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Progressive Routing Protocol using Hybrid Analysis for MANETs

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***Abstract*— In this paper, we proposed a replacement hybrid multipath routing protocol for MANET known as Hybrid Multipath Progressive Routing Protocol for MANET (HMPRP), during this work we improve 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 proposed routing protocol optimizes the information measure usage of MANETs by reducing the routing overload and overhead. This proposed routing protocol additionally extends the battery lifetime of the mobile devices by reducing the specified variety of operations for (i) Route determination (ii) for packet forwarding. Simulation results are used to draw conclusions regarding the proposed routing algorithm and compared it with the AODV, OLSR, and ZRP protocol. Experiments carried out based on this proposed algorithm, shows 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.**

***Index Terms*— MANETs, HMPRP, CSMA/CA, RSS, EXATA CYBER 1.1**

I. INTRODUCTION

MANET has emerged jointly of the foremost centered analysis areas within the field of wireless networks and mobile computing [1]. Mobile ad hoc network (MANET) is an autonomous system of mobile nodes that can be built without any backbone or infrastructure; it can be deployed anytime when needed. MANETs provide communication between the nodes in the network without the presence of a centralized authority which is normally found in the cellular and other fixed networks. Nodes that are involved in MANETs organize themselves arbitrarily, store and forward packets for other nodes. The wireless network topology is henceforth created "on the fly" and may change rapidly and, especially, unpredictably. In addition, nodes that participate in a MANET may be highly mobile and therefore the network topology is very much dynamic. Therefore MANET nodes themselves have to act as routers for other nodes by using the CSMA/CA they forward packets for other nodes.

In mobile ad hoc network, routes are basically multi hop because of this limited radio propagation range, topology changes frequently and unpredictably since each network host moves randomly. Because of unpredictable topology, in this power consumption provoke by RTS/CTS mechanism to detect hidden node for every node to have a better knowledge of the topology of the network and preserving its energy consumption [3] [4]. Therefore, routing is an integral part of ad hoc communications.

The routing protocols for MANET are broadly classified into three categories such as: Proactive, Reactive and Hybrid [5, 6]. Proactive routing protocols attempt to maintain consistent, up-to-date routing information

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from each node to every other node in the network. The OLSR protocol is belongs to proactive category. Reactive routing protocol [5] creates routes only when desired by the source node. Once a route has been established, it is maintained by a route maintenance procedure until either the destination becomes inaccessible along every path from the source or until the route is no longer desired. The Ad hoc On-demand Distance Vector (AODV) and Dynamic Source Routing (DSR) [7] protocols belong to the category of reactive routing protocol. And Hybrid routing protocol commonly referred to as balanced-hybrid routing, is a combination of the advantages of both distance vector and link state protocols and merges them into a new protocol. Normally, hybrid protocols are based on a distance vector protocol but contain many of the features and advantages of link state protocols. The ZRP protocol belongs to the category of hybrid routing protocol. That has received the most attention; however, they do not utilize multiple paths. This paper proposes a hybrid node disjoint multipath routing protocol which is based on the on-demand distance vector routing [1].
In this research paper we have proposed an approach for mobile ad-hoc networks routing called Hybrid Multipath Progressive Routing Protocol which performed significant improvement based on Received Signal Strength [8].

II. Background And Related Work

MANET Routing Protocols: The Routing in networking can be defined as the process of moving packet of information from a source to a destination. In this mechanism, a packet may travel through a number of network points with routers before arriving at its destination. Researchers in the field of MANET have investigated many routing protocols including various aspects of the MANETs and their properties. There are some protocols for proactive, reactive and hybrid routing in MANET. Ad-hoc On-demand Distance Vector (AODV) [6], Dynamic Source Routing (DSR), Zone Routing Protocol (ZRP) and the Optimized Link State Routing (OLSR) are some name out of them.
Reactive routing is also known as on-demand routing protocol is a popular routing protocols for wireless ad hoc routing because they do not maintain routing information or routing process at the network nodes if there is no communication. If a node wants to send a packet to another node then this protocol searches for the route in an on-demand scheme and establishes the connection in order to transmit and receive the packet. The route discovery occurs by broadcasting the route request packets throughout the network [2]. In proactive routing protocols, each node maintains a table with the routing information, and perform periodic updates and/or if the network topology changes to keep it consistent. 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.

A. The Ad-hoc On-demand Distance Vector (AODV)

The Ad hoc On-demand Distance Vector (AODV) [6], [14] protocol is one in each of them on-demand routing algorithms that has received the most attention, however, it does not utilize multiple routes. It basically joins the mechanisms of DSDV and DSR algorithm. In AODV the periodic beacons, hop-by-hop routing and the sequence numbers of DSDV and pure on-demand mechanism of Route Discovery and also the Route Maintenance of DSR are combined [9].
In AODV protocol at each instance, route discovery is done for fresh communication which consumes more bandwidth and generates more routing over-head. The source creates RREQ packet which is broadcast to it's neighbor nodes. When destination receives the RREQ packet, it sends RREP packet on received path. This RREP packet is unicast to the next node on RREP path. The intermediate node on receiving the RREP packet creates reversal of path set by the RREQ packet along with RREP packet is received by the source, it starts send data transmission on the forward path set by RREP packet. While data transmission is continue and path break occurs due to mobility of node or out of coverage area of nodes on the active path, data packets will be lost due to this reason multi route is better then unipath [10] [11].

B. Optimized Link State Routing (OLSR)

It belongs to proactive routing protocol category where the routes are always ready when required. OLSR is an optimized mechanism of a pure link state protocol. The key concept used in the protocol is that of multipoint relays (MPRs). MPRs are selected nodes which forward broadcast messages during the flooding process. To reduce the possible overhead in the network protocol multipoint relays (MPR) are used. To reducing the time interval for the control messages transmission brings more reactivity to the topological changes [12].

OLSR uses two types of the control messages first hello and second topology control. Hello messages are used for searching the information about the link status and the host's neighbours whereas topology control messages are used for broadcasting information about its own advertised neighbours, which includes at least the one MPR selector list [22].

C. Zone Routing Protocol (ZRP)

Zone routing protocol is belongs to the hybrid routing protocol category which basically combines the best features of proactive and reactive routing protocol [13]. The key concept is to use a proactive routing scheme within a limited zone in the r-hop neighbourhood of every node, and use reactive routing scheme for nodes beyond this zone. An Intra-zone routing protocol (IARP) is used in the zone where particular node employs proactive routing whereas inter-zone routing protocol (IERP) is used outside the zone. The routing zone of a given nodes is a subset of the network, within all nodes are reachable which are less than or equal to the zone radius hops. The IERP is responsible for finding paths to the nodes which are not within the routing zone. When a node A wants to send data to node B, it checks that node B is within its zone. If exist packet is delivered directly using IARP. If not exist then it broadcasts (uses unicast to deliver the packet directly to border nodes) the RREQ packet to its peripherals nodes. If any peripheral nodes find B in its zone, it sends RREP packet; otherwise the node re- broadcasts the RREQ packet to the peripherals nodes. This procedure is repeated until node B is located [21].

III. DESCRIPTION OF PROPOSED PROTOCOL

In this research paper, we have use AODV protocol as the base routing protocol therefore, the basic functionality of the proposed protocol, Hybrid Multipath Progressive Routing Protocol (HMPRP) with node-disjoint is similar to AODV protocol. We have modified AODV protocol on the basis of Received Signal Strength.

In this protocol at the time of route creation we compared RSS of every routing packet with threshold value at every neighbouring node. We apply node disjoint, multipath and load balancing technique using hybrid approach [15]. Our goal is to propose an algorithm that has a high Packet delivery ratio and throughput with low end-to-end delay and energy consumed.

IV. PERFORMANCE PARAMETER & METRICS

a. *Packet delivery Ratio***:** It shows the ratio of total packets received at destination nodes, to total packets which are sent by source nodes. Figure 2 shows Packet Delivery Ratio [19].
b. *Energy Consumption:* Energy consumption is defined as the amount of energy consumed by nodes in the networks through radio communication and processing during transmission and receiving. Figure 3 shows Energy Consumptions.
c. *Throughput:* Throughput is the average rate of successful data packets received at destination. It is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second and rarely in packets per second or packets per time slot. Figure 4 shows the average rate of successful message delivery over a communication channel [19].
d. *Average end to end delay of data packets:* Delay or latency could be defined as the time taken by the packets to reach from source to destination. This includes all possible delays from the moment the packet is generated to the moment it is received by the destination node [19]. Here we have calculated end to end delay. Figure 5 shows End-to-end delay.

V. SIMULATION ENVIRONMENT

Using the Exata Cyber simulation tool, we run several simulations with these routing schemes examining the influence of the traffic load on the routing performances. The following parameters are shown in table 1 used in our simulations.

Simulator EXata Cyber 1.1 is used to create a simulation environment to develop and analyze the newly developed HMPRP protocol and compare its performance with the already existing ad hoc routing protocol AODV, ZRP and OLSR figure 1 show the simulation of 200 nodes with 5 source nodes.

The random waypoint model is used to model mobility of nodes. This model was first used by Johnson and Maltz in the evaluation of DSR, and was later refined by the same research group.

TABLE: I SIMULATION SETTINGS

Parameter	Value
Simulator	EXata CYBER 1.1 Emulator
Studied Protocol	AODV
Area	1500m x 1500m
No. of nodes	50,100,150,200,250 nodes
No. of Applications	5
Type of sources	CBR
MAC protocol	802.11
Packet size	512 bytes
Traffic Rate	1 packet per second
Mobility model	Random waypoint
Simulation time	100 seconds
Channel type	Wireless Channel
Antenna model	Omni Directional
Energy model	MicaZ
Access Model	DCF (Distributed Coordinated Function) with CSMA/CA

VI. RESULTS AND DISCUSSIONS

The EXata CYBER 1.1 Emulator has been used to analyze the parametric performance of Hybrid Multipath Progressive Routing Protocol (HMPRP), Ad-hoc On-demand Distance Vector Routing Protocol (AODV), OLSR and Zone Routing Protocol (ZRP). The metric based analysis is shown in figure 2 to figure 5. We have done simulation on 50, 100, 150, 200 and 250 nodes using 5 CBR (source nodes) applications.

A. Packet Delivery Ratio

HMPRP shows high increase in its delivery ratio with increasing load as shown in the figure and it is also performing better than AODV, OLSR and ZRP. For highly active networks AODV, OLSR and ZRP have variable PDR but HMPRP maintain consistency with increase network size [18]. There is a good improvement in PDR for HMPRP due to hybrid nature. It can be seen in the figure 2 that packet delivery ratio for HMPRP has much better performance than of OLSR and ZRP with the increase in the number of nodes. When the number of nodes increases, OLSR and ZRP drop a larger ratio of the packets than HMPRP, AODV. The performance of HMPRP protocol is better than other protocols.

B. Energy Consumed

We can understand from figure 3 that HMPRP consume less energy than AODV, OLSR and ZRP. The Energy Consumptions of the four protocols is shown in figure 3. The Figure depicts the variation of energy consumption as a function of the number of nodes. HMPRP although uses multi routing [17]. It is observed that HMPRP has much lower energy consumption than AODV, OLSR and ZRP in all possible numbers of nodes.

C. Throughput

The throughput is analyzed with varying CBR data traffic. According to our simulation results better performance is shown by HMPRP and it is performing uniformly in the all case. Throughput of ZRP is decreasing as the network size is increasing but HMPRP performs well in large sized networks. It is evident from the figure 4 that while comparing throughput of HMPRP, AODV, OLSR, and ZRP with 50, 100, 150, 200 and 250 nodes with 5 numbers of connections it is not much reduced for all protocols. For ZRP it is highest drop. It is better going up in case of HMPRP than OLSR and AODV when no. of nodes varied 50-250 nodes.

D. End-to-End Delay

In figure 5 we see that the average packet delay increases with number of nodes while routing protocols try to find valid route to the destination. Besides the actual delivery of data packets, the delay time is also affected by route discovery, which is the first step to begin a communication session .In this analysis it is observed as expected the delays are more for ZRP in comparison to HMPRP and AODV. Delays are incurred by ZRP'S IARP and IERP methods. The end-to-end delay of HMPRP is also less than to AODV and OLSR because it

has reduced routing overhead and queuing delay whereas OLSR are proactive protocol it has already routing table.

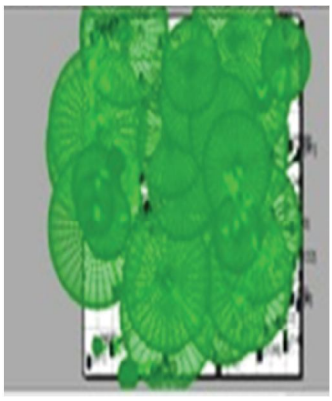

Figure 1: Simulation of 200 nodes

1) Packet Delivery Ratio

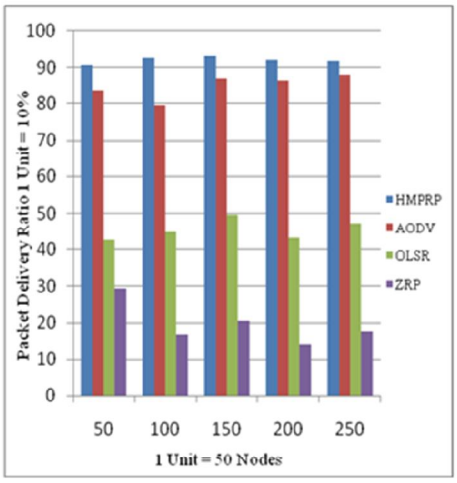

Figure 2: Packet Delivery Ratio Vs No. of Nodes

2) Energy Consumptions

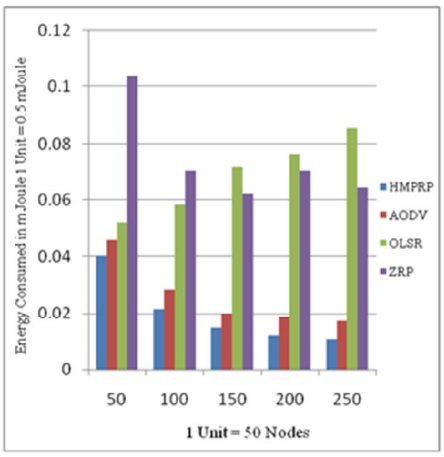

Figure 3: Energy Consumed in transmission and receiving Vs No. of Nodes

3) Throughput

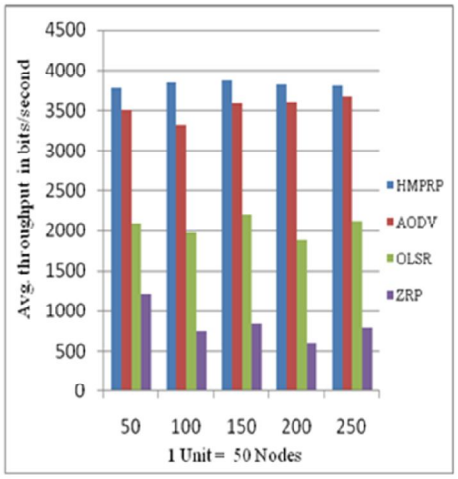

Figure 4: Throughput Vs No. of Nodes

4) Avg. End-to-end Delay

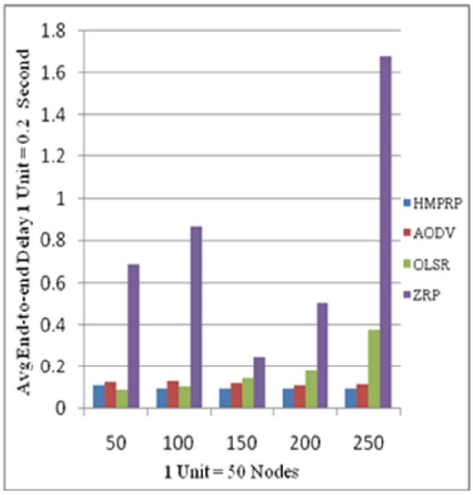

Figure 5: Avg. End-to-End Delay Vs No. of Nodes

VII. How Exata Is Different From Other Simulator?

HPMRP has been implemented using Exata Cyber 1.1 Emulator. The choice of the simulator which is most appropriate to our work based on compare some of the popular simulators, (GlomoSim, Exata Cyber , QualNet and NS-2++).

Exata Cyber 1.1 Emulator [16] is a commercial version of GloMoSim [20] but it dramatically expands its capabilities, in terms of contributed models and protocols coding, graphical tools for experiment planning, analysis and visualization, as well as in terms of available documentation, demo and technical support. Exata supports also some from of network emulation and allows designing realistic 3D environment. While it compiles using a standard C/C++ compiler, support is directly provided by the manufacturer.

Exata Cyber 1.1 Emulator appears as the best compromise, in terms of number of pre-built components, modularity and scalability. In this sense, we see Exata as an effective simulation framework, on which we can build the complete Hybrid Progressive Multipath Routing Protocol for mobile ad hoc networks.

The advanced capabilities of Exata, among network simulators, are the powerful Graphical User Interface (GUI) for custom code development and reporting options, the instant playback of simulation results to minimize unnecessary model executions, the fast simulation results for thorough exploration of model

parameters and the scalable up to tens of thousands of nodes the real time simulation and multi platform support.
Exata's analysis capabilities allow the modeler to analyze the quantitative performance of protocols that can be measured, in terms of packet delivery ratio, average end-to-end delay time and throughput. It can also provide statistical data on protocol performance when subject to increasing node density, network load, number of sources and increasing mobility.

VIII. CONCLUSIONS

In this work we have select two well known MANET routing protocols (AODV and OLSR) and has considered their most popular properties in routing messages towards their destinations and have combined these most popular properties to formulate a Hybrid MANET routing protocol through simulation and analysis Packet delivery ratio, throughput, energy consumed and average end to end delay.
We have designed, implemented and have run simulation based studies to measure the performance merits of this proposed HMPRP routing protocol. The performance evaluation of new proposed hybrid routing protocol with proactive (OLSR), reactive (AODV) and hybrid (ZRP) routing protocols for stationary and mobile nodes are studied by varying the node density (50, 100, 150, 200 and 250) using Exata Cyber 1.1 simulator. From the results it can be observed that the proposed protocol outperforms the other three protocols in the considered performance metrics, this proposed protocol achieves this performance increase by the elimination unwanted message exchanges and route requests and route replies. Our future work includes testing this protocol under various testing scenarios in order to optimize the performance of it. We are also planning to implement it in one of the MANET network testbeds and to validate the performance excellence of this protocol.

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