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A Survey paper on Comparative Analysis on Routing Protocol for Energy Efficiency in MANET

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Abstract: Mobile Adhoc Network (MANET) is characterized by mobile hosts, dynamic topology, multi-hop wireless connectivity and infrastructure less ad hoc environment. The adhoc environment is accessible to both legitimate network users and malicious attackers. Moreover, as the wireless links are highly errors prone and can go down frequently due to mobility of nodes, therefore, energy efficient, secure and stable routing over MANET is still a very critical task due to highly dynamic environment. Moreover, the nodes in MANETs are typically powered by batteries which have limited energy reservoir and some times it also becomes very difficult to recharge or replace the battery of the nodes. Hence, power consumption becomes an important issue. The power consumption rate of each node must be evenly distributed to maximize the lifetime of ad hoc mobile networks, and the overall transmission power for each connection request must be minimized. In this paper, we compare a two types of Mobile ad-hoc network i.e., proactive and reactive for Energy Efficiency in Manet. Energy Efficient is basically termed as which consume a less energy. So, this paper gives comparison about various routing protocols related to Energy Efficiency.

Keywords: MANET, PROACTIVE, REACTIVE, Network

I. INTRODUCTION

Mobile ad hoc Network (MANET) is a special type of wireless network in which a collection of mobile network interfaces may form a temporary network without the aid of any established infrastructure or centralized administration. Wireless ad hoc networks usually consist of mobile battery operated computing devices that communicate over the wireless medium. These protocols try to satisfy various properties, like: distributed implementation, efficient utilization of bandwidth and battery capacity, optimization of metrics, fast route convergence and freedom from loops.

II. WHAT IS MANET?

MANET is self-organizing, rapidly deployable, and requires no fixed infrastructure. An Adhoc wireless network is a collection of mobile devices equipped with interfaces and networking capability. It is adaptive in nature and is self organizing. A formed network can be de-formed and again formed on the fly and this can be done without the help of system administration. Each node may be capable of acting as a router. Applications include but are not limited to virtual classrooms, military communications, emergency search and rescue operations, data acquisition in hostile environments, communications set up in exhibitions, conferences and meetings, in battle field among soldiers to coordinate defence or attack, at airport terminals for workers to share files etc. Mobile Ad-hoc Network usually has a dynamic shape and a limited bandwidth. Routing is one of the key issues in MANETs due to their highly dynamic and distributed nature; the use of mobile networks is growing very fast. The performance of a mobile ad-hoc network depends on the routing scheme employed, and the traditional routing protocols do not work efficiently in a MANET. Developing routing protocols for MANETs has been an extensive research area in recent years, and many proactive, reactive and hybrid protocols have been proposed from a variety of perspectives.

III. PROTOCOL CLASSIFICATION IN MANET

Routing protocols of MANETs can be divided into different types depending on the different criteria. Generally, these protocols are categorized into three types, Proactive, Reactive and Hybrid Routing Protocols [1]. Following fig. Shows the various MANET routing protoc

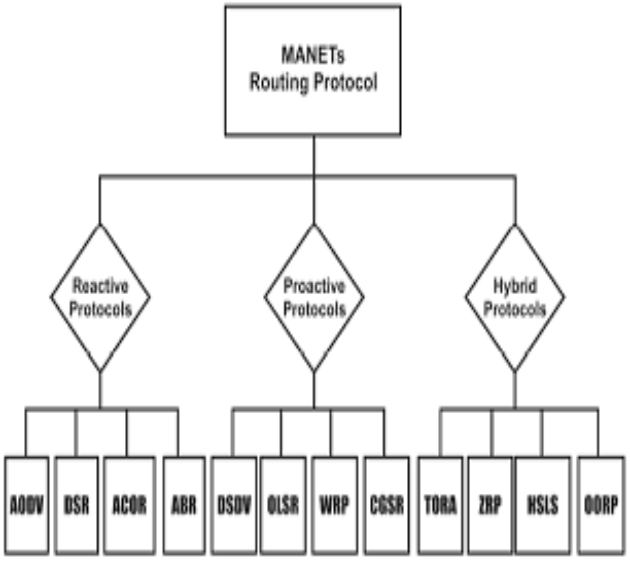

Figure.1: MANET Routing Protocols

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A. Proactive Protocols:

Proactive protocols are generally called as table driven protocols in which, the route to all the nodes is maintained in routing table. Packets are transferred over the predefined route specified in the routing table. In this scheme, the packet forwarding is done faster but the routing overhead is greater because all the routes have to be defined before transferring the packets. Proactive protocols have lower latency because all the routes are maintained at all the times. Again, these types of routing protocols are divided into two types, link state and distance vector routing protocols. In link state routing protocols every node continuously observe the network topology, stores the cost of each outgoing link and send this information periodically to all participating nodes. This process is known as flooding. In distance vector proactive routing protocols, each node maintain tabular history of every other node in the network, next node to reach the destination, the total number of nodes to reach the destination and this tabular information is sent to all neighbouring nodes in the network. Here, we discuss the DSDV, OLSR, WRP, CHGSR proactive routing protocols. Table 1 gives comparison of characteristics of proactive protocols[2].

a. Destination Sequenced Distance Vector:

DSDV is based on the distributed version of Bellman Ford algorithm [2]. The information concerning to all participants of the network is stored in tabular form by each node. Each entity is stored as a unique sequence digit. The destination node assigns this unique sequence digit. These entries contain information of next hop as well as all the hops to the destination. The latest sequence number is always preferred to use, which helps to keep away from impaired routes. The route having least amount of hops is used in the case of two similar sequence numbers. Hence the shortest route is always selected for communication. DSDV lies under minimum-weight route category. Fig.2 shows the working of DSDV routing protocol.

b. Wireless Routing Protocol:

Wireless routing protocol also belongs to minimum-weight path category and its beautification is that it gets rid off looping problems. For this purpose it uses the information of distance and secondly considers the last hop for each destination in the network. The shortest path is selected again by counting the number of hops. The shortcoming of this protocol is that every node needs to store information in four tables, which become overloaded in the case of large network. Another disadvantage is, its use of more bandwidth while transmitting HELLO message again and again, in case of no successful transmission in recent past [2].

c. Cluster Head Gateway Switching Routing Protocol(CHGSRP):

This protocol is basically an extended version of DSDV routing protocol and has almost same routing overhead as that of DSDV. All nodes of the network are divided into clusters and one node is chosen as cluster head after an election process. The key factor of election of cluster head is based on the stability. In CHGSR, Least Cluster Change (LLC) algorithm is preferred over other clustering algorithms. LLC uses the information of nodes movement and cluster head will be changed if a node goes out of the range of all cluster heads.

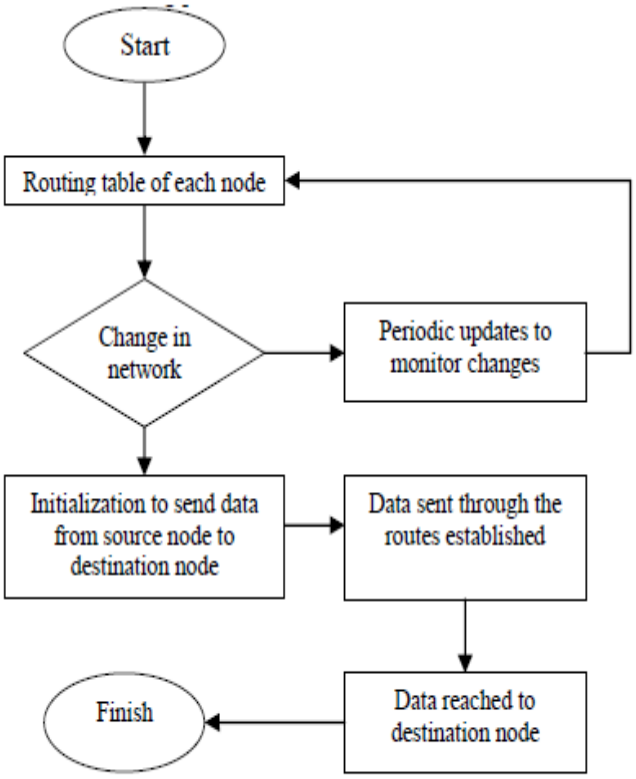

Fig.2 Destination Sequenced Distance Vector Routing Protocol.

d. Optimized Link-State Routing (OLSR):

The Optimized Link State Routing (OLSR) protocol is an optimization of the classical link state algorithm, adapted to the requirements of a MANET. Because of their quick convergence, link state algorithms are somewhat less prone to routing loops than distance vector algorithms, but they require more CPU power and memory. They can be more expensive to implement and support and are generally more scalable. OLSR operates in a hierarchical way (minimizing the organization and supporting high traffic rates). The key concept used in OLSR is that of multipoint relays (MPRs).

MPRs are selected nodes which forward broadcast messages during the flooding process. This technique substantially reduces the message overhead as compared to a classical flooding mechanism (where every node retransmits each message received). This way a mobile host can reduce battery consumption. In OLSR, link state information is generated only by nodes elected as MPRs. An MPR node may choose to report only links between itself and its MPR selectors. Hence, contrarily to the classical link state algorithm, partial link state information is distributed in the network. This information is then used for route calculation. OLSR provides optimal routes. The protocol is particularly suitable for large and dense networks as the technique of MPRs works well in this context.

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e. Comparison between characterstics of Proactive Protocls:

Table 1 Characteristics of Proactive Protocols

Parameters	DS-DV	WRP	CGSR	ST-AR	OLSR
Routing composition method	Flat	Flat	Hierarchical	Hierarchical	Flat
Tables Requirement	2	4	2	1 & 5 lists	3
Updating	Periodical	Periodical	Periodical	Conditional *	Periodical
Loop Freedom	Yes	Yes	Yes	Yes	Yes
Multicast Capability	No	No	No	No	No
Need of beaconing	Yes	Yes	No	No	Yes
Critical Nodes	No	No	Yes (CH)	No	No
Routing metric	Smallest	Smallest	Smallest	Smallest	Smallest

IV. REACTIVE PROTOCOLS

These types of protocols are also called as On Demand Routing Protocols where the routes are not predefined for routing. A Source node calls for the route discovery phase to determine a new route whenever a transmission is needed. This route discovery mechanism is based on flooding algorithm which employs on the technique that a node just broadcasts the packet to all of its neighbors and intermediate nodes just forward that packet to their neighbors. This is a repetitive technique until it reaches the destination. Reactive techniques have smaller routing overheads but higher latency.
Example Protocols: DSR, AODV etc.

A. Ad Hoc On-demand Distance Vector Routing (AODV) Protocol:

The Ad Hoc On-demand Distance Vector Routing (AODV) protocol is a reactive unicast routing protocol for mobile ad hoc networks [2]. As a reactive routing protocol, AODV only needs to maintain the routing information about the active paths. In AODV, the routing information is maintained in the routing tables at all the nodes. Every mobile node keeps a next hop routing table, which contains the destinations to which it currently has a route. A routing table entry expires if it has not been used or reactivated for a pre-specified expiration time. In AODV, when a source node wants to send packets to the destination but no route is available, it initiates a route discovery operation. In the route discovery operation, the source node broadcasts route request (RREQ) packets which includes Destination Sequence Number. When the destination or a node that has a route to the destination receives the RREQ, it checks the destination sequence numbers it currently knows and the one specified in the RREQ. To guarantee the freshness of the routing information, a route reply (RREP) packet is created and forwarded back to the source only if the destination sequence number is equal to or greater than the one specified in RREQ. AODV uses only symmetric links and a RREP follows the reverse path of the respective RREQ. Upon receiving the RREP packet, each intermediate node along the route updates its next-hop table entries with respect to the destination node. The redundant RREP packets or RREP packets with lower destination sequence number will be dropped.

B. Dynamic Source Routing Protocol (DSR):

DSR is unicast routing protocol and belongs to the category of reactive protocols. Two main procedures are involved in this routing; route discovery and maintenance. To find a route, it uses cache technology to preserve the information of all nodes routes . Entries of cache are continuously revised whenever a fresh route is detected. When data is desired to be send to destination, cache is consulted [2] and data is sent to destination if path is available. Route request packets are broadcasted if no path is available. When Route Request packet is received, the node verify its own cache and if no path is available, it forwards the request to neighboring nodes and data transmission is started when a route information is available by neighboring or intermediate nodes. At this stage a Route_Reply is sent back with the information of all nodes traversed. A Route_Error message is sent back for maintenance purpose whenever link disengagement is detected. In comparison of its counterparts like AODV, LMR, TORA, it is best for small or moderately large networks where the number of nodes is several hundreds. An added advantage is that it does not require periodic beaconing and hence uses less power. The disadvantage of DSR is its usage of more bandwidth with the increase of network size. Weight Based Dynamic Source Routing (WBDSR) is improved version of conventional DSR.

V. HYBRID PROTOCOL

A. Temporarily Ordered Routing Algorithm Protocol:

TORA also maintains a DAG by means of an ordered quintuple with the following information:

a. t time of a link failure
b. o id originator id
c. r reflection bit indicates 0=original level 1=reflected level
d. d integer to order nodes relative to reference level
e. i the nodes id

The triplet (t,oid,r) is called the reference level. And the tuple (d,i) is said to be an offset within that reference level. The heights of the nodes for a given destination to each other determine the direction of the edges of the directed acyclic graph. The DAG is destination oriented (routed at the destination) when the quintuples which represent the heights are maintained in lexicographical order, the destination having the smallest height, traffic always flowing downstream. Heights are however not needed for route discovery; instead a

mechanism as in LMR is used. Also nodes which do not currently need to maintain a route for themselves or for others won't change a height value. Each node has a Route required flag for that purpose, additionally the time since the last UPD (update) packet was sent is recorded. Each node maintains a neigbour table containing the height of the neighbour nodes. Initially the height of all the nodes is NULL. (This is not zero "0" but NULL "-") so their quintuple is (-,-,-,-,i). The height of a destination neighbour is (0,0,0,0,dest). E.g. Zone Routing Protocol (ZRP): The Zone Routing Protocol (ZRP) is either a proactive or reactive protocol. It is a hybrid routing protocol. It combines the advantages from proactive (for example AODV) and reactive routing (OLSR). It takes the advantage of pro-active discovery within a node's local neighbourhood (Intrazone Routing Protocol (IARP)), and using a reactive protocol for communication between these neighbourhoods (Interzone Routing Protocol (IERP)). The Broadcast Resolution Protocol (BRP) is responsible for the forwarding of a route request. ZRP divides its network in different zones. That's the nodes local neighbourhood. Each node may be within multiple overlapping zones, and each zone may be of a different size. The size of a zone is not determined by geographical measurement. It is given by a radius of length, where the number of hops is the perimeter of the zone. Each node has its own zone.

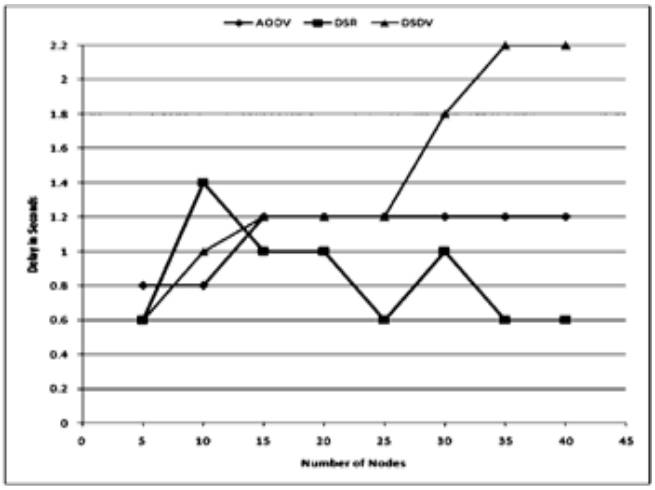
VI. ENERGY EFFICIENCY

For a wireless networks, the devices operating on battery try to pursue the energy efficiency heuristically by reducing the energy they consumed, while maintaining acceptable performance of certain tasks. Using the power consumption is not only a single criterion for deciding energy efficiency. Actually, energy efficiency can be measured by the duration of the time over which the network can maintain a certain performance level, which is usually called as the network lifetime. Hence routing to maximize the lifetime of the network is different from minimum energy routing. Minimum energy routes sometimes attract more flows, and the nodes in these routes exhaust their energy very soon; hence the whole network cannot perform any task due to the failure on these nodes. In other words, the energy consumed is balanced consumed among nodes in the networks. Routing with maximum lifetime balances all the routes and nodes globally so that the network maintains certain performance level for a longer time. Hence, energy efficiency is not only measured by the power consumption but in more general it can be measured by the duration of time over which the network can maintain a certain performance level. It goes without saying that node failure is very possible in the wireless network. Hence saving energy when broadcasting in order to recover from the node failure or to re-routing around the failed nodes is essential. By the same token, multicast has the same challenge to achieve the energy efficiency. For unicast, it is highly related to the node and link status, which require a wise way to do routing as well. Sometimes, shortest path routing is possibly not the best choice from the energy efficiency point of view. Following graph shows the Number of nodes vs. delay speed in AODV, DSR, DSDV routing protocol[1].

VII. COMPARISON OF PROACTIVE AND REACTIVE ROUTING

A. Protocols:

Routes to destination nodes are always available in Proactive or table driven routing protocols whereas routes are available on demand in Reactive protocols. Most of the Proactive protocols require periodic updates and a few needs conditional updates as STAR needs. The advantage of this protocol is low Connection setup delay and the disadvantage is more number of control overheads due to many route reply messages for single route request.



VIII.COMPARISON BETWEEN DSDV AND OLSR

Table2.Diffence between DSDV and OLSR

Parameter	DSDV	OLSR
Algorithms used	Distance vector	Link state
Unidirectional link Support	No	Yes
QoS Support	No	Yes
Multicasting	No	Yes
Frequency of updates	Periodic and as Required	Periodic
Characteristic feature	Loop free	Reduces control overhead using MPR

In table 2, we compare the DSDV and OLSR routing protocol on the basis of various parameters like algorithms used, unidirectional link support, QoS support, Multicasting, Frequency of updates, and characteristic feature**.**

IX. COMPARISON OF AODV AND DSR

DSR has access to significantly greater amount of routing information than AODV by virtue of source routing and promiscuous listening.

DSR replies to all requests reaching destination from a single request cycle where as AODV only replies once thereby learning only one route.

In DSR no particular mechanism to delete stale routes unlike AODV.

In AODV the route deletion causes all the nodes using that link to delete it, but in DSR only the nodes on that particular part are deleted.

X. COMPARISON OF MAIN ROUTING PROTOCOLS ON THE BASIS OF ROUTE TYPE, ROUTE SELECTION, ROUTE MAINTENANCE AND DISCOVERY

Table 3. Comparison of DSR,ABR,SSA,AODV, LAR

Protocol	Route	Route Selection Criteria	Beacon	Maintenance	Route discovery
DSR	Multiple	Shortest path	No	Global, notify source	Global
ABR	Single	Link Stability	Yes	Local, bypass broken link	Global
SSA	Single	Signal Strength	Yes	Global, notify source	Global
AODV	Single	Shortest path	Yes	Global, notify source	Global
LAR	Multiple	Shortest path	No	Global, notify source	Localized

Table 3 shows the comparison of different routing protocols in Manet. Here we discuss the DSR, ABR, SSA, AODV, LAR routing protocols on the basis of on the basis of route type, route selection, route maintenance and discovery.

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