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A Hexagonal Topology and Coordinate Based Routing for Wmns

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Abstract— Wireless mesh networks (WMNs) contain both i.e mesh router and clients, where backbone of WMNs is mesh router due to immaterial portability. They give orchestrate access to both work and customary clients. In a WMN, it is feasible to accomplish an IGW or any Mesh Routers via various paths. Anyway this may prompt an unwanted circumstance, in which the most ideal ways may degenerate on account of the disbalancing of burden, subsequently bringing about problematic execution. To avoid this problem, we propose coordinate based multi-way routing protocol, which knows about area of its neighbors for an Infrastructural WMN. The principal thought is on the examination of directing estimation with speedy route revelation, as possible least hopes, least delays, most outrageous information rates and least possible defect-rates. Reproduction outcome, demonstrate that our introduced method estimation is preferable than current lattice, ETX and ETT metric employed in directing.

***Index Terms*: Wireless Mesh Networks (WMNs), Interconnectivity Gateway (IGW), Mesh Routing (MR), Hexagonal Topology, Coordinate based Routing.**

I. INTRODUCTION

As we know routers of mesh networks has lots of resources in comparison with traditional ad hoc networks, thus this can be exploited it more to perform in term of resources profound actions. WMNs are required to reform fundamentally the execution and bypass, the impediments of numerous networks in ad-hoc fashion, such as wireless LANs, wireless PANs, and wireless MAN. WMNs will convey wireless handlings in an extensive assortment of situations of various scales, including individual, neighborhood, campus of colleges and companies, and metropolitan territories. With these facilities WMNs [1] has come out recently very fast in research. Nodes, In WMNs, are worked as both mesh routers and clients, all nodes work as a router and as well as a host and used to transmit packets towards other neighbor nodes, which may not be in direct connection. Nodes are dynamically organized and configured itself, and install and handle, automatically, mesh connectivity among them.

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These features convey numerous favorable circumstances to WMNs, for example, low cost, simple system upkeep, vigor, and service inclusion. With the visualized use of WMNs [2, 3], the system ought to have a high limit and enough data transmission rate, in giving wireless broadband web access to end clients. A specific routing algorithm designed for a WMN, will expect to select the optimal node or links, while discovering paths from any router to Interconnection Gateway[4].
Meanwhile, certain hubs/connections might be overloaded while a couple of hubs/connections are just every once in a while used. It is big issue, in which routing protocol cannot help because it has so many unstable operation in network, However, protocols monitor links and paths time to time. Moreover, in a WMN, the traffic which contains multimedia content has heterogeneous in nature, wanted Quality of Service (QoS) turns into a critical necessity [5]. Analysts have proposed numerous measurements for WMN and connected them in QoS routing techniques [6, 7]. Our essential thought for this technique is to convey the WMNs with a particular sort of a graph as the system topology, and after that structure a steering convention by explosion of diagram's routing properties. Our proposed steering conventions are propelled by existing investigations on Hop-Count and Coordinate based Routing methods. For evaluation of the execution of the proposed plan, we simulate the networks, which exhibit that practical arrangements exist with discretionarily high probability in the irregular wireless network. The rest of the paper is organized as follows: Section II present a brief review of studies related to routing protocols, whereas Section III contains some background prerequisites and assumption related to our network model. Section IV explain the details of our proposed coordinate base routing design and algorithm for WAN Section V shows the experimental results and their comparative evaluations are reported using NS2 [18, 19]. Section VI concludes our paper.

II. RELATED WORK

In the review study, most of the protocols are based on topology control around the qualities of the subsequent diagram and skirt the detail routing, scheduling schemes, which may influence the throughput and defer execution in wireless network systems [8, 9]. Traditional routing protocols has created so many hot spots, which lead dependent performance, specially design for MANETs, such as AODV [11], DSR [12] routing protocols for Ad Hoc Networks [10], which slowly finalize routes based on hope count. Recent works are defined in [13] shown that routes with a small hop,
clog the networks

from performing with higher rates while the wireless interface has Multi-rate capability. For multi radio and channel WMNs, [14] has come up with a source routing protocol, which using a novel routing metric, Weighted Cumulative Expected Transmission Time (WCETT). This metric empowers the nodes to pick the most ideal path that have a great blend of channel variation hops with high data transmission rate.

Anyway, they don't consider load balancing for their protocol, i.e. traffic fixation and blockage on specific ways. Another issue is if a node has great connect to the following jump, however it is vigorously stacked at that point there is no utilization in choosing a way to IGW through such a hub. Yang et al. [15] demonstrated that WCETT can in certainty make routing loops in specific circumstances. They further propose another routing protocol (LIBRA) considering the intra and interflow obstruction. However, this protocol does not concentrate on traffic blockage development along great paths. Ramachandran et al. [16] propose AODV-ST protocol, which is based on spanning tree and include Expected Transmission Time (ETT) with some modification of the AODV protocol as the routing metric. Each traffic through an essential gateway that has least started to finish delay. So as to appraise the least loaded gateway, occasional RTT testing is performed which is costly. In Geographic routing [6] node only keep the states of their neighbors, support a mesh communication, used node's location for their address and forwards packets towards the destination in the insatiable manner [17]. These reasons lead this routing as is versatile. However, Geographic routing has serious extending, particularly when we have dead ends, obstacles and how to run at very low densities. Managing voids is a genuinely known issue with algorithm, for example, GFG/GPSR[7], and all the more as of late GOAFR+ [13], which is appeared to be both normal case proficient and most pessimistic scenario ideal. Fixing those issues isn't our concentration here. Rather, our objective here is essentially to investigate whether one can apply the geographic routing worldview, with the two its qualities and its shortcomings. Our methodology includes relegating virtual coordinates to every node and afterward applying standard geographic routing over these coordinates. These virtual coordinates need not be exact portrayals of the hidden topography but rather, so as to fill in as a premise of routing, they should mirror the fundamental network. Since we have local connectivity information with nodes, we create these virtual coordinates. This strategy can be employed in at most settings.

III. BACKGROUND PREREQUEDIES

Our proposed method is used for highly dynamic Adhoc networks and based on AOMDV designed. However, AOMDV configuration has been altered to suit to the consistent idea of nodes in a WMN. In this paper, we propose to find the most brief way utilizing direction-coordinates in WMN, execution examination of the proposed routing algorithm has contrasted with the traditional algorithms.

We have some essential suppositions for this calculation that all nodes, node's neighbors, and nodes neighbor's neighbors, know their own coordinates and we recognized it as a routing table. Packets have virtual coordinates for destination. Routing has been done with the help of two rules:

- Greedy: In the routing table, the packet has been forwarded to the nearest node in the way of destination using virtual coordinates.
- Stop: In the routing table, if destination is on the next node, then packet will be forwarded and stop further transition.

Following are the assumptions taken:

1. As we consider an infrastructural WMN, in which numerous equal sized hexagonal cells has covered the area, same as done in cellular networks. Regular hexagon has some specific properties such as all the side, all interior angles are equal and perpendiculars from center to each side are equal. We can locate the coordinate (x, y) of all its vertices. Let the center coordinate has (0, 0) with radius of each vertex is 5 then any vertex coordinate (x, y) can be calculated as: The value of x and y coordinates are determined by rcosΘ◦, rsinΘ◦, respectively.
2. The structure of the cell is designed as: with one center node all other six node places at each vertex of hexagonal and all they are connected to the center one. We are forwarding the packets using the resulting graph location information in terms of coordinates. The forwarding decision completely depends on the coordinates of destination, source and neighboring nodes location with information of load and current information of all six neighbors.

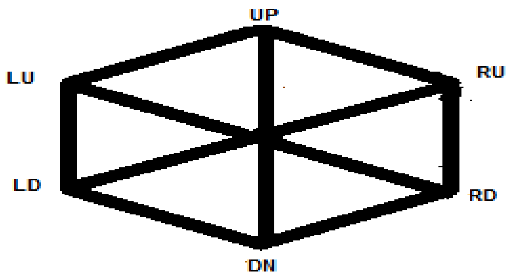

Figure 1. A typical Cell Structure, DN= Down, UP= Up, RU=Right Up, RD=Right Down, LU=Left Up, LD=Left Down.

3. We have divided the network into clusters. The center of every cluster is filled by a gateway. Default gateway for each cluster define that node and gateway belong to that.
4. Each node has all information about its six neighbors like links and load status. Every node, record link status of its all neighbor, intermittently sends signal messages to all of its neighbors to get their connection status. They also record how much hops in between the node and destination with distance with Gateway, as we know that every node is at the common margin from the gateway. To reduce the percussion effect, every node has to modify its efficiency in terms of dimension that can work only with its six neighbors not more.

5. Our antenna, which is placed at the router level, may operate as double resource: only directional or omnidirectional system [14], node works as omnidirection if node has only incoming signals and as directional antennas if node has something to transmit. With this assumption data send only in required signal quality and direction.

IV. PROPOSED COORDINATE BASED ROUNTING PROTOCOL

Our algorithm forwards packets in greedy manner and uses location coordinates for node address. We send coordinates with gateway's IP-Address to identify uniquely each address. These dummy coordinates, no need to be appropriate in the term of geometry, must be good enough for connectivity in the service of basic routing. In this manner, dummy coordinate's construction will depend on local location information. Since each node has information about their neighbors, this setting must be applied in most of the techniques. In this scenario targets in packets are also dummy coordinates. The construction of these dummy coordinates method is described below:

A. Coordinate Construction

Our proposed method is based on the construction of virtual coordinates. Our Gateway, tagged as origin, source point, i.e. (0, 0), is placed on the center of each cluster. We choose a standard radius 5 for each vertex, i.e. all neighbors are of distance 5 with their central node. Each vertex coordinate (x, y) can be calculated as: The value of x and y coordinates are determined by r*cosϴ◦, r*sinϴ◦, respectively, as shown in the Figure 3, and similarly can calculate the coordinate of all other vertexes. Proposed protocol, considered the destination location, used only lightly loaded nodes for destination in x-y coordinate direction, if the node has heavily teeming, then it considered the other nearer node in the network which has light traffic for transmitting. The route formerly chose may be altered subsequently if a portion of the route or any node within route interrupted or heavily teeming.

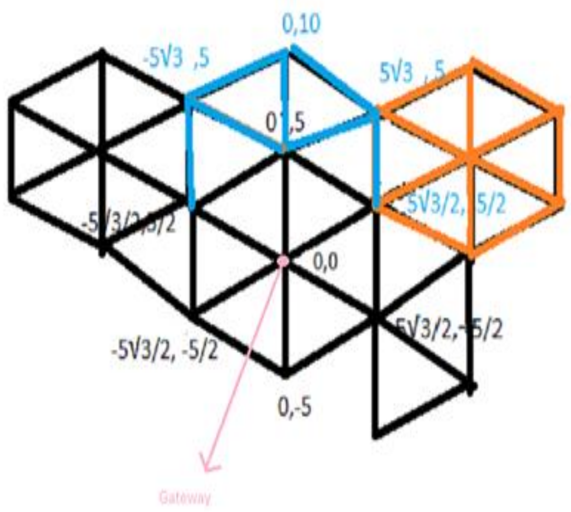

Figure 2. Virtual Coordinate calculation of a Hexagonal topology

To find out the route, first, determine the destination's location. The packet has been sent via a node, which has lightly loaded, in the direction of the destination. Once the route has been discovered, it may be used for ahead communication. Prior to sending any information packets through the recently found way, every hub checks the route in terms of connectivity and availability. On the off chance that any node interrupted in these criteria, at that point the middle node sends the bundle of packets through the other nodes, which find with a similar procedure. In the scenario if Gateway is placed at the destination, then the node with a light load and less hop count is selected. If the complete network is not available, due load or connection failure, then the local location is used for transmitting the packets and stopped all other. Just an early connection disappointment warning is utilized by taking criticism from the physical layer of the OSI model.

B. Algorithm

1. Decided the final destination with its virtual coordinate for packets transmission.
2. Finished the data transmission, if desired destination is next hop.
3. if Gateway at the final destination, then
   (a) Encore Step 3(a)(i) and 3(a)(ii) so long as packets does not arrived at destination.
   (i) Node with a light load and less hop count is selected.
   (ii) Transmit the packet using the node from step 3(a)(i).
4. else check the IP address of destination Gateway,
   (a) If target is default Gateway (DG) certainly,
   (i) Encore Step 4(a)(ii) and 4(a)(iii) So long as packets does not arrived at destination.
   (ii) Find out the neighbor's load after comparing destination and present node's virtual coordinates.
   (iii) the node with a light load and less hop count in the direction of destination. If the closest node is not fulfilling the criteria then go for next hop and convey the packet;

   (b) else
   (i) Transmit the packet to its DG, picking the node with criteria.
   (ii) Gateway either transmits the packets straightforwardly to the exists destination gateway or scans for the predetermined gateway utilizing conventional AOMDV protocols, and send the packets.
   (iii) When destination gateway received the packets, it transmit packets to the nearest node with specific criteria.
   (iv) Goto Step 4(a)(i).

To check which node is the closest, the proposed protocol looks at the virtual coordinate of the destination node (d_x, d_y) and current node (c_x, c_y), compare the both nodes. Based on the comparison results, it decided the direction of the route of the packet transmission and other remaining node kept for the backup path. These backup paths are utilized when the elementary path comes up short or is over-burden. Eq. 1 has been used to find the elementary and backup paths.

$Route =$

$$\begin{cases} PR = LD, BR = LU, DN, UP, RU, RD \ if \ c_x > d_x \ and \ c_y > d_y \\ PR = LU, BR = LD, DN, UP, RU, RD \ if \ c_x > d_x \ and \ c_y = d_y \\ PR = LU, BR = UP, LD, DN, RU, RD \ if \ c_x > d_x \ and \ c_y < d_y \\ PR = DN, BR = LD, LU, UP, RU, RD \ if \ c_x = d_x \ and \ c_y > d_y \\ destination \ reached \ Stop \ \ if \ c_x = d_x \ and \ c_y = d_y \\ PR = UP, BR = LU, DN, LD, RU, RD \ if \ c_x = d_x \ and \ c_y < d_y \\ PR = RU, BR = LU, DN, UP, LD, RD \ if \ c_x < d_x \ and \ c_y < d_y \\ PR = RU, BR = LU, DN, UP, LD, RD \ if \ c_x < d_x \ and \ c_y = d_y \\ PR = RD, BR = LU, DN, UP, RU, LD \ if \ c_x < d_x \ and \ c_y > d_y \end{cases}$$

……(1)

Where, PR = Primary Route and BR = Backup Route

From the Eq(1) destination node's virtual coordinates compare with the current node's virtual coordinates. Based upon the condition in which they lie, the primary and backup paths are maintained.

C. Simulation Setup

As described in the previous section, our proposed protocols are to improve multipath routing in WMNs that performs better than the previously discovered protocols. The introduced protocols, feigning of done in Network Simulator Version 2 [19, 20], is accomplish in open source Linux OS. The hexagonal topology is used with 36 nodes, in which each node is used hexagonal geometry. The 802.11 MAC layer is employed in the Data/Acknowledge modality. Moreover, recreation utilizes a UDP data traffic modality accompanied by Constant Bit Rate (CBR) traffic. So as to contrast and a current Grid topology, similar traffic replica and protocol of their usage were utilized. The default environment of simulation is demonstrated in Table 1. In this simulation setting we are not considered multi channel. This issue is out of scope for our paper.

Table 1. Setting for Simulation.

Parameter	**Default Values Used**
Topology Used	Hexagon
No. of nodes	36
Range of Transmission	100 mtr
Used Protocol (MAC)	802.11
Size of Packet	512 Byte
Interval among Packets	100 packets/sec
Bandwidth of Networks	5 Mbps
Probe message Interval	1sec
Time for Simulation	200 Sec

V. EXPERIMENTAL RESULTS AND ANALYSIS

In our simulation, it is assumed that the transmission has 100 meters for each mesh node. Each node received packets from any other node. The area of network Fields is 450*450 square. We used the 36 number of mesh nodes.

In computer simulation screening, we similitude our coordinate based topology accompanied by other topology naming Grid topology. The results are shown below with the help of graphs made using "x graph".

We quantified from beginning to end delay by looking at the volume of data packets sent and received. For estimating the from beginning to end delay, we considered a similar 4 simulations each with fluctuated load with 4 pkts/sec to 16 pkts/sec.

Table 2: Results for the Proposed Topology

S.no	**Number of pkts**	**Total sending time (in sec)**	**Total receiving time (in sec)**	**End to End Delay**
1.	4	.00115	.00556	.00441
2.	8	.00261	.00641	.00380
3.	12	.003341	.003741	.00410
4.	16	.004198	.004600	.00402

Table 3: Results for the Grid Topology

S.no	**Number of pkts**	**Total sending time (in sec)**	**Total receiving time (in sec)**	**End to End Delay**
1.	4	.00622	.01072	.00450
2.	8	.00813	.01203	.00390
3.	12	.008619	.009039	.00420
4.	16	.009894	.010304	.00410

A. Observation

After obtaining and plotting the figures we are comparing them and found that the beginning to end delay mean of all simulations is superior to Grid. We likewise discovered that the beginning to end defer is additionally short when few nodes achieves its clog limit, as our convention alteration its paths to the following optimal way accessible, if there should be an occurrence of disappointment or blockage on any node. We trust that our congestion evaluation procedure can be utilized to plan maiden solutions that bring out well beneath clog situations.

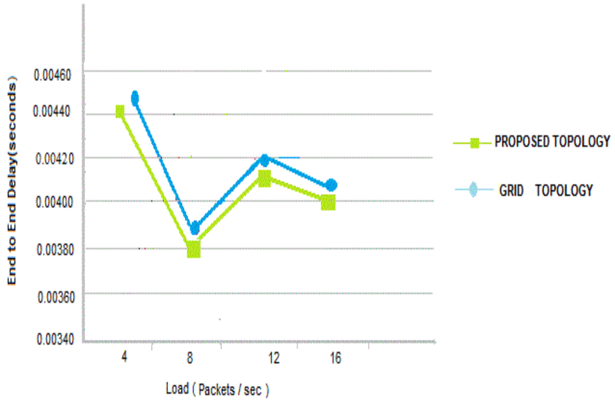

Figure3: Delay Analysis (End-to-End)

VI. CONCLUSION

Overall performance of any network is greatly depend on routing of node, thus the design of protocol or algorithm accordingly a directing convention or calculation ought to be deliberately structured considering the particular attributes of the system. We propose a novel topology and a geographic steering methodology in our paper. Our proposed work has the accompanying key commitments: (i) We structured a novel topology (ii) We characterized an approach to allocate directions to every one of the hubs in a system and find any hub utilizing those directions. (iii) We structured a calculation to transmit a bundle through virtual directions with least defer utilizing most brief way. (iv) We reenact our calculation utilizing NS2 in which our outcomes demonstrated that our topology is better that matrix topology.

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