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REVIEW ON ROUTING PROTOCOLS FOR MOBILE AD HOC NETWORKS

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Abstract - A Mobile Ad hoc network (MANET) is a collection of mobile nodes that is connected through a wireless medium forming a dynamic network. An Ad hoc network doesn't have any centralized arbitrator or server. In ad hoc networks nodes move arbitrarily and network may experience rapid and unpredictable topology changes. Because nodes in MANET normally have limited transmission ranges, some nodes cannot communicate directly with each other. Hence routing paths in mobile ad hoc networks potentially contains multiple hops and every node in a network has the responsibility to act as a router. In this paper we provide an overview of routing protocols by presenting their characteristics and functionality and also provide a comparison between protocols to analyze performance.

Key words: MANET, Proactive and Reactive routing protocols

I. INTRODUCTION

A mobile ad hoc network (MANET) is a self configuring dynamic network comprising of mobile nodes, where each and every Participation node voluntarily transmit the packets destined to some remote node using wireless transmission. An ad hoc network doesn't have any centralized arbitrator or server. In MANET each and every mobile node is assumed to be moving with more or less relative speed in arbitrary direction. Because of that there is no long term guaranteed path from any one node to other node. Every node in the MANET can assist in routing of packets in the network. MANET posses certain characteristics like Bandwidth-Constrained, Variable capacity links, Energy constrained operation, Limited physical security, dynamic network topology, Frequent routing updates. MANET very have enterprising use in emergency scenarios like military operations and disaster relief operation where there is a need of communication network immediately following some major event or some temporary requirement like conference and seminar at a new place without the existence of network infrastructure.

The rest of the paper is organized as follows:

Section II presents a Routing in MANET. Section III presents a Classification of various routing protocols. Section IV, V, VI presents the detailed analysis of all the three categories ad hoc routing protocols. Finally Section VII concludes the paper.

II. ROUTING IN MANET

"Routing is the process of information exchange from one host to the other host in a network."[1]. Routing is the mechanism of forwarding packets towards its destination using most efficient path. Efficiency of the path is measured in various metrics like Number of hops, traffic, security, etc., In Ad hoc network each host act as specialized router itself . A mobile Ad hoc network or spontaneous network is an infra structure less, self organized and multi hop network with rapidly changing topology causing wireless links to be broken and re-established. A key issue is the necessity of the routing protocols must be able to respond rapidly to the topological changes in the network. In these networks, each node must be capable of acting as a router. As a result of limited bandwidth of nodes, the source and the destination have to communicate via intermediate nodes [2]. Major problems in routing are Asymmetric links, Routing Over head, Interference and dynamic topology.

Routing in MANET has been an active area of research and number of routing protocols has been introduced for addressing the problems of routing. In Section III classifies the routing protocols for MANET. Section IV, V, VI presents the detailed analysis of routing protocols in MANET.

III. CLASSIFICATION OF ROUTING PROTOCOLS

The routing protocols for ad hoc wireless networks can be divided into three categories based on the routing information update mechanism namely Pro active (Table driven), Re active (on demand), Hybrid routing.

PROACTIVE ROUTING PROTOCOLS:

Proactive protocols continuously learn the topology of the network by exchanging topological information among the network nodes. Thus when there is a need for a route to a destination such route information is available immediately. If the network topology changes too frequently, the cost of maintaining the network might be very high. If the network activity is low, the information about actual is not used.

REACTIVE ROUTING PROTOCOLS:

The reactive routing protocols are based on some sort of query-reply dialog. Reactive protocols proceed for establishing routes to the destination only when the need arises. They do not need periodic transmission of topological information of the network.

HYBRID ROUTING PROTOCOLS:

The hybrid routing protocols are based on the combination of proactive and reactive routing protocols. There exists a number of routing protocols of globally reactive and locally proactive states.

IV. PROACTIVE PROTOCOLS

The proactive protocols always maintain up-to-date information about the routes from each node to every other node in the network. The proactive protocols continuously learn the topology of the network by exchanging topological information among the network nodes. Thus when there is a need for a route to a destination, such route information is available immediately [3]. These protocols require each node to maintain one or more tables to store up to date routing information and to propagate updates throughout the network. These protocols are often referred to as Table-driven routing protocols. These protocols maintain all valid routes to all communication mobile nodes at all the time, which means before a route is needed. Periodic route updates are exchanged in order to synchronize the tables. Some examples of table driven routing protocols includes: Dynamic Destination Sequenced Distance-vector Routing Protocol (DSDV), Optimized Link State Routing Protocol (OLSR), Wireless Routing Protocol (WRP).

DYNAMIC DESTINATION SEQUENCED DISTANCE-VECTOR ROUTING PROTOCOL (DSDV):

DSDV [4] is developed on the basis of Bellman-Ford routing algorithm [5] with some modifications. In this routing protocol each mobile node in the network keeps a routing table. Each of the routing table contains the list of all available destinations and the number of hops to each. Each table entry is tagged with a sequence number, which is originated by the destination node. Periodic transmission of updates of the routing table helps maintaining the topology information about the network. If there is a change in the routing information, the updates are transmitted immediately. So, the routing information updates might be periodic or event-Driven. DSDV protocol requires each mobile node in the network to advertise its own routing table to its current neighbors. The advertisement is done either by broadcasting or multicasting. By the advertisements neighboring nodes can know about any change that has occurred in the network due to movement of nodes. The routing updates may be sent in two ways: Full Dump: The entire routing table is sent to the neighbors. Incremental Dump: Only the entries that require changes are sent.

WIRELESS ROUTING PROTOCOL (WRP):

WRP [6] is a table based protocol is similar to DSDV that inherits the properties of Bellman Ford algorithm. The main goal is to maintain the routing information among all the nodes in the network

regarding the shortest distance to every destination. WRP belongs to general class of path finding algorithms defined as the set of distributed shortest path algorithms. It calculates the path using information regarding the length and second-hop the shortest path to each destination. WRP reduces the temporary routing loop which occurs. Each node in the network maintains a set of four tables to provide accurate information: Distance Table (DT), Routing Table (RT), Link-cost table (LCT), Message Retransmission list (MRL). WRP uses periodic update message transmission to the neighbors of a node. The nodes in the response list of update message should send acknowledgements. If there is no change in the last update the nodes in the response list should send a Hello Messages to ensure connectivity. A node can decide to update routing table after receiving an update message from a neighbor and always look for better path using new information. If node gets better path, it relays back that information to the original nodes. So it can update their tables. After receiving the acknowledgement, original node update their MRL. Thus each time the consistency of the routing information is checked and it eliminates looping and enable faster route Convergence when a link failure occurs.

CLUSTER GATEWAY SWITCH ROUTING PROTOCOL (CGSR)

CGSR [7] consider a clustered mobile wireless network is a hierarchical instead of flat network. For structuring the network into separate interrelated groups, cluster heads are elected using a cluster head selection algorithm. By forming several clusters this protocol achieves a distributed processing mechanism in the network. One disadvantage of using this protocol is that, frequent change or selection of cluster head might be resource hungry and it may affect the routing performance. CGSR uses DSDV as a underlying scheme. It modifies DSDV by using hierarchical Cluster head Gateway routing approach to route traffic from source to destination. A packet sent by a node is first sent to the cluster head and then it sends to gateway to another cluster head and so on until it reaches from cluster head to the destination. The following table shows a comparison of proactive protocols.

Table: I Comparison of Proactive Protocols

Parameters	**DSDV**	**CGSR**	**WRP**
Loop free	Yes	Yes	Yes
Required routing table	Two	Two	Four
Critical nodes	No	Yes	No
Utilizes Hello Messages	Yes	No	Yes
Routing Philosophy	Flat	Hierarchical	Flat

V. REACTIVE PROTOCOLS

The reactive or on demand routing protocols are based on Query-Reply. In this topology need not to maintain up-to-date of the network. When a route is desired, a procedure is invoked to find a route to a destination. The major goal of this protocol is to minimize the network traffic overhead. When a need arises, a reactive protocol invokes a procedure to find a route to the destination such procedure involves flooding the network with the route query. In reactive the mechanism for discovering routes. The source node emits a request message requesting route to a destination. The message is flooded and sent to all the nodes in the network until it reaches the destination. The path followed by the request message is recorded in the message and returned to the sender by the destination or intermediate nodes as reply messages. When multiple reply messages result it gets multiple paths from that can choose shortest path. Some examples of On-Demand Routing Protocols include: Dynamic Source Routing (DSR), Ad hoc On-Demand Distance Vector Routing (AODV), and Temporarily Ordered Routing Algorithm (TORA).

DYNAMIC SOURCE ROUTING:

DSR [8] allows nodes in the MANET to dynamically discover a route across multiple network hops to any destination. DSR is a reactive protocol i.e. it doesn't use periodic updates. It computes the route when necessary and maintains them. In this protocol

mobile nodes are required to maintain a route caches. Route cache is updated when any new route is known for a entry in the route cache. Routing in DSR is done in two phases: Route Discovery and Route Maintenance. When source node wants to send a packet to the destination, it first checks in route cache if already there is an entry then source uses that and it sends packet to the destination. If the entry is not in route cache it first broadcast a route request message to all the nodes in the network. The Route Request includes destination address, source address and unique identification number. If the intermediate nodes don't know about the destination it again forwards the packet and finally it reaches the destination. A route reply is generated by the destination or intermediate when it knows about how to reach the destination.

AD-HOC ON-DEMAND DISTANCE VECTOR ROUTING:

AODV [9] is basically an improvement of DSDV. But AODV is a reactive routing protocol instead of proactive. It minimizes the number of broadcasts by creating routes based on demand. When any source node wants to send a packet to a destination, it broadcasts a RREQ packet. The neighboring nodes in turn broadcast to their neighbors and the process continues until it reaches the destination. During the process of forwarding the RREQ, intermediate nodes records the address of the neighbor from which packets received while broadcasting. This route information is stored in route tables, which helps for establishing Reverse Path. If additional copies of same RREQ are received later it simply discards it. Then reply is sent using Reverse Path. For Route Maintenance, when a source node moves, it can re-initiate a route discovery process. If any intermediate node moves with in a particular route, the neighbor of the drifted node can detect the link failure and sends a link failure notification to its upstream neighbor. This process continues until the failure notification reaches the source node. After receiving the failure notification source again re-initiate a discovery phase.

TEMPORARILY ORDERED ROUTING ALGORITHM

TORA [10] is a reactive routing protocol. In this a link between nodes is established creating a Directed Acyclic Graph (DAG) of the route from source to destination. This protocol uses a "link reversal" for route discovery. A route discovery query is broadcasted to the entire network until it reaches the destination or a node that has information about the destination. Main feature of this protocol is propagation of control messages only around the point of failure or link failure occurs. In comparison, all other protocols need to re-initiate a route discovery when a link fails but TORA would be able to patch itself around the point of failure. TORA involves four major functions: Creating, maintaining, erasing and optimizing routes. Since every node must have a height, any node which doesn't have a height is considered as a erased node. Sometimes the nodes are given new heights to improve the linking structure. This function is called optimization of routes.

Table: II Comparisons of Reactive Protocols

Parameters	**AODV**	**DSR**	**TORA**
Route creation	By source	By source	Locally
Routes maintained in	Route Table	Route Cache	Route Table
Route Reconfiguration Methodology	Erase route, notify source	Erase route, notify source	Link reversal, Route repair
Routing Philosophy	Flat	Flat	Flat
Multiple Route possibilities	No	Yes	Yes

VI. HYBRID ROUTING PROTOCOLS

This protocol is a combination of proactive and reactive routing protocols. It is used to provide hierarchical routing. The common disadvantage of hybrid routing protocol is that the nodes that have high level topological information maintains more routing information, which leads to more memory and power consumption. Hybrid protocol includes: Zone Routing Protocol (ZRP), Core Extraction Distributed Ad hoc Routing (CEDAR).

ZONE ROUTING PROTOCOL (ZRP):

ZRP [11] is a hybrid routing protocol for MANET which localizes the nodes into sub-networks (Zones). With each zone, proactive routing is adapted to speed up communication among neighbors. The inter-zone communication uses on-demand routing to reduce unnecessary communication. The network is divided into zones according to distance between nodes. Given a hop distance d and a node N, all nodes with in a hop distance at most d from N belongs to the routing zone of N. The issue of zone routing is to determine the size of the zone. Every node periodically needs to update the routing information inside the zone. Some local route optimization is performed at each node, which includes the following actions: removal of redundant routes, shortening of routes, detecting of link failures.

CORE EXTRACTION DISTRIBUTED AD HOC ROUTING (CEDAR):

CEDAR is a partitioning protocol, integrates routing with QoS support. Each partition includes a core node called dominator node. A dominator set (DS) of a graph is defined as a set of nodes in the graph such that every node is either present in DS. The core node uses a reactive source routing protocol to outline a source from destination. It has three phases:

1. Establishment and maintenance of self organizing routing infrastructure to perform route computations.
2. Propagation of link-states of high-bandwidth and stable links in the core.
3. A QoS route computation algorithm that is executed at the core nodes using only local available states.

Table III: Comparison between three categories of Routing Protocols

Parameters	**Proactive**	**Reactive**	**Hybrid**
Route Availability	Always	Only when needed	Depends on location of destination
Routing Philosophy	Flat	Flat	Hierarchial
Scalability	100 nodes	>100 nodes	1000 nodes

VII.CONCLUSION

This paper presents a number of routing protocols for MANET, which are broadly classified as proactive, reactive and hybrid. Proactive routing protocols tend to provide lower latency than that of On-demand protocols, because they try to maintain routes to all the nodes in the network all the time. Each routing protocol has unique features. On the other hand, reactive protocols discover routes only when they are needed, and still generate amount of traffic when network changes frequently. Depending on the network traffic and number of flows, the routing protocol is chosen.There is congestion in the network because of traffic reactive protocol is preferable. For example: AODV, DSR, and OLSR these protocols are suitable for smaller networks. TORA, ZRP are suitable for larger networks. When network is static, proactive routing protocol can be used. Mobility of nodes in the network increases, reactive protocols performs better. Often it is more appropriate to apply a hybrid protocol rather than proactive or reactive as hybrid protocols often posses the advantages of both types of protocols.

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