

# Routing in Highly Dynamic Ad Hoc Networks: Issues and Challenges

Varun G Menon

Research Scholar, Department of Computer Science Engineering  
Sathyabama University, Chennai, India-600119  
varungmenon46@gmail.com

Joe Prathap P M

Professor, Department of Information Technology  
RMD Engineering College, Chennai, India-601206

**Abstract**—The aim of this research paper is to analyze the various issues and challenges involved in routing of data packets in highly mobile ad hoc networks. Routing in ad hoc networks has always been a challenging and tough task due to the dynamic topology and error prone wireless channel. There are a number of issues like lack of centralized control, constantly moving nodes etc that has to be considered while routing a data packet from the source to the destination in the ad hoc network. Routing of data packets becomes much more difficult with increased mobility of nodes. This paper analyses the various issues in routing of data packets from the source to the destination node and also lists down the parameters that has to be considered while designing and selecting a routing protocol for highly mobile ad hoc networks.

**Keywords**- *Ad Hoc Networks, Routing protocols, Issues, Challenges, Design.*

## I. INTRODUCTION

A Mobile Ad hoc Network (MANET) is a self configuring network of wireless devices with no access point or a centralized control. All the nodes in the network are free to join or leave the network at any point of time. Every node in the network must be able to act as a router to find out the optimal path to forward a packet. As the nodes remain mobile, entering and leaving the network, the topology of the network changes continuously. Here the mobile devices in the network are able to detect the presence of other devices and perform necessary set up to facilitate communication and sharing of data and service. One of the most unique features of a MANET is that it does not need any fixed infrastructure. The network can be set up anywhere without the help of any fixed infrastructure. As the network is decentralized, the network organization and message delivery must be executed by the nodes themselves.

MANETs have gained a great deal of attention over these years because of its significant advantages brought about by multi-hop, infrastructure-less transmission. MANETs provide an emerging technology for both civilian and military applications. They are found to be very suitable for military applications and also for emergency communication purposes. Due to this growing demand of MANETs, over these years a lot of research have been carried out to move different applications from traditional infrastructure environment into the ad hoc context, so that a great deal of new services will be generated for the new environment.

Although MANETs have brought in a lot of advantages to set up new applications, a number of issues still remain to be addressed. The most important issue is routing of data packets in MANET. As the nodes enter and leave the network, the topology changes continuously and it becomes very tough to select a forwarding node to route the packets. Selection of an optimal path from the source to the destination also remains a challenge. The absence of a centralized control also adds to this issue. Apart from routing, there are some more issues in MANET that needs to be addressed. One of the major challenges is dealing with the wireless medium of communication with limited bandwidth. Also wireless links are often prone to errors from interference and other issues. Another important constraint is the constant drainage of energy due to the mobility of the nodes in the network. Quality of service (QoS) is often difficult to guarantee in these networks as the topology change dynamically and network state information is generally imprecise [1]. Reliable data delivery and security of the network needs to be maintained. MANETs are more vulnerable than wired network due to the mobility of nodes, threats from compromised nodes inside the network, limited physical security, dynamic topology, scalability and lack of centralized management. Because of these vulnerabilities, MANETs are more prone to malicious attacks and this raises the need for proper security in these types of networks.

Our paper mainly focuses on the various issues and challenges existing in highly dynamic ad hoc networks and studies the impact of each issue on the performance of the network. We focus on the most important challenge of routing in highly dynamic ad hoc networks and list out the various parameters that has to be considered while designing and selecting a routing protocol for the network. In section II we discuss the unique

characteristics of mobile ad hoc networks and in section III we discuss the various issues and challenges existing in MANETs. We discuss the various parameters that needs to be considered while designing a routing protocol for MANETs in section IV .We conclude the paper in section V.

## II. CHARACTERISTICS OF MANETS

### A. *Dynamic Topology*

Nodes can join or leave the network at any point of time. Thus the network topology which is typically multihop changes continuously. The change in topology can be random and unpredictable sometimes. Many applications take advantage of this dynamic and flexible topology of MANETs.

### B. *Infrastructure less*

MANETs does not need any fixed infrastructure to be set up. The network can be set up anywhere by a group of mobile nodes. This is one of the most important and favorable characteristic in MANETs. This property of MANETs enables users to dynamically set up networks anywhere without depending on any infrastructure.

### C. *Autonomous Terminal*

Every mobile terminal in a MANET is an autonomous node. Every node in these networks has to act as both a host and a router. In MANET, each mobile terminal is an autonomous node, which functions both a host and a router. All the nodes have equal responsibility in a MANET.

### D. *Wireless links*

The communication medium used in MANETs is wireless medium. The links usually has constrained bandwidth and variable capacities. Wireless connections bring in a number of advantages for the applications to use MANETs in remote areas.

### E. *No centralized control*

MANETs does not have any centralized control. All the operations in the network including control and management of the network are distributed among the terminals. The nodes involved in a MANET collaborates with each other and each node acts as a relay node when needed.

### F. *Multihop Routing*

As the number of nodes changes frequently and the topology remains dynamic, multihop routing is preferred in MANETs. When delivering data packets from a source to its destination within the wireless transmission range, the packets should be forwarded via one or more intermediate nodes.

### G. *Light-weight Terminal*

Most of the MANET nodes are mobile devices with less CPU processing capability, small memory size, and low power storage. Such devices need optimized algorithms and mechanisms that implement the computing and communicating functions.

### H. *Energy*

Most of the nodes in a MANET rely on batteries or other exhaustible means for their energy. For these nodes, the most important system design criteria for optimization is energy conservation.

## III. ISSUES AND CHALLENGES IN MANETS

### A. *Mobility of nodes and unpredictable topology*

All the nodes are free to move throughout the network. They are free to join or leave the network at any point of time. Links will be dynamically formed when two nodes moves into transmission range of each other and are broken down when they move out of transmission range. Links of the network vary timely and are based on the proximity of one node to another node. Often the topology undergoes unpredictable changes and routing of data packets from the source to the destination becomes a difficult task [2-3]. As a result of mobility, MANETs are prone to numerous types of problems such as,

- Transmission errors: The unpredictable changes in topology may lead to the loss of transmitted data or sometimes may lead to transmitted packets being garbled and thus received in error [4]. Reliable delivery of data is a very important issue that needs to be addressed while using MANETs for different applications [5-9]
- Route breakages: Random and unpredictable movement of nodes in the network may lead to the breakage of a link and thus breaking the route selected for transmission of the data. Thus the transmission of data cannot rely on a single selected path.
- Node failures: The mobile devices or nodes may fail due to several reasons. Mobility and problems in the wireless environment may lead to the failure of nodes. They may also drop out of the network either voluntarily or when their energy supply is depleted.

- Congested nodes or links: Due to the topology of the network and the nature of the routing protocol, certain nodes or links may become over utilized and thus may lead to congestion. Congestion in the network would lead to unpredictable delays and also may lead to loss of data packets in the network.

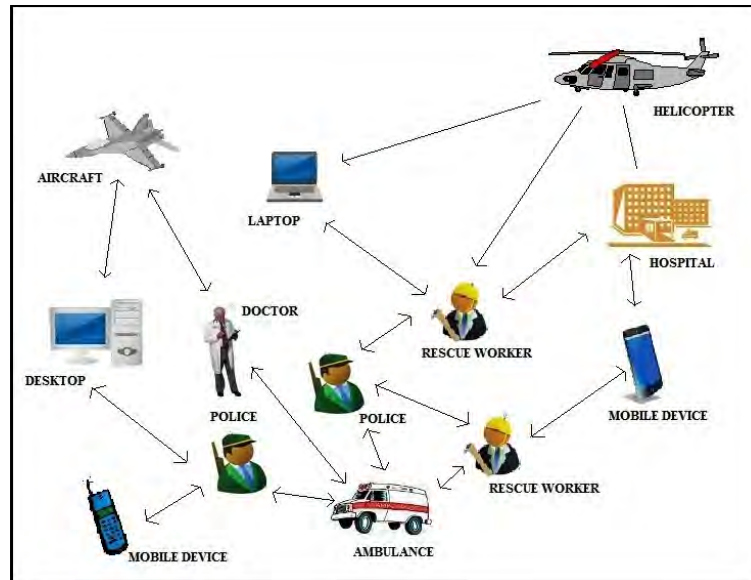


Figure 1. MANETs deployed for disaster recovery operations

**B. Routing and route maintenance:**

Routing is one of the most important issues in the MANET. Due to the dynamic topology and error prone wireless channel, design and selection of the suitable routing protocol for the network is very important to obtain a good performance. The dynamic nature of the network topology and the changing behaviour of the communication medium make the precise maintenance of network state information very difficult. Because of this, the routing algorithms in MANET must operate on imprecise information. Since the nodes can join and leave the ad hoc network environment as they please, the established routing path may be broken at any time even during the process of data transfer. Thus, the need arises of routing protocols with minimal overhead and delay. Reliable data delivery also has to be taken care off while routing the data packets from the source to the destination.

**C. Infrastructure less and self operated**

Every time the MANET has to organize itself in the absence of a fixed infrastructure. Self healing feature demands MANET should realign itself to adjust with any node moving out of its range.

**D. Autonomous**

Lack of a centralized control to manage the functions and operations of different nodes also raises serious challenges to MANET.

**E. Unreliability of wireless medium**

Error prone wireless medium is another area of concern. Unpredictable link properties raise a number of problems in the network. Wireless mediums are often affected by channel interferences and other problems leading to error in transmitted data.

**F. Difficulty in discovery of Devices**

It's always difficult to identify the newly moved in nodes in the network and informing the other nodes about them. This data needs to be updated always and should be shared among all the nodes in the network so that routing of data packets can be done efficiently

**G. Limited resources**

Constrained energy supply is one of the important issues concerning a MANET. As the nodes rely on battery power, minimizing the utilization of energy is very important. Also storage capacity and power are severely limited.

**H. Security**

There are a number of security issues that needs to be take care off. Security problems may be caused by compromised nodes or lack of proper management of wireless links [10]. As any node can join the network,

security of data transmitted is serious issue. MANETs must be protected from security threats like eavesdropping, jamming, impersonating etc.

#### IV. PARAMETERS FOR DESIGNING AND SELECTING ROUTING PROTOCOLS

The protocol must be designed to support the highly dynamic nature of the ad hoc networks. The protocol must take care of constantly moving nodes and must be able to make proper routing decisions for the data packets.

##### A. Forwarding of packets

Forwarding of packets must be made by the protocol in an efficient way considering many factors like transmission range of the nodes, traffic in the link etc [11].

##### B. Absence of a centralized control

Design and selection of the protocol must be done considering the fact that the ad hoc network does not have a centralized control. Every node can join or leave the network at any time and can move freely throughout the network.

##### C. Free of Loops

The routing protocol must make sure that the data sent across is not circulated around the network on the same paths or between the same nodes which consider each other equally close to the destination [12-14]. If proper consideration is not given to issue, performance degradation in the network can occur.

##### D. Memory

As the ad hoc network has mobility, routing algorithms with additional memory requirements may face some problem [15]. Maintaining current accurate location information subject to topological changes causes high traffic, queues, congestion, overhead, latency and energy expenditure [16-17]. Therefore it is desirable to avoid solutions which involve large memory demands at node level

##### E. Delay

The routing protocol must make sure that the delay experienced by the data packets in the ad hoc network is minimum and a good performance is guaranteed always.

##### F. Guaranteed Message Delivery

Routing protocols must make sure that all the data has been delivered properly to the destination [18]. This is one of the most important requirements for every routing protocol used in MANETs.

##### G. Selection of Optimal Path

Selection of the optimal path to send the data packet is a very important factor with the routing protocol [19-20]. The algorithm has to be designed to select the most optimal path to the destination for the data packet.

##### H. Overhead

While including all these features and characteristics, the routing protocol must make sure that the additional overhead required is minimum and it does not affect the performance of the network significantly. Both the routing overhead and the control overhead should be kept minimum to provide a good performance for the routing protocol in the ad hoc network.

#### V. CONCLUSION

In this paper we examined the main issues and challenges concerned with highly mobile ad hoc networks. Initially we studied the various characteristics that are unique to MANETs. We then examined the various issues and challenges existing in MANETs and then analyzed each issue in detail along with its importance and possible ways to handle them. The most important issue of mobility and its effect on routing of data packets was examined in detail. Finally we also discussed the various parameters that have to be considered for designing and selecting a routing protocol in highly mobile ad hoc networks.

#### REFERENCES

- [1] S. Giordano and W. W. Lu, "Challenges in mobile ad hoc networking," *IEEE Communications Magazine*, vol. 39, no. 6, pp. 129–181, June 2001.
- [2] J. Broch, D.A. Maltz, D.B. Johnson, Y.-C. Hu, and J. Jetcheva, "A performance comparison of multi-hop wireless ad hoc network routing protocols," *Proc. ACM MobiCom*, pp. 85-97, 1998.
- [3] Perkins CE, Bhagwat P (1994) Highly Dynamic Destination-Sequenced Distance-Vector Routing (DSDV) for Mobile Computers. *Proceedings of ACM SIGCOMM 1994*:234–244.
- [4] C. Perkins and E Royer, "Ad Hoc On-Demand Distance Vector Routing," 2nd IEEE Wksp. Mobile Comp. Sys. and Apps., 1999.
- [5] Chlamtac, I., Conti, M., and Liu, J. J.-N., "Mobile ad hoc networking: imperatives and challenges. *Ad Hoc Network*", 1(1), 2003, pp.13–6.
- [6] Varun G. Menon and Joe Prathap P. M., Performance of various Routing Protocols in Mobile Ad Hoc Networks-A Survey, *Research Journal of Applied Sciences, Engineering and Technology*, 6(22), pp. 4181-4185, December 2013.
- [7] Varun Menon and Joe Prathap P.M., "Performance analysis of geographic routing protocols in highly mobile ad hoc network," *Journal of Theoretical and Applied Information Technology*, vol. 54 no. 1, pp 127-133, 2013.

- [8] Varun G Menon, Jogi Priya P M, Joe Prathap P M, "Analyzing the behavior and performance of greedy perimeter stateless routing protocol in highly dynamic mobile ad hoc networks", *Life Science Journal* , 10(2): pp 1601-1605, 2013.
- [9] V. G. Menon and P. M. Joe Prathap, "Opportunistic routing with virtual coordinate to handle communication voids in mobile ad hoc networks," in *Advances in Signal Processing and Intelligent Recognition Systems*, vol. 425 of *Advances in Intelligent Systems and Computing*, pp. 323–334, Springer International, 2016.
- [10] P. Gupta and P. R. Kumar, "The Capacity of Wireless Network," *IEEE Trans. Info. Theory*, Vol. 46, no. 2, March. 2000.
- [11] Yau P.-W., Mitchell C.J., "Security Vulnerabilities in Ad Hoc Networks", In *Proc. of the 7th Int. Symp. on Communications Theory and Applications*, pp. 99-104.
- [12] Jie Wu , Fei Dai, *Broadcasting in Ad Hoc Networks: Based on Self-Pruning* , *Int'l J Foundations of Computer Science*, vol. 14, no. 2, pp. 201-221, Apr. 2003.
- [13] E. Royer and C.-K. Toh, "A Review of Current Routing Protocols for Ad Hoc Wireless Networks," *IEEE Pers. Commun.*, Apr. 1999, pp. 46–55.
- [14] Marco Conti, *Body, Personal and Local Ad Hoc Wireless Networks*, in *Book The Handbook of Ad Hoc Wireless Networks (Chapter 1)*, CRC Press LLC, 2003.
- [15] Chen T-W, Gerla M (1998) *Global State Routing: A New Routing Scheme for Ad-hoc Wireless Networks*. *Proceedings of IEEE ICC 1998*:171–175.
- [16] Tsuchiya PF (1988) *The Landmark Hierarchy: A New Hierarchy for Routing in Very Large Networks*. *Computer Communication Review*, Volume 18, Issue 4:35–42.
- [17] Park VD, Corson MS (1997) *A highly adaptive distributed routing algorithm for mobile wireless networks*. *Proceedings of IEEE INFOCOM 1997*, Volume 3:1405–1413.
- [18] Varun G. Menon, Joe Prathap Pathrose, and Jogi Priya, "Ensuring Reliable Communication in Disaster Recovery Operations with Reliable Routing Technique," *Mobile Information Systems*, vol. 2016, Article ID 9141329, 10 pages, 2016.
- [19] B. Williams and T. Camp, "Comparison of broadcasting techniques for mobile ad hoc networks," in *Proceedings of the Third ACM International Symposium on Mobile Ad Hoc Networking & Computing (MobiHoc)*, 2002, pp. 194–205.
- [20] K. Zeng, W. Lou, and H. Zhai, "Capacity of opportunistic routing in multi-rate and multi-hop wireless networks," *IEEE Trans. Wireless Commun.*, vol. 7, no. 12, pp. 5118–5128, Dec. 2008.