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Load Balancing Parallel Routing Protocol in Mobile Ad Hoc Network

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ABSTRACT

The combination of link-quality variation with the broadcasting nature of wireless channels has revealed a direction in the research of wireless networking, namely, cooperative communication. Existing system, tackle the problem of opportunistic data transfer in mobile ad hoc networks using a solution called Cooperative Opportunistic Routing in Mobile Ad hoc Networks (CORMAN). It is a pure network layer scheme which can be designed atop of wireless networking equipment. Nodes inside the network use a light-weight proactive source routing protocol to see a list of intermediate nodes that the information packets need to follow to the destination. Once associate data packet is broadcast by upstream node and goes on to be received by a downstream node any on the route and it continues it suggest that from there so will reach the destination node sooner. This can be achieved through cooperative electronic communication at the link and network layers. Since a pipeline of data transportation could promote better spatial channel reuse we enhanced our system with Load Balancing Parallel Routing Protocol (LBPRP) which distributes traffic among multiple paths) sending data in parallel form as it uses all paths in the same time. Evaluation results shows that load balancing in sending data, decreased the end-to-end delay and increased the packet delivery ratio and throughput, thus the performance of CORMAN can be improved consequently.

Index Terms---Mobile Ad Hoc Network, Opportunistic Data Forwarding, CORMAN, LBPRP.

I. INTRODUCTION

A mobile ad hoc network (MANET) is a wireless communication network wherever nodes that are not within direct transmission range establish their communication via the help of different nodes to forward data. It will operate without a fixed infrastructure, support user quality, and falls below the general scope of multi hop wireless networking. Such a networking paradigm originated from the requirements in battlefield communications, emergency operations, search and rescue, and disaster relief operations [1]. The network layer has received most attention when working on mobile ad hoc networks. As a result, abundant routing protocols have been proposed [2]. Two most important operations at the network layer are routing and forwarding. Data forwarding regulates how packets are taken from one link and put on another. Routing determines that path an information packet should follow from the source node to the destination.

MANET Network Model:

The MANET could be a collection of nodes that have the chance to connect on a wireless medium and form an arbitrary and dynamic network with wireless links [10]. In infrastructure network computers nodes are connected via a inter connection network like Bus, LAN etc. this suggests that links between the nodes will change with time, new nodes will be part of the network, and different nodes will leave it. A MANET is expected to be of larger size than the radio range of the wireless antennas, because of this reality it may be necessary to route the traffic through a multi-hop path to convey two nodes the flexibility to communicate. There are neither fixed routers nor fastened locations for the routers as in cellular networks that is additionally referred to as infrastructure networks.

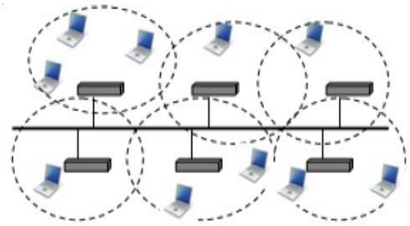

Fig-1 (Wireless Network Structures-I (Infrastructure Networks))

A MANET is a collection of various nodes that are connected via wireless network like wireless Mesh Network. Cellular networks contain a wired backbone that connects the base-stations [10]. The mobile nodes will solely communicate over a one-hop wireless link to the base-station; multi-hop wireless links are not potential. By contrast, a MANET has no permanent infrastructure at all. All mobile nodes act as mobile routers. A MANET is extremely dynamic as a result of links, quality of the links and participants are usually dynamic. Furthermore, asymmetric links are potential. New routing protocols are required to satisfy the particular needs of mobile ad hoc networks. There exists a large family of ad hoc routing protocols.

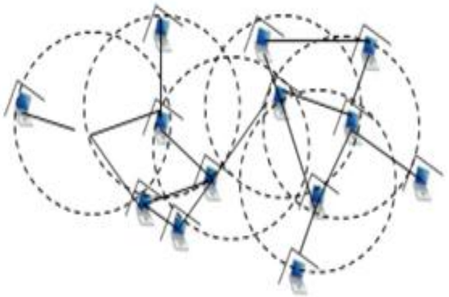

Fig-2 (wireless Network Structure-II(Infrastructureless Networks)

II. Ad hoc On-Demand Distance Vector Routing (AODV)

The ad hoc On-demand Distance Vector Routing (AODV) protocol may be a reactive unicast routing protocol for mobile ad hoc networks. As a reactive routing protocol, AODV solely has to maintain the routing data concerning the active methods. In AODV, the routing data is maintained within the routing tables at all the nodes. Each mobile node keeps a next hop routing table that contains the destinations to that it presently includes a route [7]. A routing table entry expires if it's not been used or reactivated for a pre-specified expiration time. In AODV, once a supply node desires to send packets to the destination however no route is offered, it initiates a route discovery operation. Within the route discovery operation, the supply node broadcasts route request (RREQ) packets which incorporates Destination Sequence range. Once the destination or a node that features a route to the destination receives the RREQ, it checks the destination sequence numbers it presently is aware of and therefore the one laid out in the RREQ. to ensure the freshness of the routing data, a route reply (RREP) packet is formed and forwarded back to the supply given that the destination sequence range is adequate or bigger than the one specified in RREQ.AODV uses solely symmetric links and a RREP follows the reverse path of the individual RREQ [7], [8].

III. ExOR

ExOR [9] is an explorative cross-layer opportunistic data forwarding technique in multi-hop wireless networks by Biswas and Morris. It fuses the MAC (Medium Access Control) and network layers so that the MAC layer can determine the actual next-hop forwarder after transmission depending on the transient channel conditions at all eligible downstream nodes. Nodes are enabled to take in all packets transmitted within the channel, whether or not meant for it or not. A large number of forwarders will doubtless forward a packet as long because it is enclosed on the forwarder list carried by the packet. In fact, the forwarder list in ExOR contains all nodes on the entire route from source to the destination, and a node which is closer to the destination has the higher priority to forward the packet it just received. Thus, if a packet is heard by a listed forwarder closer to the destination with a good reception condition, this long-haul transmission should be utilized. Otherwise, shorter and thus more robust transmissions can always be used to guarantee reliable progress

IV. OVERVIEW OF CORMAN

CORMAN is a network layer solution to the opportunistic data transfer in mobile ad hoc networks. Its node coordination mechanism is essentially inline with that of ExOR and it's an extension to ExOR so as to accommodate node quality. CORMAN forwards information in a very similar batch-operated fashion as ExOR. A flow of information packets are divided into batches .All packets within the same batch carry identical forwarder list after they leave the source node. To support CORMAN, we have associate underlying routing protocol, Proactive source Routing (PSR), that gives each node with the whole routing information to any or all completely different nodes among the network. Thus, the forwarder list contains the identities of the nodes on the path from the source node to the destination. CORMAN generalizes the opportunistic data forwarding in ExOR to suit mobile wireless networks. That is, once a batch of packets are forwarded on the route towards the destination node, if an intermediate node is turned into a new route to the destination, it is able to use this new route to forward the packets that it has already received. There are a few implications of this. First, this new route will also be used to forward the subsequent packets of the same batch. Second, when packets are forwarded along the new route, such an updated forwarder list replaces the old list in the packets [11].

V. DESIGN OF THE PROPOSED LBPRP SCHEME

Load Balancing Parallel Routing Protocol (LBPRP)

Multipath routing permits building and use of multiple ways for routing between a source-destination pair. It exploits the resource redundancy among at intervals the underlying network to provide benefits like fault tolerance, load reconciliation, bandwidth aggregation, and improvement in Quality of Service (QoS) metrics such as delay. Our main concern in this proposed system is to introduce a model that increases the MANET life time through load balancing multipath new technique representing parallelism in sending data using 100% disjoint multiple paths (all selected paths sending data at the same time). We applied the load balancing concept to distribute data packets on the generated disjoint paths to solve the overloading problem and to prevent node starvation. For more explanations and to be sure of our proposed model efficiency we performed some tests on it using a real example as following:

a) RREQ: Node [A] propagates a route request to Node [G]. In Fig.1, node [A] broadcasts a RREQ packet to destination node [G] and appends its own address in the route record field on the packet header. The RREQ packet is received by all nodes within the transmission range of the initiator node (node [A]). The RREQ packets arrive at node [B], node [C] and [D].

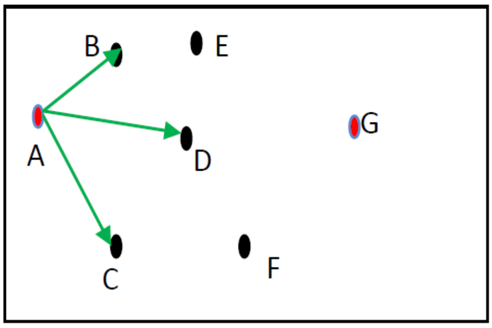

Fig. 1: LBPRP RREQ propagation

In Fig.2 node [B], node [C] and node [D] rebroadcast the RREQ packet and appends their own addresses in the route record field. RREQ packet is received by all nodes within the transmission range of node [B], node [C] and [D]. The RREQ packets from node [B] arrive at nodes [A, D and E], from node [C] is received by nodes [A, D and F] and from node [D] is received by nodes [A, B, C, E &G]. Now, the RREQ packet arrives at the destination node [G]. Then node [G] replies with a RREP packet to the initiator node [A]. The RREQ packet arrives at its destination via node [D].

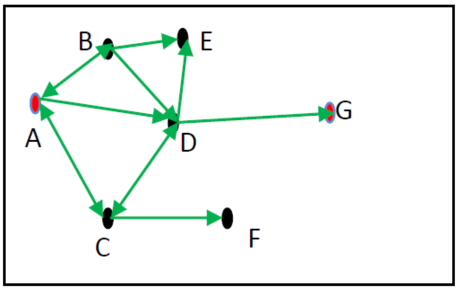

Fig. 2: LBPRP RREQ propagation

b) RREP: Node [G] sends a route reply to Node [A] while nodes [E] and [F] send RREQ. The node [G] sends the RREP packet to the node [F]. RREP packet includes the traversed path by RREQ packets.

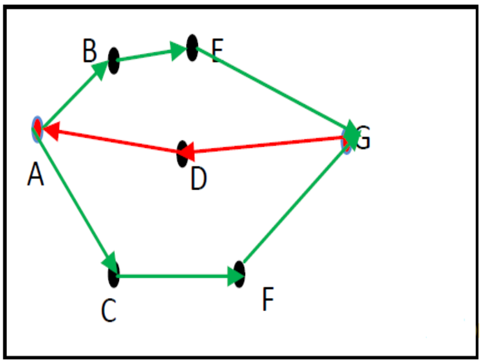

Fig. 3: LBPRP RREQ & RREP

All intermediate nodes and edges that were a part of the *s-d* path will be removed. Here node [D], [G] ↔ [D] and [D] ↔ [A] is deleted from the graph. Node [E] and [F] rebroadcast the RREQ packets and appends their own addresses in the route record field. RREQ packet is received by all nodes within the transmission range. The RREQ packets from nodes [E] and [F] arrive at node [G], and then node [G] replies with a RREP packet to the initiator node [A], through two paths [G→F→C→A] and [G→E→B→A].

c) LBPRP arranges the paths in an ascending order depending on the hop count, and start sending data on the shortest one with least hop counts. Then the next shortest path till it sends on all paths. Here in our example the protocol will start sending on [A-D-G] path first.

In next round of sending LBPRP balances data load through arranging paths in a descending order depending on path speed. Then it starts sending data on arranged paths starting with the highest speed path then the next till it uses all paths. In each sending LBPRP repeat this step.

d) finally if any link is broken during sending for example if [D-G] link is broken, node[D] sends RREP packet to source [A] to delete [A-D-G] path from source cache. Then LBPRP selects another path for resending corrupted data.

In the end we can finally say that our LBPRP multipath protocol steps forward other load balancing multipath algorithms as it has no limitation to the number of generated paths and introduces a reliable and efficient load balancing techniques. Experimental analysis shows that LBPRP provides a high packet delivery ratio, a good effect on increasing network life time, a high level of reliability and low routing overhead.

VI. PERFORMANCE EVALUATION

a) End-to-End Delay

End-to End delay refers to the time taken for data packet to be transmitted across a network from source to destination.

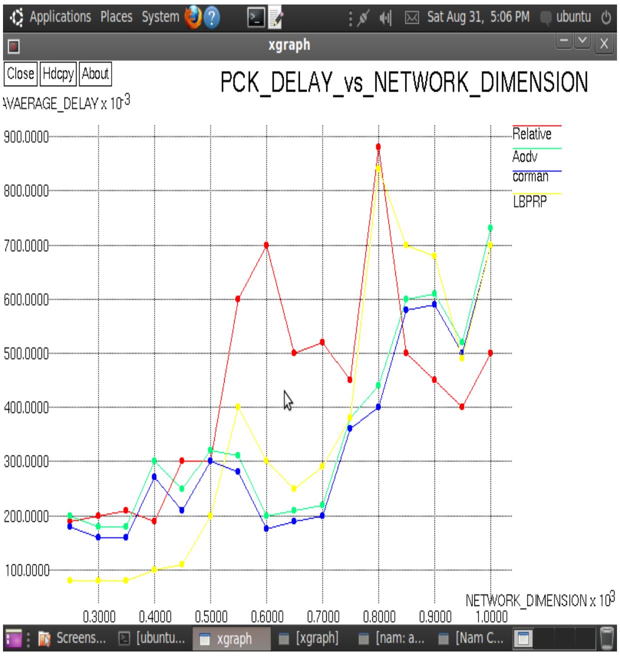

Fig.1 End-to End delay Vs Network Dimension

We are also interested in the end-to-end delay and its variance of LBPRP, CORMAN, Relative and AODV. Fig 1 presents the end-to-end delay of these protocols in different dimension scenarios. We compare the existing and proposed system with packet delay Vs Network Dimension. The proposed system result is better than the existing system. Figure 1 presents the end-to-end delay of these protocols in different dimension scenarios. We see that, when the node density is higher LBPRP has a shorter delay than CORMAN.

Table1 End-to End delay Vs Network Dimension

Table1 represents the result of the LBPRP. It shows that the comparison of the proposed method and existing method in End-to-End delay.

b) The Packet Delivery Ratio

Packet Delivery Ratio (PDR) measures the percentage of data packets generated by nodes that are successfully delivered.

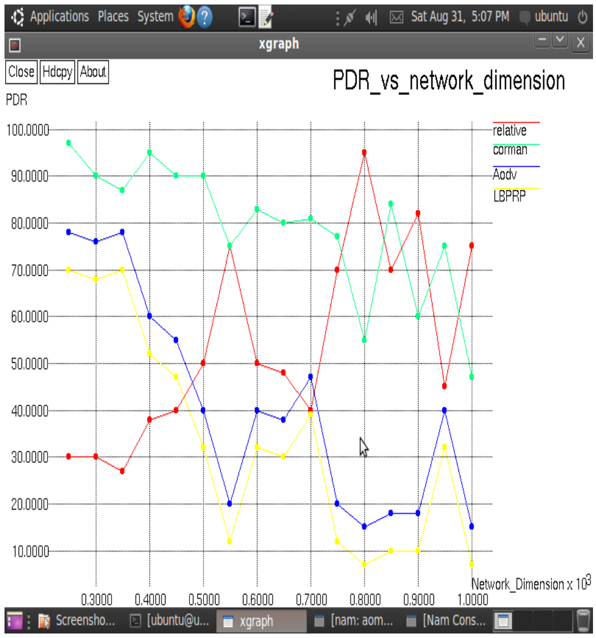

Fig.2 Packet Delivery Ratio graph

The graph of Packet Delivery ratio is shown in following Fig.2, we are able to infer, because the variety of nodes will increase, the packet delivery ratio also will increase because there are more route selections for the packet transmission. Among the three response mechanisms, we also notice the packets delivery ratio of the LBPRP, CORMAN, Relative and AODV. The proposed system result's higher than the existing system.

Table 2 The Packet Delivery Ratio Vs Network Dimension

PARAMETER	LBPRP	CORMAN	AODV
Packet Delay	$7*10^3$	$48*10^3$	$15*10^3$

PARAMETER	LBPRP	CORMAN	AODV
PDR	$650*10^3$	$700*10^3$	$750*10^3$

Table 2 represents the result of the LBPRP. It shows that the comparison of the proposed method and existing method in End-to-End delay.

The experimental result shows that the proposed method achieves high packet delivery ratio, reduces the packet delay. The result shows that the proposed method is efficient on comparing with AODV, CORMAN and LBPRP.

VII.CONCLUSION

The proposed a load balancing parallel routing protocol (LBPRP) for mobile ad-hoc networks. LBPRP allows routing multiple packets in parallel from a source node to a destination node over disjoint paths. The LBPRP balances the data load through calculating each path speed and selecting the path with the high speed for sending first. LBPRP is a load balancing parallel routing protocol achieving low communication delays, high packet delivery ratios, high routing path stability, and low routing overheads. Evaluation results shows that load balancing in sending data**,** decreased the end-to-end delay and increased the packet delivery ratio and throughput, thus the performance of CORMAN can be improved consequently.

VIII. FUTURE WORK

Nodes running CORMAN forward data packets in fragments. Once the source and destination nodes are separated by several hops, it should permit nodes at completely different phase of the route to work at the same time. That is, a pipeline of data transportation can be achieved by better spatial channel reuse. The design of LBPRP may be further improved to deal with this expressly. This may involve timing node backoff more exactly and tightly, or even devising a completely different coordination scheme.

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