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# ROUTING PROTOCOLS IN MOBILE AD-HOC NETWORKS

**Anit Kumar***

**Pardeep Mittal****

**Abstract:** *Mobile Ad-Hoc Networks are those networks which don't have any fixed infrastructure. There is no central administrator Due to mobility of nodes, frequent link breakage takes place. Therefore routing in MANETs is challenging task and this has led to the development of many different routing protocols. This paper concentrates on routing techniques which is the most challenging issue due to the dynamic topology of ad hoc networks. There are different routing protocols for MANETs which makes it quite difficult to determine which protocol is suitable for different network conditions.*

***Keywords:*** *MANETs, routing protocols, reactive, proactive, hybrid.*

*Department of Computer Science and Applications, Kurukshetra University, Kurukshetra, Haryana, India

**Assistant Professor Department of Computer Science and Applications, Kurukshetra University, Kurukshetra

## 1. INTRODUCTION

Ad hoc networks [1] are autonomous, self configuring, adaptive which make them applicable in various fields. At present there are two variations of wireless network- first is [2] known as Infrastructure or base stations. A mobile unit, which moves within these networks, communicates to nearest base station. When it moves out of one base station, a process called Handoff and it comes in the range of the other base station. The second is Infrastructure less or ad hoc network. In Infrastructure less or Ad Hoc wireless network [3] the mobile node can move while communicating with the base station which are not fixed. The mobile nodes change their location and establish their own network 'on the fly'.

## 2. CHARACTERISTICS OF MANETS

Some of the major characteristics of these protocols are:

**Topology:** Since the nodes are mobile, the topology may change rapidly and the connectivity within the network varies with time.

**Limited Resources:** MANETs are bandwidth and power constrained [4]. Moreover the battery life of mobile nodes is also a limiting factor in their operation.

**Distributed Operation:** There is no central control and nodes collaborate them to implement functions.

**Security:** The wireless links lack defense against threats. Various attacks such as denial of services, eavesdropping, replay attacks are possible.

MANETs are resource constrained and the network topology changes dynamically. Therefore routing must be done effectively and hence the need of efficient routing protocols. In MANETs, the protocols for routing are grouped into three categories based on the way how they work.

## 3. ROUTING PROTOCOLS

Routing protocols tells the way how a packet/packet is sent from source to the destination. These protocols are categorized as shown in figure Taxonomy of routing protocols

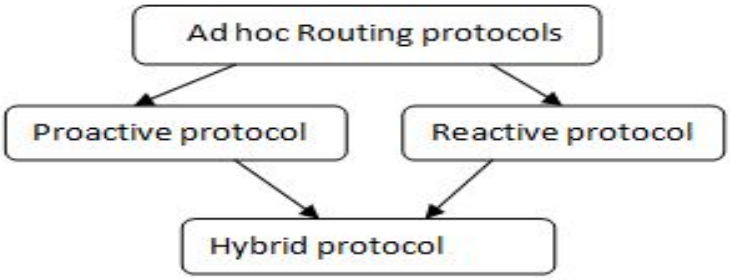


**Figure:-. Taxonomy of routing protocols [4]**

**I. Reactive Routing Protocols**

In Reactive routing protocols or demand routing protocols, nodes are set up when needed. When a node wants to send a packet to another node, it initiates communication with that node [3]. The reactive routing protocols have two major components [4]

Route discovery: When [5] the source wants to send a packet to the destination node, it first scans its cache to find the route to the destination, if route not present, it initiates route discovery process containing through a packet having the destination address and the address of intermediate nodes to the destination.

Route maintenance: Due to mobility of nodes, the nodes change their topology and hence route maintenance is done. Route maintenance is achieved through the use of acknowledgement.

**i. Dynamic Source Routing (DSR):** It uses the concept of [5] source routing in which the node create routes only when source requires [7]. It maintains the Route cache which contains the recently discovered routes. As it is on demand routing protocol, the routing overhead is less. This Protocol is composed of two essential parts of route discovery and route maintenance.

Route Discovery*:* When a source node S wants to send a packet to the destination D, it checks its route cache first. If it finds the route, then the source uses the available route in cache. If route not found or the route cache has an expired route, then it initiates the route discovery process. Route discovery requires 7 fields during this process such as sourceId, destnationId, RequestID, Addresslist, Hoplimit, Network Interface List, Acknowledgment list. Then source node broadcasts the packet to its neighbor. Moreover, source node also maintains a replica of send packet in its send buffer. Packets can be dropped if send buffer is

overflow or the time limit for route discovery is over. Any intermediate node having route to destination can generates route reply [7] else process continues and packet eventually reaches the destination and it replies to the source node.

Route Maintenance: Route maintenance includes monitoring the routes against failure through route error packets and route cache [5]. There is no need of keeping routing table in DSR [3] protocol. Route cache can further decrease route discovery overhead. However DSR is not scalable to large networks and packet size grows with length of the route due to source routing.

**ii. Ad Hoc on Demand Distance Vector**

Ad Hoc on Demand Distance Vector (AODV) [3] is based on DSDV and DSR collectively. Each node in AODV maintains information about the neighboring routing in tables. Route is between two nodes is discovered as when needed.

When a source S node wants to send a packet to the destination node D, it checks route table and if there is route not present, it initiates route discovery process. It broadcasts a route request ROUTE REQUEST (RRQ) packet to its neighbors [7]. The RRQ contains IP addresses of S and D, current sequence number of S and last known sequence number of D, a broadcast ID from S, which is incremented each time S sends a RRQ packet. The broadcast ID, IP address pair of the source S forms a unique identifier for the RRQ. AODV utilizes destination sequence numbers to guarantee the fresh route. When a node broadcast ROUTE REQUEST packet, it waits for RREP. If the reply is not received within certain time limit, the source node rebroadcast the RRQ or it assumes that there is no route present. When a node receives a RRQ packet, it broadcast the RRQ packet to its neighbor if it is not the destination route and creates a temporary reverse route to the source IP address in its routing table with next hope equal to the IP address of neighboring node that sent the RRQ. Intermediate nodes can reply to the RRQ only if they have a route to the destination whose corresponding destination sequence number is greater than or equal to that contained in the RRQ. Once the RRQ reaches the destination or an intermediate node with a fresh enough route, it generates RREP and it is unicasted back to the requested node which eventually reaches the Source node. The intermediate node records the route to the destination as the RREP follows from destination to source. The nodes are mobile, so it can move anytime. IF the source node moves to different location, it can rediscover the route

the destination node by route discovery process. IF the destination node/the intermediate node moves to different location [7], it informs the upstream node through Route error packet which eventually reaches the source node. The source node terminates the ongoing communication and initiate route discovery process. Hello packets are used to maintain the local connectivity. AODV reduces number AODV protocol reduces number of routing packets in the network. It handles the dynamic behavior efficiently. However there is possibility of various attacks on AODV. The route discovery latency is high.

**iii. Temporary Ordered Routing Protocol**

Temporary Ordered Routing Protocol (TORA) is a distributed routing protocol that uses the source initiates the route establishment to the destination. For a given source and destination, it can find loop free [8] multiple routes [9]. TORA uses height metric to establish [7] directed acyclic graph (DAG) rooted at destination. Query packet is used to find the route between two nodes. A node broadcast the query [3]. The node that receives the Query packet then broadcasts the Update packet which determines its height with respect to the destination. As the Update propagates in the network, each node sets its height to a value greater than the height of the node from which the Update was received. This creates a link between the nodes from the source node and eventually reaches the destination. TORA requires synchronization between the nodes in the ad – hoc network.

**Comparison:** Table 1 compares different [3], [7], [8] reactive routing protocols

**II. Proactive routing protocols**

Proactive routing protocols are also knows as table driven protocol. In these protocols, each node maintains a routing table consisting of routing information to every other node in the network [10]. Since the nodes are mobile, they keep on changing their location. So the routing tables maintained by different nodes are periodic or whenever a change occurs, are updated. There are a number of proactive routing protocols. They differ in various areas like number of routing table [7] maintained and how the changes are propagated in the network

**i. Destination-sequenced distance vector**

The Destination-sequenced distance vector (DSDV) is a proactive routing protocol [3]. It is an enhancement of Bellman Ford algorithm to deal with looping and count to infinity problem [7]. Every node maintains routing table which consists of distance, in number of hops, to all the possible destination. Each entry is tagged with sequence number that is assigned by the

destination node which indicates the freshness of route. The greater the sequence number, fresher the route is. Whenever there is change in the network, the change is propagated through "full dump" [10] or the "incremental dump". Full dump propagates entire routing information while incremental dump propagates only the changes information since the last dump. Whenever a route id found broken [5], it is assigned a infinite value metric and the other nodes are informed through broadcasting the update to them.

**ii. Cluster-head gateway switch routing**

Cluster-head gateway switch routing(CGSR) CGSR is table driven routing protocol where the nodes in the networks are grouped into cluster [10]. In CGSR, there is a cluster head elected by all the nodes. The cluster head manages the communication between inter clusters. The nodes in the cluster are- undecided node which does not belong to any cluster, cluster head and the member node. Each cluster head periodically broadcast its cluster information. However there is considerable overhead in maintaining the clusters.

**iii. Wireless Routing Protocol (WRP)**

WRP is a table driven routing protocol. It is a variation of distance vector routing protocol using bellman Ford algorithm to counter count to infinity problem. Each node in WRP maintains [13] four table i. Distance table ii. Link state table iii. Routing table iv. Message retransmission list (MRL). Nodes in GSR periodically exchange update message with their neighbor only. The update message have a update list which contain three parameters – destination, distance to the destination and the penultimate node to the destination. In WRP, nodes use hello messages [7] to find the existence of the neighbor node. However nodes in WRP require more bandwidth and the power as the nodes cannot go into sleep mode save power [10].

**Comparison**

Table 2 compares different proactive routing protocols **[**7], [10].

**III. Hybrid routing protocols**

Hybrid routing protocols [10] are both proactive and reactive in nature. There protocols work on the merits of these protocols to increase scalability and to decrease the routing overhead.

**i. ZRP (Zone Routing Protocol)**

ZRP is [11] hybrid routing protocol with both a proactive and a reactive routing. ZRP reduce the control overhead of proactive routing protocols and decrease the latency caused by route discovery in reactive routing protocols. In ZRP the nodes in the network are divided into various zones. The routing within the Zone is done using Intra Zone Routing Protocol (IARP) while packets between various zones are routed using Inter Zone routing Protocol (IERP). When the node has to send a packet, it checks the destination's zone first. Routing within zone is done with IARP. When the destination is in different zone, the node sends the route request [12] to the peripheral Node. If the node receiving the request has the route to the destination, it returns with route to the destination otherwise the process continuous till the destination is reached. During this process, routing information is stored in route request packet to enable route reply when needed.

## 4. APPLICABILITY CRITERIA

There are different kinds of routing protocols in mobile ad – hoc network [13] that suitable to different network characteristics. So which protocol to use in a given network depends upon various network characteristics like routing overhead, power required, scalability, average delay in the network, network security etc.

## 5. COMPARISON

There are various differences in the way these three protocols wok [4], [10]. Table 3 compares three category of routing protocols.

## CONCLUSION & FUTURE WORK

There are different routing protocols in MANETs. The different routing protocols are suited to different network behavior. Reactive protocols have less overhead in routing as they are on demand routing protocols but they have high latency. Protocols routing protocols on the other hand have more routing overhead and they require more memory. Hybrid protocols combine the features of both protocols and they perform well and are designed for larger network. The field of mobile adhoc networks is very vast. These networks are going to have widespread use in the future. Scalability, Power control and network security are some of issues of the future work and the efforts will be made to make Mobile ad hoc networks more scalable, secure and power efficient.

## REFERENCES

[1] Pore Ghee Lay, John C. McEachen "A Comparison of Optimized Link State Routing with Traditional Ad-hoc Routing Protocols" U.S. Navy Research Paper 2.

[2] Umang Singh "Secure Routing Protocols in Mobile Adhoc Network-A Survey and Taxonomy" International Journal of Reviews in Computing 30th September 2011. Vol. 7

[3] Sunil Taneja and Ashwani Kush "A survey of Routing Protocols in Mobile Ad Hoc Networks" , International Journal of Innovation, Management and Technology, Vol. 1, No. 3, August 2010 ISSN: 2010-0248

[4] Robinpreet Kaur & Mritunjay Kumar Rai "A Novel Review on Routing Protocols in MANETs", Undergraduate Academic Research Journal (UARJ), ISSN : 2278 – 1129, Volume-1, Issue-1, 2012

[5] Dr.D.Siva Kumar "Review: Swarm Intelligent based routing Protocols for Mobile Adhoc Networks" International Journal of Engineering Science and Technology Vol. 2 (12), 2010, 7225-7233

[6] Luo Junhai, Xue Liu, Ye Danxia "Research on multicast routing protocols for mobile ad-hoc networks" , School of Computer Science and Engineering, University of Electronic Science and Technology of China, Chengdu 610054, PR China School of Computer Science, McGill University, Montreal, Canada H3A 2A7 Received 1 April 2007; received in revised form 26 November 2007; accepted 28 November 2007 Available online 5 December 2007

[7] Elizabeth M. Royer, "A Review of current routing protocols for Ad-Hoc Mobile Wireless Networks", IEEE Personal Communication, April 1999

[8] Anuj K. Gupta,Dr. Harsh Sadawarti, Dr. Anil K. Verma "Performance analysis of AODV, DSR & TORA Routing Protocols", IACSIT International Journal of Engineering and Technology, Vol.2, No.2, April 2010 ISSN: 1793-8236

[9] http://en.wikipedia.org/wiki/Temporally-ordered_routing_algorithm [19th Jan, 2013, 7:35 pm IST]

[10] Mehran Abolhasan, Tadeusz Wysocki, Eryk Dutkiewicz, "A review of routing protocols for mobile ad hoc networks", Telecommunication and Information Research Institute, University of Wollongong, Wollongong, NSW 2522, Australia b

Motorola Australia Research Centre, 12 Lord St., Botany, NSW 2525, Australia Received 25 March 2003; accepted 4 June 2003

[11] http://en.wikipedia.org/wiki/Zone_Rou_ting_Protocol [20th Jan. 2013,7:09 pm IST]

[12] Nicklas Beijar "Zone Routing Protocol (ZRP)", Networking Laboratory, Helsinki University of Technology P.O. Box 3000, FIN-02015 HUT, Finland

[13] Petteri Kuosmanen "Classification of Ad Hoc Routing Protocols", Finnish Defence Forces Naval Academy P.O. Box 5, FIN-00191 Helsinki, Finland

**Table 1**

| **Parameters** | **DSR** | **AODV** | **TORA** |
|---|---|---|---|
| **Routing Type** | Source Routing | Distance Vector | Link Traversal |
| **Loop Freedom** | Yes | Yes | No |
| **Multiple Routes** | Multiple routes not there | There are multiple routes | Multiple routes are not there |
| **Destination update Procedure** | Source | Source | Neighbor |
| **Route stored** | In Route cache | In routing table | In routing table |

**Table 2**

| **Parameters** | **DSDV** | **CGSR** | **WRP** |
|---|---|---|---|
| **Routing philosophy** | Flat | Hierarchical | Flat |
| **Storage Space** | Low | Low | High as each node stores 4 tables |
| **Hello Message** | Yes, hello message is used | No, hello message is not used | Yes, the hello message is used |
| **Critical node** | No, all nodes have same capability | Yes ,the cluster head is critical node | No, all nodes have same capability |
| **Update frequency** | Periodic and when there is a change | Periodic | Periodic |
| **Updates transmitted to** | Neighbor | Neighbor and to cluster head | Neighbor |

**Table 3**

| Parameters | Reactive | Proactive | Hybrid |
|---|---|---|---|
| **Routing Philosophy** | Flat | Flat/Hierarchical | Hierarchical |
| **Routing Technique** | On demand | Table Driven | Combination of both |
| **Overhead in Routing** | Low | High | Medium |
| **Route availability** | Set up when needed | Always available | Depends upon destination's location |
| **Latency** | High | Low | Zone dependent |
| **Periodic updates** | No | Yes | Required inside zone |
| **Storage need** | Depends upon number of routes kept | Low | Depends upon size of the zone |
| **Scalability** | Not scalable, suited to small network | Not scalable | Scalable to large network |