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An Assessment on Energy Efficient Protocols for MANETS

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Abstract: ***A Mobile Ad-hoc Network (MANET) is a wireless network created without any static infrastructure and works in a decentralized fashion. The nodes are independent and communicated with each other by self-organizing among those nodes to provide the global network functionality. It draws more attention in recent years because of enormous applications and its cost-effective implementation. The communication among these nodes entirely depends on the routing path and battery power. Many researches have concentrated only on finding the shortest path and throughput in this area. The energy-efficient routing has a lot of scope and important factor to be considered for routing in MANET's. In this article, the current energy-efficient routing protocols will be extensively reviewed and results tabulated. Finally, the paper proposes open areas in which the performance of the network may be improved by considering energy-efficient networks, achieving stability in the network and finding better routes.***

Keywords: Energy Efficiency, MANET, Routing Protocols, Scalability

I. INTRODUCTION

A Mobile Ad hoc Network also called as MANETs are clusters of wireless devices commonly used in daily life to do day to day activities. This are the devices that interconnect with each other in an infrastructure-less environment. Nodes in the network collaborate with each other in a distributed manner in order to provide the necessary network functionality both locally and globally [1].

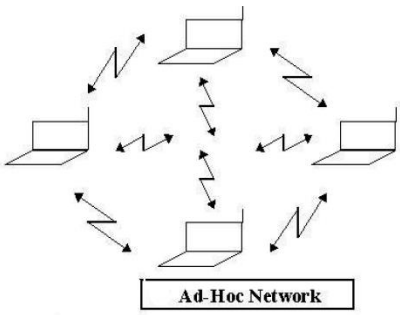

Figure 1: Manets

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The lack of centralized controllers differentiates them from the wired network. MANET nodes should be capable of routing the packets from the sender to the receiver outside the transmission range using rely nodes. Routing of packets is an important consideration in MANET's due to their non-static nature. Since nodes are powered by batteries a lot of energy is consumed during the routing process. Energy preservation is an important key issue in MANET's. A lot of proposals about the energy-efficient protocols have been taken up by the researchers. The protocol should decrease the energy consumption of the battery and increase the overall lifespan of the network. The amount of energy consumption in the nodes can be reduced by minimizing the node traffic forwarding, hence reduce the path utilization. In Ad-Hoc network routing and maintenance of established route is a challenging task. Hence an additional power is required for selection and maintenance of route which reduces the performance of the network [2]. The network lifespan is an important factor to be considered because the decrease in lifespan may cause less throughput and further affect network performance.

The important factors affecting the lifespan of the network are: Number of hop counts, Energy consumptions of the node and Time taken for route establishment. The lifespan of the network may be improved by minimizing the selection of relay nodes, as well as maximizing the energy efficiency among the nodes. In MANET's, if a node intends to transfer data to a non-reachable node that is outside its range, it can forward the packets through its trusted neighboring nodes. This will increase energy efficiency and network lifetime in a dynamic environment.

II. CHARACTERISTICS OF A MANET

Some important features of MANET's are listed below:

- **Wireless:** the communication and connection among the nodes in MANET's is through wireless.
- **Infrastructure less:** A MANETs are framed by a set of nodes organized among themselves randomly which does not have a fixed infrastructure.
- **Dynamic Topologies:** The non-static nature of the MANET nodes makes topological network changes happen very frequently.
- **Routing:** The data transmission among nodes is through the same set of nodes without an access point. Here the nodes act as router.
- **Energy Constraint:** The nodes are operated on low power batteries and Energy conservation is an important constraint in MANET's.

III. APPLICATIONS OF MANETS

MANETs are helpful in many fields like in:

- Military environments they are used for Automation of the battlefield, Special tasks, Soldiers, tanks, facilities.
- In Civilian environments, MANET's are used for disaster Management like floods, fire, earthquakes, Law enforcement during critical situations, and various search and rescue operations.
- MANET's also find their usage during several events organizing like sports and entertainment, Navigation systems used in cars and Bluetooth applications.
- Other applications include Patient monitoring systems, Vehicular communications, Video gaming.

IV. ENERGY-EFFICIENT ROUTING

In Manets, the nodes are mostly operated on batteries, so the network performance may be improved by reducing the energy consumption required for many tasks. The energy efficiency of the network can be defined as the amount of time where the network is active and also maintains a minimum level of performance. Maximize the energy efficiency during routing, not only depends on the energy of the nodes but also on several other factors. The requirement of balanced energy consumption in the network is an important design constraint. Hence routing through more energetic nodes in Ad-Hoc networks balances the energy globally and maintains the efficiency of the network. Energy-saving during the route recovery process when there is a failure of nodes is an important criterion. The broadcasting or multicasting techniques for finding a route suffers from energy saving. Therefore, designing energy-efficient routing protocols with optimum energy consumption is an important research problem. The transmission of power control and uniform load distribution will reduce the consumption of energy and improves the overall network gain**.**

V. ROUTING PROTOCOLS CLASSIFICATION IN MANETS

The Routing Protocols are mainly classified into three types. They are Reactive protocols, Proactive protocols, and Hybrid Protocols.

In Proactive or the table-driven protocols, Information of route establishment is maintained in the data table and requires frequent updations. The table consists of the information like a list of paths to all destinations, its next node, and hop count to reach its destination. Frequently updates to the routing table require, the route request (RREQ) message to be sent from the source to all other nodes. Hence the data table has all the necessary data regarding the available routes in the present network. By the use of information present in the table, the sender sends data to its destination using the pre-established routes which preserve the energy of nodes. Unnecessary routing of control packets results in a reduction of the speed at which data can be transferred and also overloads the network system. Some of the proactive protocols include: Wireless Routing Protocol (WRP), Destination Sequenced Distance Vector (DSDV), Global State Routing (GSR) and Optimal Link State routing (OLSR).

The on-demand routing protocols are also called as **reactive protocols**, in which the paths are not pre-established and are created when sender request for initializing the packet transfer process to the destination. The receiving node has sent back an acknowledgment to the sender. On completion of the process, the link between the sender and the receiver is established and data is exchanged between them. The information about the previously used route is maintained in the routes memory which can be used for the same route connection. The network has smaller overheads due to the non-presence of the routing tables. The route is established only when there is an exchange of information between the sender and the specified receiver node. Hence the name On-demand routing. The Reactive routing protocol consumes less power and also cost is reduced because unrequired routes are eliminated. Some of the reactive protocols are: Dynamic Source Routing (DSR), Ad-hoc On-Demand Distance Vector (AODV), etc.

The highest characteristics of reactive and proactive routing protocols are called **Hybrid protocols**. The necessity of maintaining information regarding each route in the base table is absent like in regardence to link-state algorithms, hence reduction in the traffic overhead. On-demand protocol reduces the delays incurred during the route discovery process. Hybrid protocols use the table-driven approach while routing the packets within the autonomous networks, while protocols use the on-demand routing protocols while routing packets between the Autonomous networks. Some of the hybrid routing protocols available are *Cluster Based Routing Protocol (CBR) and Zone Routing Protocol (ZRP).*

A. Proactive routing protocols:

a) Destination Sequenced Distance Vector (DSDV)

DSDV, is an example of proactive protocol with table driven information. It is an enhancement to the classical Bellman-Ford Algorithm [4]. The node data table include the list of all destinations with sequence number and number of hops. Every time the nodes communicate with the intermediate nodes, messages are forwarded with the sequence number attached to it. If a higher priority node arrives then routing table is updated with new sequence number. The shortest path to the target receiver is computed on the basis of this data. The use of sequence numbering of the nodes eliminates the formation of loops during the routing process which is most prevalent in the Bellman-Ford algorithm. Some of the advantages of this protocol are: loop less transmission, reduction in routing overhead and delay during the communication process.

b) Wireless Routing Protocol (WRP)

WRP is the shortest distance path finding algorithm. To compute the shortest route WRP uses the link size and the previous node in the destination in the optimal path.

Each node has four main tables for the purpose of routing the data. They are: 1. Distance, 2. Routing 3. Link- cost 4. Message Retransmission List (MRL). WRP the neighbors of each node are periodically informed with updated message transmissions. The nodes present in the network frequently update the relay nodes with message transmissions. The nodes in the response state should acknowledge. At a given time interval, the nodes send an idle Hello message in the response state to check for the liveliness of the nodes whenever there are null updates. Depending upon the update message received from a relay, a node decides the best route to be used to reach the destination and updates this information in the table.

c) Global State Routing (GSR)

In the GSR routing protocol, the routing process is carried by every node, having to exchange vectors of link states among their fellow nodes. Node retains a global network topological information based on the link state vectors and optimize their local routing choices. Any Updates in the network topology, every node present in the network propagates the link-state information to all its neighbor nodes. Functionally, GSR performs alike DSDV and it enhances DSDV in the sense that the network does not get flooded.

d) Optimized Link State Routing (OLSR)

OLSR is an IP routing protocol in MANET. This protocol is also supported by other wireless ad-hoc networks. The decentralized system makes it a flat routing protocol. It is used when there are frequent changes in source and destination pairs. OLSR discovers the messages using Hello and Topology Control (TC) messages and distributes the information related to link state to the network. By using the above information, every node using shortest hop forwarding paths to calculates the next-hop destination [5].

B. **Reactive routing protocols:**

a) Dynamic Source Routing (DSR)

The Manet nodes use DSR protocol source routing techniques to dynamically calculate several network hops to the destination. It does not rely on a routing table at each intermediate device. The DSR protocol requires portable nodes to maintain route reserves. Updates to route cache will be done frequently using the routing table information. The packet routing process in DSR happens in two phases: route discovery and route maintenance. Whenever a source node has to share information with the receiver node, it inspects the route memory inspect if the destination is previously known. If a route to the destination is already available in the routing table, the source will move to the ready state to send the packet from source to destination. Otherwise, the source initiates a route request broadcast. Upon receiving the message requesting for the route establishment the nodes check its memory to see if an entry is marked. If an entry is found, then the node forwards the packet, else the source node updates it addresses in the memory. Maintaining of the route cache eliminates the need for the node to contain route data in its routing table.

b) Ad Hoc On-Demand Distance Vector (AODV)

AODV is a simple, efficient routing protocol which is an enhancement of DSR routing protocol [17]. It is a reactive protocol and the path is established on demand. The path information is not present in the DSR protocol. As the network grows, the byte requirement of the data packet increases. This disadvantage of DSR is overcome by using AODV. Whenever the source node has a request to the destination node, the source node will broadcast a route request (RREQ) packet first. The relay nodes transmit the packet to their nearest nodes until the packet reaches the intended receiver node. Along with the transmission of the request packet, the relay node collects the neighbor node's address. The information is updated in the route table which can be used for reverse path creation. The receiving node replies back with route reply (RREP). Duplicate packets are discarded by the relay nodes and RREP is transmitted only if the path is active with the larger sequence number.

C. Hybrid Routing Protocols

a) Zone Routing Protocol (ZRP)

The Zone Routing Protocol (ZRP) [10] uses the best features of proactive and reactive protocols to form a hybrid protocol and finds solutions to various issues present in both protocols. ZRP reduces the traffic path which is concentrated towards nearby nodes to a zone-based. In the zone, maintenance of routing information is modest and this reduces the amount of unused routing information. The farther nodes can be reached through proactive routing. Due to the flat view parameter over the network, the ZRP can be called as flat. Network paths are maintained by means of the local topology information.

b) Zone-Based Hierarchical Link State (ZHLS)

ZHLS is a hierarchical protocol, where the network is sliced into non-overlapping zones. The random movement of nodes is prevalent in the zones. Using the locating assistance of GPS or beacon the nodes find their real addresses. Every node has been informed with connectivity possible within the zone and the zone connectivity of the entire network. Topological information at each level of the zone is spread across the entire network of nodes. The number of nodes present in the zones transmitting area can be controlled by regulating the node's transmission capability.

Table 1: The Parametric Assessment of Manet Routing Protocol

Parameters	Proactive Protocol	Reactive Protocol	Hybrid Protocol
Method of Routing	Table driven	On-demand	Combines both
Traffic Overhead	More	Less	Moderate
Routing Overhead	More	Less	Moderate
Battery capability	More	Medium	Moderate
one-to-one communication	Yes	No	Yes
One-to-many	No	Yes	Yes
Quality of service	Yes	Yes	Yes

VI. LITERATURE SURVEY

The authors M. Bakhouya, J.Gaber b, P.Lorenz have proposed an adaptive information dissemination (AID) algorithm which updates its energy values based on the information received from its neighboring relay nodes without much wasting of energy for more querying [5].

The communication performance was an issue during broadcast operation due to communication overhead. A new Trust Routing Model was developed by Adel et al to reduce the DoS attacks by using Box Plot Theory. The technique has reduced the number of false positives and accurately detected the attacks [6]. But the authors have failed to compare the proposed algorithm with existing models.

Tameem Eissa Shukor et al have proposed A trust-based scheme using friendship mechanism for enhancing security for AODV routing protocol and they have evaluated each and every node based on friend's value [7]. The node trustiness is calculated based on more friend value a node has got. The friendship mechanism cannot be applied in real environment for existing protocols.

Security enhancement for Manets using trust management protocol proposed by Zhexiong Wei, Helen Tang, have considered the direct and indirect observations [8]. By using the Bayesina inference the direct method derives its trust value whereas the indirect method uses the Dempster–Shafer theory (DST), for generating the trust value. The drawback of this methods is delay overhead and uncertainties during the packet transmission like shedding of packets, and duplication.

Shelja Malhotra et al proposes a protocol for analysing the geographical routing protocols where several calculations were made and different characteristics were considered [9]. Limited number of protocols were studied due to which only few parameters were taken into consideration.

The author R Nagadevi et al suggests a Multivariate correlation analysis which identifies several DOS attacks which detects the SYN flooding attacks [10]. A plan detector is used to analyse traffic for new arriving and if the result is above the threshold the traffic is considered to be legal otherwise it is marked as an attack. Even though accurate results were obtained algorithm fails for other types of attacks like Land, Neptune and Teardrop.

Liana Khamis et al propose a procedure for increasing the scalability in Manets using ARANz protocol [11]. This algorithm enhances the security, and solves centralized failure and centralized attacks by using Local Certificate Authority (LCA) servers in which the trust is shared among each. The performance is enhanced through the equal load distribution among the nodes present in the network. Cryptographic certificates guard the Ad-hoc routing protocols against most attacks.

A Survey on Position-Based Routing proposed by Martin Mauve et al discuss about packet forwarding techniques based on locality services and position based [12]. The papers suggest that based on the position based forwarding techniques, several other routing techniques like Home zone and GLS, can be combined with greedy packet forwarding can be designed for Manets.

Akshai Aggarwal et al demonstrate that AODV protocol is prone for Black Hole and Dos attacks and security for such type of attacks is proposed though a trust based framework [13]. The disadvantage of such protocol is additional table maintenance by each node.

Jelly fish attack prevention proposed by Ashish Thomas, Vijay Kr. Sharmaa and Gaurav Singhal believes that due to frequent topology changes, node get congested and to resolve this Links between the node has to be established in secure way [14]. But energy constraint of the nodes and banwidth of the network are issue in this protocol design.

The Author Charusheela M. Pandit, Seema A. Ladhe uses TAC of the rely nodes to announce the degree of trustworthiness. Each node in the network will get the TAC for the path discovery process and node with the highest threshold value is considered for further communication in the network [15]. Issues like maintaince of the transmission history of the packet, key distribution process places an extra load on the node.

VII. COMPARISON OF PROTOCOLS

The different protocols studied above are compared and the advantages and disadvantages are tabulated in Table 2.

Table 2. Different Routing Protocols with Advantages and Drawbacks

Protocols	Advantages	Drawbacks
DSDV (Proactive)	DSDV is one of the initial algorithms to be defined.	More power consumption. Idle network has a lesser bandwidth requirement for updating the routing table. DSDV is not appropriate for bigger and non-static networks
WRP (Proactive)	WRP works similar to DSDV. It has a lesser number of table updates and nodes converge rapidly.	The use of multiple tables requires a bigger cache and large computational power from the nodes. The control overhead is more due to the frequent movement of nodes and also suffers from less scalability.
GSR (Proactive)	The cluster head maintains routing of packets which reduces the information stored in the distance vector table. Bandwidth can be utilized effectively.	The selection of cluster head requires more time and the use of CDMA/TDMA consumes time in acquiring permission for packet transmission. Suffers from frequent link breakages dues to changes in the cluster heads.
OLSR (Proactive)	Fewer number of transmissions	Overlapping multipoint relaying sets.
AODV (Reactive)	Flexible to the changing networks .time required for route establishment is less and reduction in the network overhead.	Frequent updating of the routes required and routes are unpredictable.
DSR (Reactive)	Dynamic route formation and Routing of packets in the network if loop less.	Poor Route preservation between the nodes in the network which causes more delay.
ZRP (Hybrid)	Bandwidth can be conserved because the processing overhead for the routes is reduced	Routing causes more number of zones to be overlapped and maintenance of the zones requires a larger amount of memory.
ZHLS (Hybrid)	No overlapping zones. The topological information of zones present in each level is circulated among the nodes.	Maintenance of the information of zones at every level places extra burden on the network

VIII. CONCLUSION

The extensive survey on the different routing protocols were carried out in detail with reference to MANET's. The survey has listed more open issues for research in the area of energy efficiency, network size, traffic and mobility in the network. The survey of protocols concluded that it is important to design a protocol for the more scalable and stabilized network. The results of the survey proposed to design a new scalable protocol, which defines various models such as (a) traffic prediction (b) mobility prediction (c) stable route maintenance and (d) link stability. In this traffic prediction model, it develops the local traffic model and global traffic model using the priority-based traffic control algorithm

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