A Study on Characteristics of MANET Routing Protocols

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***Abstract*—** This A mobile ad-hoc network (MANET) is a infrastructure less dynamic network comprising of mobile nodes moving in omni directional. 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. A mobile node can act both as a mobile node and router. Because of that there is no long term guaranteed path from any one node to other node. MANET have very enterprising use in emergency scenarios like military operations & disaster relief operation where there is need of communication network immediately following some major event, or some temporary requirement like conference & seminar at new place where there is no earlier network infrastructure exist and need alternative solution. This paper studies the characteristics, applications, different routing protocols used in MANET and their performance behaviour**.**

***Keywords*— Mobile Ad-hoc Network, routing.**

I. INTRODUCTION

An ad-hoc network is a collection of wireless mobile hosts forming a temporary network without the aid of any stand-alone infrastructure or centralized administration. Mobile Ad-hoc networks are self-organizing and self-configuring multihop wireless networks where, the structure of the network changes dynamically. The nodes in the network not only act as hosts but also as routers that route data to/from other nodes in network [1]. Ad hoc networking allows the devices to maintain connections to the network as well as easily adding and removing devices to and from the network. Due to the mobility nature of MANET, the network topology may change rapidly and unpredictably over time. Message routing is a problem in a decentralize environment where the topology fluctuates. While the shortest path from a source to a destination based on a given cost function in a static network is usually the optimal route, this concept is difficult to extend in MANET. The routing concept basically involves, determining optimal routing paths and transferring the information groups through an internetwork. Mobile Ad hoc networks do not have trusted entities such as routers, so every node in the network actively participates in the routing function. Therefore, routing protocols need to be specifically designed for MANET. Routing is the most fundamental research issue in MANET and must deal with limitations such as high power consumption, low bandwidth, high error rates and unpredictable movements of nodes.

A. Characteristics of MANET

1) *Dynamic topologies:* Nodes are free to move arbitrarily; thus, the network topology--which is typically multihop--may change randomly and rapidly at unpredictable times, and may consist of both bidirectional and unidirectional links.[2]
2) *Bandwidth-constrained, variable capacity links:* Wireless links will continue to have significantly lower capacity than their hardwired counterparts. In addition, the realized throughput of wireless communications--after accounting for the effects of multiple access, fading, noise, and interference conditions, etc.--is often much less than a radio's maximum transmission rate.
3) *Energy-constrained operation:* Some or all of the nodes in a MANET may rely on batteries or other exhaustible means for their energy. For these nodes, the most important system design criteria for optimization may be energy conservation.
4) *Limited physical security:* Mobile wireless networks are generally more prone to physical security threats than are fixed- cable nets. The increased possibility of eavesdropping, spoofing, and denial-of-service attacks should be carefully considered.
5) *Multi hop routing:* When a node tries to send information to other nodes which is out of its communication range, the packet should be forwarded via one or more intermediate nodes.

B. Challenges in MANET

1) *Limited bandwidth:* Wireless link continue to have significantly lower capacity than infrastructure based networks. In addition, the realized throughput of wireless communication after accounting for the effect of multiple access, fading, noise, and interference conditions, etc., is often much less than a radio's maximum transmission rate.
2) *Dynamic topology:* Dynamic topology membership may disturb the trust relationship among nodes. The trust may also be disturbed if some nodes are detected as compromised.
3) *Routing Overhead*: In wireless ad-hoc networks, nodes often change their location within network. So, some stale routes are generated in the routing table which leads to unnecessary routing overhead.

4) *Hidden terminal problem:* The hidden terminal problem refers to the collision of packets at a receiving node due to the simultaneous transmission of those nodes that are not within the direct transmission range of the sender, but are within the transmission range of the receiver.
5) *Packet losses due to transmission errors:* Ad hoc wireless networks experiences a much higher packet loss due to factors such as increased collisions due to the presence of hidden terminals, presence of interference, uni-directional links, frequent path breaks due to mobility of nodes.[3]
6) *Mobility-induced route changes:* The network topology in an ad hoc wireless network is highly dynamic due to the movement of nodes; hence an on-going session suffers frequent path breaks. This situation often leads to frequent route changes.
7) *Battery constraints:* Devices used in these networks have restrictions on the power source in order to maintain portability, size and weight of the device.
8) *Security threats:* The wireless mobile ad hoc nature of MANETs brings new security challenges to the network design. As the wireless medium is vulnerable to eavesdropping and ad hoc network functionality is established through node cooperation, mobile ad hoc networks are intrinsically exposed to numerous security attacks

II. ROUTING IN MANET

Routing is the most fundamental research issue in MANET and must deal with limitations such as high power consumption, low bandwidth, high error rates and unpredictable movements of nodes. The following is the problems with routing in MANET: [4]

1) *Asymmetric links:* Fixed networks rely on the symmetric links which are always fixed. But in ad-hoc networks the nodes are mobile and constantly changing their position within network.
2) *Routing Overhead:* because the node in ad hoc networks often change their location within network. So, some stale routes are generated in the routing table which leads to unnecessary routing overhead.
3) *Interference:* in mobile ad hoc networks links come and go depending on the transmission characteristics, one transmission might and can corrupt the total transmission.
4) *Dynamic Topology:* The mobile node might move or medium characteristics might change. In ad-hoc networks, routing tables must somehow reflect these changes in topology and routing algorithms have to be adapted.

III. CLASSIFICATION OF ROUTING PROTOCOLS IN MANET

Routing Protocols in MANET can be classified into three broad classes

i. Proactive or table driven routing protocols
ii. Reactive or on demand routing protocols
iii. Hybrid routing protocols

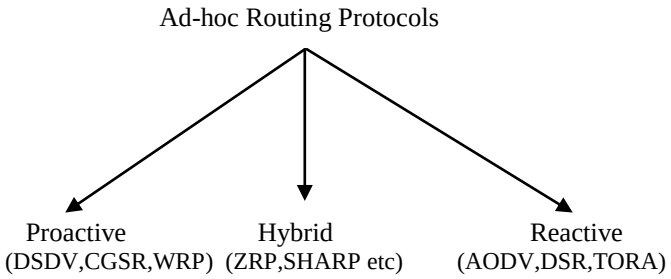

Fig 1. Classification of Mobile ad-hoc routing protocols

A. *Proactive or table driven routing protocols*

These protocols are also called as proactive protocols since they maintain the routing information even before it is needed. Each and every node in the network maintains routing information to every other node in the network. Routes information is generally kept in the routing tables and is periodically updated as the network topology changes.

1) *Destination-sequenced distance-vector (DSDV):* Destination-Sequenced Distance Vector (DSDV) is a traditional table-driven protocol for MANET [5]. In DSDV routes are established based on constant control traffic and they are available all the time. Each node maintains one or more tables that contain route information to other nodes in the network. Nodes continuously update the tables to provide fresh view of whole network. Updates are so frequent that the advertisement must be made regularly enough to make sure that every node can almost always find every other node in the network.

2) *Wireless routing protocol (WRP):* Wireless routing protocols (WRP) [6] 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.

3) Cluster Gateway Switch Routing Protocol (CGSR): CGSR [7] considers a clustered mobile wireless network instead of a flat network. For structuring the network into separate but interrelated groups, cluster heads are selected using a cluster head selection algorithm. By forming several clusters, this protocol achieves a distributed processing mechanism in the network. However, one drawback of this protocol is that, frequent change or selection of cluster heads might be resource hungry and it might affect the routing performance. CGSR uses DSDV protocol as the underlying routing scheme and, hence, it has the same overhead as DSDV. However, it modifies DSDV by using a hierarchical cluster-head-to- gateway routing approach to route traffic from source

to destination. Gateway nodes are nodes that are within the communication ranges of two or more cluster heads. A pack et sent by a node is first sent to its cluster head, and then the packet is sent from the cluster head to a gateway to another cluster head, and so on until the cluster head of the destination node is reached. The packet is then transmitted to the destination from its own cluster head.

B. *Reactive Routing Protocols*

Reactive routing protocol is also known as on demand routing protocol. In this protocol route is discovered whenever it is needed Nodes initiate route discovery on demand basis. Source node sees its route cache for the available route from source to destination if the route is not available then it initiates route discovery process. The on-demand routing protocols have two major components [8]:

Route discovery: In this phase source node initiates route discovery on demand basis. Source nodes consults its route cache for the available route from source to destination otherwise if the route is not present it initiates route discovery. The source node, in the packet, includes the destination address of the node as well address of the intermediate nodes to the destination.

Route maintenance: Due to dynamic topology of the network cases of the route failure between the nodes arises due to link breakage etc, so route maintenance is done.

1) *Dynamic source routing (DSR):* DSR is a reactive routing protocol [5]. Thus, routes get created only when they are needed and there is no periodic routing traffic for creating or maintaining routes. DSR also makes use of source routing. In source routing, when a node originates a data packet it puts in the header of the packet all the hops that the packet needs to traverse to get to the destination. DSR has two main components: route discovery and route maintenance. When a node needs a new route to a destination it initiates the route discovery process by sending a route request message. The route request is broadcast by the originator and contains the address of the originator and the destination. The route request also has a unique identity associated with it. When a node receives the route request, it checks the unique identity to determine whether it has seen this request before. If it has not seen the request before, it appends its address in the route request message and then broadcasts the message to its neighbors. If the node has seen this request before, it just ignores it. Once the destination receives the route request message, it sends back a route reply message that contains the route information accumulated in the route request message.

2) *Ad Hoc On - Demand Distance Vector Routing (AODV):* 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, which is not the case for DSDV. When any source node wants to send a packet to a destination, it broadcasts a route request (RREQ) packet. The neighboring nodes in turn broadcast the packet to their neighbors and the process continues until the packet reaches the destination. During the process of forwarding the route request, intermediate nodes record the address of the neighbor from which the first copy of the broadcast packet is received. This record is stored in their route tables, which helps for establishing a reverse path. If additional copies of the same RREQ are later received, these packets are discarded. The reply is sent using the reverse path. For route maintenance, when a source node moves, it can reinitiate a route discovery process. If any intermediate node moves within 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. Based on the received information, the source might decide to re – initiate the route discovery phase [10]

3) Temporarily Ordered Routing Algorithm (TORA): TORA is a reactive routing protocol with some proactive enhancements where a link between nodes is established creating a Directed Acyclic Graph (DAG) of the route from the source node to the destination. This protocol uses a link reversal model in route discovery. A route discovery query is broadcasted and propagated throughout the network until it reaches the destination or a node that has information about how to reach the destination. TORA defines a parameter, termed height. Height is a measure of the distance of the responding node's distance upto the required destination node. In the route discovery phase, this parameter is returned to the querying node.

C. *Hybrid routing protocols*

Hybrid routing protocols aggregates a set of nodes into zones in the network topology [9][10]. In each zone the proactive approach is used to maintain routing information. To route packets between different zones, the reactive approach is used. Consequently, in hybrid schemes, a route to a destination that is in the same zone is established without delay, while a route discovery and a route maintenance procedure is required for destinations that are in other zones.

1) *Zone Routing Protocol (ZRP):* ZRP is suitable for wide variety of MANETs, especially for the networks with large span and diverse mobility patterns. In this protocol, each node proactively maintains routes within a local region, which is termed as routing zone. Route creation is done using a query – reply mechanism. For creating different zones in the network, a node first has to know who its neighbors are. A neighbor is defined as a node with whom direct communication can be established, and that is, within one hop transmission range of a node. Neighbor discovery information is used as a basis for Intra - zone Routing Protocol (IARP). Rather than blind broadcasting, ZRP uses a query control mechanism to reduce route query traffic by directing query messages outward from the query source and

away from covered routing zones. A covered node is a node which belongs to the routing zone of a node that has received a route query. During the forwarding of the query packet, a node identifies whether it is coming from its neighbor or not. If yes, then it marks all of its known neighboring nodes in its same zone as covered [2]. The query is thus relayed till it reaches the destination. The destination in turn sends back a reply message via the reverse path and creates the route.

2) Sharp Hybrid Adaptive Routing Protocol (SHARP): SHARP adapts between reactive and proactive routing by dynamically varying the amount of routing information shared proactively. This protocol defines the proactive zones around some nodes. The number of nodes in a particular proactive zone is determined by the node -specific zone radius. All nodes within the zone radius of a particular node become the member of that particular proactive zone for that node. If for a given destination a node is not present within a particular proactive zone, reactive routing mechanism (query - reply)is used to establish the route to that node. Proactive routing mechanism is used within the proactive zone. Nodes within the proactive zone maintain routes proactively only with respect to the central node. In this protocol, proactive zones are created automatically if some destinations are frequently addressed or sought within the network. The proactive zones act as collectors of packets, which forward the packets efficiently to the destination, once the packets reach any node at the zone vicinity [2] comparison of routing protocols

TABLE I
COMPARISON OF MANET ROUTING PROTOCOLS CLASSES

Parameters	Proactive protocols	Reactive protocols	Hybrid protocols
Route computation	Prior to the route request the route is available and updated periodically	Route is computed only when the request is generated	Uses both proactive and reactive route computation.
Routing overhead	Low. Because the routes are already computed to all nodes	Medium. Because it uses route request and route reply	High. Because inter zone protocols use reactive mechanism
Scalability	Not suitable for larger networks	Low	Suitable for larger networks
Communication method	Broadcast	Broadcast	Broadcast
Throughput	Increased	Stable	Variable

IV. CONCLUSIONS

MANET is suited for the situations where infrastructure is either not available of not able to quickly deployed. MANET has to deal with efficiently with the factors like battery consumption, network bandwidth, high error rate, route failure and mobility of a node to route a packet across the network to the destination node. The routing protocol plays a major role in determining the optimal path between the source node and the destination node and transmitting the data between them with consideration of the above factors. This paper compares the different routing protocols classes of routing methods used and their differences.

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