

## Research Article

**Review of Routing Protocols in Mobile Ad-hoc Networks**Anamika<sup>a\*</sup> and Umesh Kumar<sup>b</sup><sup>a</sup>Department of Computer Science and Engineering, IPEC, Ghaziabad, India.<sup>b</sup>Amazon.com Inc., Seattle, USA.Accepted 9 April 2013, Available online 1 June 2013, **Vol.3, No.2 (June 2013)****Abstract**

*To find and maintain routes between nodes in a dynamic topology, using minimum resources is a challenge in mobile ad-hoc network. A number of protocols have been developed to accomplish this task. In this context, only few of the proposed solutions used for routing of packets from source to destination are commonly analyzed and evaluated. In this Paper, various routing protocols are analyzed critically which are reported in available literature. This will help to understand problem sphere of protocols better and can be used to widen already proposed routing protocols or to propose new efficient routing solutions that focus on security and Quality of Service parameters.*

**Keywords:** Location Aided Routing, MANETs, Reactive Routing, Table Driven Routing.

**1. Introduction**

First wireless network was invented by Guglielmo Marconi in 1897 (P. K. Suri et al, 2011). Since then wireless communication has grown too many folds and still it is an area of interest to large number of researchers. In Ad Hoc wireless network, the mobile node can move while communicating, there are no fixed base stations and all the nodes in the network act as routers. The mobile nodes in the Ad Hoc network dynamically establish routing among themselves to form their own network 'on the fly'. This fact creates many challenging research issues, since the objectives of how routing should take place is often unclear because of the different resources like bandwidth consumption, battery life, limited physical security, latency, limited transmission range and flooding of message (A. K. Gupta et al, 2010). Therefore the routing protocols used in ordinary wired networks are not well suited for this kind of dynamic environment and attention has been paid to use specific network parameters when specifying routing metrics.

Rest of the paper is organized into following sections. Section II presents the definition of MANETs. Section III provides an overview and comparison of existing work in the area of routing. Section IV presents conclusion.

**2. Related Work****2.1 Mobile Ad-hoc Networks**

Mobile Ad hoc Network (MANETS) is a combination of autonomous mobile nodes that can interact with each other

by means of radio waves (S. Mangai et al, 2010). The mobile nodes can directly communicate to those nodes that are in radio range of each other, whereas others nodes need the help of intermediate nodes to route their packets. In MANETs the nodes are self-organized; they may move and join or leave the network at will with or without central controlling entity. Hence, routing paths in mobile ad hoc networks potentially contain multiple hops, and every node in mobile ad-hoc networks has the responsibility to act as a router. Although number of routing protocols for ad hoc networks, when thinking about any routing protocol, generally the following properties are expected, though all of these might not be possible to incorporate in a single solution.

1. The routing protocol should enhance bandwidth utilization and minimize battery consumption.
2. The routing protocol should consider security and provide distributed operation in order to increase its reliability.
3. Route computation and maintenance must involve a minimum number of nodes (B. R. Hanji et al, 2010).
4. The routing protocol should overhead per packet and select optimal route to route the packet to destination.
5. It must be loop-free and free from stale routes (B. R. Hanji et al, 2010).

**2.2 Classification of Routing Protocols**

Numerous routing protocols have been proposed and developed for ad hoc networks, but most of these are classified on basis routing strategy and network structure. According to the routing strategy, routing protocols can be

---

\*Corresponding author: Anamika

categorized as Table driven, On-demand driven and Hybrid (see Fig. 1), while depending on the network structure they are classified as flat routing, hierarchical routing and geographical routing.

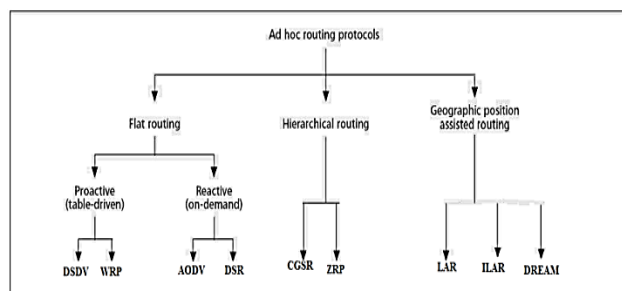


Fig 1. Classification of Routing Protocols

**Flat Routing Protocols:** Flat routing protocols distribute information as needed to any router that can be reached or receive information. No effort is made to organize the network or its traffic, only to discover the best route hop by hop to a destination by any path. 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 is readily available (B. R. Hanji et al,2010).

In source initiated routing protocols mobile nodes maintain path information for destinations only when they need to contact the source node or relay packets (A. K. Gupta et al,2010). Hybrid Routing Protocols: Often reactive or proactive feature of a particular routing protocol might not be enough; instead a mixture might yield better solution (C. A. Dhote et al,2010).

**Hierarchical Routing Protocols:** In this method of routing the nodes are divided into regions based on hierarchy. A particular node can communicate with nodes at the same hierarchical level or the nodes at a lower level and directly under it.

**Geographical Routing Protocols:** Geographic routing protocols are which those prevent network-wide searches for destinations (C. A. Dhote et al,2010). If the recent geographical coordinates are known then control and data packets can be sent in the direction of the destination.

### 3. Routing Protocols

#### 3.1 Destination-Sequenced Distance-Vector Routing Protocol (DSDV)

DSDV is a table-driven protocol based on the Bellman-Ford routing mechanism [1, 6]. The improvements made to the Bellman-Ford algorithm include freedom from loops in routing tables. Each node keeps a routing table which contains all possible destinations, number of hops to reach the destination. Each mobile node in the network keeps a routing table that contains the list of all available destinations (C. E. Perkins et al,1994) and the number of hops to each. Each table

entry is tagged with a sequence number, originated by the destination node to distinguish stale routes from new ones, thereby avoiding the formation of routing loops. 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. 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 changes are sent.

#### Critiques of DSDV

Excessive communication overhead (C. A. Dhote et al,2010) due to periodic and triggered updates of routing information throughout the network to maintain table consistency regardless of the network traffic. When network grows the size of the routing tables and the bandwidth required to update them also grows. Apart from this overhead of flooding route advertisement to maintenance convergence and settling time of routes, or the weighted average time that routes to a destination will fluctuate, before the route with the best metric is received. A malicious node can easily disrupt the routing protocol by arbitrarily tempering the sequence numbers or the metrics (J. W. Wang et al,2009).

#### 3.2 Wireless Routing Protocol (WRP)

WRP keep routing information among all nodes in the network. For the purpose of routing, each node maintains four things: 1. A distance table 2. A routing table 3. A link-cost table 4. A message retransmission list (MRL) [1, 8]. WRP uses periodic update message transmissions to the neighbors of a node. The nodes in the response list of update message (which is formed using MRL) should send acknowledgments. If there is no change from the last update, the nodes in the response list should send an idle Hello message to ensure connectivity (V. Sharma et al,2012). After receiving the acknowledgment, the original node updates its MRL. Thus, each time the consistency of the routing information is checked by each node in this protocol, which helps to eliminate routing loops and always tries to find out the best solution for routing in the network.

#### Critiques of WRP

Every node in network keep four tables thus require large memory storage and computing resource (V. Sharma et al,2012). Periodic transmission of hello message between the nodes in the network not only consumes power of mobile nodes and bandwidth, but also adds to routing overhead. WRP use distance vector shortest-path routing as the underlying routing protocol and it has certain degree of complexity during link failure and additions. Moreover not suitable for large network due to mobility (V. Sharma et al,2012).

### 3.3 Ad-hoc On-demand Distance Vector Routing (AODV)

AODV is an improvement on DSDV (C. E. Perkins et al, 1999) because it typically minimizes the number of required broadcasts by creating routes on an on-demand basis. It enables multi-hop routing between the participating mobile nodes wishing to establish and maintain an ad-hoc network. Whenever source requires route it broadcasts a Route Request (RREQ) to all its neighbors. The RREQ propagates through the network until it reaches the destination or the node with a fresh enough route to the destination. Then destination replies by unicasting the route reply (RREP) (A. K. Gupta et al, 2010) towards the source node.

AODV uses hello messages (V. Sharma et al, 2012) that are broadcasted periodically to the immediate neighbors indicating continued presence of the node, and neighbors using routes through the broadcasting node will continue to mark the routes as valid. If hello messages stop coming from a particular node, the neighbor can assume that the node has moved away and mark that link to the node as broken and notify the affected set of nodes by sending a link failure notification to that set of nodes.

#### Critiques of AODV

AODV uses periodic beaconing (V. Sharma et al, 2012) to track neighboring nodes that leads to unnecessary bandwidth consumption and causes network overhead. Moreover the quality of path can be discovered only while setting up the path not prior to call set-up and monitoring of path by all intermediate nodes adds to cost of latency. Apart from this intermediate nodes can lead to inconsistent routes if the source sequence number is very old (V. Sharma et al, 2012) and the intermediate nodes have a higher but not the latest destination sequence number, thereby having stale entries. Also, multiple route reply packets in response to a single route request packet can lead to heavy control overhead. AODV is vulnerable to various kinds of attacks as it is based on the assumption that all nodes must cooperate and without their cooperation no route can be established (S. Taneja et al, 1996).

### 3.4 Dynamic Source Routing (DSR)

DSR allows nodes in the MANETS to dynamically discover a source route across multiple network hops to any destination. Routing in DSR is done using two phases: route discovery and route maintenance [2, 8, 11]. When a source node wants to send a packet to a destination, it first consults its route cache to determine whether it already knows about any route to the destination or not. If already there is an entry for that destination, the source uses that to send the packet. If not, it initiates a route request by broadcasting (D. B. Johnson et al, 1996). Each node receiving a RREQ packet rebroadcasts it unless it is the destination or it has a route to the destination. A route reply is generated by the destination or by any of the intermediate nodes. For route maintenance whenever a link on a source

route is broken the source node is notified using a route error (RERR) packet.

#### Critiques of DSR

Quality of path is not known prior to call setup which leads to increase in cost of additional latency and overhead. Route is searched before actual data packet transmission that may degrade the performance of interactive applications. Moreover, it may have poor performance in terms of control overhead in networks with high mobility and heavy traffic loads and not scalable to large networks because route discovery process initiated by source to search a route to destination is based on flooding. In order to obtain the routing information, each node must spend lot of time to process any control data it receives, even if it is not the intended recipient (S. Taneja et al, 1996).

### 3.5 Zone Routing Protocol (ZRP)

ZRP is a hybrid routing protocol [5, 12] in which every node has a predefined zone centered at itself in terms of number of hops. For nodes within the zone it uses proactive protocols to maintain routing information and uses a reactive protocol for interaction among neighborhoods.

The ZRP protocol consists of three components. In the zone proactive Intra-zone Routing Protocol (IARP) is used to maintain routing information. For nodes outside the zone, reactive Inter-zone Routing Protocol (IERP) is performed. IARP provides a route to nodes within a node's zone. IERP uses the route query (RREQ) route reply (RREP) packets to discover a route very similar to some on-demand routing protocol.

#### Critiques of ZRP

Zones cannot be formed dynamically in addition it is difficult to identify area of zone. As the distance between the sender and border nodes increases, the zone area also increases, which means the radio coverage of the sender node will not be able to reach the border nodes in the zone and sender node will increase the number of broadcasts to find the border nodes in the zone, which will result in bandwidth utilization (R. Dilli et al, 2012), unpredictable communication overhead and delay. Apart from it, restricts overhead by proactive protocol to zone plus reactive search overhead to border nodes only. Besides that increase in network size poses higher memory requirement.

### 3.6 Cluster-head Gateway Switch Routing Protocol (CGSR)

CGSR is a clustered multi-hop mobile wireless network with several heuristic routing schemes (P. K. Suri et al, 2011). In CGSR a cluster head controls a group of mobile nodes. A framework for code separation and channel access through which routing and bandwidth

allocation is achieved. A cluster head selection algorithm is utilized to select a node as the cluster head using a distributed algorithm within the cluster. Using LCC cluster-heads only change when two cluster heads come into contact or when a node moves out of contact of all other cluster-heads.

### Critiques of CGSR

Frequent cluster head changes not only affect routing protocol performance but LCC clustering algorithm introduces additional overhead and complexity in the formation and maintenance of clusters (X. Hong al,2002). Cluster head node not only need memory in order to store table maintained by cluster head but also lead to chances of missing optimal path. The network reliability may also be affected due to single points of failure of these critical nodes.

### 3.7 Location Aided Routing Protocol (LAR)

Using location information to reduce the number of nodes to whom route request is propagated.

**Expected Zone:** Expected Zone is the region where source node S thinks that the destination node D may contained at some time  $t$  assuming that node S knows that the node D was at location L at time  $t_0$  and current time is  $t_1$  (Y. Ko al,2000). Now, If S knows that D travels with average speed  $v$ , then S assumes that the expected zone is the circular region of radius  $v(t_1 - t_0)$  centered at location L.

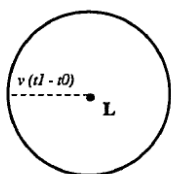


Fig 2: Expected Zone

**Request Zone :** The request zone is created as a rectangle with the source  $s$  in one corner and the expected zone in the opposite corner of the rectangle.

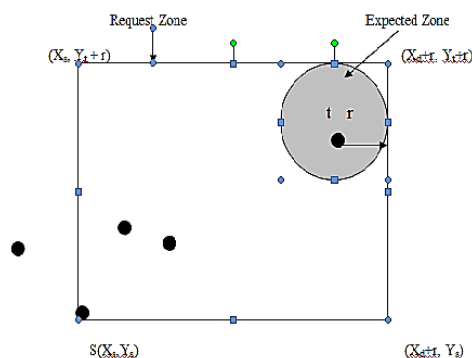


Fig 3: Request Zone and Expected Zone

### Critiques of LAR

Being a location dependent protocol, applicability of LAR protocol relies on the availability of Global Positioning System (GPS) and does not take into account any obstruction. In addition request zone is rectangular and the RREQ packet contains large amount of information, which in turn consumes large amount of bandwidth. As the forwarding node takes the decision by comparing the distance, power of mobile nodes get consumed at much higher rate because power consumption is proportional to the number of computations done at the device. This in turn results in early route failure. Apart from it, when number of nodes in the path to destination are more there are more chances of broken link problem which is caused when any node in the route do not meet the requirement required to forward the request.

### 3.8 Improved Location Aided Routing Protocol (ILAR)

ILAR (Improved Location Aided Routing) is another location based technique which uses the concept of base line lying in between the source and destination node (N. C. Wang al,2009). Node which is closest to this line of sight will be chosen as the next intermediate node. As the transmitting node check the distance of every neighboring node from base line and find the closest neighbor for further transmission.

### Critiques of ILAR

As the transmitting node check the distance of every neighboring node from base line and find the closest neighbor for further transmission. This process will increase the delay (N. C. Wang al,2009) in data transmission and also increases the nodal overhead and in turn decreases the battery life of nodes and increases bandwidth consumption. Furthermore ILAR assumes that there are no bad nodes in the network and doesn't provide any protection against malicious intent.

## 4. Conclusion

More and more efficient routing protocols for MANETs will be developed in the future, which might take security and Quality of service (QoS) parameters such as bandwidth and power consumption, overhead, delay as the major concern. Until now, the routing protocols mainly focused on the methods of routing, but in future a secured and QoS-aware routing protocol could be worked on. It has been further concluded that due to the dynamically changing topology and infrastructure less, decentralized characteristics, security and power awareness is hard to achieve in mobile ad hoc networks. The focus of the study is on these issues in our future research work and effort will be made to propose a solution for routing in Ad Hoc networks by tackling these core issues of secure and power aware/energy efficient routing.

## References

- P. K. Suri, M. K. Soni, and Parul Tomar (2011), Routing in Mobile Adhoc Network: A Review , *International Journal of Advances in Computing and Information Technology*.
- A. K. Gupta, H. Sadawarti, and A. K. Verma (2010), Performance Analysis of AODV, DSR and TORA Routing Protocol , *IACSIT International Journal of Engineering and Technology*, Vol. 6, No. 4.
- S. Mangai, and A. Tamilarasi (2010), Evaluation of the Performance Metrics in Improved Location Aided Cluster Based Routing Protocol for GPS Enabled MANETs, *European Journal of Scientific Research*, Vol. 46, No. 2, pp. 296-308.
- B. R. Hanji, and R. Shettar (2012), Survey on QoS Routing protocols Challenges and recent advances in MANETs, *Journal of Computing Technologies*, Vol. 1, Issue 2.
- C. A. Dhote, M. A. Pund, and R. S. Mangrulkar (2010), Hybrid Routing Protocol with Broadcast Reply for Mobile Adhoc Network, *International Journal of Computer Applications*, Vol. 1, No. 10.
- C. E. Perkins, and P. Bhagwat (1994), Highly Dynamic Destination-Sequenced Distance-Vector Routing (DSDV) for mobile computers, *Computer Communication Review*, pp. 234-244.
- J. W. Wang, Y. P. Lin, and H. C. Chen (2009), A Secure DSDV Routing Protocol for Ad Hoc Mobile Networks, *International Joint Conference on INC, IMS and IDC*.
- V. Sharma, and B. Alam (2012), Unicast Routing Protocols in Mobile Ad hoc Networks: A Survey, *International Journal of Computer Applications*, Vol. 51, No. 14.
- C. E. Perkins, and E. M. Royer (1999), Ad-Hoc On Demand Distance Vector Routing, *Proceedings of the 2nd IEEE Workshop on Mobile Computing Systems and Applications*, New Orleans, USA, pp. 90-100.
- S. Taneja, and A. Kush (1996), A Survey of Routing Protocols in Mobile Ad Hoc Networks, *Mobile Computing, Kluwer Academic Publishers*.
- D. B. Johnson, and D. A. Maltz (1996), Dynamic Source Routing in Ad Hoc Wireless Networks, *Mobile Computing, Kluwer Academic Publishers*.
- Z. J. Hass, M. R. Pearlman, and P. Samar (2002), The Zone Routing Protocol (ZRP) for Ad Hoc Networks, IETF draft, available at <http://tools.ietf.org/id/draft-ietf-manetzone-zrp-04.txt>.
- R. Dilli, and P. C. S. Reddy (2012), Energy management in Zone Routing Protocol, *International Journal of Emerging Technology and Advanced Engineering* ,Vol. 2, Issue 5.
- X. Hong, K. Xu, and M. Gerla (2002), Scalable Routing Protocols for Mobile Ad Hoc Networks, *IEEE Network*, pp. 11-12.
- Y. Ko, and N. H. Vaidya (2000), Location-aided routing (LAR) in mobile ad hoc networks, *ACM Wireless Networks* , Vol. 6, No.4, pp. 307-321.
- N. C. Wang, Y. F. Huang, J. S. Chen, S. M. Wang, C. L. Chen (2009), An Improved Location-Aided Routing Protocol for Mobile Ad Hoc Networks with Greedy Approach, *Wseas Transaction on Communications* , Vol.8, Issue 8.