Routing Protocol in Mobile Ad-Hoc Network: A Review

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Abstract- **MANETs can manage dynamic infrastructure and can stay active rapid changes in the network topology. The one of the key challenges in deploying Mobile Ad-hoc Networks is routing with scalable and robustness. The objective of this paper is to create of the different mobile ad-hoc routing protocols, and to survey and compare representative examples for every classification of protocols.**

In this paper we compared three types of routing protocols i.e. proactive, reactive and hybrid. In order to operate the Ad-hoc Networks as efficiently as possible, appropriate on-demand routing protocols have to be incorporated, to find best effective routes between source to destination. In this paper we provide an overview of a wide range of the existing routing protocols with focused on their characteristics and functionality. This paper focus on the survey of reactive (on-demand), proactive (table-driven) and hybrid routing protocols like AODV, DSDV and ZRP. Further this paper will help the researchers to get an overview of the existing protocols and suggest which protocols may perform better with respect to varying network scenarios.

Keywords- **MANETs, Routing Protocol, Proactive and Reactive Protocol**

I. INTRODUCTION

Wireless network has become more popular in the computing industry [14][1]. Wireless network are adapted to enable mobility. There are two categories of mobile network . The first is infra-structured network (i.e. a network with fixed and wired gateways) [24]. A mobile unit within the network connects to and communicates with the nearest base station (i.e. within the communication radius). Application of this network includes office WLAN. The another type of network is infrastructure less mobile network commonly known as Ad-hoc network. They have no fixed routers.

All nodes are capable of freely moving and be connected in an arbitrary manner. These nodes works as routers, which find and maintain routes to other nodes in the network. Ad-hoc networks can be used in those areas where less communication infrastructure is or the existing infrastructure is expensive or inconvenient to use.

Mobile Ad-hoc Networks (MANETs) are self organizing multi-hop wireless networks, where all the mobile nodes take part in the process of communication or the process of forwarding the data packets. MANETs are highly applicable in several areas such as, emergency deployments and networking etc. Routing is the core problem in networks for delivering the data from one node to another node. To overcome this problem there is a challenging task to develop an efficient routing algorithm in MANET. Several routing protocols have been planned to achieve a given level of routing operation for MANET. Routing is used to discover and preserve the routes between the source and destination nodes.

All nodes can be mobile, and also the topology changes frequently. Therefore Routing protocols are play an important role in Ad-hoc Network communications. The routing protocols are divided into several categories. The setup or deployment of these networks is very simple because these networks are infrastructure less or don't have a fixed topology also they have a very less set up time. The routers are free to move randomly.

The rest of the paper is organized as follows: Section II provides an overview of related work Section III presents classification of various routing protocols and present the detailed analysis of all the three categories of ad hoc routing protocols and Section IV presents the Comparison of reactive and proactive routing protocol. Finally V concludes the paper.

II. RELATED WORK

For the advancement of routing protocols in Ad-hoc network, an enormous number of current works and efforts are on the go. These routing protocols are grounded on the application needs and the structure of the network. However, there are some issues that must be taken into different consideration while mounting the routing protocols for Ad-hoc networks. There are numerous surveys and journals on different routing protocol in ad-hoc networks and an effort is presented below to discuss the dissimilarities between them.

In[9] Layuan et.al. AODV, DSR, TORA and DSDV are compared in terms of performance matrices such that end-to-end delay, jitter, packet loss ratio ,throughput, normalized routing load, scalability and connectivity by increasing the network size ,which providing a table with a ranking based on the protocols' performance.

In [3] Das et.al. .have compared two on-demand routing protocols, DSR and AODV. In future, they have studied more routing protocols such as DSDV, TORA based upon three key performances: fraction of packet delivery, end to end delay and routing overhead.

In [22]Samara et.al., AODV, DSDV and OLSR are compared using three real-life scenarios in terms of delay, packet delivery ratio, average delay, throughput and total energy consumption. The packet size, the number of packets ,the nodes' speed, the transmission interval, the mobility models, the number of receivers and transmitters, and the Direct Sequence Spread Spectrum rate are varied among the scenarios, and the most appropriate routing protocol in each scenario is suggested.

In [2] Broach et. al. have evaluated four routing protocols; DSDV, DSR, AODV and TORA, by measuring the reliability of each protocol and routing overhead.

In [6]Camp et.al. have compared the two location routing protocols; LAR and DREAM with DSR. This comparison was based upon packet delivery, end to end delay and routing overhead.

In [7 Sesay et.al. compared DSDV, DSR, AODV and TORA with respect to end to end throughput, delay, control overhead and route acquisition time.

In [12] Rehman A. et al. gave the comparison of reactive and proactive routing protocols AODV, DSDV and I-DSDV (Improvement of DSDV). They compared in terms of packet delivery ratio, end to end delay and routing overhead in different environments such as, varying the no. of nodes, speed and pause time. The results indicate the performance of I-DSDV is better than DSDV, especially when the no. of nodes in the network is higher.

In [5] Aaron A. et al. Presented the comparison of two routing protocols like DSDV and DSR that is based upon node density. DSR performs better than DSDV for high node density in the network. It is due to the more overhead incurred by DSDV during exchanging the routing tables.

In [8] Broustis A. et al. compared DSR, AODV, TORA and LAR in large density wireless networks and evaluated after simulations these protocols based upon packet delivery fraction, end to end delay in large-scale MANETs.

III. CLASSIFICATION OF ROUTING PROTOCOL

The Routing Protocols for ad hoc wireless networks are ordered into three categories based on the routing information update mechanism. They can be Reactive (On-demand), Proactive (Table-driven) or Hybrid [14] . Figure 1 shows the three categories of Ad- hoc routing protocol and various proposed Protocols under each category [14,15]..

A. Proactive Protocols

In Proactive, each node maintains a routing table where data packets are broadcasted periodically within the network. In this routes from source to destination are computed at a regular time before establishing the route from source to destination. When a source node wants to transmit the data from source to Destination, it searches the routing table to find a destination node match. The

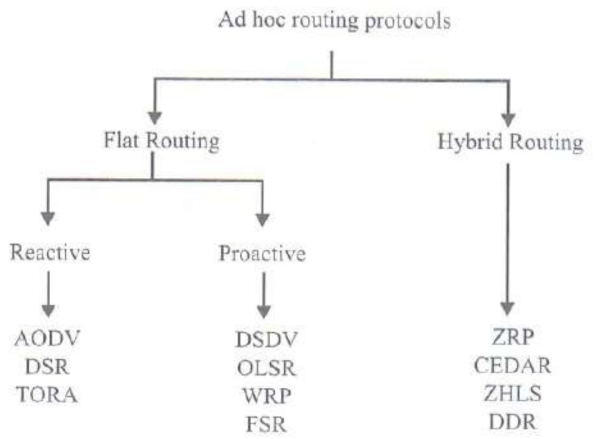

table-driven Ad-Hoc routing approach is similar to the connectionless approach of forwarding packets, without considering to when and how frequently such routes are desired. These protocols always maintain up-to-date information of routes from every node to each other node in the network.

These protocols continuously maintain the topology of the network by exchanging topological information among the different network nodes. Thus, whenever is needed for a route to a destination, such route information is available immediately. Different protocols keep track of different routing state information [17]. These protocols require every node to maintain one or more routing tables to store up to date routing information and to propagate updates throughout the whole network.

These protocols try and maintain valid routes to communicate all mobile nodes all the time, which means before a route is actually needed [10]. Periodic route updates are exchanged in order to synchronize the tables. Optimized Link State Protocol (OLSR), Wireless Routing Protocol (WRP), Destination Sequenced Distance Vector (DSDV), is the examples of proactive protocols. These protocols differ in the number of routing related tables and how changes are broadcasted in the network structure.

1) Destination Sequenced Distance Vector (DSDV):

Perkins and Bhagwat proposed DSDV. The Destination-Sequenced Distance-Vector (DSDV) Routing protocol is used the concept of the Bellman-Ford Routing Algorithm with certain improvements such as making it loop-free. The distance vector routing is less robust as compared to the link state routing due to problems such as count to infinity and bouncing effect. In this routing protocol each device maintains a routing table which contains entries for all the devices in the network.

In order to keep the all routing table completely updated at all the time each device periodically broadcasts routing message to its neighbour devices. When a neighbour device receives the broadcasted routing message and knows the current link cost to the device, it compares this link cost value and the corresponding value which stored in its routing table. If some changes were found, it updates the value and again computes the distance of the route which includes this link in the routing table. Every node of the network maintains a routing table in which all the possible combinations of destinations, number of routing hops are recorded.

Thus routing information is already available, except of whether the source node requires a route or not. In DSDV, updated routing tables are sent periodically throughout the wireless network to maintain the consistency. Due to this a lot of control traffic in the network generate, that is the disadvantage of this protocol [1], [2], [5], [7], [13].

2) Optimized Link State Protocol (OLSR):

Optimized Link State Protocol is proposed by Clausen and Jacquet. It is a point-to-point proactive protocol that works an efficient link state packet forwarding mechanism called multipoint relaying [12]. OLSR optimizes the pure link state routing protocol. Optimization is done in two ways: by reducing the number of links used for forwarding the link state packets and by reducing the size of the control packets. Here each node maintains the topology information about the network by periodically exchanging the link-state messages among the all other nodes. OLSR is based on the following three mechanisms: efficient flooding ,neighbor sensing and computation of an optimal route using the shortest-path algorithm.

Neighbor sensing is to identifies the changes in the neighborhood of node. Each node determine an optimal route to every known destination node using this topology information and stores this information in a routing table The shortest path algorithm is applied for computing the optimal path. Routes to every destination are immediately available when data transmission begins and it remain valid for a specific period of time till the information is expired. OLSR protocol is an optimization protocol for MANET of legacy link-state protocols. The key point of the optimization is the multipoint relay (MPR). Every node identifies (among its neighbors) its Multipoint relay. By flooding a message to its multipoint relays, node is guaranteed that the message, when retransmitted by the MPRs, will be received by all its two-hop neighbors. Furthermore, when exchanging the link-state routing information, a node lists only the connections to those neighbors that have selected it as MPR that is its Multipoint Relay Selector set. The protocol selects bi-directional links for routing, over unidirectional links [14].

3) Wireless Routing Protocol (WRP):

The Wireless Routing Protocol is proposed by Murthy and Garcia-Luna-Aceves It is a table-driven protocol similar to DSDV [18]. The main goal is maintaining routing information among all nodes in the network regarding the shortest distance to every destination. Wireless routing protocols is a loop free routing protocol. WRP is a path-finding algorithm with the exception of avoiding the count-to-infinity problem by forcing each node to perform consistency checks of predecessor information reported by all its neighbors. Each node in the network uses a set of four tables to maintain more accurate information: Distance table (DT), Routing table (RT), Link-cost table (LCT), Message retransmission list (MRL) table. In case of link failure between two nodes, the nodes send update messages to their neighbors. WRP belongs to path-finding algorithms with an important exception. It counters the count-to-infinity problem by forcing each node to perform consistency checks of predecessor information reported by all its neighbors. This eliminates looping situations and enables faster route convergence when a link failure occurs. WRP is one of the loop-free proactive protocol where four tables are used to maintain distance, link cost, routes and message retransmission information. Loop avoidance is mainly based on providing for the shortest path to each destination both distance and the second-to-last hop (predecessor) information. Despite the variance in the number of routing tables used, and the difference in routing information maintained in these tables, table driven routing protocols like DSDV, CGSR and WRP are all distance vector shortest-path based.

TABLE-1
shows the summary of the comparison of some existing proactive routing protocols.

Parameters	DSDV	OLSR	WRP
Route updates	Periodic	Periodic	Periodic
Throughput	Low	High	Low
Routing tables	2	4	4
Routing overhead	High	Low	High
Loop free	Yes	Yes	Yes

B. Reactive Protocols

In Reactive (On-demand) protocol, the routes are discovered only whenever the source needs to transmit the data, so the control packets overhead will be reduced. The reactive or on-demand routing protocols are mainly based on Query-Reply topology in which they do not attempt to regularly maintain the up-to-date topology of the network. When a route is desired, a procedure is called to find a route to the destination node. The main goal of reactive routing protocols is to minimize the network traffic overhead. Rather, when the need arises, a reactive protocol invokes a procedure to find a effective route to the destination; such a procedure involves some sort of flooding the network with the route query. The common element in on -demand protocols is the mechanism used for discovering routes. The source node sends a request message to all the intermediate node, requesting a route to the destination node. This message is flooded, that is relayed by all nodes in the network, until message reaches the destination. The path followed by the every request message is recorded in the message, and returned to the sender by the destination node , or by intermediate nodes with sufficient routing information, in a reply message. Thus multiple reply messages give result, one of the multiple paths is chosen of which the shortest is to be used. Route discovery is the key mechanisms used in on-demand routing protocols.

The drawback of Table-Driven needs upheld the routing table information for network normally. Temporally-Ordered Routing Algorithm (TORA), Location-Aided Routing Protocol (LAR) ,Dynamic Source Routing Protocol (DSR), Ad-Hoc On-Demand Distance-Vector Routing Protocol (AODV), etc. are the examples of reactive protocols.

1) Ad -hoc On-Demand Distance Vector Routing Protocol (AODV):

AODV is a most accepted reactive routing protocol in ad hoc networks proposed by C. E. Perkins and E. M. Royer [18]. Ad hoc On-demand Distance Vector (AODV) is a combined form of both DSR and DSDV. It is pure on - demand reactive Routing Protocol is an extension of DSDV in the direction of on-demand behavior. The key feature of this is that applying a distributed routing scheme. In AODV, route discovery packets are initiated and broadcasted only when a source desires to contact a focused destination for which it does not have a valid route. Furthermore, changes in network topology must be sent only those nodes that will need this information.

To initiate the route discovery, the source floods the network with an RREQ (route request) packet to the destination node for which the route is requested. After the receiving the RREQ, it checks to see whether it is destination or whether it has a route to the destination. If yes, the node generates the RREP (Route Reply) packet to the source node in the reverse path, otherwise packet will be discarded. When a node detects the broken line, it generates the RRER (Route Request Error) packets and initiates the new route discovery process. Thus AODV dynamically establishes the route in the network [2, 3, 7, 8].

It follows the basic on-demand mechanism of Route finding and Route Maintenance from DSR, plus the use of hop-by-hop routing, sequence numbers, and periodic changes from DSDV. AODV uses destination sequence numbers to ensure loop freedom at all times and by ignoring the Bellman-Ford "count-to infinity problem" offers quick convergence when the ad hoc network topology changes. AODV finds routes only when required and hence it is on demand in nature. The major vulnerabilities present in AODV protocols are: Deceptive decrease of hop count and Deceptive increase of sequence number.

2) Dynamic Source Routing Protocol (DSR):

Dynamic Source Routing is reactive routing protocol designed by D. B. Johnson, Maltz and Broch to restrict the bandwidth consumed by all control packets in ad hoc wireless networks by removing the periodic table update messages required in the proactive routing protocols. The different feature of Dynamic Source Routing (DSR) [11] is the use of source routing. DSR doesn't use periodic updates because it is on -demand routing protocol. It computes the routes when necessary and then maintains them. Source routing is a technique in which the sender of a packet determines the complete sequence of nodes from where the packet has to pass, the sender explicitly lists this route in the packet's header ,identifying each forwarding node "hop" by the address of the next node to which to transmit the packet on its way to the destination host. There are two main parts of DSR protocol: route finding and route maintenance. Every node maintains a cache to store recently searched paths. When a node wants to send a packet, it first checks the its cache whether there is an entry for that. If it have entry then it uses that path to transmit the packet. Also it attaches its source address on the packet. If there is no entry found in the cache or the entry is expired, the sender broadcasts a route request packet to all its neighbor node asking for a path to the destination. Until the route is discovered, the sender host have to wait.

When the route request packet arrives to any other nodes, they check whether they know the destination asked. If they have route information, they send back a route reply packet to the destination. Otherwise they broadcast the same route request packet. Once the route is searched, the sender will send its required packets using the discovered route as well as insert an entry in the cache for future use. Also the node keeps the age information of the entry to recognize whether the cache is fresh or not. When any intermediate node receives a data packet, it first sees whether the packet is sent to itself or not. If it is the destination, it receives that else it forwards the packet using the path attached on the packet. This protocol makes the routing overhead traffic scales to the actual needed size automatically, which is the main advantages of DSR. On the other hand this employs the source routing, so that each data packet contains the full path it should traverse to its destination. Sometimes source routing becomes the disadvantage of DSR.[14].

3) Temporally-Ordered Routing Algorithm (TORA) :

The Temporally-Ordered Routing Algorithm (TORA) [9] was developed by Park and Corson [18]. Temporarily ordered Routing algorithm (TORA) is loop-free, highly adaptive, distributed routing algorithm based on the concept of link reversal. TORA uses directed acyclic graphs (DAG) to find the routes either as upstream or downstream. This graph enables TORA to provide better route aid for networks with large, dense population of nodes. However to provide this feature TORA needs that to synchronize the different nodes. Which limits the application of the protocol? TORA is a fairly complicated protocol but what makes it prominent and unique is its main feature of propagation of control messages only when around the point of failure and when a link failure occurs. In comparison, all the other routing protocols need to re-initiate a route discovery when a link is fail but TORA would be able to patch up itself around the point of failure. This feature allows TORA to scale up to wider networks but it has higher overhead for smaller networks. TORA involves four major functions: route creating, route maintaining, route erasing and optimizing. Since each node must have a height, any node which does not have a height that node is considered as an erased node and its height is considered as null. Sometimes the nodes are give with new heights to improve the structure of linking . This function is known as optimization of routes

TABLE-2
shows the summary of the comparison of some existing reactive routing protocols.

Parameters	AODV	DSR	TORA
Route creation	By source	By source	Locally
Periodic update	No	No	No
Performances metrics	Speed	Shortness	Speed
Routing overhead	High	High	High
Throughput	High	Low	Low
Multipath	No	yes	yes

C. Hybrid Routing Protocols

In addition to table driven and on-demand protocols, another class of unicast routing protocols that can be identified is that of hybrid protocols. These protocols try to incorporate all the aspects of proactive and reactive routing protocols in combined form. Hybrid protocol are generally used to provide hierarchical routing; routing in general can be either flat or hierarchical. The main difficulty of all hybrid routing protocols is that how to organized the network according to network parameters. The main disadvantage of hybrid routing protocols is that the nodes that have high level topological information maintains more routing information, which leads to more memory and power consumption. Some examples of Hybrid Routing Protocols include CEDAR, ZRP and SRP [21].

I) Zone Routing Protocol(ZRP):

Haas and Pearlman proposed Zone Routing Protocol. ZRP is a hybrid routing protocol for mobile ad- hoc networks which localized the nodes into sub-networks (zones). ZRP incorporates the merits of reactive and proactive routing protocols. Within every zone, table driven routing is adapted to speed up communication among neighbors. The inter-zone communication uses reactive routing to reduce unnecessary communication. The network is divided into different routing zones based on distances between mobile nodes. Given d is a hop distance and a node N, all nodes within hop distance at most d from N which belong to the routing zone of N. Peripheral nodes of N are N's neighboring nodes in its routing zone which are exactly d hops away from N. The main issue of zone routing is to determine the size of the zone. An enhanced zone routing protocol is Independent Zone Routing (IZR), which allows adaptive and distributed reconfiguration of the optimized size of zone, is introduced in [21]. Furthermore, the adaptive nature of the Independent Zone Routing improves the scalability of the ad hoc network. Each node periodically needs to update the routing information inside the zone. Additionally, some local route optimization is performed at every node, which includes the following actions: removal of redundant routes, shortening of routes, detecting of link failures.

IV. COMPARISON OF REACTIVE AND PROACTIVE ROUTING PROTOCOLS

In terms of performance metrics comparisons between the two routing protocols are:

- Throughput: proactive protocols perform better then reactive protocol;
- End to end delay: table driven protocols perform well than reactive protocols;
- Routing load: reactive protocols perform better than proactive protocols.

The various routing protocols of Ad-Hoc Networks are studied based upon network simulations. Consequently, in proactive the route is previously identified, but the control packets overhead are very large containing with high bandwidth. Reactive (on-demand) protocols incur less routing overheads as compared to table driven routing protocols. However, high route discovery latency together with frequent route discovery attempt in dynamic networks can affect the performance adversely. Reactive routing protocols have very high response time as the route is needed to discover on demand. These are bandwidth proficient protocols.

Reactive protocols minimize the control overhead and power consumption since routes are only established whenever needed. But in proactive protocols require periodic updates of routes to keep information consistent and current; in addition, maintain multiple routes that might never be needed, by adding unnecessary routing overhead. Proactive routing protocols provides well quality of service than reactive protocols. As routing information is constantly updated in the proactive protocols, routes to every destination are always up-to-date and available so end- to- end delay can be minimized. In on-demand protocols, the source node has to be wait for the route to be searched before communication can happen. Latency in route discovery might be intolerable for real-time communications.

While it is not clear that which protocol or class of protocol is the best for all scenarios, each protocol has some advantages and disadvantages and has certain conditions for which it is best suited. The field of ad-hoc mobile networks is rapidly challenging and growing, and while there are still many challenges that need to be met.

TABLE-3

shows the summary of the comparison of proactive & reactive routing protocols in terms of different characteristics and performance metrics.

Parameters	Proactive Routing Protocols	Reactive Routing Protocols
Route Availability	Always available	Available as per need
Throughput	High	Low as compared to proactive
Delay	Low	High
Routing Information	Stored in table	Doesn't stored
Control Traffic	High	Low
Routing Load	High	Low
Scalability	Less	more
Periodic Route Updates	Always required	Not required
Storage Requirements	Higher	Depend on the no of routes needed

V. CONCLUSION AND FUTURE SCOPE

MANETs change the dynamic topology where mobile nodes may connect and leave the network at any time. Routing protocols contribute a vital job in Ad-Hoc communication. Ad -hoc networking is at the centre of the evolution towards the 4th generation wireless technology. At last we have provided the characteristic features of some basic routing protocols and which described that which protocols may perform best in large networks . Mobile ad hoc networks have posed a great challenge for the researchers due to changing different topology and security attacks, and none of the protocols is fully secured and research is going on around the globe.

In this paper we have compared the proactive and reactive routing protocol on there their characteristic feature. But our aim is to find the best routing protocols in terms of different performances metrics by using different simulation.

In future, the performances evaluation of reactive proactive and hybrid protocols like AODV, OLSR and ZRP under different types of attacks can be evaluated by using different type of parameters and using different security technique is developed to prevent routing protocols from different attacks

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