobile node in network breakdown it entirely affects the network and also packet forwarding for others is also affected, Ultimately the network period also extends. Various studies classify varied energy-efficient routing mechanisms introduced for wireless infrastructure-less networks. Eventually when mobile node sends or receives packets it consumes its battery power. It also stays idle while listening to the wireless medium for any potential communication requests from completely different nodes. So aim behind designing energy-efficient routing protocols is to minimize either communication energy required to transmit and receive data packets or the energy throughout inactive periods. The main objective of this paper is to analyze the TORA protocol for efficiency in terms of power and suggest ways it could be improved. This will be made by measuring the energy with respect to different network size and taking into consideration the remaining battery power

II. REVIEW OF EXISTING PROTOCOLS

Adhoc routing protocols are categorized into following

- Flat Routing Protocols

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- Proactive Routing Protocols
- Reactive Routing Protocols

- Hybrid Routing Protocols

Numerous protocols have been proposed for Manets. The Initial three protocols discussed here namely AODV, DSR, TORA are from the Reactive family whereas OLSR protocol is selected from the proactive family [3]. Here we give the brief description of each protocol as well as its working. And based on these description we compare their working and ability to deal with different networks in different scenario [12].

2.1 Ad-hoc On Demand Distance Vector (AODV)

AODV protocol falls in the reactive family which finds the path from source to destination only once needed that means the route discovery as well as maintenance is purely based on request of nodes [11]. Destination sequence number is used by AODV to ensure the loop free and fresh route[12]. This protocol can do both unicast and multicast routing. AODV operates in two phases: route discovery and route maintenance[12]. Here when the node wants to communicate with another node it goes for route discovery mechanism[9]. The source node sends RREQ when it wants to build a route to all of it's neighbours. Once these nodes have the information of destination node then it further broadcasts the RREQ to its neighbour until it reaches the destination node[12]. In return the nodes which are aware of destination node information replies back with Route Reply RREP message to the initiator of the RREQ message. Routing Table maintains the path information which is recorded by intermediate nodes in routing table and thus the route is found/identified.[12] Once the sender node receives the route reply message RREP, the route is ready to send the packets and the sender starts sending its packets to the required destination. Route which is erroneous is found out by RRER and is reported when link to the next hop breaks and thus further communication is not possible.

2.2 Dynamic Source Routing (DSR)

The Dynamic Source Routing (DSR) is an efficient routing protocol which is simple and designed specially for use in multi-hop wireless networks comprised of mobile nodes[5]. DSR can manage self organizing and self configuring network without the aid of existing network infrastructure or administration [11]. Network consists of nodes moving in it which are free to move or join or leave the network. When the change in wireless transmission conditions such as sources of interference change, all routing is automatically determined and maintained by the DSR routing protocoll[4]. DSR can deal with dynamically changing topology because the number of intermediate hops or the sequence of nodes changes rapidly if route change occurs. DSR consists of the two main mechanisms of Route Discovery and Route Maintenance, where one is for discovery of route to destination by nodes participating in network and other is to maintain routes to arbitrary destinations in the ad hoc network until communication ends [12].

2.3 Temporally Ordered Routing Algorithm (TORA)

Temporally Ordered Routing Algorithm (TORA) is a highly adaptive, distributed protocol designed to be operated in a network which is dynamic and dense. Also TORA is used for a scalable network which can grow or shrink in size as per the requirements. For reaching a particular destination, TORA make use of arbitrary height parameter, which determines the direction of link between any two nodes[11]. Capability of TORA is to maintain multiple routes from source to destination, but none of the route are necessarily shortest route[5]. LMR is the base of TORA routing protocol. Thus TORA uses similar link reversal and route repair procedure as in LMR and also the creation of a DAGs, which is similar to the query/reply process used in LMR[11]. Thus LMR and TORA has similar benefits. Yet another benefit of TORA is that it prevents the far-reaching control messages to a set of neighbouring nodes, which has undergone topology changes. TORA supports multicasting; however this is not incorporated into its basic operation[6]. TORA can be used along with LAM (Lightweight Adaptive Multicast) to provide multicasting. Only limitation of TORA is that the algorithm may also produce temporary invalid routes which requires maintenance and hence the energy drain[6]. But here multi-routes can be taken as a benefit in TORA as it supports multiple paths from source to destination . Thus, failure or removal of any of the nodes can be quickly resolved without source intervention by switching to an alternate route to improve congestion. Also as it does not require a periodic update, consequently communication overhead and bandwidth utilization and energy drain is supposed to be minimum[14]. It provides the support of link status sensing and neighbour delivery, reliable in-order control packet delivery and security authentication[12].

2.4 Dynamic Sequence Distance Vector (DSDV)

It removed the shortcomings of contemporary distance vector protocol which was not suited for ad-hoc networks. Sequence number is used to avoid loop freeness. Due to avoidance of loop freeness it reacts immediately on topology

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changes which provide the availability of route to destination. In DSR, TORA, AODV routes are not always available to destination. Traffic load and time delay are the two limitations of DSDV as it support to low density network

III. SIMULATION PARAMETERS

The aim of these simulations is to analyze the TORA protocol by comparing it with other protocols (AODV, DSR, and DSDV) for its efficiency in terms of power as well as throughput. This has been made by measuring the energy with respect to different network size and taking into consideration the remaining battery power. The simulation tool that has been used in this study is ns2 [7]. Communication Management Unit's (CMU's) wireless extension to ns2 provides the implementation of the DSR, AODV, DSDV, TORA routing protocols. So ns2 is selected for evaluating these protocols. The performance of the simulated results are analyzed based on different performance metrics. The measurements are quantitative and are useful because it is used as a prerequisite for evaluating the performance of network. This is also used for comparing the performance of different routing protocols[12]. Table below shows the outcomes of different routing protocols while measuring various parameters like throughput, end to end delay and Packet delivery ratio.

TABLE 1.1 Comparison of Routing protocol outcomes

Protocol Route Route	End to End Delay in ms	Throughput in %	PDR(Packet Delivery Ratio)
AODV	16.04	98.34	0.9978
DSDV	13.09	92.67	0.9956
DSR	12.05	93.86	0.9996
TORA	14.08	96.09	0.9945

IV. CONCLUSION & FUTURE WORK

In this paper our objective is to discuss the parameterized study of energy efficient routing protocols in MANET and to highlight the energy constraints for MANET. This paper highlights the benefits and limitation of various routing protocols. Idea here is to go for energy management in MANET by considering various parameters like energy, delay, throughput and data drop ratio[5]. In conclusion we can say that choice of protocol solely depends on the user requirement as well as network structure and application need. This study has evaluated four ad-hoc routing protocols in different network environment taking into consideration node mobility. Overall, the findings show that the energy consumption and throughput in small size networks did not reveal any significant differences. However, for medium and large ad-hoc networks the TORA performance proved to be inefficient in this study. In particular, the performance of AODV, DSDV and DSR in small size networks was comparable. But in medium and large size networks, the AODV and DSR produced good results and the performance of AODV in terms of throughput is good in all the scenarios that have been investigated. In further continuance to this study we can analyze these protocols with varying area and loads and varying pause time and speed to further go into greater depth of the routing protocols.

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