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A Hybrid Adaptive Model for District-Based Proactive-Geographic Routing Approach in MANET

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Abstract:
MANET is infrastructureless type of wireless and self-configuring network of mobile nodes connected by wireless link. Nodes in such type of network cooperate with each other in routing and forwarding process. In the last few decades a lot of routing algorithm have been developed for MANET. However, no single routing strategy is found, which is well-suited for different network size scenario. This is the result due to the dynamic nature of nodes, where nodes can move freely in an arbitrarily manner. Moreover, the routing strategies considered as robust for fast moving nodes may not be suitable for slow moving nodes. Also nodes which perform well in large size network might not execute well in small-sized network. Thus, in this paper we present a two layered architecture that recently unified to handle both small-sized and large-sized network scenario solve two major issues in MANET, i.e. Scalability and Routing. The proposed architecture comprehensively unify two different routing families, each families employ distinct routing concept, (i.e. proactive and position-assisted routing). The top layer, i.e. Region Formation layer, devised to divide large-sized network into multiple smaller networks called Regions. And the bottom layer, which is eluded as Routing Layer, is obligated in the actual routing activity, i.e. during the actual sending and receiving process. This layer is enabled with the aforementioned philosophy, proactive and geographic routing rules. The scope of proactive routing is limited within the district only known as In-Sub-District Steering Convention (IsDSC) and geographic scheme for remote communication known as Inter-Sub-District Steering Convention (IeDSC). IeDSC employ location information of node with the help of sequence of greedy face and greedy algorithm to forward data packets in case when the destination node reside outside the regions.

Keywords: Wireless network, MANET, Mobility, Scalability and Routing.

I. INTRODUCTION

In the current accelerated and rapidly growing world technologies, more and more business realize the benefit of using computer networking, especially wireless networks. Wireless networks became popular in the communication industry since 1970's [1]. Such type of network provides a connectivity for mobile user any-time, any-place for any-thing computing capability irrespective of where the mobile user physically reside. Likewise, one of the loving fact of wireless network is their ability to eliminate the demand for laying out expensive cable and maintenance cost. The emerging capabilities of mobile devices have given a new direction to the internet, which decreases the cost and allow us to use infrastructure-based wireless networks and infrastructure less wireless networks (i.e. Mobile Ad Hoc Wireless Network). Mobile Ad Hoc Networks are infrastructure-less Ad-Hoc networks [2,3], identified by their self-forming,self-maintained, self-healing, self-organizing and self-configuring multi-hop network property, where the topology changes dynamically due to the mobile nature of the nodes allowing for extreme network flexibility.MANETs can be completely self-contained as shown in figure 1, where nodes can serve as a router which are able to discover and keep path to other node in the network. Since the inception of wireless technologies, the application of MANET is increasingly in the area such as Battlefield communication, disaster relief management, conferences, and electronic classrooms, among others [4]. In the past few decades, broad range of routing algorithms were formulated for different wireless network types, However the basic goal of such algorithms are the same, i.e. maximizing throughput, minimizing packet loss, minimizing control overhead, minimizing energy wage and minimizing end-to-end delay [5]. Nodes in MANET are equipped with limited resource and the mobile nature of the nodes mainly change the structure of the network frequently. Moreover, without prior notice of other nodes, nodes freely join and leave the network. Such behavior and characteristics of the mobile nodes makes up link interruption in their corresponding topology and routing procedure challenging task in MANET. To beat such routing challenges different routing algorithms were brought up by combining the active routing philosophy. However, none of them is best suited for small-sized and large-sized network scenario.

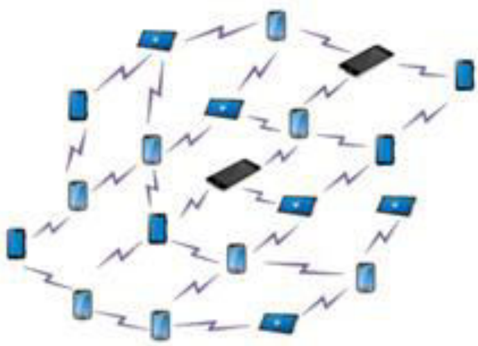

Figure. 1. Mobile Ad Hoc Networks

In this paper, a new hybrid routing architecture is introduced. The proposed architecture of DB-PG is two layered where the top layer is devised to divides the large network into multiple smaller networks called Districts. And the bottom layer is amenable for the actual routing activity by employing two different routing scheme. First, brief overview of related works in the literature are reviewed in section II. A detailed discussion is present on the proposed Hybrid Adaptive District based proactive-geographic architecture in section III. Finally concluding remarks are forwarded in section IV.

II. RELATED WORKS

This section of the paper present detailed review of the literature pertaining to routing convention in wireless ad hoc network. Beijar [6] was the first one who discuss the drawback of the different class of topology-based routing convention, i.e. proactive and reactive approaches. Utilization of excess bandwidth to maintain routing information of proactive approach and long route request delay and inefficiently floods of entire network for route determination of reactive approach are mentionable drawbacks. Thus, Beijar propose a new routing framework called Zone Routing Protocol (ZRP), which address the problem of proactive and reactive and combines their best features. Lakhatric [7] showed the effect of node density (number of node) on the performance of ZRP with simulation. The result of the simulation depicted that ZRP having smaller radius decreases compared to higher radius as the number of node increases. Kaur and Kaur [8] have simulated to measure the performance of ZRP by varying the node density (i.e. 20, 40, and 60) in different scenario of mobile nodes. The pause time and traffic load are kept constant under all scenario and result draws that with an increase in the number of nodes the routing overhead increase highly and the delay too. Therefore, the overhead highly affect the scalability of routing convention in MANET. Another experimental study have carried out on this routing framework and evaluated with three different performance metrics by varying node density and zone radius. Result showed that the performance decreases significantly in two performance metrics such as throughput and PDR. Husain et.al.[9] attempted to evaluate the performance of three routing protocols, two from topology based (AODV and DSR) and the other from position based routing (LAR), on vehicular ad hoc network. The three protocols were tested against node density for various metrics. It is found that position based routing protocol (LAR) outperforms topology based routing protocols (DSR and AODV) in different VANET environment, in terms of packet delivery ratio, throughput and end-to-end delay for Ad Hoc network. Ahmed et.al [10] conducted an extensive experiment in order to compare the performance of three MANET routing protocols i.e. AODV, OLSR and ZRP. The purpose of the simulation was to compare the efficiency of these routing protocols under different network states and network sizes using three performance metrics, Packet delivery ratio, end-to-end delay and throughput. Result shows that in a low density network, AODV has a better packet delivery ratio. Far more with the increase in number of nodes, packet delivery ratio of OLSR and ZRP drops significantly. This could be due to their proactive nature, which introduces many control overheads when the network size grows, leading to higher packet losses and consequently lower packet delivery ratios. AODV and OLSR have the lowest average end-to-end delay. ZRP has significantly higher end-to-end delay. Furthermore, AODV has a relative good throughput while ZRP has a poor throughput in the low density network. These results suggest that ZRP is best suited for small network size. More often than not, from the above literatures it is understood that hybridizing distinct routing philosophy is the best way to have better routing process. And the existing hybrid approaches are more applicable for small-sized network.

III. PROPOSED ARCHITECTURE

This section of the paper present detailed discussion on the proposed hybrid architecture. The architecture attempts to consolidate distinct routing methodology that works productively cross-wise over extensive variety of operational condition and network arrangement in Ad hoc networks, i.e. Convention Hybridization. The more encouraging rule for hybridizing diverse routing approach is quiet recently to have base convention which works all the while in various extension. Let say we have given more than one convention, every convention is appropriate for various Ad hoc networks scenario, this gives sense to gain by every convention's quality by consolidating them into single structure. The proposed hybrid architecture is presented in figure 2. The major distinction between this routing architecture from the current hybrid routing approach is that, while the existing hybrid approaches combines routing standard from one sort of routing convention particularly, Topology-based routing approach, the proposed hybrid approach attempts to combine from different routing philosophy, i.e. topology-based and position-based routing approaches.. Figure 2 delineates the proposed architecture for District-Based Proactive-Geographic routing approach, District Formation layer and routing layer.

A. District Formation layer

This layer is designed to divide the large-scale network into multiple smaller network called district. To do so the layer goes through three different activities, representation, grouping and district formation.

1. Representation

We demonstrated the topology of the network as accumulation of focuses in 2-Dimensional Euclidean

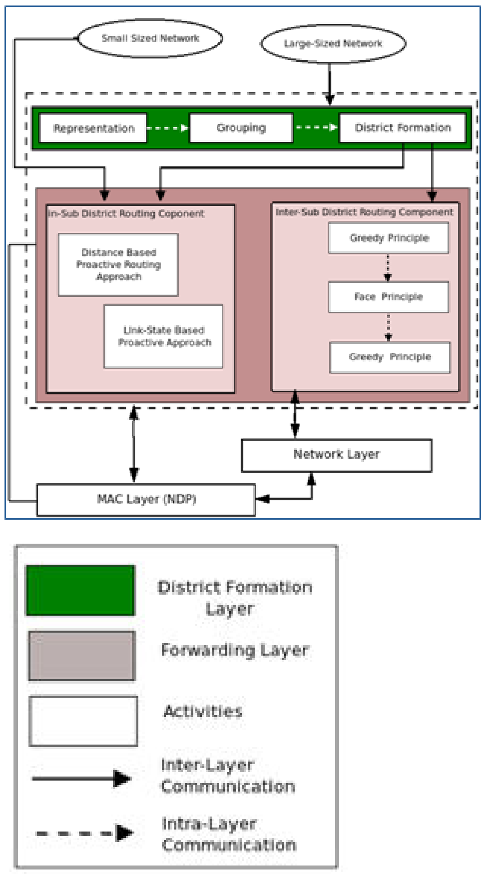

Figure.2. the High-Level architecture of the proposed DB-PG routing approach

space, where the focuses represent to a nodes and the line fragment between the nodes is utilized to speak to the remote connection as appeared in figure 3. Subsequently we utilized less complex Graph display used to extract these topology as appeared in the Figure 3.

Graph are utilized to speak to numerous genuine application, for example, network as depicted in [11, 12], so the network is displayed as network Graph. Diagram should be spoken to in a way reasonable for Computers. So in the proposed Architecture we embraced one of the representation mechanism, i.e. Adjacency List for representing the graph as appeared in the figure 4, due its Straightforwardness and time it takes to represent the entire network graph.

Now we gave an algorithm, **REPRESENTATION**, used to represent to the network chart in the frame appropriate for Computer handling. As it is specified in the Algorithm I, the representation component of the top layer would take the network size, i.e. total number of nodes and the quantity of neighbors of nodes in the network with the end goal that it makes the nodes and embed it into a rundown or summing up into ***TOPO_LIST[nodes]***. ***TOPO _LIST [nodes]*** comprises of neighbors node of every node in the network as demonstrated in the Figure 4.

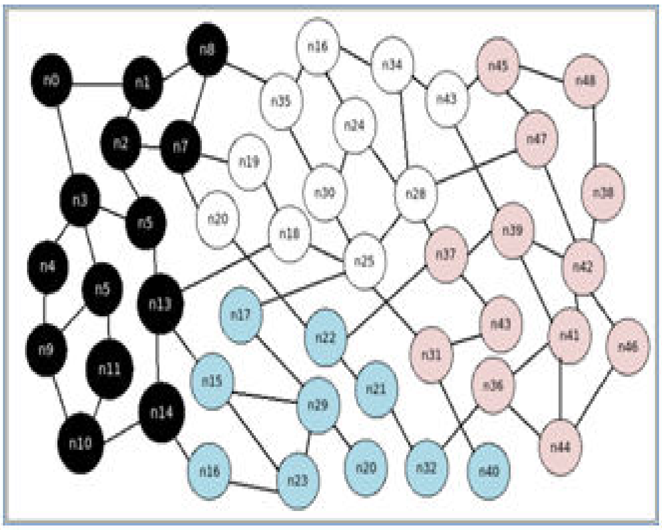

Figure.3.Representing Network topology as Network Graph

Algorithm I: - REPRESENTATION

```
Input: Total number of nodes (NN),
       Number of  neighbor nodes

FOR (all nodes in NN)
    Receive number of neighbor nodes n
      FOR (every neighbor node)
         DO
           Create mobile nodes
           Insert mobile nodes in TOPO_LIST [nodes]
      END FOR
END FOR

Output: Representation of nodes as TOPO_LIST [nodes]
```

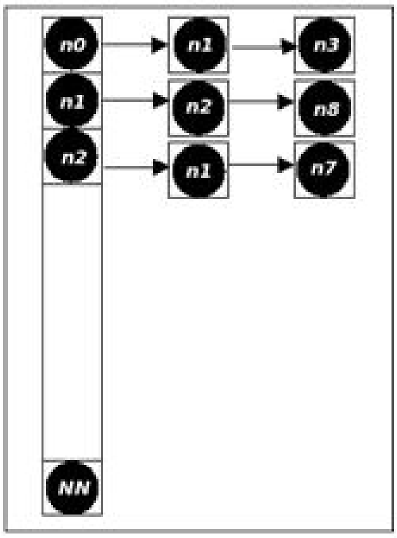

Figure.4. Adjacency List of nodes

2. Grouping

MANET is ordinarily one of remotely appointed network in which nodes bolster multi-hop routing. At that point, when the accessible number of nodes in the network is huge, neighbor nodes might be near to each other. Thus, the transmission control level for the corresponding neighbor nodes kept low. The second activity in the District Formation layer is grouping, a strategy for collaboration between nodes where nodes in a similar transmission range are assembled together to frame into District. It is realized that such gathering strategy of nodes give better execution to the group as well as to entire network by maintaining strategic distance from pointless message sending and extra overhead. Grouping of nodes may be performed based on area, neighborhoods, work, reason, and location and other. Henceforth we utilized neighborhoods as grouping criteria. We provide second algorithm utilized to gather nodes based on the neighborhoods. The general thought of the Grouping algorithm, as it is depicted in Algorithm II, is to gather nodes. The algorithm takes ***TOPO_LIST [nodes]***, the amount of node to be gathered, that implies the quantity of nodes to be assembled or gathered together. In light of the last two data, that implies organize measure and the nodes number to be assembled, the calculation processes the number of district as it is shown in the first line of the algorithm i.e. *District(d)*, which is acquired by dividing the aggregate number of node to the quantity of node to be assembled. For best execution the GROUPING algorithm choose a node with least index. On the off chance that, if the chosen node exist in the *TOPO_LIST [nodes]* the calculation begins to gathering its neighbor node and it individual neighbors amass or accumulate their neighbors until the nn is fulfilled. There is a case with the end goal that the node might be taken in another area so that the calculation proceed to the following step.

3. District Formation

The last usefulness of the District Formation layer is recently to frame the district utilizing the nodes gathered by grouping. Routing in mobile Ad Hoc networks should be efficient and resource saving [13], such that as the size of the network become huge the corresponding routing table of nodes likewise develops relatively. Thus, the efficiency of the routing convention can be influenced either certainly or unambiguously. Moreover, resource Utilization likewise develops relatively. So to minimize the routing overhead and to enhance the routing process we utilize area arrangement, i.e.

District Formation. The above algorithm takes group of nodes from the result obtained from grouping algorithm. Then it finds nodes in the ***MemberList of D(d)*** , afterward it makes those nodes in the same ***MemberList of D(d)*** in the same region

Algorithm II: - GROUPING

```
Input: TOPO_LIST [nodes], NumberOfNode (nn)

District (d)← NN/nn; // Number Of District
Initialize the first district as District(d)=1
FOR (every district D(d)) DO
  select node with minimum ID node(MIN)
    IF(node(MIN) is in TOPO_LIST)
     THEN
       WHILE( D(d) is not equal to nn)
        DO
          FOR (every node N except node(MIN)) DO
             IF (node N is not in D(d))
             THEN
                  Make node N in MemberList of D(d)
             ELSE
              stop and move to other nodes
           ENDIF
              FIND neighbor of node N in TOPO_LIST
         END FOR
      END WHILE
  ELSE
      Print No Such Node exist
END IF
END FOR
Output: Group of Nodes for the district formation
(MemberList of D(d))
```

Algorithm III: - DISTRICT FORMATION

```
Input: MemberList of D (d)

FOR (every district d) DO
     Find the nodes in the MemberList
  Put nodes in Member List in the same District D(d)
END FOR
Output: Districts D={D(1), D (2), D(3), … D(n) }
```

B. Forwarding Layer

The base layer is amiable while the nodes yearning to transmit message. Clearly, the fundamental goal of any routing convention is to provide an optimal route between nodes with reasonable less overhead. This layer joins two distinct routing philosophy, i.e. proactive and position routing convention as shown in the figure 2.

1. In-Sub-District Routing Component(IsDR*)*

IsDR is the first component of the proposed DB-PG routing approach, which is distance or link-state based proactive convention which permit a network nodes utilize the routing table to keep routing information for every other node inside district. In the proposed routing approach i.e. DBPG it is assumed that every nodes keep up two different tables. The main table is Path-table, which keeps a path of every other node inside district only, each entry in the table incorporate the next intermediate node used in the path to the destination, regardless whether the route is actually necessary or not. The table is updated often to indicate the network topology changes, and should be broadcast periodically to the neighbors. Thus, path to destinations node is always accessible when needed. This routing convention usually rely on shortest path algorithms to figure out which route will be chosen to forward packet to the intended destination. The other is Location-table used to keep the location information, i.e. X-coordinate and Y-coordinate, of every other nodes inside district. This information is basically obtained either by location services such as Global positioning System (GPS) or other type of positioning system. [13, 14, 15]. Location services is used by the initiator node to figure out the position of the Goal node. Nodes in MANET move subjectively throughout the network, accordingly connection or link breakage would happen while nodes are flying, Keeping in mind the end goal to identify neighbor nodes and connection disappointment. Therefore, DBPG work in-intersection or collaboration with Neighbor Discovery Protocol as appeared in figure 2. NDP is given by the MAC layer and pass "**HI**" guide message or beacon at prescribed or consistent interim. Upon receiving the message, the neighbor node update its table. In the event the nodes doesn't receive the beacon message within prescribed interval of time, it has been expelled from the table. Be that as it may, if the MAC layer does not include a NDP, then the practicality is offered by IsDSC as in the Zone Routing protocol (ZRP) [16]. So the route update caused by NDP which notifies IsDSC when the neighbor table is updated.

2. Inter-Sub-District Routing (IeDR)

The second component of DBPG is IeDR. This Routing approach is applied when the yearning node dwell in different district which utilize area data of nodes to forward the packet starting with one district onto next district and so on, until the messages reaches to the goal node. Not at all like, IsDR, IeDR doesn't require up table construction and maintenance. It is also unnecessary to have global view of the network topology and changes, due to these two main reason position-based routing convention scale better than other conventions [17]. In this component of IeDR a sequence of Greedy followed by Face and followed by Greedy is utilized.

Greedy Forwarding

Greedy is the most popular algorithm used in the routing world. It always makes the choice that looks best at particular moment. Besides is also considered as a rule that builds up a solution piece by piece, choosing optimal one with minimum cost with the hope that this choice will lead to the global solution [18]. Greedy forwarding strategies are being applied in geographic routing conventions based on distance, progress and direction. Using this strategy the sender node include the position of the destination node in the packet header, such information is gathered with the aid of location services. In DBPG a sequence of Greedy-Face-Greedy rule is utilized. Greedy of IeDR is used the idea of distance to locate the optimal route when the source node has no any information about how to send the bundle to the goal node assuming that Position assisted routing convention accept that the source node knows the location area of the goal node. In our scheme, when the source node need to forward the bundle to other node in the network, first it checks its path-table to find path. But in the case, when the way is not known to goal node the source node realizes that the goal node is in various district, so the source node needs to discover intermediate node. So DBPG computes the distance from its location and other nodes inside the district to goal since the goal physical location is assumed that it is known. In the wake of computing the distance, the source node choose a node with the least distance is selected as an intermediate node. However, there are cases greedy comes up short, that is the point at which the node doesn't locate the intermediate node with least separation than itself. For this situation, principle of face is employed.

Algorithm IV: - GREEDY OF THE PROPOSED MODEL

Input: Group of node in the District D (d) = {n1, n2, n3, nn}

1. *IF (source node doesn't know how to send the bundle)*
2. ***THEN***
3. ***GOTO** Location Table*
4. ***FOR** (each node n in the Location table) **DO***
5. *Calculate the distance between node n and Destination node as Dist =sqrt($(X_d - X_n)^2 + (Y_d - Y_n)^2$)*
6. ***END FOR***
7. *Select Intermediate Node $I_{Intermediate}$ with minimum distance*
8. *Forward the bundle to Intermediate Node*
9. ***END IF***

Output: Select Intermediate Node $I_{Intermediate}$

Face Routing

Most wireless ad hoc network utilizes face routing as a recovery strategy when the greedy forwarding comes up short. Such routing scheme is used in conjunction with greedy in most geographic based routing protocol to guarantee the delivery of the packet to the destined node. Face routing approach is based on the idea of graph planarity and connected plane graph of the network topology [19].

However, the graph formed by wireless ad hoc network is mostly not planar because of the transmission range of each node contain all other nodes, this brings crossing edges in the network [20]. As a result of this, the idea of face routing begins with the development of planar or plane graph [20] and utilized as part of most geographic routing convention.

Hence, the development of planar graph is tedious task. Therefore, we adopted the concept of virtual graph. Adroitly, virtual node is included at each point, where two or more edges intersect as demonstrated in figure 8, and divided the edges at these virtual nodes [21].

A virtual node cannot receive or send a packet simply maintain routing tables at real nodes to enable messages to be sent to and from virtual nodes. In this manner, a virtual plane graph is acquired that comprises of the original node and the virtual node. If the original graph is connected, so is the virtual plane graph, and if face routing is applied in this virtual plane graph, it would discover a path to the destination. This virtual path contains a virtual node, such unrealistic node simply used to figure out the real path that comply the virtual path in the network.

Once the intermediate node is acquired by using greedy, DB-PG would apply face routing to forward the bundle out of the district, then intermediate node has to decide the direction to which face the traversal start in light of the fact that, the source node or intermediate node where another beginning stage is found the node follow the clockwise direction around the beginning stage.

Algorithm V: - VIRTUAL GRAPH FORMATION

Input: $I_{Intermediate}$, link b/n $I_{intermediate}$ and node in D(d)

1. *IF (there is a path intersect between Intermediate node and node in other districts)*
2. ***THEN***
3. *Create a Virtual node at the Intersection Point as V_n;*
4. *Create Virtual link that contain the virtual Connection V_l ; // this link contain the $I_{Intermediate}$, Vn and node in D(d)*
5. *Create real path R_{path} // this is the real path the bundle goes to node Distinct region*
6. ***ELSE***
7. *Vitrual node V_n = node in D(d)*
8. *R_{path} is a path from $I_{intermediate}$ and node in D(d)*

Output:- Virtual Node V_n, Real Path R_{path}, Path from node D(i) to node in D(k),

The input to this algorithm is the intermediate, i.e. $I_{intermediate}$ node obtained from the Greedy and the path from this node to whatever other node in various district. What's more, the yield is Virtual node V_n, Real way R_{path} and the Virtual link that contain the virtual connection V_l. Since Intermediate, $I_{intermediate}$ node has data about nodes in its own particular locale or district. So it doesn't know to which node will forward the bundle. Clearly, nodes which are near the goal are found around the visitor of the district so nodes at the guest are accepted has connection with nodes in neighbor locale. As appeared in figure 3, the chart defined by an adhoc network mostly not planar as a result of transmission orbit of all node, that means, each node comprise all the other node with intersecting edges in the network. Once the middle of the road node found, it needs to decide the bearing or direction to which face the traversal start in light of the fact that at the source node or at a middle of the road node where another beginning stage is found, the node needs to decide the heading or direction of the principal virtual way on the virtual face to be crossed.

Algorithm VI: - BUNDLE NAVIGATION

***Input:** Intermediate Node, $I_{Intermediate}$*

1. *[$I_{intermediate}$ Node (D (d)] ← way in clockwise direction to be navigated.*
2. *V_l ← next. Link // stores a path that contain the following virtual connection around the limit of the current virtual face*
3. *last.node ← Vn*

The input to this algorithm is the beginning stage i.e. the transitional node of the virtual face to which the traversal start. The main virtual way is on the first way from the line to the goal node in the other district, i.e. in clockwise request around the beginning stage. BUNDLE NAVIGATION allocates the network link that comprise the next virtual link along the boundary of the current virtual face to next.link, allots the beginning stage of the following virtual way to last.node.

IV. CONCLUSION

In this paper, an attempt is made to introduce a hybrid architecture that consolidate two antithetic routing philosophy, topology-based and position-assisted routing approaches of mobile ad hoc network. One key relevant part of the study was to find out an appropriate model including the architecture and algorithm through which we are able to understand the difficulty in the existing hybrid routing philosophy so as to discover a way to come up with a solution for those challenges. In-line with this, a concept of graph model is adopted to symbolize the topology which enable to clearly and properly segment the network in multiple small networks. In addition, an effort is made to show the strength of convention hybridization, i.e. given multiple routing scheme, each suited or various network scenario of adhoc network design space. This makes a sense to capitalize on each protocol strength by combining them into framework which is better solution for scalable routing. We are now working towards the simulation to evaluate how the proposed solution behave in different size network scenario.

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