Effective Route Selection Based on Transmission Time and Bandwidth for Multipath Routing in MANETs

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Abstract - *Multipath routing is a widely used technique of using several alternative routes in the Mobile Ad Hoc Networks (MANETs). In multipath routing transmitting message is separated into streams and they are send through separate paths. While transmitting message there may be a chance for failure in the path. To overcome this failure the alternative path must be selected to send the message stream successfully. The efficient alternative path is selected based on the new parameter ERS (Effective Route Selection) which includes maximum available bandwidth and minimum transmission time. The proposed parameter is implemented in Network Simulator (NS-2), and the performance is analysed. The new parameter ERS selects efficient alternate path with increased bandwidth and improves the reliability of the network.*

Keywords : *MANETs, ERS, Bandwidth, RREQ, RREP, Routing, Multipath, Single path, Transmission time.*

I. INTRODUCTION

A. Mobile Ad-hoc Networks

A mobile ad-hoc network (MANET) is a continuously self-configuring, infrastructure-less network of mobile devices connected without wires. Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently. Each must forward traffic unrelated to its own use, and therefore be a router. MANETs are a kind of Wireless ad hoc network that usually has a routable networking environment on top of a Link Layer ad hoc network. MANETs consist of a peer-to-peer, self-forming, self-healing network in contrast to a mesh network has a central controller (to determine, optimize, and distribute the routing table). MANETs circa 2000-2015 typically communicate at radio frequencies (30 MHz - 5 GHz) [1].

B. MANETs Applications

Military battlefield: Ad-Hoc networking would allow the military to take advantage of commonplace network technology to maintain an information network between the soldiers, vehicles, and military information head quarter.

Collaborative work: For some business environments, the need for collaborative computing might be more important outside office environments than inside and where people do need to have outside meetings to cooperate and exchange information on a given project [2].

Local level: Ad-Hoc networks can autonomously link an instant and temporary multimedia network using notebook computers to spread and share information among participants at a e.g. conference or classroom. Another appropriate local level application might be in home networks where devices can communicate directly to exchange information [3].

Personal area network and Bluetooth: A personal area network is a short range, localized network where nodes are usually associated with a given person. Short-range MANET such as Bluetooth can simplify

the inter communication between various mobile devices such as a laptop, and a mobile phone [4].

Commercial Sector: Ad hoc can be used in emergency/rescue operations for disaster relief efforts, e.g. in fire, flood, or earthquake. Emergency rescue operations must take place where non-existing or damaged communications infrastructure and rapid deployment of a communication network is needed.

C. Routing Protocols for MANETs

Routing is the process of moving packets from the source to a destination in internetworking. Routing protocols use a routing algorithm which is a mathematical formula to forward the packet to its destination.

Many protocols have been proposed for MANETs. They are classified into three categories depending on the routing policy. They are:

- Table driven (proactive) routing protocols,
- On-demand (reactive) routing protocols, and
- Hybrid routing protocols. [5]

D. Single path Vs Multipath routing

In a single-path routing infrastructure, only a single path exists between any two nodes in the internetwork. While this may simplify the routing tables and the packet flow paths, single-path internetworks are not fault tolerant.

Multipath routing is the routing technique of using multiple alternative paths through a network, which can yield a variety of benefits such as fault tolerance, increased bandwidth, or improved security.

E. Advantages of Multipath routing

There are many advantages to having multiple routes when possible, including

- increased reliability
- potentially better load balancing
- more energy consumption

F. Multipath routing in MANET

Multipath routing is the routing technique of using multiple alternative paths through a network, which can yield a variety of benefits such as fault tolerance, increased bandwidth, or improved security.

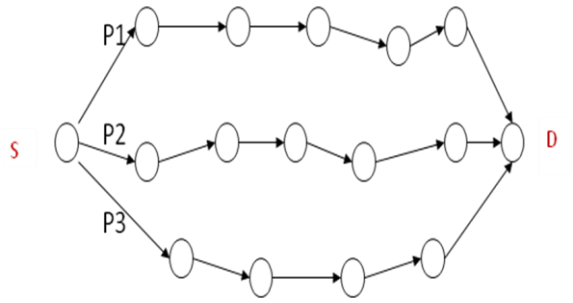

Figure.1 Multiplepaths from Source and Destination

Figure.1 shows the multiple paths (P1, P2, P3) from Source S and Destination D. Concurrent Multipath Routing is often taken to mean simultaneous management and utilization of multiple available paths for the transmission of streams of data emanating from an application or multiple applications. In this form, each stream is assigned a separate path, uniquely to the extent supported by the number of paths available. If there are more streams than available paths, some streams will share paths. This provides better utilization of available bandwidth by creating multiple active transmission queues. It also provides a measure of fault tolerance in that, should a path fail, only the traffic assigned to that path is affected, the other paths continuing to serve their stream flows; there is also, ideally, an alternative path immediately available upon which to continue or restart the interrupted stream.

- This method provides better transmission performance and fault tolerance by providing:
- Simultaneous, parallel transport over multiple carriers.
- Load balancing over available assets.
- Avoidance of path discovery when reassigning an interrupted stream.

Difficulties of this method are:

- Some applications may be slower in offering traffic to the transport layer, thus starving paths assigned to them, causing under-utilization.
- Moving to the alternative path will incur a potentially disruptive period during which the connection is re-established [14].

G. Multipath Routing Protocols

Standard routing protocols in ad hoc wireless networks, such as AODV and DSR are mainly intended to discover a single route between a source and destination node. Multipath routing consists of finding multiple routes between a source and destination node. Some examples of Multipath routing protocols are MLAR, AODMV, MP-DSR, MP-OLSR, SMR [15].

II. RELATED WORKS

Indu Kashyap, R K Rathy and Diwaker Pandey have proposed an Efficient Location based Reactive Multi-Path Routing Protocol for MANET. A node-disjoint location based multi-path routing protocol (Location-BMP) for mobile ad hoc networks to reduce the number of broadcast multi-path route discoveries and the average hop count per path from the source to the destination. During route discovery process, the intermediate nodes include their location information along with the distance in the Route-Request (MP-RREQ) packet. The destination node selects a set of node disjoint paths from the MP-RREQ packet received and sends a Route-Reply (MP-RREP) packet on each of the node-disjoint paths [6].

Geetha. G and N J R Muniraj have proposed Efficient Energy based Stable Multipath Routing Scheme for MANET. Efficient Energy based Stable Multipath Routing Scheme is proposed to make a correct balance between stability of multipath and energy conservation. It reduces energy consumption and provides better stability using the stability model. It includes three phases; they are multipath routing, stability of multipath and energy consumption model. Multipath routing is developed to ensure better network lifetime and more energy efficiency. The multipath routing stability is calculated to ensure more network stability. Energy spent for transmission is reduced using the energy consumption model [7].

D. Jagadeesan and S.K. Srivatsa have proposed Multipath Routing Protocol for Effective Local Route Recovery in Mobile Ad hoc Network. In the proposed protocol, each source and destination pair establishes multiple paths in the single route discovery and they are cached in their route caches. The cached routes are sorted on the basis of their bandwidth availability. In case of route failure in the primary route, a recovery node which is an overhearing neighbour, detects it and establishes a local recovery path with maximum bandwidth from its route cache. The proposed route recovery management technique prevents the frequent collision and degradation in the network performance [5].

V. Jayalakshmi and Dr. R. Rameshkumar have proposed Multipath Fault Tolerant Routing Protocol in MANET. Mobile ad hoc networks (MANETs) consist of a collection of wireless mobile nodes which dynamically exchange data among themselves without the reliance on a fixed base station or a wired backbone network and it the makes the routing a crucial issue to the design of the MANET. Multiple path routing protocols are shown to be performance-effective alternatives over single-path routing for ad hoc networks and it represents a promising routing method for wireless mobile ad hoc networks. Multi-path routing achieves load balancing and is more resilient to route failures. In this paper they propose an energy efficient multipath fault tolerant routing protocol to improve the reliability of data routing in Mobile ad hoc networks. RFTA is a multi objective routing protocol that meets diverse application requirements by considering the changing conditions of the network. The efficiency of the proposed protocol has been evaluated on different scenarios and there has been a noticeable improvement in the packet delivery ratio and also in the reduction of end-to-end delay comparing to SMR, SMS and MDSR [8].
Simmi Jain, Prof.Hitesh Gupta have proposed Survey on MANET Routing Protocol and proposed Multipath Extension in AODV. Routing is key in to enhance MANET performance. Routing in mobile ad hoc networks and some fixed wireless networks use multiple-hop routing. Routing protocols for this kind of wireless network should be able to maintain paths to other nodes and in most cases, must handle changes in paths due to mobility. AODV is most popular routing protocol among others. It is On-demand type routing protocol and its performance is better than other routing protocols in MANET environment. They have proposed AODV routing protocol to enhance the break avoidance mechanism using multipath extension in core AODV to avoid route break problem in existing AODV method [9].

Pooja and Ajay Dureja have proposed Enhancement of Multipath Routing Protocol for Route Recovery in MANET. In this paper they 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. 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 [10].

Pratapa A Reddy and N Satyanarayana have proposed Multipath Routing Protocol for Reducing Congestion and Delay in MANET. In the congestion aware multipath routing protocol the paths which have better bandwidth will be initially selected. For selected paths, first the congestion status of the node is found by using the early congestion detection technique which is based on the queue status and data arrival rate of the nodes. The delay includes weighted channel delay and buffer queuing delay. The paths which have better bandwidth will be initially selected. . If the congestion status is lower than the threshold value, the packets are sent directly through the path. If it is more than the threshold value, a congestion aware routing is initiated. In this congestion aware routing, routes having less end-to-end delay will be selected from the backup routes, so that they have low congestion [11].

Gursharan Singh, Sandeep Kaushal, Harpal, Sabiapreet Bedi have proposed Mobility Based Route Selection on the Basis of Nodes for Stable Link Management. The proposed method selects effective route basis of nodes for stable link management which works in two phases first is the comparative measure between signal strength and the RSSI value if it is greater than threshold value then it is accepted for further processing otherwise it is discarded if it is not find any route if this approach is not work then it switch to second phase means work like as normal AODV. The benefit of this scheme is by selecting a strong route to the destination, increases the lifetime of the network [12]**.**

III. Proposed Work

A. Effective Route Selection(ERS)

The new parameter ERS selects efficient route among multiple paths available between Source and Destination. Initially source node broadcasts request packets to the whole network. The intermediate nodes update their route caches about the routing information whenever they receive RREQ and Route Reply (RREP) packets and continue packet broadcasting. The destination node upon receiving all RREQ packets attaches the route code constituting available bandwidth, transmission time information and feedback RREP packets. Upon receipt of RREP packets, the source node selects the primary route based on the route code. In the case of route failure in the primary route, the recovery node detects it and establishes a local recovery path with maximum bandwidth and minimum transmission time from its route cache. The route recovery management technique is used to avoid frequent collisions and degradation in the network performance.

B. Calculation of ERS

Effective route selection parameter can be calculated from transmission time and maximum available bandwidth. Mathematically it can be expressed as,

ERS = Tt + MABW ..... (1)

Where,
ERS - Effective Route Selection
Tt - Transmission time
MABW - Maximum Available Bandwidth

B.1. Calculation of Transmission Time

Transmission time can be defined as, the time required to transmit message from Source to Destination. Transmission time is measured from message transmitting, receiving time. It can be expressed as,

Transmission time= Tr-Tt ..... (2)
Where,
Tr- Message receiving time
Tt-Message transmitting time

B.2. Calculation of Maximum Available Bandwidth

By using the time slots in the destination node, the route with maximum bandwidth can be calculated.
Let us assume that N routes (n1, n2,…,n_N) are discovered between source and destination nodes.
Using the function "Set_Tentative", bandwidth B of route n_i (i=1,…,N) is computed as follows:

$B_i = Min (T/2, T_{bi})$ .....(3)
where
T = total number of time slots in each route T_{bi} = number of free time slots in the bottleneck link of route N_i. [5,16].

C. Steps to find alternative route:

The following steps are involved in the multipath routing technique:

Step 1 : Whenever a data packet needs to be forwarded by the source node to the destination and no route is found in the cache, then the source floods the route request (RREQ) packets over the entire network.
Step 2 : If a non-duplicate RREQ packet reaches the intermediate nodes, it attaches the node ID to packet and continues broadcasting.

Step 3 : If duplicate packets are received, as an alternative to drop all duplicate packets, the packets received from longer routers are dropped to minimize the packet drop.

Step 4 : Even if, route information to the destination is present in the route cache of intermediate node, it has no permission to send RREP back to the source and permission is given only for destination node.

Step 5 : The destination node upon receiving all RREQ packets attaches the route code and feeds it back as RREP packets. Let n RREP packets be generated for the paths $P_1, P_2,\ldots,P_n$. The route code is to recognize the available bandwidth. The RREP with route code R_{C1} has maximum available bandwidth and RREP with route code R_{C2} has next maximum bandwidth availability and so on. The priority condition for bandwidth selection is as follows:
$B_1 > B_2 > B_3 > B_4 > \ldots > B_n$.
where
$B_1, B_2, B_3,\ldots,B_n$ are the available bandwidth of the routes and $P_1,P_2,\ldots,P_n$ path in the network.

Step 6 : Next, the RREP with route code R_{C1} has minimum transmission time and RREP with route code R_{C2} has next minimum transmission time and so on. The priority condition for transmission time selection is as follows:
Tt1<Tt2<Tt3<Tt4<...<Ttn.
Then calculate new parameter ERS for each route code.

Step 7 : After an intermediate node receives RREP packets, it stores the routes $P_1,P_2,\ldots,P_n$ in its route caches and then forwards them to subsequent nodes.

Step 8 : Upon receipt of RREP packets, the source node selects the primary route based on the route code.

Step 9 : If the primary route fails, the recovery node detects it and establishes a local recovery path based on new parameter ERS from its route cache.

IV. RESULTS AND DISCUSSION

A. Simulation model

NS-2 [16] is used to simulate the proposed protocol. The channel capacity of the mobile hosts is initialized to 2 Mbps. The Distributed Coordination Function (DCF) of IEEE 802.11 is used as the MAC layer protocol for wireless LANs. It indicates the network layer regarding the link failure.The mobile nodes of size 50 travel in a 1000×1000 m region for 50 seconds simulation time in our simulation. It is assumed that every node travels freely with similar average speed. All nodes possess similar transmission range of 250 m. In our simulation, the minimal speed is 5 m/sec and maximal speed is 25 m/sec. The speed is kept at 5, 10, 15, 20 and 25 m/sec successively. The simulated traffic is Constant Bit Rate (CBR).Simulation settings and parameters are tabled as,

Table 3.1 Simulation parameters

Number of nodes	50
Area size	1000 X 1000 m
Mac	802.11
Routing protocol	MP-ERS
Radio range	250 m
Simulation time	50 sec
Traffic source	CBR
Speed (m/sec)	5,10,15,20 and 25
Rate	100Kb

B. Performance metrics

The proposed MP-ERS protocol is compared with MP-LRR protocol. The performance is assessed using the following metrics:

Average end-to-end delay: It is averaged among all existing data packets from the sources to the destinations.

Average packet delivery ratio: It is defined as the ratio of successful reception of the data packets to the total number of packets sent.

Drop: It refers to the number of data packets dropped at the time of data transmission.

Control overhead: The ratio of the total number of routing control packets regulated to the total number of received data packets is termed as control overhead.

C. Results

The speed of the mobile node is varied between 5 m/sec and 25 m/sec for the simulation environment. Figures 2 through 5 present the graphical representations of the results of the delay, packet

delivery ratio, drop and overhead. The number of nodes is kept as 50.

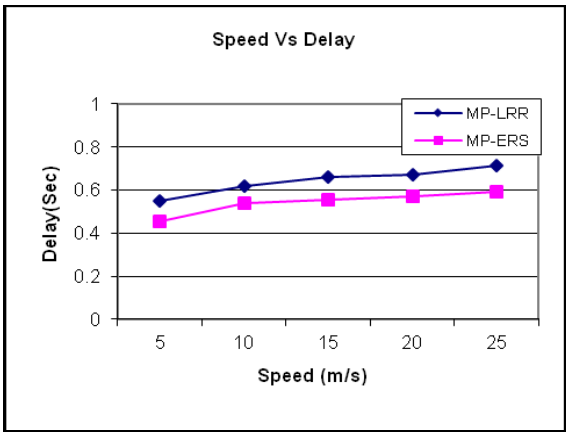

Figure.2 Speed Vs Delay

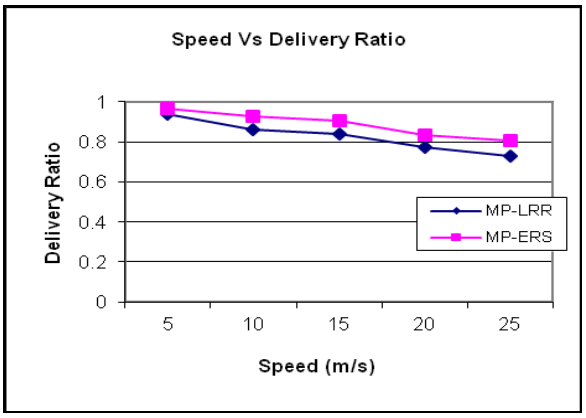

Figure.3 Speed Vs Delivery Ratio

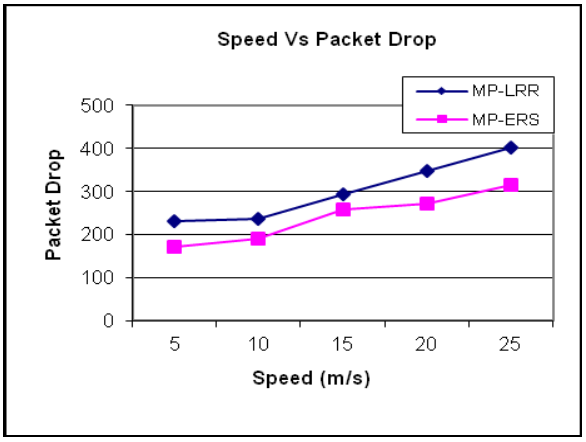

Figure.4 Speed Vs Packet Drop

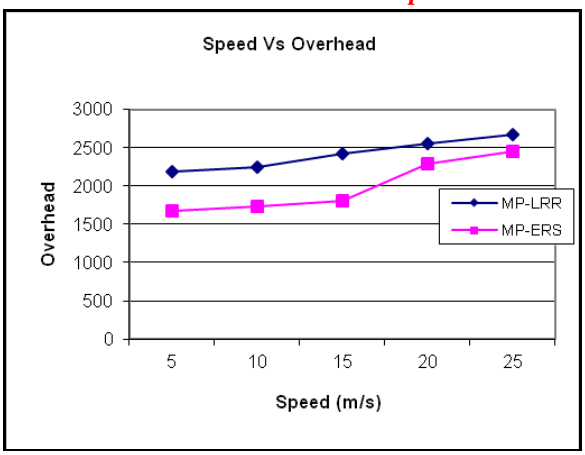

Figure.5 Speed Vs Overhead

V. CONCLUSIONS

In this paper, a multipath routing protocol for effective Route Selection in Mobile Ad hoc Networks is proposed. It avoids frequent collisions and degradation in the network performance. By simulation results, we show that the proposed approach improves network performance.

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Biographies

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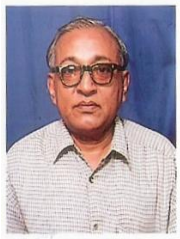

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