Multipath Routing for Opportunistic Data Transfer in Mobile Adhoc Network

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ABSTRACT :-Mobile Adhoc Network is an infrastructure less and self-configuring network of wireless communication between nodes. In Mobile Adhoc Network, routing is a difficult task and it is an important research area of work due to its unpredictable network topology changes. The challenging task is to make the wireless network communication as best as the wired ones. Routing could be made efficient by knowing the topological information of the wireless network and thus the packets can be transmitted efficiently which results in high packet delivery ratio. Multipath routing is more advantageous compared to single path routing in terms of increased bandwidth, balanced traffic load, balanced power consumption, reduced end to end delay and robustness of data delivery. We propose a multipath routing technique for efficient opportunistic data transfer between nodes by providing a node disjoint paths between source and destination. Resource utilization is the maximum in multipath routing and it is also less costly alternative to flooding the network. There is also a higher rate of data delivery and reliability. We show that the performance of our technique is better in terms of packet delivery ratio, throughput, delay jitter, and energy when compared with single path routing.

***Keywords* –** CORMAN, MANET, Network Layer, Packet Delivery Ratio, Routing.

I. INTRODUCTION

Mobile Adhoc Network is a wireless network of self organising, dynamic environment where mobile devices communicate through wireless links. It has no dedicated infrastructure ie., there is no central controller authority which takes care of transmission between nodes. In a dynamic environment nodes are independent and they move in any direction and thus mobility causes frequent change of network connectivity. Nodes in MANET can act both as end points of data interchange and routers when the two end points are not in direct range of each other. In a decentralized network it is the responsibility of a node to find both the topology information and deliverance of data to the destination. MANET is a standalone, reconciling network and is quickly deployable. Such network model is derived from the requirements of battlefield communications, disaster relief operations, emergency operations and search and rescue.

Topology changes occur swiftly and unpredictably as it is not a static environment. Topology control [1] is needed to determine appropriate topology in adhoc network which saves energy, reduce interference between nodes and extends the lifetime of the network. Based on connectivity, efficiency of energy, robustness to mobility and throughput the quality of topology is determined. High level routing protocols are implemented over a suitable topology [2]. All nodes connected in a network must act as routers to have accurate delivery of data packets. Routes contain links which is the connection between two nodes. The route quality is influenced by change in link quality. A varying link route does not produce good results.

The network layer has received a notice when working on Mobile Adhoc Network. Therefore plenty of routing protocols in such network with different objectives and with different specific needs have been proposed. [1]. As a matter of fact, the two vital operations at the network layer are data forwarding and routing. Data forwarding controls how packets are taken from one link and put on another. Routing finds out the path which the packet must follow to reach the destination from the source. Routing protocols can be divided into single path and multipath based on the number of routes discovered [3]. Single path protocols learn routes and select a single best route to reach each destination. These protocols are unable to balance traffic load [4]. Single route simplify the routing table and packet forwarding but it has many disadvantages. Even though additional network resources may be available, using a single path, it is difficult to respond to a large burst in traffic. If the path fails a new route discovery must be initiated resulting in significant delay and packet loss. Multi path protocols learn routes and select more than one path to reach the destination. They are better for load balancing. Multipath routing improves communication efficiency and promotes Quality of Service by utilising different paths simultaneously [5]. Also they are more reliable, robust and consequently reduces control overhead, enhances data transmission rate, the network bandwidth is increased and the energy is saved [6]. Contributions in our solution are as follows.

- A multipath proactive source routing protocol is used as each node has complete knowledge of how to route data to all nodes in the network at any time. Based on the number of paths available to reach destination, the packets can be divided and sent simultaneously to destination.

- When the data packets are forwarded towards destination the intermediate nodes can adjust the route information carried by them. Furthermore, as these packets are forwarded along the new route, such updated information is propagated upstream quickly without any additional overhead. As a result, all upstream nodes learn about the new route at a rate much faster than via periodic route exchanges. Opportunistic data forwarding is taken to another level by allowing nodes that are not listed as intermediate forwarders to retransmit data if they believe certain packets are missing.

The rest of this article is organized as follows. Section II reviews related work. Section III describes the related work and section IV shows the result analysis and section V shows the conclusion.

II. RELATED WORK

The use of the broadcasting nature of wireless channels at the link layer and above has a relatively recent history when compared to the efforts at the physical layer. ExOR [7] is a cross- layer explorative opportunistic data forwarding technique in multi-hop wireless networks by Biswas and Morris. MORE [8] improves ExOR to further increase the spatial channel reuse in a single flow via intra flow network coding [9] to reach destination from the source. Leontiadis and Mascolo and Yang et al. [10] suggest using position information for routing in mobile muti-hop wireless networks. Therefore it is supposed that each and every node in a network is mindful of all other node position in the network. To simplify the idea behind ExOR to mobile wireless networks and other types, a lightweight routing procedure with proactive source routing capabilities are preferred. Multipath routing is a technique of using multiple alternative paths through a network, which has many benefits such as fault tolerance, increased bandwidth, or improved security. The multiple paths computed might be overlapped, edge-disjointed or node-disjointed with each other [11]. Meng Wang, Chee Wei Tan, Ao Tang and Steven H. Low et al. shows the performance loss of joint congestion control and routing when the routing is single path routing in comparison with multipath routing [12]. Thus spreading traffic over multiple paths enhances the network performance compared to single path routing. CORMAN [13] is a network layer solution to the opportunistic data transfer in Mobile Adhoc Network and it accommodates node mobility. When using multipath routing, to address the issues of load sharing and fault tolerance, the routes must satisfy some form of disjointness [3]. Node disjoint paths address the issues of load sharing and fault tolerance. When there are multiple node disjoint paths from source to reach a destination, the source can defer the route discovery until all the paths to the destination are failed. Recently a lot of research has been done in QoS based multipath and node disjoints routing. These days the approaching concern is the energy issues in Mobile Adhoc Network. The AODVM presents [14] loop free and node disjoint paths. The CM AODV [15] selects nodes based on signal to noise interference ratio. To improve the throughput and delay, the Multipath Source Routing [16] use the weighted round robin packet distribution technique. The split Multipath Routing [17] selects the disjoint multiple routes based on limited hop counts. Node Disjoint Multipath Routing (NDMR) gives multi path [18] with disjoint nodes. The various energy aware multipath routing are GEANDMRA [19], EASR [20] AND ENDMR [21]. There is another multipath node selection protocol based on Minimum Transmission Power [22] and Power Aware Source Routing [23].

III. PROPOSED TECHNIQUE

The proposed technique is the extension of CORMAN [13]. It shows that the network resources are well shared when data transfer are done with multiple simultaneous flows. The coordination among multiple qualified small scale retransmitters can be achieved in better measures with link stability. The three modules are Multipath Proactive Source Routing, Large Scale Live Update and Small Scale Retransmission. Figure 1 shows the overall view and figure 3 tells about th Live Update and Retransmission.

3.1 Multipath Proactive Source Routing

According to the proactive source routing the nodes periodically exchange the topology structure information with each other. It converges when the number of iterations is equal to the network diameter. Thus each node has the path structure information indicating the path to all other nodes. When a source wants to communicate with the destination first it finds multiple paths to the destination. It forms a matrix based on the possible paths available and finds number
of disjoint paths available [3]. After finding the available disjoint paths the packets are then transferred towards the destination.

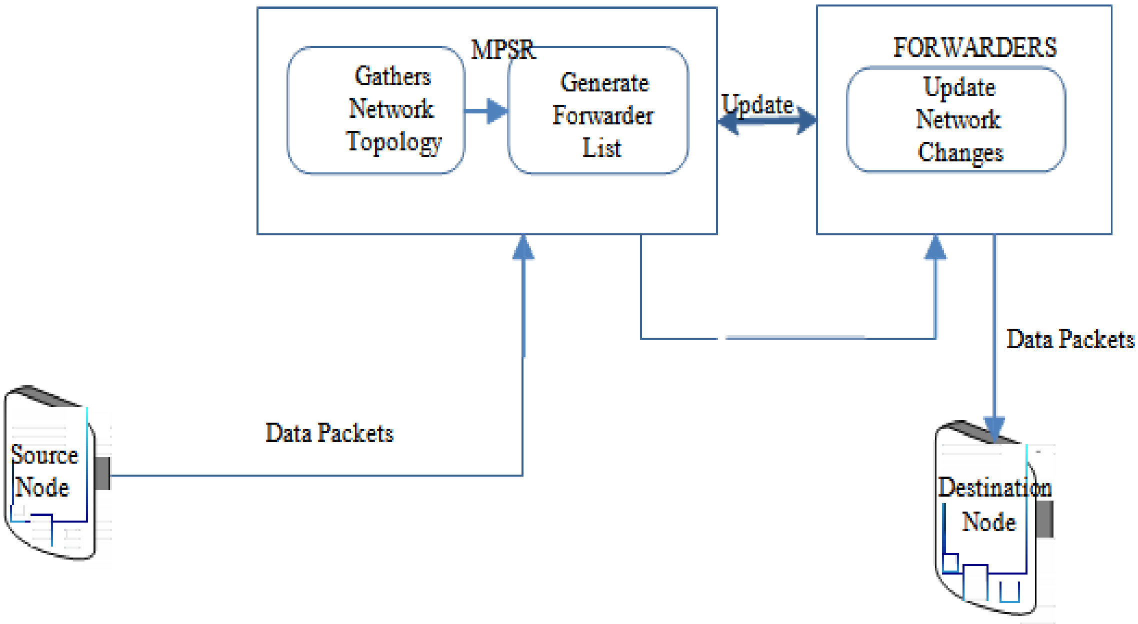

Fig.1 The overall view

3.2 Large Scale Live Update

As per the Source routinto each packet through which the data is transferred. But when a packet is received by a forwarding node, it may have a different view of how to forward the data to the destination. Since the forwarding node in the forwarder list is close to the destination than the source node, the forwarding node has more updated routing information. In that case from this point on the forwarding node can update the part of the forwarder list in the packets according to its own knowledge ie when the network diameter is large and when nodes are moving fast, the routing information can be obsolete by the time it reaches a remote node. A node's knowledge about the network structure becomes less correct when the destination node is situated farther away. Thus the forwarder list sent by the source needs to be adjusted as the packets are forwarded towards the destination. A node that is on the forwarder list sent by the source and which has the higher priority and has received any packet is called the frontier. Only the frontier updates the forwarder list and also only the segment of the list between the frontier and the destination is updated. A node which is no longer a frontier node should only incorporate the forwarder list that it hears from the downstream nodes to avoid unnecessary updates. The upstream nodes can overhear these packets and the new forwarder list and they update their own routing information. This information is incorporated when forwarding their fragments.

This backtrack continues until the source node is known about latest route information.

3.3 Small Scale Retransmission

It is a technique to enhance the reliability of data transmission between two consecutive listed forwarders. Nodes that are not in the forwarder list but positioned between this consecutive forwarders can retransmit data when the packets are not received successfully. Consider figure 2, there are two consecutive forwarders such as I1 and I2. Let f be a node present somewhere in between I1 and I2. After I2 has transmitted its fragment of packets and by comparing the packets transmitted by I1 to those by I2, node f knows which packets I2 has missed. It is now qualified to retransmit these packets that are believed to be missing. If there are more than one such f in that area, such as f1 and f2, then at most one such node should retransmit. For a node f to be a retransmitter it must meet the following conditions.

1. The node f should be a neighbour of both I1 and I2.
2. The distance between I1 and I2 that is d(I1, I2) should be greater than d(I1, f) and d(I2, f).
3. We must find the link stability, which is found by using the formula:

Link stability= Mobility factor / Energy factor [24].

3.1.1 Mobility factor

Link Expiration Time (LET) [25] is found by using velocity, position parameters of a node. Let d be the transmission distance between two nodes and their position coordinates are (x_i, y_i) and (x_j, y_j). The velocity and direction of the two nodes be (v_i, θ_i) and (v_j, θ_j) :

$$LET = \frac{-(ab+ce) + \sqrt{(a^2 + c^2)\, d^2 - (ae - bc)^2}}{a^2 + c^2}$$

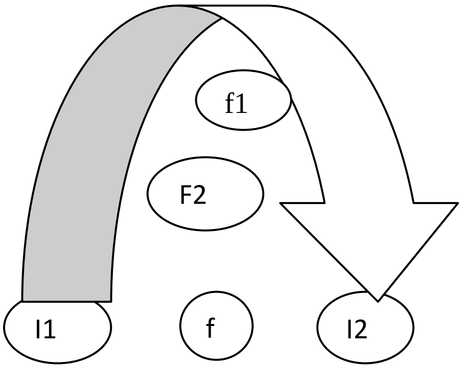

Fig.2 Small Scale Retransmission

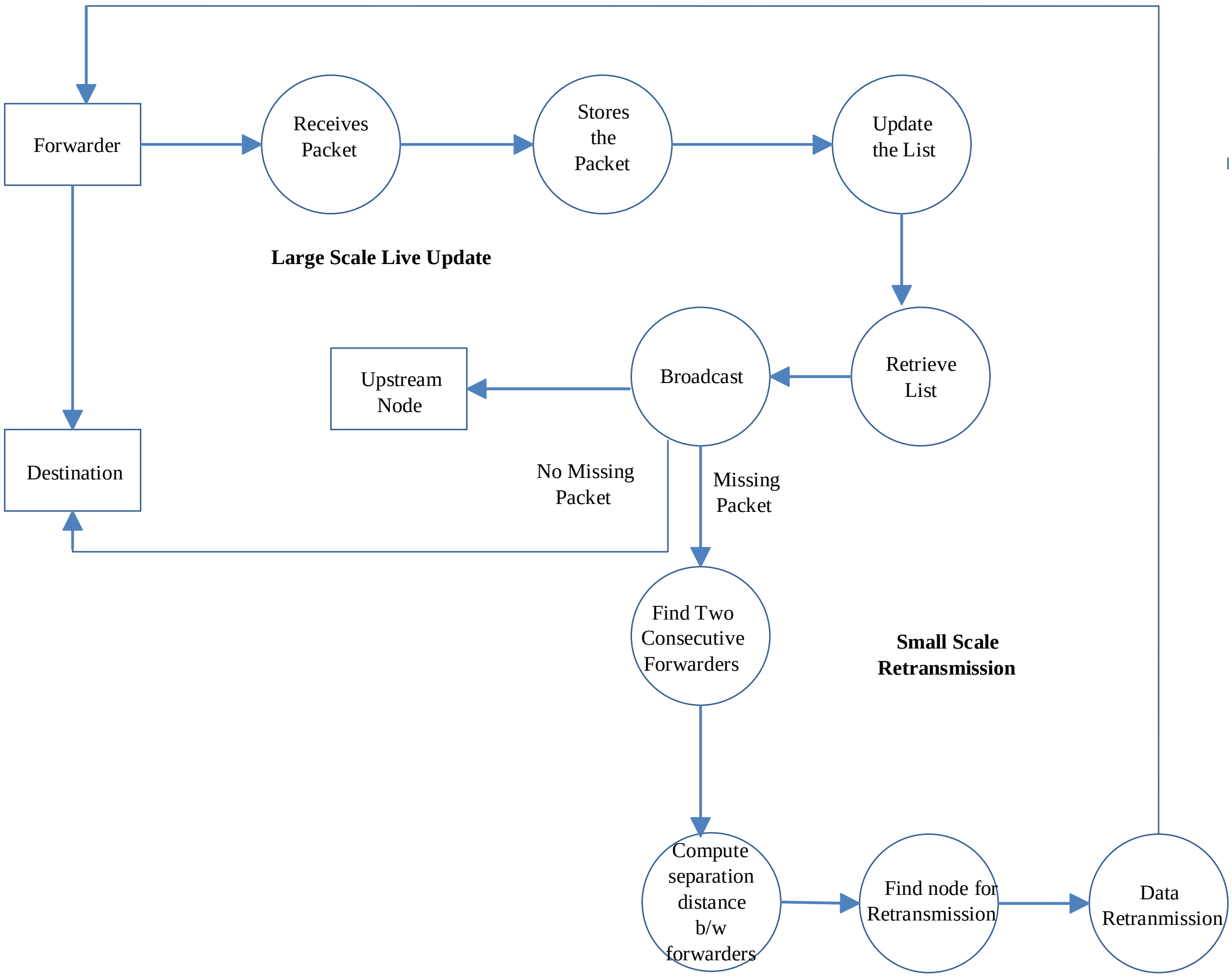

Fig.3 Live Update and Retransmission

where,
$a = v_i \cos \theta_i - v_j \cos \theta_j$
$b = x_i - x_j$
$c = v_i \sin \theta_i - v_j \sin \theta_j$
$e = y_i - y_j$

3.1.2 Energy factor

Drain rate [26] of a node is described as the rate of dissipation of energy of a node. Each node finds its total energy consumption for every T seconds and evaluates the Drain Rate, the actual Drain Rate is found by exponentially averaging the values of E_{old} an E_{new} such as :

$DR_i = \alpha E_{old} + (1- \alpha) E_{new}$, $0< \alpha <1$

Higher the Link Stability value, greater the stability of the link and greater the duration of the existence of a node.

IV. PERFORMANCE ANALYSIS

In this section, we study the performance of CORMAN by running computer simulation using Network Simulator ns-2 (version 2.34).

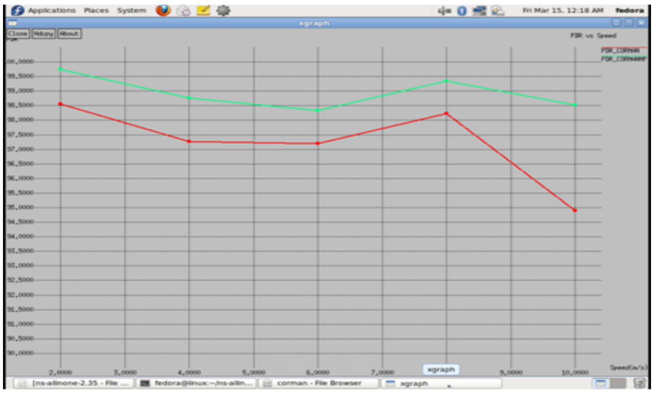

Fig.a Speed vs PDR

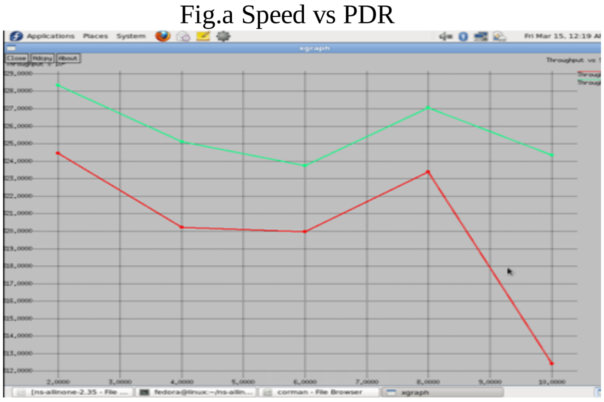

Fig.b Speed vs Throughput

The experiment is carried out by modifying a) Packet Delivery Ratio b) Throughput c) Drop d) Jitter. The Proposed technique performs better than CORMAN in terms of PDR, Throughput, Drop and Jitter. In all figures the red colour indicates CORMAN and the green colour indicates the Multipath technique.

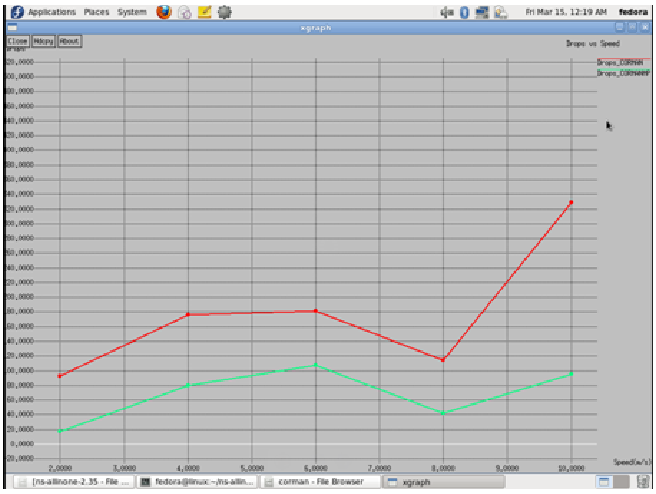

Fig.c Drop vs Speed

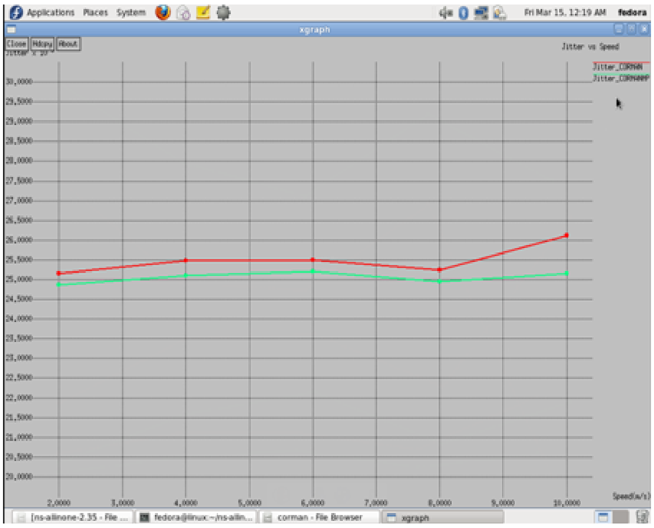

Fig.d Jitter vs Speed

V. CONCLUSION

In this article, we have proposed an multipath routing scheme for mobile ad hoc networks. It is composed of three components. 1) MPSR—a multipath proactive source routing protocol, 2) large-scale live update of forwarder list, and 3) small-scale retransmission of missing packets. All of these explicitly utilize the broadcasting nature of wireless channels and are achieved via efficient cooperation among participating nodes in the network. It is also shown that the multipath routing for MANET have superior performance measured in PDR, delay, and delay jitter.

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