

# Extensive Survey of Hybrid Routing Protocols in MANET

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**Abstract:** - In Mobile Ad hoc Networks (MANETs), proactive protocols involve huge storage overhead because of routing table size and reactive or on-demand routing protocols involve high latency. Hybrid routing protocol combines the advantages of both proactive and reactive protocols. Though lot of surveys has been done on hybrid routing protocols on MANET, mostly the survey was on zone routing protocol (ZRP) and its variants. In this paper an extensive survey has been made on hybrid routing protocols in MANET. It classifies the hybrid routing protocols as zone based, multi path based and Ant colony based. It presents the detailed description of each work under each category. A comparison table is also presented with advantages and disadvantages of each work.

**Keywords:** - MANET; Proactive; Reactive and Zone routing protocol.

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## I. INTRODUCTION

In mobile ad hoc network (MANET), mobile devices are formed as self-organizing, self-creating and self-administering wireless network. A MANET is a collection of mobile platforms called as nodes that can dynamically be set up anywhere and anytime without using any pre-existing network. It is considered as a self-governing system in which mobile nodes are connected by wireless links and moving randomly. The system may be operated independently or integrated with gateways to a fixed network [1].

There is a compromise between table driven and on-demand routing protocols. Proactive or table driven protocols have less latency and more traffic, while reactive or on-demand protocols have more latency and less traffic. Hybrid routing approach is introduced to overcome the shortcomings of both reactive and proactive routing approaches. It merges the advantages of both proactive and reactive approaches. It uses table maintenance technique of proactive and route discovery mechanism of reactive protocols, so as to avoid overhead issue and latency in the network. Hybrid routing approach is relevant for large networks. This broad network is divided into sets of zones. Proactive and reactive approach can be applied inside and

outside the zone respectively. There are numerous popular hybrid routing approaches for MANET like Zone Routing Protocol (ZRP), Zone-Based Hierarchical Link State Routing Protocol (ZHLS), Dynamic Source Tracing Protocol (DST) and Distributed Dynamic Routing Protocol (DDR) [3].

## II. EXISTING SURVEY ON HYBRID ROUTING PROTOCOLS

Lot of survey works have been done related to hybrid routing protocols in MANET. This section presents some of the existing survey works on hybrid routing protocols.

Ibukunle Frank et al [1] have examined three hybrid routing protocols in MANET. They are, Adaptive Distance Vector (ADV) routing protocol, Zone Routing Protocol (ZRP) and Sharp Hybrid Adaptive Routing Protocol (SHARP). The performances of these protocols were compared with each other using NS2. ADV shows better performance than ZRP and SHARP in terms of packet delivery ratio and average end-to-end delay.

Gaurav Kadyan et al [2] have compared Zone routing protocol (ZRP), Core extraction distributed Ad-hoc routing protocol (CEDAR) and Secure Zone routing protocol (SZRP). They have considered two metrics for evaluation they are, Average routing load and average route

acquisition latency. From their study they have found that the SZRP is the best hybrid routing protocol among other hybrid protocols.

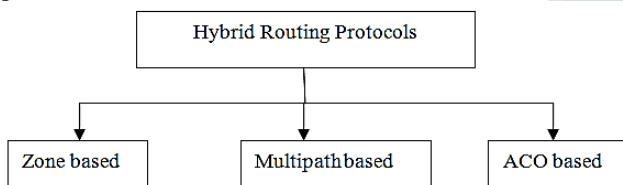
Nawneet Raj et al [3] have done qualitative and quantitative comparison of proactive, reactive and hybrid routing protocols. The comparison has been done based on various parameters such as routing structure, routing scheme, routing overhead, latency, scalability, storage requirements, route availability etc.

Harmandeep Kaur et al [4] have presented a review of hybrid routing protocols Zone Routing Protocol (ZRP), Hybrid Cluster Routing (HCR) and AntHocNet. A comparison table was presented which contains advantages and disadvantages of these protocols.

But all these survey works have considered only limited number of protocols for review and comparison.

### III. CLASSIFICATION OF HYBRID ROUTING PROTOCOLS

Figure 1 shows the classification of hybrid routing protocols.



**Figure 1 Classification of Hybrid Routing Protocols**

As seen in Figure 1, the hybrid routing protocols are classified as follows.

- i) Zone based hybrid routing protocol
- ii) Multipath based hybrid routing protocol
- iii) Ant Colony Optimization (ACO) based hybrid routing protocol

#### 3.1 Zone based Hybrid Routing Protocols

A hybrid protocol, such as zone routing protocol (ZRP), combines the advantages of both proactive and reactive protocols. In ZRP, the network is divided into zones with each node belonging to one of the routing zones. Each node proactively maintains a routing table for nodes within its zone and reactively finds a route to its destination if the destination node lies beyond its zone. In proactive protocols, the update information is sent to all the nodes in the network. However, ZRP limits the scope of the proactive procedure only to the node's local neighborhood (zone). ZRP is based on the idea that the changes in the network topology should have a local effect only. That is, if a node moves, or a new link is added, the

entire network need not be informed of the change as in proactive protocols since this is a local event [7].

Some of the other hybrid routing protocols based on zones are presented below.

Niranjan Kumar Ray et al [5] have proposed an energy conservation technique called Location Based Topology Control (LBTC) with Sleep Scheduling for MANET. It uses the feature of both topology control approach and power management approach. Like the topology control approach, it attempts to reduce the transmission power of a node, which is determined from its neighbourhood location information. A node goes to sleep state based on the traffic condition as that of power management approach. In the proposed scheme, a node goes to sleep state only when its absence does not create local partition in its neighbourhood. LBTC is compared with two existing schemes and observed that it is more energy efficient and delivers higher throughput. However, the end-to-end delay is higher. This is because as the transmission power is controlled, packets take more number of hops to travel the destination.

Basetty Mallikarjuna et al [6] have proposed a new system VCZRP (Virtual Coordinate Zone Routing Protocol) to address the following problems considerably. In the proposed protocol they introduced the concepts of zone routing into Virtual Coordinate system. The main idea here is by maintaining the VC Id (Virtual Coordinate Id) instead of nodes' virtual coordinate vector through routing tables inside the nodes. These VC Id is used for updating the node with their neighboring nodes through frequent flooding of HELLO message packets.

Shadi S. Basurra et al [8] have discussed the Zone based Routing with Parallel Collision Guided Broadcasting Protocol (ZCG) that uses parallel and distributed broadcasting technique to reduce redundant broadcasting and to accelerate the path discovery process, while maintaining a high reachability ratio as well as keeping node energy consumption low. ZCG uses a one hop clustering algorithm that splits the network into zones led by reliable leaders that are mostly static and have plentiful battery resources. The performance of ZCG protocol is compared with AODV and DSR protocols. It shows that ZCG performs well under many circumstances. One of the drawbacks of the ZCG was that all the nodes at each zone compete to use the physical medium for sending all their messages regardless of whether these are sent over the backbone links or not. This can cause delay which impacts on the parallelism of the collision guided broadcasting technique.

Dhanya Sudarsan et al [9] has proposed Distance Aware Zone Routing Protocol (DZRP) to determine the

zone radius or the actual physical distance of ZRP. Their research identifies the issues with DZRP and proposed a cost effective modification to solve the identified issue. Their research also provided a detailed look into the implementation of the modified distance aware zone routing protocol. The enhanced distance aware ZRP reduces the total time required by the packet to reach the intended destination and provides efficient power and bandwidth utilization, in addition to all the advantages due to hybridization.

Indrajit Bhattacharya et al [10] have addressed routing problem using the existing Minimum Estimated Expected Delay (MEED) and Zone Routing Protocol (ZRP). In their work a technique to send data within a reasonable amount of delay to the destination is suggested. The features of ZRP is combined with MEED to increase the efficiency. In this procedure a fewer comparisons is made that in turn reduce the average waiting time for data transmission in the network. Here the nodes between zones are compared but in MEED the node which has lowest average waiting time is found across the entire network.

### 3.2 Multipath based Hybrid Routing Protocols

Nagaraj M. Lutimath et al [11] have proposed Interference Aware Hybrid Multipath Dynamic Source Routing protocol (IAHM-DSR). It establishes minimum interference path considering the Link Expiry Time (LET) metric for better data delivery. An interference model based on Poisson distribution is assumed. By simulation, they have shown that IAHM-DSR performs better than DSR in terms of packet delivery ratio and throughput.

Rama Devi et al [12] have proposed a QoS enhanced hybrid multi-path routing protocol for MANET. In this protocol, topology discovery is performed proactively and route discovery is performed in reactive manner. In proactive topology discovery phase, the information of battery power, queue length and residual bandwidth of every nodes are stored in topology information table (TIT). When the source node wants to forward the data packet to the destination, it utilizes the reactive route discovery technique where multiple paths are established using multi-path Dijkstra algorithm. By simulation results, it is shown that the proposed approach reduces the overhead.

Jesin Mary Chacko et al [13] have proposed Signal-to-Interference plus Noise Ratio (SINR) based Hybrid Multipath Routing Protocol (SHMRP). It is an extension of the multipath routing protocol AOMDV by considering SINR of the links as the routing metric. It selects multiple paths based on the path cost which is the sum of all the link costs along a path. The link cost is derived from the SINR value. The protocol provides a better performance in comparison

with AOMDV.

Rohan Verma et al [14] have designed Token On-Demand Hybrid Multipath Routing (TOHMR) protocol to reduce the effect of flooding in network. It overcomes the drawbacks of AODV and DSR algorithms. A token is allocated to reduce the flooding and network traffic. When the source node wants to forward the data packet to the destination, it utilizes the reactive route discovery technique with multiple paths. The alternative paths of the node-disjointed multipath are not affected by the node failure on the primary path.

### 3.3 ACO based Hybrid Routing Protocols

Ant Colony Optimization (ACO) belongs to the category of bio-inspired algorithms which takes inspiration from the behaviour of ants for obtaining the food. It is a metaheuristic used to provide solution for different problems, including routing. Some hybrid routing protocols using ACO technique have been proposed in the literature, which are discussed below:

Ruperez Canas et al [15] have presented Hybrid ACO Routing (HACOR) protocol which combines both proactive and reactive routing techniques. It consists of a buffering technique for storing control packets, improved link failure management technique and a proactive route discovery technique. The experimentation results show that HACOR has a better performance than AODV by reducing the control overhead, end-to-end delay and improving the throughput.

Gianni Di Caro et al [16] have proposed AntHocNet, a hybrid multipath routing algorithm. The main idea is to continuously sample possible paths using ant agents and to indicate the quality of paths by means of artificial pheromone variables. If the proactive routing information was not found in the routing table, it reactively sends out forward ant agents, to search for paths towards the destination. Simulation experiments showed that AntHocNet outperform AODV in terms of delivery ratio and average delay.

Nivetha et al [17] have proposed a Swarm-based Hybrid Routing Protocol (SHRP) based on ACO. It uses a proactive routing technique within a limited zone of radius  $r$  (Ant-IARP) and uses a reactive routing scheme, outside this zone (Ant-IERP). It selects a minimum delay path with the maximum available bandwidth at nodes. SHRP is compared with existing ZRP and HOPNET in terms of packet delivery ratio, end-to-end delay and available bandwidth. Even though SHRP results in a slightly high routing overhead, it produces much better throughput with very low delay.

Vignesh Ramamoorthy et al [18] have proposed a

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hybrid routing scheme that combines the best properties of ACO and Multi Agent Systems (MAS). MAS can be used to solve problems that are difficult or impossible for an individual agent or a monolithic system to solve. In this protocol, ACO is applied for proactive routing and MAS is applied for reactive routing. By simulation, it was shown that it reduces the delay and packet loss with increased packet delivery ratio.

### IV. COMPARISON OF HYBRID ROUTING PROTOCOLS

Table 1 Comparison of Hybrid Routing Protocols with their merits and demerits.

Author	Title	Technique Used	Metrics	Advantages	Drawbacks
Niranjan Kumar Ray et al	A Hybrid Energy Efficient Protocol for Mobile Ad Hoc Networks	Zone Based	Energy Consumption, Network life time, Delay and throughput	The proposed method more energy efficient and delivers high throughput	
Basetty Mallikarjuna et al	VCZRP: Enhancing Performance of Mobile Ad Hoc Networks Using Virtual Coordinates		Network bandwidth,	Better bandwidth utilization achieved, Routing becomes faster, Easily can manage node mobility.	Security is essential
Nicklas Beijar	Zone Routing Protocol (ZRP)		Bandwidth	Better bandwidth achieved and less cost	
Shadi S. Basurra et al	Energy Efficient Zone based Routing Protocol for MANETs		Bandwidth, Overhead, Network throughput	It achieves good reachability ratio, less power consumption	
Dhanya Sudarsan	Modified Distance Aware Zone Routing Protocol for Less Delay Transmission in MANET		Throughput, packets received, delivery ratio, end-to-end delay	It achieves better delivery ratio and less delay	
Indrajit Bhattacharya	ZMEED: A Zone based Enhanced Hybrid Routing Protocol for Delay Tolerant Network		Energy and delay	The dissipation of energy is excellent and takes less time delay.	In here the need of optimal path estimation is eliminated
Nagaraj M. Lutimath et al	Interference Aware Hybrid Multipath Protocol for Mobile Ad hoc Network	Multipath based	Packet delivery ratio, throughput and data loss	It achieves better delivery ratio and throughput	
Rama Devi	QOS ENHANCED HYBRID MULTIPATH ROUTING PROTOCOL FOR MOBILE ADHOC NETWORKS		Delivery ratio, delay, overhead, throughput and energy consumption	The proposed method reduces overhead.	



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Jesin Mary Chacko	SINR Based Hybrid Multipath Routing Protocol for MANET		Delay, Delivery ratio, Control overhead	The proposed method reduces route discovery frequency and reduces control overhead.	
Rohan Verma	Design a Token Based On-demand Hybrid Multipath Routing Algorithm for Mobile Ad-hoc Network		Flooding traffic and Network traffic	It reduces food traffic and route discovery frequency	
Ruperez Canas et al	Hybrid ACO Routing Protocol for Mobile Ad Hoc Networks	ACO Based	Delay, Jitter, Overhead, packet delivery ratio and throughput	It reduces the overhead packets	
Gianni Di Caro et al	AntHocNet: an Ant-Based Hybrid Routing Algorithm for Mobile Ad Hoc Networks		Delay and Packet delivery Ratio	It produces reliable data transmission, achieves better delivery ratio and less delay, jitter	
Nivetha	A Swarm-based Hybrid Routing Protocol to Support Multiple Quality of Service (QoS) Metrics in Mobile Ad Hoc Networks		Delay, delivery ratio, bandwidth, throughput and hop-count	It achieves better throughput, delivery ratio with low delay	
Vignesh Ramamoorthy et al	Hybrid Routing Scheme Of Multi Agent Ant Based System In MANET Combination Of Proactive And Reactive		Delay, Delivery Ratio and Packet loss	It achieves better delivery ratio and less packet loss and low delay	The proposed method is not suitable for higher network load and for some complex metrics

### V. CONCLUSION

In our survey, we have studied about different routing principles specifically about hybrid routing protocols. We have given detail explanation for hybrid routing and its working principles with relevant algorithms. In our section we have classified the hybrid routing protocols into three different groups. The first classification is based on Zone based routing method, in here different zone based techniques are explained with its algorithms. The second classification is based on multipath routing strategy, in here different multipath scenarios are explained with its relevant working principles. The third classification is based on Ant Colony (ACO) based routing technique; in

here the implementation of ACO algorithm in routing process is briefly explained. In here we highlighted the drawbacks in each technique. Our future research work purely based on these drawbacks to find optimal solution.

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