ENHANCEMENT OF MULTIPATH ROUTING PROTOCOL FOR ROUTE RECOVERY IN MANET

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Abstract

Route failure is a vigorous issue in MANET that is mainly responsible for interrupted service between source and destination, so there should be some mechanism to handle this issue as soon as it is detected, to continue the transmission. In this paper we have proposed "Enhancement of Multipath Routing Protocol for Route Recovery (EMPRR) in MANET", a routing protocol which provides multipath discovery, efficient utilization of bandwidth and controlled traffic load route recovery at the time of failure. Aproach: At the time of failure the recovery node is selected from the neighboring nodes of node detecting failure ,by performing route discovery from node detecting failure and the neighboring node which is first to send the route reply packet from the destination to the node detecting failure is selected as recovery node and if the two neighbors of failure node send the route reply packet at the same time then the node with higher available bandwidth is selected in the mean while we send stop transmission till route recovery packet to source node through reverse path, as soon as new path is selected start transmission packet is sent to source to start transmission again and updates its cache by storing new route for transmission. **Results:** The proposed protocol is efficient in overcoming the problem of stale routes in multipath routing protocols. Also proposed protocol shows significant improvement in packet delivery ratio and reduced end to end delay.

Keywords: MANET, Multipath Routing Protocol, Fault Tolerance, Link Failure

Introduction

Mobile Ad Hoc Networks (MANET)

MANET is a self organizing network with autonomous mobile nodes connected dynamically in arbitrary manner through wireless links. These autonomous nodes can communicate with each other if and only if they are in transmission range of each other. As ad hoc network is economically beneficial, it is utilized in the military application, collective and distributed computing, emergency services, wireless mesh and sensor networks and even in hybrid networks [Seethalakshmi, 2011].

Routing in MANET

Routing protocols are mainly used for determining optimal packet routes for sending data between source and destination. Exchanging route information, gathering information about route breaks, repairing broken routes, load balancing are also some useful features of routing protocols.

Unipath Routing Protocols

Unipath Routing Protocols provide single route between source and destination for each data transmission session. In these protocols every node acts as a router that find route for transmission, maintain them and relay packets along the route.

There are two types of unipath routing protocols. First one is Proactive or Table Driven routing protocols, these protocols provide up-to-date topological view of network by constantly monitoring the known routes. If there is any change in the network all nodes in the network receive updates and also if source wants to send packet to destination route is already known. Examples of these protocols are DSDV, OSPF etc. Second type referred to Reactive or On Demand routing protocols, these protocols does not required constant updates as in these protocols route is discovered only when there is need to transmit data between source and destination. Examples of these protocols are DSR and AODV.

Hybrid Routing Protocols are combination of the above two unipath protocols. Examples of these protocols are ZRP and TORA.

Multipath Routing Protocols

Multipath Routing Protocols discover multiple routes between source and destination at the time of route discovery as alternate routes such that if there is any failure in primary path an alternate path can be used for recovery [R.L.Lagendijik, 2003]. These protocols are generally extensions to unipath routing protocols. Due to limited channel bandwidth, limited power and frequent mobility of nodes in MANET, the path connecting the source and destination may go down at any time. To abate these issues multipath routing came into existence in which alternate paths are determined.

Multipath Routing Protocols for Fault Tolerance

These types of routing protocols provide mechanisms to deal with faults in MANET. Due to random movements of node in MANET, it is prone to various faults like failure of nodes, failure of link, breakage of routes and congested links [D. Jagadeesan ,2012]. These protocols follow proper route maintenance mechanism to provide appropriate route recovery at the time of failure by selecting the alternate route discovered at the time of route discovery in optimal way. Node Disjoint, Link Disjoint and Non Disjoint provide more fault tolerance.

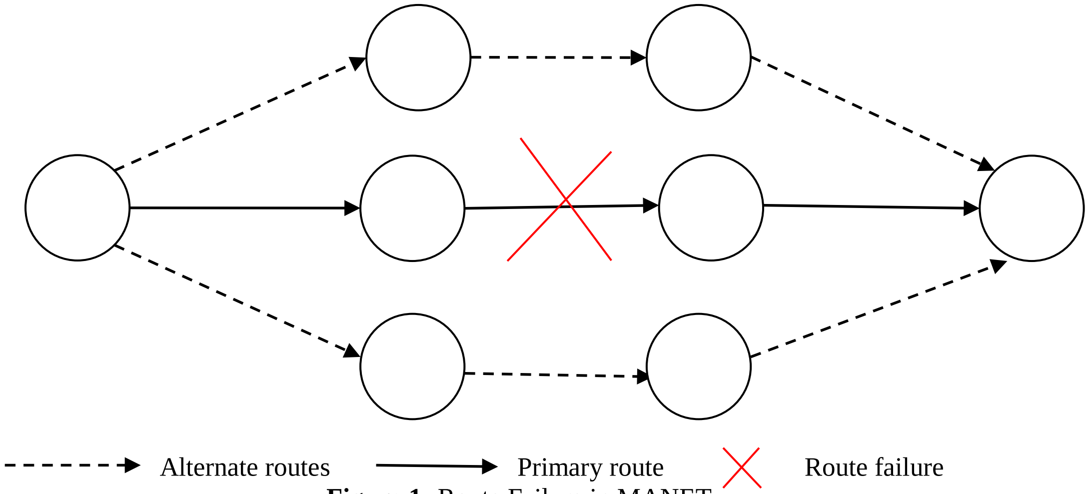


Figure 1: Route Failure in MANET

Problem Statement

Traditional on demand routing produces heavy routing traffic by blindly flooding the entire network with RREQ packets during route discovery. The routing overhead associated with dissemination of routing packets is quite huge especially when topology changes [2] .Multipath routing protocols cache multiple routes to a destination in a single route discovery. However, in presence of mobility, multipath protocols incur additional packet drops and delay due to their dependency on potentially stale routes from caches Protocols using either limited broadcast or local recovery have focused on reducing packet drops and not on utilizing the bandwidth efficiently during route recovery[D. Jagadeesan, 2012].Multipath routing protocols involving multipath discovery and local route recovery at the time of node mobility creates additional burden and heavy traffic load on the network by selecting recovery node as random overhearing node.

So we propose an enhanced routing protocol which provides multipath discovery and controlled traffic load route recovery at the time of failure. Whenever a link or a route break occurs, a route recovery is performed which in turn invokes the alternate route selection from the available nodes on the basis of the neighboring node which is first to send route reply packet from destination if there are more than one node sending packet at same time then node with higher available bandwidth will be selected. The proposed routing protocol has the following advantages:

- Reduces packet drops

- Controlled traffic load at the time of route failure
- Provide optimal routes
- Utilize bandwidth efficiently
- Loop-free
- Reduce stale routes problem

Related Work

This section focuses on literature survey, it present a critical appraisal of the previous work published in the literature pertaining to the topic of the investigation.

Mahesh K. Mariana et al. (2006) proposed AOMDV multipath extension to AODV (single path routing protocol). The proposed protocol provides loop freedom and disjointness of alternate paths also the proposed reduces packet loss and improved end-to-end delay. Sirisha Medidi and Jiong Wang (2007) proposed a location-based route self-recovery technique for source-initiated routing protocols. The purpose of route self-recovery is to reduce overhead and delay during route maintenance as well as allowing continuous packet forwarding for fault resilience. Ha Duyen Trung and Watit Benjapolaku (2007) proposed (MLAR) A Caching Strategy for Multiple Paths in Mobile Ad Hoc Network to provide efficient search and selection basis for multiple paths. The proposed method also provides efficient routing for Mobile Ad Hoc Networks. Aminu et al. (2009) proposed a new probabilistic counter-based (PCBR) method that can significantly reduce the number of RREQ packets transmitted during route discovery operation. There simulation results reveal that equipping AODV routing protocol which traditionally uses the blind flooding. The effect of traffic load, mobility and topology size on the performance of PCBR-AODV route discovery is not considered. Kang and In-Young Ko (2010) proposed a location-based hybrid routing protocol to improve data packet delivery and to reduce control message overhead in mobile ad hoc networks. In mobile environments, where nodes move continuously at a high speed, it is generally difficult to maintain and restore route paths. Dhirendra et al. (2010) enhance the performance of Split Multipath Routing protocols by using route update mechanism. The proposal is useful in route recovery process. In MANET for sending the data packets through alternate path takes more time in comparison with stale route that was broken. So, they repair the broken route through route update mechanism process and reduce the delay through new updated path. Khalid Zahedi et al. (2011) proposed idea of link breakage prediction has appeared. In link breakage prediction, the availability of a link is evaluated, and a warning is issued if there is a possibility of soon link breakage approach has been implemented on the well-known Dynamic Source Routing protocol (DSR). Praveen Yadav *et al*. (2012) proposed a novel routing algorithm for route maintenance based on link failure localization called DSR-LFL. DSR-LFL takes decision on the basis of location of failure link in source route. Proposed algorithm may improve the packet salvaging, delivery ratio and performance of DSR. Rajesh.T *et al*. (2012) present a method by using backtracking algorithm which can be used to find alternative path to reach destination, thereby it reduces the path cost by selecting the optimal alternate node. It uses the process of repeatedly exploring various paths until you encounter the solution. Here current node estimates the shortest path to reach destination while choosing alternative path. When the data has been lost, current node immediately sends request back to the source and retransmission is done. D. Jagadeesan and S.K. Srivatsa (2012) proposed multipath routing protocol for effective local route recovery in Mobile Ad hoc Networks (MANET). In case of route failure in the primary route, a recovery node which is an overhearing neighbor, detects it and establishes a local recovery path with maximum bandwidth from its route cache. Ahmed Alghamdi *et al*. (2012) present a group of protocols (c-protocols) that addresses the issue of dropping packets each time the end-to-end path breaks. In the c-protocol, rather than being dropped, the packets are allowed .

Proposed Work

Overview

We propose an enhanced routing protocol which provides multipath discovery and controlled traffic load route recovery at the time of failure. When the source wants to forward packets to the destination it broadcast the route request packets (RREQ) to whole network. The RREQ propagation from source to destination establishes multiple reverse paths both at intermediate nodes and destination. The multiple paths discovered are loop free and disjoint paths. The destination node upon receiving all RREQ packets attaches the route code consisting of route bandwidth and feedback Route Reply (RREP) packets. These multiple RREPs traverse reverse paths back to from multiple forward paths to the destination at the source and intermediate node. After receiving RREP packets, the source node selects the primary route on the basis of route with higher bandwidth. In case of route failure in primary route the node detecting failure performs the route recovery procedure. The route recovery technique is performed to avoid congestion and degradation in network.

Enhancement of Multipath Routing for Route Recovery

Route Discovery

Step 1: Whenever data packets are needs to be forward by the source node to the destination, the RREQ packets are flooded to entire network. Since RREQ is flooded network-wide, a node may receive several copies of the same RREQ. These duplicate copies can be gainfully used to form alternate reverse path.

Step 2: The reverse paths are formed only using those copies that preserve loop freedom (never form a route at a downstream node via upstream node) and disjointness (ensure the last hops and the next hops before destination are unique) among the resulting set paths to the source.

Step 3: If route information to the destination is present in the route cache of intermediate node, it has no permission to send Route Reply (RREP) back to the source, permission is given only to the destination node.

Step 4: The destination upon receiving all RREQ packets attaches route code and sent it as RREP packet. Upon reception of RREP packets the source selects the primary route on the basis higher bandwidth.

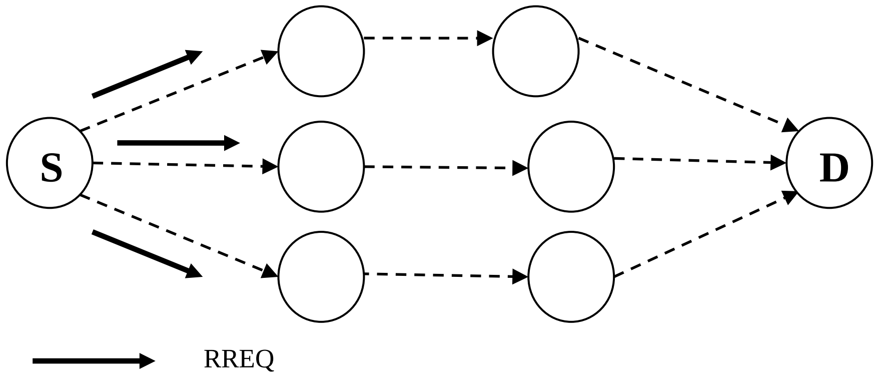
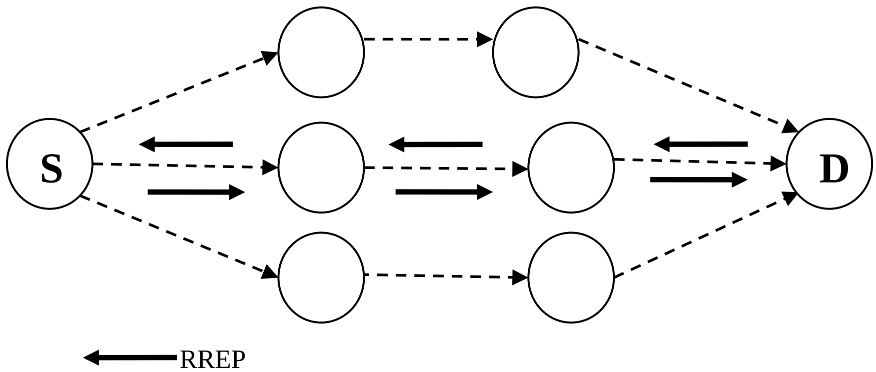


Figure 2: Shows flooding of RREQ by Source



Destination Sending RREP, setting a forward and reverse path, and intermediate nodes update their routing cache.

Figure 3: RREP by Destination

Route Recovery

Step 5: In case of route failure in primary route the recovery node is selected from the neighboring nodes of node detecting failure by performing route discovery from node detecting failure. Now the node detecting failure starts route discovery.

Step 6: In the mean time send Stop Transmission till route recovery packet to source node through reverse path to control congestion.

Step 7: The neighboring node which is first to send the route reply packet from the destination to the node detecting failure is selected as recovery node.

Step 8: If the two neighbors of failure node send the route reply packet at the same time then the node with higher bandwidth is selected as recovery node.

Step 9: As soon as new path is selected a start transmission packet is sent to source to Start transmission again and updates its cache by storing new route for transmission.

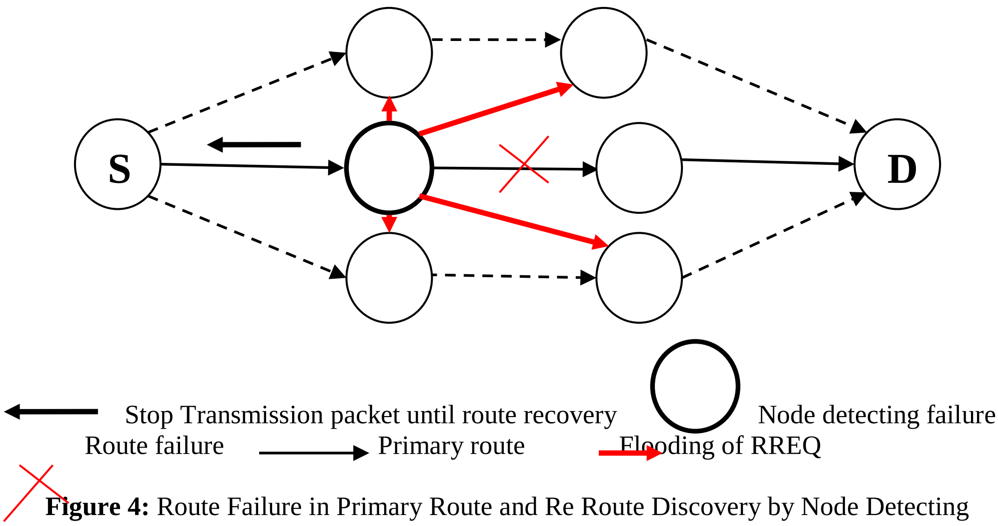
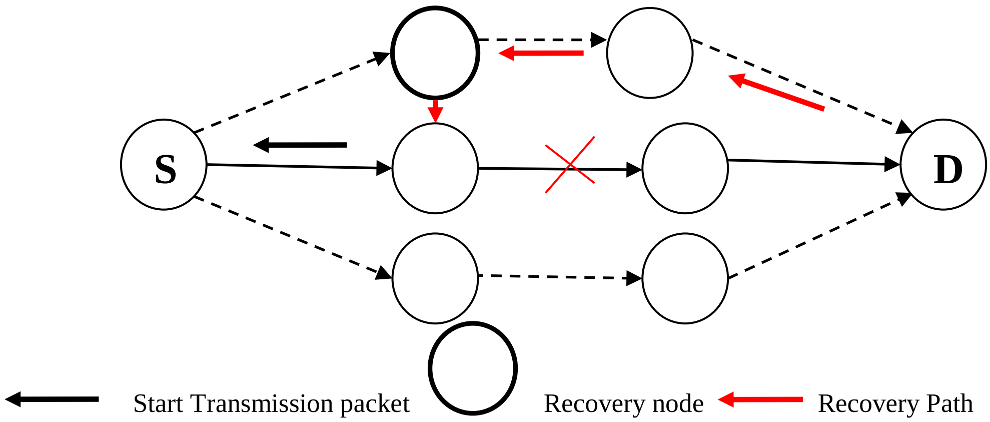


Figure 4: Route Failure in Primary Route and Re Route Discovery by Node Detecting Failure



Neighboring node first to send route reply packet is considered as recovery path and after that start transmission packet is sent to source to start transmission again.

Figure 5: Shows Recovery Path and Start Transmission Packet to Source

Detailed flowchart of EMPRR

Detailed flowchart represents the pictorial overview view of protocol.

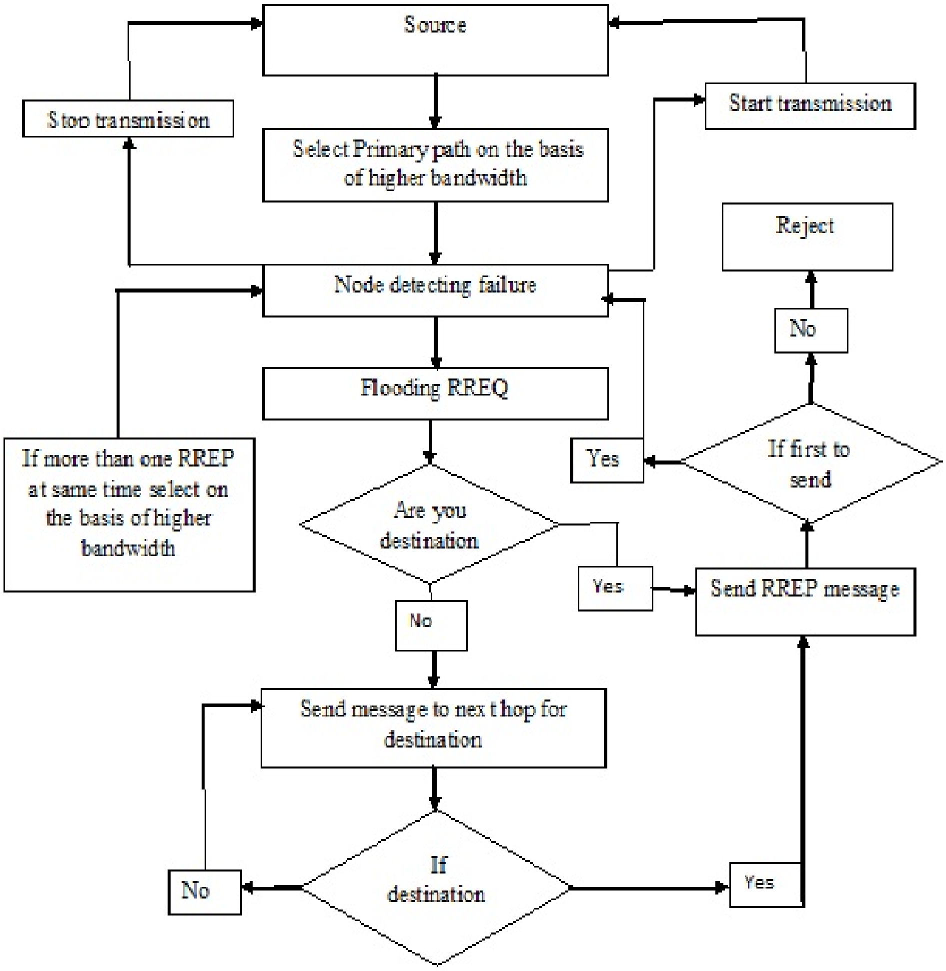


Figure 6: Flow diagram of EMPRR protocol

Results and Discussion

Simulation model and parameters

We use NS2 to simulate our proposed protocol. In our simulation, the channel capacity of mobile hosts is set to the same value: 2 Mbps. We use the Distributed Coordination Function (DCF) of IEEE 802.11 for wireless LANs as the MAC layer protocol. It has the functionality to notify the network layer about link breakage. In our simulation, mobile nodes of sizes 5, 15, 25, 30, 50 and 60 move in an 800×800 m region for 05 seconds simulation time. We assume each node moves independently with the same average speed. In our simulation, the minimal speed is 5 m sec-1 and maximal speed is 25 m sec-1. The simulated traffic is TCP (ftp).Our simulation settings and parameters are summarized in Table 1.

Table 1: Simulation parameters

Parameter	**Value**
Simulator	NS 2.35
MAC Type	802.11
Routing Protocol	EMPRR
Channel Type	Wireless Channel
Antenna Model	Omni
No.of Nodes	5,15,25,30,50 and 60
Area Size	800*800
Simulation Time	5 secs
Traffic Source	TCP(ftp)
Mobility Model	Random way point
Radio Propagation Model	two way ground
Interface Queue Type	Droptail/priqueue
Max packet in queue	50

Performance metrics

Performance Metrics are quantitative measures that can be used to evaluate any MANET routing protocol. We compare our EMPRR protocol with the AOMDV protocol .We evaluate mainly the performance according to the following metrics [Trung, H.D, 2007].

Average end-to-end delay

The end-to-end-delay is averaged over all surviving data packets from the sources to the destinations.

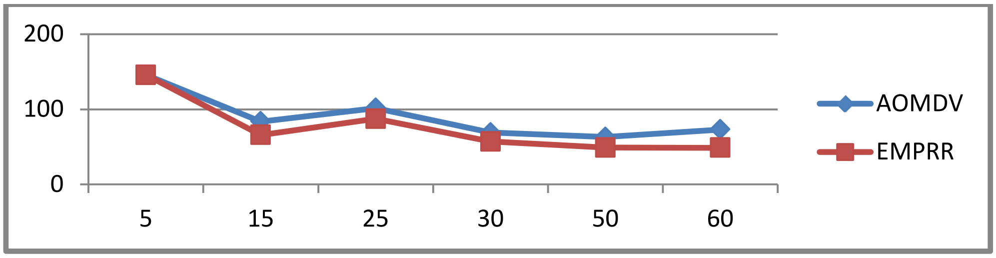


Figure 10: Nodes Vs Delay

Average packet delivery ratio

It is the ratio of the number of packets received successfully to the total number of packets sent.

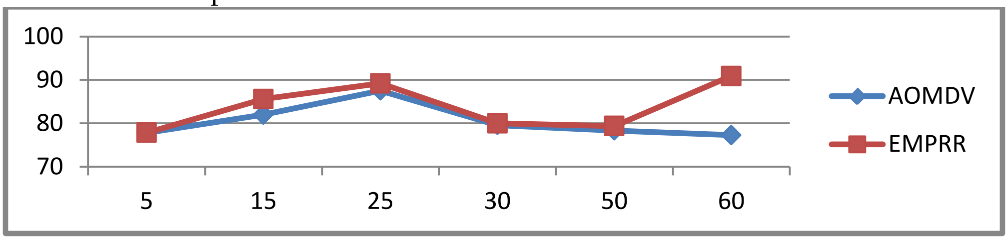


Figure 11: Nodes Vs PDR

Average Throughput

Average Throughput is the number of bytes received successfully.

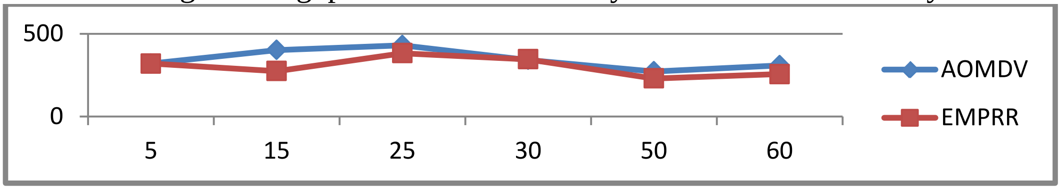


Figure 12: Nodes Vs Throughput

Drop

It is the number of packets dropped during the data transmission.

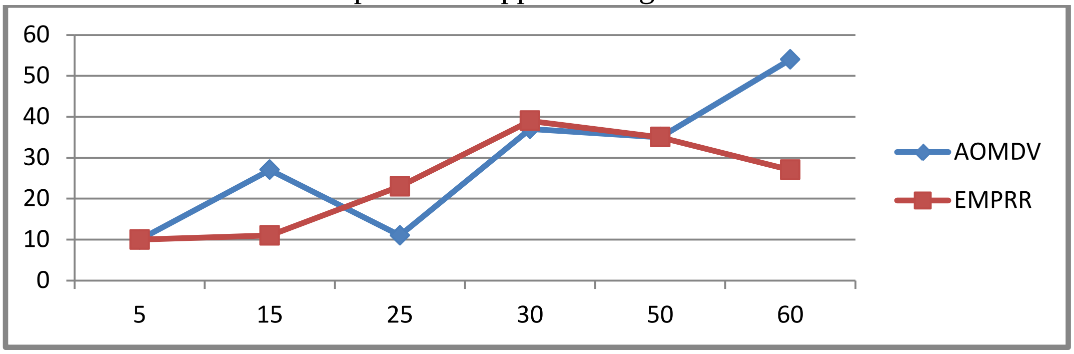


Figure 13: Nodes Vs Drop

Routing Overhead

Routing overhead is the total number of control packets or routing packets generated by routing protocol during simulation and is obtained by

Routing Overhead = Number of RTR packets.

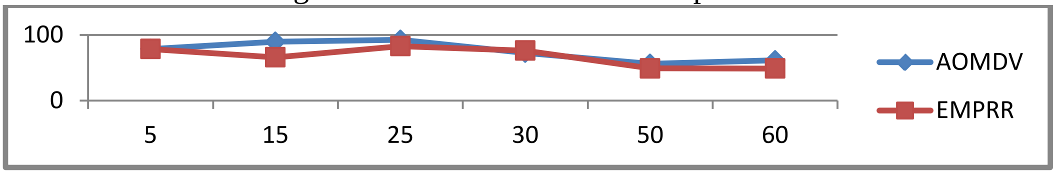


Figure 14: Nodes Vs Overhead

Based on nodes

In the initial experiment we vary the number of Nodes as 5, 15, 25, 30, 50 and 60.From Fig. 10; we can see that the average end-to-end delay of the proposed EMPRR protocol is less when compared to the AOMDV protocol. From Fig. 11, we can see that the packet delivery ratio for EMPRR increases, when compared to AOMDV, since it utilizes robust links. From Fig. 12, we can see that the throughput for EMPRR is almost equal to AOMDV. From Fig. 13, we can see that the packet drop for EMPRR is less, when compared to AOMDV. Figure 14 shows the overhead of the protocols. The values are considerably less in EMPRR when compared with AOMDV.

Table 2: Result Analysis of Proposed Protocol (EMPRR)

Protocol	No. of Nodes	End to End Delay	PDR	Throughput	Packet drop	overhead
EMPRR	5,15,25,50,60	Reduced	Increased	Min.	Less	Reduced

Conclusion and Future Work

In this paper we have proposed "Enhancement of Multipath Routing Protocol for Route Recovery (EMPRR) in MANET", a routing protocol which provides multipath discovery, efficient utilization of bandwidth and controlled traffic load route recovery at the time of failure. The proposed protocol is efficient in overcoming the problem of stale routes in multipath routing protocols. Also proposed protocol shows significant improvement in packet delivery ratio and reduced end to end delay. In future researchers can develop hybrid multipath routing protocols that will provide feature of fault tolerance at the time of failure of node, failure of link and breakage of route and also balance load at the time of large volume traffic and finally increase quality of service aspects of multi path routing protocols. As in our protocol throughput didn't show large variation.

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