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A Survey on Routing Protocols in MANET

Anju Minocha[1], Preeti Bajaj[2] and Nitin Verma[3]

[1]M.C.A, DCSA M.D.U, Rohtak, Haryana (India)
anju.minocha17@gmail.com

[2]M.C.A, P.D.M College of Engineering, Bahadurgarh, Haryana (India)
preeti.pdm@gmail.com

[3]M.Tech Scholar, D.A.V College Jalandhar, Punjab (India)
rudrapartapverma@yahoo.com

Abstract

Mobile means moving and ad hoc means temporary without any fixed infrastructure so mobile ad hoc networks are a kind of temporary networks in which nodes are moving without any fixed infrastructure or centralized administration. MANETs are generating lots of interest due to their dynamic topology and decentralized administration. 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. 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 concentrates on routing techniques which is the most challenging issue due to the dynamic topology of ad hoc networks.

Keywords: *MANET, ZRP, AODV, DSDV, DSR.*

I. Introduction

Mobile ad hoc networks (MANETs) are becoming more essential to wireless communications due to growing popularity of mobile devices. Their ability to be self-configured and form a mobile mesh network using wireless links, makes them suitable for a number of cases that other type of networks cannot fulfill the necessary requirements. MANETs offer the freedom to use mobile devices and move independently of the location of base stations (and outside their coverage) with the help of other network devices. The lack of predefined infrastructure makes them suitable for emergence conditions like for example after physical disasters. Also, the widespread of mobile devices that are equipped with Wi-Fi interfaces opens new research areas that study the IEEE 802.11 performance over these networks. The integration of mobile ad hoc devices inside vehicles has led to another type of networks, called Vehicular Ad hoc Networks (VANETs). In this type of network, the end points are mainly vehicles that communicate among each other and sometimes with static devices/stations. Up to now, the main use of VANETs, is to transmit road and traffic information, but they can also be used for any application that utilize wireless ad hoc connections. The topology of these networks can be considered as extremely dynamic due to the fact that the nodes are constantly moving. That means that a connection between two nodes may be interrupted several times during the transmission period. The reestablishment of a new connection requires the discovery of any available path from the source to destination node [1].

Figure 1: Mobile Ad hoc Network [2]

The routing protocols that have been developed for Mobile Ad hoc Networks are directly affecting data transmission, the performance of network applications and the end user experience. Each protocol has its own routing strategy that is used in order to discover a routing path between two ends. The performance varies, depending on network conditions like the density of nodes in a specific area, their speed and direction. Guaranteeing delivery and the capability to handle dynamic connectivity are the most important issues for routing protocols in wireless mobile ad hoc networks. Once there is a path from the source to the destination for a certain period of time, the routing protocol should be able to deliver data via that path. If the connectivity of any two nodes changes and routes are affected by this change, the routing protocol should be able to recover if an alternate path exists. Different types of communications used in mobile ad hoc networks are

- Unicasting
- Broadcasting
- Multicasting
- Any casting

➢ Unicasting

Unicast transmission is between one-to-one nodes. Only two nodes are exchanging the information.

➢ Broadcasting

Broadcast is a type of transmission in which information is sent from just one node but is received by all the nodes connected to the network. One to all communication is called as broadcast.

➢ Anycasting

Anycast is communication between a single sender and several receivers topologically nearest in a group. The term exists in contradistinction to multicast, communication between a single sender and a group of selected receivers.

➢ Multicasting

Multicast is a very much different from Unicast. It is a type of transmission or communication in which there may be more than one nodes and the information sent to a set of nodes. It is a limited case of broadcasting. Multicasting is used within the network has many advantages. Multicasting reduces communication cost for applications that send the same data to more recipients [3].

II. Taxonomy for Routing Protocols in MANET

Routing is the process of information exchange from one host to the other host in a network."[4].Routing is the mechanism of forwarding packet towards its destination using most efficient path. Efficiency of the path is measured In various metrics like, Number of hops, traffic, security, etc.

a. Table-driven or Proactive Protocols

Proactive routing protocols attempt to maintain consistent, up-to-date routing information between every pair of nodes in the network by propagating, proactively, route updates at fixed intervals. Representative proactive protocols include: Destination-Sequenced Distance-Vector(DSDV) routing, Clustered Gateway Switch Routing(CGSR), Wireless Routing Protocol (WRP), and The Fisheye State Routing (FSR).

(i) Dynamic Destination-Sequenced Distance-Vector Routing Protocol (DSDV)

DSDV is developed on the basis of Bellman–Ford Routing algorithm 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 transmissions of updates of the routing tables help maintaining the topology information of the network. If there is any new significant change for the routing information, the updates are transmitted immediately. So, the routing information updates might either 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 by multicasting. By the advertisements, the neighboring nodes can know about any change that has occurred in the network due to the movements of nodes. The routing updates could be sent in two ways: one is called a ''full dump'' and another is ''incremental.'' In case of full dump, the entire routing table is sent to the neighbors, where as in case of incremental update, only the entries that require changes are sent[5].

(ii) Cluster Gateway Switch Routing Protocol (CGSR)

CGSR [6] considers a clustered mobile wireless network instead of a ‘‘flat’’ network. For structuring the network into separate but 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. 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 packet 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.

(iii) WRP (Wireless routing protocol)

Wireless Routing Protocol (WRP) is a distance vector based protocol designed for ad hoc networks. WRP modifies and enhances distance vector routing in the following three ways. First, when there are no link changes, WRP periodically exchanges a simple HELLO packet rather than exchanging the whole route table. If topology changes are perceived, only the ‘path-vector tuples contain the destination, distance, and the predecessor (second-to-last-hop) node ID. Second, to improve reliability in delivering update messages, every neighbor is required to send acknowledgments for update packets received. Retransmissions are sent if no positive acknowledgements are received within the timeout period. Third, the predecessor node ID information allows the protocol to recursively calculate the entire path from source to destination.

(iv) FSR (Fisheye state routing)

Fisheye State Routing (FSR) is a link state type protocol which maintains a topology map at each node. To reduce the overhead incurred by control packets, FSR modifies the link state algorithm in the following three ways. First, link state packets are not flooded. Instead, only neighboring nodes exchange the link state information. Second, the link state exchange in only time-triggered, not even-triggered. Third, instead of transmitting the entire link state information at each iteration, FSR uses different exchange Intervals for different entries in the table. To be precise, entries corresponding to nodes that are nearby (within a predefined scope) are propagated to the neighbors more frequently than entries of nodes that are far away. These modifications reduce the control packet size and the frequency of transmission [7].

b. On – demand or Reactive Protocols

A different approach from table-driven routing is reactive or on –demand routing. Reactive protocols, unlike table- Driven ones, establish a route to a destination when there is a demand for it, usually initiated by the source node through discovery process within the network. Representative reactive routing protocols include: Dynamic Source Routing (DSR), Ad hoc On Demand Distance Vector (AODV) routing, Temporally Ordered Routing Algorithm (TORA) and Associativity Based Routing (ABR).

(i) AODV

AODV stands for Ad-hoc On demand Distance Vector. AODV is distance vector type routing where it does not involve nodes to maintain routes to destination that are not on active path. As long as end points are valid AODV does not play its part. Different route messages like Route Request, Route Replies and Route Errors are used to discover and maintain links. UDP/IP is used to receive and get messages.. AODV uses a destination sequence number for each route created by destination node for any request to the nodes. A route with maximum sequence number is selected. To find a new route the source node sends Route Request message to the network till destination is reached or a node with fresh route is found. Then Route Reply is sent back to the source node. The nodes on active route communicate with each other by passing hello messages periodically to its immediate neighbor. If a node does not receive a reply then it deletes the node from its list and sends Route Error to all the members in the active members in the route. AODV does not allow unidirectional link . Finally the animator in any simulation has to be discussed.NAM is used in NS2 [5].

(ii) DSR (Dynamic Source Routing)

The Dynamic Source Routing (DSR) protocol is an on-demand routing protocol based on source routing. In the source routing technique, a sender determines the exact sequence of nodes through which to propagate a packet. In DSR, every mobile node in the network needs to maintain a route cache where it caches source routes that it has learned. When a host wants to send a packet to some other host, it first checks its route cache for a source route to the destination. In the case a route is found, the sender uses this route to propagate the packet. Otherwise the source node initiates the route discovery process. Route discovery and route maintenance are the two major parts of the DSR protocol .Every node maintains a cache to store recently discovered paths. When a node desires to send a packet to some node, it first checks its entry in the cache. If it is there, then it uses that path to transmit the packet and also attach its source address on the packet. If it is not there in the cache or the entry in cache is expired (because of long time idle), the sender broadcasts a route request packet to all of its neighbors asking for a path to the destination. The sender will be waiting till the route is discovered. During waiting time, the sender can perform other tasks such as sending/forwarding other packets. As the route request packet arrives to any of the nodes, they check from their neighbor or from their caches whether the destination asked is known or unknown. If route information is known, they send back a route reply packet to the destination otherwise they broadcast the same route request packet. When the route is discovered, the required packet swill be transmitted by the sender on the discovered route. Also an entry in the cache will be inserted for the future use. The node will also maintain the age information of the entry so as to know whether the cache is fresh or not. When a data packet is received by any intermediate node, it first checks whether the packet is meant for itself or not. If it is meant for itself (i.e. the intermediate node is the destination), the packet path attached on the data packet. Since in Ad hoc network, any link might fail anytime. Therefore, route maintenance process will constantly monitors and will also notify then odes if there is any failure in the path. Consequently, the nodes will change the entries of their route cache is received otherwise the same will be forwarded using the path attached on the data packet .Since in Ad hoc network, any link might fail anytime. Therefore, route maintenance process will constantly monitors and will also notify the nodes will change the entries of their route cache [8].

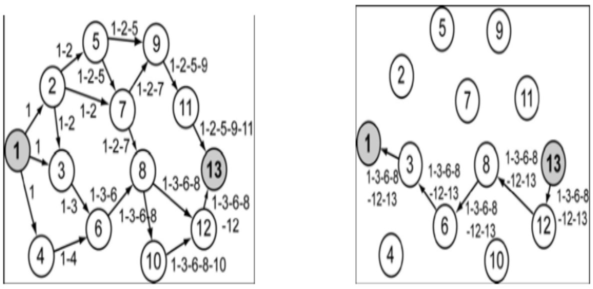

Figure 2: DSR Route Discovery Process.

(iii) Associativity Based Routing (ABR)

Associativity Based Routing (ABR) is a uniform, destination-based, reactive protocol. ABR uses end-to-end topology information in route selection, preferring routes that react long-lived associations. However, only destination-vectors are maintained during routing. When an intermediate node receives the request, it appends Route discovery is as follows: When a source has no route to a destination, it broadcasts a route request's ID to the route request and re -broadcasts it (silently ignoring duplicates). The associatively of each hop is accumulated in the route request. Routes with high threshold and aggregate associatively are considered superior, even if there are shorter routes. The destination sends a route reply back to the source along the selected route. Each intermediate node activates the appropriate forwarding information in its routing table. The route maintenance process is quite complex. Nodes downstream of the link failure send route error messages toward the destination, deleting invalid route entries. If the query fails to find a new partial route, the next node upstream is so informed and initiates a local request. If the process traverses too much of the distance back to the source, it is abandoned and a route error is sent to the source, which reinitiates the route discovery process. Consistent behavior is dependent on the most recent request suppressing earlier attempts. Fewer paths will break which reduces flooding (bandwidth). The advantage is in ABR a broken link is repaired locally, so the source node won't start a new path -finding-process when a broken link appears. Stability information's are only used during the route selection process. Sometimes the chosen path may be longer than the shortest path, because of the preference given to stable paths, which are not necessary. Local query broadcasts may result in high delays during the route repair [4].

c. Hybrid Routing Protocols:

Purely proactive or purely reactive protocols perform well in a limited region of network setting. However, the diverse applications of adhoc networks across a wide range of operational conditions and network configuration pose a challenge for a single protocol to operate efficiently. Researcher's advocate that the issue of efficient operation over a wide range of conditions can be addressed best match these operational conditions. Representative hybrid routing protocols include: Zone Routing Protocol (ZRP) and Zone Base Hierarchal Link state routing protocol (ZHLS) [4].

(i) ZRP

As seen, to maintain routing information the proactive routing uses excess bandwidth, while reactive routing comprise long route request delays. Reactive routing also inadequately floods the entire network for route determination. The Zone Routing Protocol (ZRP) [9] aims to address the problems by combining the best properties of both approaches. ZRP can be classed as a hybrid reactive/proactive routing protocol. *ZRP (Zone Routing Protocol)*[10] shown in Figure uses the hybrid approach to routing. It is based on the merits of both proactive and reactive routing protocol. The nodes of a zone are divided into peripheral nodes and interior nodes [11]. Every node in the network has a zone associated to it. The zone of a node is defined as the collection of nodes whose minimum distance from the node is not greater than the radius of the node. The minimum distance is defined in terms of n
umber of hops from that node.

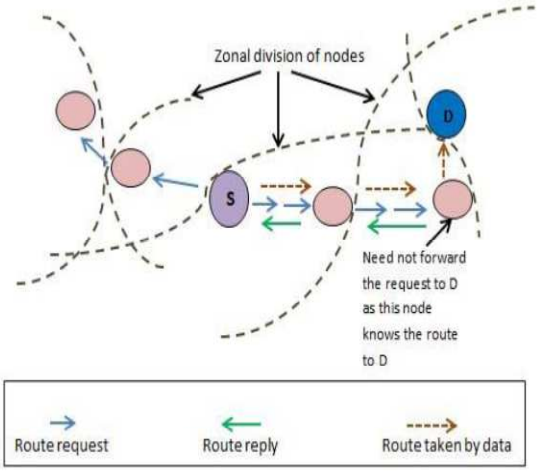

Figure 3: ZRP Protocol [10]

(ii) Zone-based Hierarchical Link State (ZHLS) Routing Protocol

State routing (ZHLS) is a hybrid routing protocol. In ZHLS, mobile nodes are assumed to know their physical locations with assistance from a locating system like GPS. The network is divided into non-overlapping zones based on geographical information. ZHLS uses a hierarchical addressing scheme that contains zone ID and node ID. A node determines its zone ID according to its location and the pre-defined zone map is well known to all nodes in the network. It is assumed that a virtual link connects two zones if there exists at least one physical link between the zones. A two -level network topology structure is defined in ZHLS, the node level topology and the zone level topology. Respectively, there are two kinds of link state updates , the node level LSP (Link State Packet) and the zone level LSP. A node periodically broadcast its node level LSP to all other nodes in the same zone. In ZHLS, gateway nodes broadcast the zone LSP throughout the network whenever a virtual link is broken or created. Consequently, every node knows the current zone level topology of the network. Before sending packets, a source firstly checks its intra-zone routing table. If the destination is in the same zone as the source, the routing information is already there. Otherwise, the source sends a location request to all other zones through gateway nodes. After a gateway node of the zone, in which the destination node resides, receives the location request, it replies with a location response containing the zone ID of the destination [12]. The zone ID and the node ID of the destination node will be specified in the header of the data packets originated from the source. During the packet forwarding procedure, intermediate nodes except nodes in the destination zone will use inter -zone routing table, and when the packet arrives the destination zone, an intra-zone routing table will be used. The advantage is no overlapping zones are here. The zone-level topology information is distributed to all nodes. Reduces the traffic and avoids single point of failure. But additional traffic produced by the creation and maintaining of the zone –level topology is difficult.

III. Conclusion

This paper presents a number of routing protocols for MANET, which are broadly categorized as proactive and reactive, Hybrid. Proactive routing protocols tend to provide lower latency than that of the on-demand protocols, because they try to maintain routes to all the nodes in the network all the time. But the drawback for such protocols is the excessive routing overhead transmitted, which is periodic in nature without much consideration for the network mobility or load. On the other hand, though reactive protocols discover routes only when they are needed, they may still generate a huge amount of traffic when the network changes frequently. Depending on the amount of network traffic and number of flows, the routing protocols could be chosen.

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