Performance Analysis of Proactive, Reactive and Hybrid Routing Protocol in Manet

Shashank Awasthi ¹, Naveen Chauhan ², Arun Pratap Srivastava ³
¹²³G.L.Bajaj Institute of Technology & Management, Greater Noida

ABSTRACT: The movement of the job to the number of tracks on the central contact, and this in turn affects the performance of the routing algorithm. We have also studied the effect of density on the performance routing node. With very sparsely populated [1] network the number of possible connection between any two nodes is very less and hence the performance is poor. It is expected that if the node density is increased the throughput of the network shall increase, but beyond a certain level if density is increased the performance degrades in some protocol. The proactive routing protocols maintain the complete network graph in current state, where it is not required to send packets to all those nodes. Consumes lots of network resources to maintain up-to-date status of network graph. Alike the proactive protocol, The reactive routing protocol have very high response time as route is needed to be discovered on demand, when there is some packet to be sent to new destination which does not lie on active path.

Both these approaches have some substantial disadvantage and to overcome hybrid routing [2] protocols designed. Hybrid routing protocols, takes advantage of proactive approach by providing reliability within the scalable zone, and for beyond the scalable zone it looks for the reactive approach. In this work an attempt has been made to compare the performance of hybrid routing protocol and prominent routing protocols such as AODV, DSR and DSDV.

Keywords:- MANETS, HYBRID ROUTING PROTOCOL, NORMALIZED ROUTING LOAD, PACKET LOSS, AVERAGE THROUGHPUT.

I. INTRODUCTION.

Mobile Ad Hoc Networks are wireless networks which do not need any infrastructure support for communicating between two nodes or more nodes. Wireless network is a computer network that is wireless and it is commonly associated with a telecommunications network whose interconnections between nodes are implemented without the use of wires. In mobile ad-hoc networks nodes are free to move randomly. Thus the network’s wireless topology may be unpredictable and may change rapidly. MANETs employ the traditional TCP/IP structure to provide end to end communication between nodes. However due [1] to their mobility and the limited resource in wireless networks, each layer in the TCP/IP model require redefinition or modifications to function efficiently in MANETs. In these networks nodes also work as routers that are they also route packet for [2] other nodes also. Nodes that are involved in MANETs organize themselves arbitrarily store and forward for other nodes. In the ad hoc mobile networks multiple routes are mainly Hip often and unexpectedly because of this small spread of radio, topology change, because each network host moves randomly.
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The hybrid routing protocol combines the advantages of proactive routing protocol and reactive routing protocol. The routing is initially [3] established with some proactively prospected routes and then serves the demand from additionally activated nodes through reactive flooding. Nodes in mobile and ad hoc networks communicate with one another via packet radios on wireless multihop links. While exchanging the information, the nodes may continue to move, so the network must be prepared to adapt continually. Because of node mobility and power limitations, the network topology changes frequently. Routing protocols therefore play an important role in mobile multihop network communications. Most of the protocols in this category, however, use single route and do not utilize multiple alternate paths.

A central challenge in ad hoc networks is the design of routing protocols that can adapt their behavior to frequent and rapid changes in the network. The [4] performance of proactive and reactive routing protocols varies with network characteristics, and one protocol may outperform the other in different network conditions. The optimal routing strategy depends on the underlying network topology, rate of change, and traffic pattern, and varies dynamically. Hybrid Routing Protocol automatically finds the balance point between proactive and reactive routing by adjusting the degree to which route information is propagated proactively versus the degree to which it needs to be discovered reactively.

Hybrid protocols seek to combine the proactive and reactive approaches. An example of such a protocol is the Zone Routing Protocol (ZRP). ZRP divides [1] the topology into zones and seek to utilize different routing protocols within and between the zones based on the weaknesses and strengths of these protocols.

An adaptive hybrid routing protocol requires the following three properties for successful deployment.

- **Adaptive:** The protocol should be applicable to a wide range of network characteristics. It should automatically adjust its behavior to achieve target goals in the face of changes in traffic patterns, node mobility and other network characteristics.

- **Flexible:** The protocol should enable applications to optimize for different application-specific metrics at the routing layer. These optimization goals should not be set by the network designer, but be placed under the control of the network participants.

The difference between these protocols exists in the way the routing information is updated, detected and the type of information kept at each routing table.
Table 1: Summary of proactive and reactive protocols

<table>
<thead>
<tr>
<th>Availability of routing Information</th>
<th>Table-driven</th>
<th>On-demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability of routing Information</td>
<td>Immediately from route table</td>
<td>After a route discovery</td>
</tr>
<tr>
<td>Route Updates</td>
<td>Periodic Advertisements</td>
<td>When requested</td>
</tr>
<tr>
<td>Routing Overhead</td>
<td>Proportional to the size of the network regardless of network traffic.</td>
<td>Proportional to the number of the communicating nodes and increases with increased node mobility.</td>
</tr>
</tbody>
</table>

The hybrid routing protocol combines the advantages of proactive routing protocol and reactive routing protocol. The routing is initially established with some proactively prospected routes and then serves the demand from additionally activated nodes through reactive flooding. Nodes in mobile and ad hoc networks communicate with one another via packet radios on wireless multihop links. While exchanging the information, the nodes may continue to move, so the network must be prepared to adapt continually. In our study, we took only advantages part of the both the routing protocols as shown in the table 2.

Table 2: Summary of proactive and reactive protocols

<table>
<thead>
<tr>
<th>Main Features</th>
<th>Proactive</th>
<th>Reactive</th>
<th>Hybrid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintain routing information on all nodes in the network at all times.</td>
<td>Maintain routing information for the nodes which are needed and only for the time when they are needed</td>
<td>Proactive for short distances and reactive for long distances</td>
<td></td>
</tr>
<tr>
<td>Low route setup</td>
<td>Low routing overhead</td>
<td>No route setup required</td>
<td></td>
</tr>
<tr>
<td>High routing overhead</td>
<td>Larger route setup</td>
<td>More complex</td>
<td></td>
</tr>
</tbody>
</table>

**Efficient and Practical:** The protocol should achieve better performance than pure, non-hybrid, strategies without invoking costly low-level primitives such as those for distributed agreement.

**II. LITERATURE REVIEW.**

A performance study of Adhoc on-Demand Distance Vector (AODV), Destination- Sequenced Distance-Vector Routing protocol (DSDV), Dynamic Source Routing Protocol (DSR), and Optimum Link State Routing (OLSR) protocols on variable bit rate (VBR). In this paper, Author was categorized routing protocols in two categories. Table-driven and on-demand routing protocols. In table-driven protocols, each node maintain up-to-date routing information to all the nodes in the network where in on-
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demand protocols a node finds the route to a destination when it desires to send packets to the destination. Several table-driven protocols were discussed as ZRP and FSR are table-driven protocols that use destination sequence numbers to keep routes loop-free and up-to-date. FSR reduces the size of tables to be exchanged by maintaining less accurate information about nodes farther away. Author has presented a detailed performance comparison of important routing protocols for mobile ad hoc wireless networks. Both reactive protocols performed well in high mobility scenarios than proactive protocol. High mobility result in highly dynamic topology i.e. frequent route failures and changes. Irrespective of mobility while in AODV it increases with increase in mobility. Both AODV and DSR use reactive approach to route discovery, but with different mechanism. DSR uses source routing and route cache and does not depend on their timer base activity. On other hand AODV uses routing tables, one route per destination, sequence number to maintain route. Author analyzed the observation from simulation is that DSR has performed well compared to AODV, ZRP protocols in terms of Delivery ratio while AODV outperformed in terms of Average delay. DSR, FSR generates lower of less number of nodes all protocols performed poorer in terms of delivery ratio as nodes breakage may be more and no route may be available, again DSR,FSR outperformed all with respect to Delivery Ratio. In case of average delay, AODV [1] [5] [6] was better than DSR. Poor performance of DSR, FSR in respect of average delay can be accounted to aggressive use of caching and inability to delete stale route. But it seems that caching helps DSR to maintain low overhead. In paper [2] we studied a replacement hybrid multipath routing protocol for MANET known as Hybrid Multipath Progressive Routing Protocol for MANET (HMPRP), in this paper author improved the performance of accepted MANET routing protocols, namely, the Ad-hoc On-demand Distance Vector routing protocol and use of their most popular properties to formulate a replacement Hybrid routing protocol using the received signal strength.

The Hybrid Multipath Progressive Routing Protocol additionally extends the battery lifetime of the mobile devices by reducing the specified variety of operations for Route determination and for packet forwarding. We studied that better performance are achieved with regard to AODV, OLSR, and ZRP routing algorithm in terms of packet delivery ratio, throughput, energy consumed and end-to-end packet delay. HMPRP achieved better performance by the elimination unwanted message exchanges and route requests and route replies. In other [1] research work, the main objective is to compare the quality of service performance parameters such as average throughput, average jitter and average delay of NOAH (No-Adhoc Routing Agent) and DSDV (Destination-Sequenced Distance-Vector routing). The NOAH protocol performed better than DSDV in term of average jitter and delay when the number of nodes increases. In term of throughput the two protocols under consideration still similar. This performance study can be enhanced by taking into account other mobility models by adding maybe other parameters like pause time.

III. PROBLEM DOMAIN.

Objective of the Problem: The proactive routing protocols maintain the complete network graph in current state, where it is not required to send packets to all those nodes. Consumes lots of network resources to maintain up-to-date status of network graph. Alike the proactive protocol, The reactive routing protocol have very high response time as route is needed to be discovered [7] on demand, when there is some packet to be sent to new destination which does not lie on active path. Alike the reactive routing protocol have very high response time as route is needed to be discovered on demand, when there is some packet to be sent to new destination which does not lie on active path.

Scope of the Problem: Due to the frequent changes in network topology and the lack of the network resources both in the wireless medium and in the mobile nodes, mobile ad hoc networking becomes a challenging task. As a result, routing in such networks experiences link failure more often than infrastructure based network. Hence, a routing protocol that supports ad hoc networks requires considering the reasons for link failure to improve its performance. Link failure results from node mobility and lack of the network resources. Therefore it is essential to analyze the characteristics to identify the quality of links. Furthermore, the routing protocols must be adaptive to cope with the time-varying low-capacity resources. For instance, it is possible that a route that was earlier found to meet certain requirements no longer does so due to the dynamic nature of the topology. In such a case, it is important that the network intelligently adapts the session [8] to its new and changed conditions. The mobile nodes must co-operate
at the routing level in order to forward packets to moderate the behavior in MANET. Let assume a network scenario, a company setups a mobile ad-hoc network in a rural area to communicate through a video conferencing. As frequent changes in network topology and the lack of network resources such as power, as a result it degrades the performance of the network. In proactive routing protocol, very huge exchanges of routing messages in a very short span [9] of time interrupt the service performance of network. While in case of reactive routing protocol, it takes too much time establish a communication path between sender and receiver that discards the IP packet, until it does not get a communication path. Due to these issues, the variation of packet transmission time is increased in exponential characteristics, which is not suitable for IP level services such as voice over internet protocol, video conferencing etc.

Both these approaches have some substantial disadvantage and to overcome hybrid routing protocols designed. Hybrid routing protocols, takes advantage of proactive approach by providing reliability within the scalable zone, and for beyond the scalable zone it looks for the reactive approach. Hybrid routing protocols are a new advanced protocol, which are having both feature proactive and reactive in nature. The motive to design these protocols is to increase scalability and reliability. Even reactive and proactive routing protocols have some advantageous features, those can be included in the proposed hybrid protocol. A central challenge in ad hoc networks is the design of routing protocols that can adapt their behavior to frequent and rapid changes in the network. The performance of proactive and reactive routing protocols varies with network characteristics, and one protocol may outperform the other in different network conditions. The optimal routing strategy depends on the underlying network topology, rate of change, and traffic pattern, and varies dynamically. Hybrid Routing Protocol automatically finds the balance point between proactive and reactive routing by adjusting the degree to which route information is propagated proactively versus the degree to which it needs to be discovered reactively.

IV. PERFORMANCE EVALUATION AND DESIGN.

We present the design parameters of our system and the various metrics considered in the performance evaluation of the routing protocols. We begin by presenting an overview of the performance metrics considered in the comparisons. We evaluate the performance of proposed hybrid routing based on some metrics. On the basis of these metrics, we evaluated the result in favor of our proposed protocol.

Performance Factors: The use of various performance metrics for the evaluation of hybrid routing protocol. They provide various features of the performance of the network in general. In this report we assess the three metrics in our comparison for the study of their impact on the total performance of the network. These metrics are the packet loss (%), normalized routing load and network throughput. In metric basis the standard measure which is used in the routing algorithm to determine the best possible efficiency and effectiveness of the route to a destination.

Network Performance Improving Factors:

(A) **Normalized Routing Load (NRL)** is the ratio of control packets to data packets in the network. It gives a measure of the protocol routing overhead; i.e. how many control packets were required (for route discovery/maintenance) to successfully transport data packets to their destinations. It characterizes the protocol routing performance under congestion. NRL is determined as:

\[ NRL = \frac{P_c}{P_d} \]

Where \( P_c \) is the total control packets sent and \( P_d \) is the total data packets sent.

(B) **Throughput** A network’s end-to-end throughput is a measure of the network’s successful transmission rate, and is usually defined as the number of data packets successfully delivered to their final destination per unit of time. However, to convert this
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metric to a measure of data throughput or to compare it to other networks, the network’s packet size and the network’s number of nodes also has to be known.

Throughput = number of bits contained in accepted packet / simulation time.

Network Performance Affecting Factors: Throughput, error rate, delay are network performance parameters and there are some factors that affect these parameters.

(A) Throughput Performance Factors Throughput of the most networks whether local area or wide area varies with time. Sometimes there is a sudden throughput change because of the failures on the network nodes, lines or traffic congestion in the network. Throughput performance affecting factors are-

1) Node or link failures
2) Congestion
3) Bottleneck
4) Buffer Capacity

(B) Node or link failures- Sometimes because of some reason there is a link failure and this causes congestion in other nodes, links. Such failures can lead to also packet loss, packet delay and file transfer errors.

(C) Network Congestion- When a network is heavily loaded the congestion occurs due to the heavy traffic or bottlenecks. Most of the networks are designed to accommodate the average [6] [7] traffic demands. However in some cases demands increase and exceed the average network capacity. In that time, throughput of the network decreases and network load increases.

(D) Bottlenecks- Bottlenecks are another reason for declining throughput in the network. It occurs due to the node failures or inadequate node and link failures.

(E) Buffer capacity- For each end to end connection there is a limited amount of buffer memory at the end systems and of the network interfaces. Data is temporarily stored in these buffers when sending from source to destination. In the transmission of large files, such as video frames, buffer capacity is very often inadequate.

Network Error Performance Issues: For the network performance, the errors should be as low as possible. Network errors arise-

1. Individual bits in packets are inverted or lost.
2. Packets are dropped.
3. Packets arrive out of order.

(A) Bit Errors- Bit errors sometimes occur. When that happens error- detecting codes are employed and detect bit error in the packet. Then this code request retransmission of the faulty packet.

(B) Packet loss- In a connection oriented network, when packets are dropped the receiving end-system is usually able to detect such situation and informing sending side of the problem. The receiving end-system does not have precise information about which packet is dropped. A standard approach is retransmission of most packets to the receiving system. However, in connectionless networks, detection of packet loss is difficult. Reason for dropped packets is congestion in the network.

(C) Out of order packets- For long transport streams, packets are numbered consecutively. The system then assigns to receive received in numerical order packets. If the system on the receiver side will not be able to arrange a package, then there is an error. A single package can miss sometimes, it was in the case of the receiving party can not rearrange the original order. Then get requests an end to the proliferation either part of the packet sequence to sequence the entire package.

V. RESULT AND ANALYSIS.
We discuss and analyze the results of our simulations. We begin our discussion by analyzing the average throughput of the network. We then analyze the packet loss and normalized routing load of the network.

**Packet Loss (%):** Packet loss is defined as the difference between the number of packets sent by the source and received by the sink. Packet loss is the failure of one or more transmitted packets to arrive at destination. This metric is very useful to predict the suitability of routing protocol for real time applications.

In the below shown figure 2, we simulate the network in three different traffic pattern. In the first traffic pattern ten mobile nodes are used to analyze the average packet loss percentage compare with four different routing protocols.

![Figure 2- Packet loss vs. No. of nodes](image)

In second and third traffic pattern, we consider 20 and 50 mobile nodes respectively. From the result, we analyze that hybrid routing protocol (zone routing protocol) performs better in a low traffic scenario comparatively to AODV, DSR and DSDV routing protocols. AODV routing protocol performs average in low traffic, but as traffic increases performance degrades in an angel of 45 degree. From the result, no. of nodes and average packet loss % are maintained by the ZRP routing protocol, which suitable for real time application such as voice over internet protocol, video conferencing, weather forecasting etc.

In zrp protocol, when the traffic is low or no. of nodes are very few, the average packet loss % is below 5%, but when the traffic slightly increase zrp performs in a stable manner, and the average packet loss % increases from 5% to 8%. Moreover DSR is good choice for real time application in heavy traffic pattern.

**Average Throughput (kbps):** The throughput metric is defined as the total amount of data a receiver receives from the sender divided by the time it takes for the receiver to get the last packet. The throughput is measured in the bits per second (bit/s or bps).

![Figure 3- Average Throughput vs. No. of nodes](image)
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We analyze the throughput of the protocol in terms of number of messages delivered per one second. In the above shown figure 3, we simulate the network in three different traffic pattern. In the first traffic pattern ten mobile nodes are used to analyze the average throughput. In second and third traffic pattern, we consider 20 and 50 mobile nodes respectively to increase the traffic load in network in smooth manner. From the result, we analyze that hybrid routing protocol (zone routing protocol) performs better in a low traffic scenario comparatively to AODV, DSR and DSDV routing protocols. AODV routing protocol performs average in low traffic compare to DSR and other proactive routing protocol such as DSDV based on our scenario, but as traffic increases performance degrads downward fastly. From the result, no. of nodes and average throughput performance are maintained by the ZRP routing protocol, which suitable for real time application such as voice over internet protocol, video conferencing, weather forecasting etc.

In zrp protocol, when the traffic is low or no. of nodes are very few, the average throughput is above 800kbps but when the traffic slightly increase zrp performs in a zigzag manner, and the average throughput changes from 800 kbps to 790kbps then again increases upto 810kbps. Moreover DSDV performs good in that situation, but comparatively slow to ZRP.

**Normalized Routing Load:** This metric is defined as the number of control packets created per mobile node. Control packets comprise route requests, route replies and error messages. The number of routing packets transmitted per data packet delivered at the destination.

Each hop wise transmission of a routing packet is counted as one transmission. Total number of routing packets (in bytes) divided by total number of delivered data packets. Here, we analyze the average number of routing packets in bytes needed to deliver a single data packet. This is needed because the size of routing packets may vary. In the above shown figure 4, we simulate the network in three different traffic pattern. In the first traffic pattern ten mobile nodes are used to analyze the total normalized routing load. In second and third traffic pattern, we consider 20 and 50 mobile nodes respectively to increase the traffic load in network in smooth manner. From the result, we analyze that hybrid routing protocol (zone routing protocol) performs better in a low traffic scenario comparatively to AODV and DSR routing protocols. AODV routing protocol performs average in low traffic compare to DSR and other proactive routing protocol such as DSDV based on our scenario, but as traffic increases performance degrads upward fastly. From the result, no. of nodes and normalized routing load performance are maintained by the ZRP routing protocol, which suitable for real time application such as voice over internet protocol, video conferencing, weather forecasting etc.

In zrp protocol, when the traffic is low or no. of nodes are very few, the average throughput is below 4 but when the traffic slightly increase zrp performs in a incremental manner, and the normalized routing load changes from 4 to 4.5 or 4.7.
VI. CONCLUSION AND FUTURE WORK:

In this work we have provided descriptions of several routing schemes proposed for ad-hoc mobile networks. We have also provided a classification of these schemes according to the routing strategy i.e., table driven and on demand. We have presented a comparison of these two main categories of routing protocols, highlighting their features, differences and characteristics. Finally we have identified possible applications and challenges facing ad-hoc wireless networks. The evaluation considers the impact of scalability, mobility and video conferencing heavy traffic load on different types of routing protocols. The simulation using ns2 consider different scenarios that attempt to cover all the aspects required for network evaluation. In this paper, analysis and investigations are carried out on the acquired simulation results of three prominent categories of routing protocols, reactive, proactive and hybrid routing protocol. All the simulations are performed over Mobile Ad-hoc networks. We consider DSDV, DSR, AODV and ZRP representative of proactive, reactive and hybrid type of Routing Protocols respectively.

Wireless mobile ad-hoc network has very enterprising applications in today’s world. With fast growing technology mobile laptop computers and wireless hardware costs are becoming very affordable. There is increasing use of wireless devices. In coming years, mobile computing will keep flourishing, and an eventual seamless integration of MANET with other wireless networks, and the fixed Internet infrastructure, appears inevitable. Ad hoc networking is at the center of the evolution towards the 4th generation wireless technology.

From the investigation, it can be easily determined that the performance of ZRP which is a hybrid protocol is best when we compare on the basis of jitter and other metrics as packet delivery ratio, average end-to-end delay, packet loss%, average throughput and normalized routing load. AODV has the poorest performance amongst the four protocols examined. ZRP which is a hybrid protocol has moderate performance which is suitable for real time application services. We consider the network in three different traffic pattern 10, 20 and 50 mobile nodes respectively. In the first traffic pattern 10 mobile nodes are used to analyze the average packet transmission delay in four different routing protocols. From the investigation, we simulate that hybrid routing protocol (zone routing protocol) performs better in a heavy traffic scenario comparatively to AODV, DSR and DSDV routing protocols. AODV routing protocol perform worst in any condition. From the result, no. of nodes and average packet transmission delay are directly proportional to each other. In zrp protocol, when the traffic is low or no. of nodes are very few, the average delay is around 3ms, but when the traffic slightly increase zrp performs better in that situation, and the average delay of packet transmission comes down to 3ms to 1.7 ms. Moreover DSDV is good choice for real time application in heavy traffic pattern. Overall reactive protocols are not suitable for real time applications, as it takes too much time to identify a path. AODV routing protocol performs good in low traffic, but as traffic increases performance decreases on the other hand. From the result, no. of nodes and average end-to-end delay are maintained upto a bearable level by the ZRP routing protocol, which suitable for real time application such as voice over internet protocol, video conferencing, weather forecasting etc. In ZRP protocol, when the traffic is low or no. of nodes are very few, the average end-to-end delay is around 300ms, but when the traffic slightly increase zrp performance decreases but very slow comparatively to other reactive and proactive routing protocols, and the average end-to-end delay increases from 300ms to 390ms. Moreover DSDV is good choice for real time application in heavy traffic pattern. Overall reactive protocols are not suitable for real time applications, as it takes too much time to identify a path.

In ZRP protocol, when the traffic is low or no. of nodes are very few, the average throughput is above 800kbps but when the traffic slightly increase ZRP performs in a zigzag manner, and the average throughput changes from 800kbps to 790kbps then again increases up to 810kbps. Overall the performance of zone routing protocol is very impressive in a heavy network traffic load. Finally, ZRP is comparatively better to providing quality in video streaming over proactive and reactive routing protocols on Mobile Ad-hoc network.

REFERENCES
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