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Integration of Clustering Approach on MANET

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Abstract: The Data Mining techniques are most useful for meaningful information retrieval. The most commonly used techniques known as Classification, Association Rules and Clustering. The goal of this paper is to discover the clustering technique using MANET by network simulator (ns2). As require the Wireless Mobile Ad-hoc Network's (MANETs) routing should be time efficient and resource saving, the researched approach is used to reduce traffic during the routing process which divides the network into clusters. This paper discusses about cluster-based routing protocol, to point out its advantages and performing cluster-based simulations.

Keywords: MANET; CBRP; RREQ; RREP; CH; Route Shortening; Local Repair;

I. INTRODUCTION

MANET stands for Mobile Ad hoc Network. It is a robust infrastructure-less wireless network. A MANET can either be formed by mobile nodes or can be fixed and mobile nodes. Nodes are associated randomly with each other. Each Node in MANET can be act as both routers and hosts. The ability of mobile routers is to configure itself which makes the technology suitable for provisioning communication. For example, disaster-hit areas where there is no communication (conferences) infrastructure. Mobile Ad-hoc network is a collection of independent mobile nodes that can communicate to each other via radio waves. Each node in a MANET is free to move in any direction independently. Mobile Ad hoc Networking (MANET) technology is to ensure communication routes are updated quickly and accurately. MANETs are self-forming, and self-maintained and also allows for extreme network flexibility due to self healing. MANETs can be completely self -contained; they can also be tied to an IP-based global or local network (e.g. Internet or private networks).

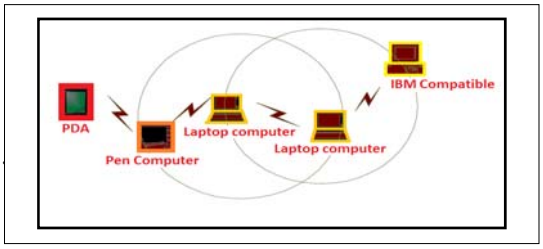

Figure 1.Infrastructure less network

A. *Routing Protocols of MANET*

In MANET protocols are necessary because without protocol computers can connect but can't be communicate so for communication purpose we need protocol and in order to provide facility to communicate within the network, a routing protocol is used to discover the routes between the nodes. The main aim of routing protocol is to find correct and efficient route between a pair of nodes so that messages may be delivered in a perfect timely manner.

Routing algorithms have some conventions. These are as follows

- Routing table should be small.
- The route should be best for given destination (Route can be fastest, most reliable, highest throughput, or cheapest).
- Table should be up-to-date when nodes die, move or join.
- It should be require small amount of time to pass the information.

Routing protocols are mainly categorized into three types which shown as in figure 2.

- Reactive routing protocol
- Proactive routing protocol
- Hybrid routing protocol

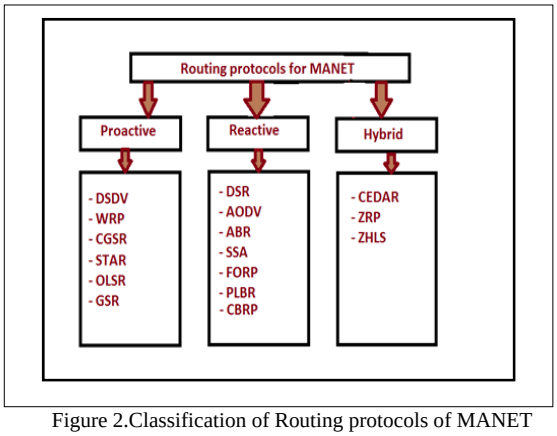

Figure 2.Classification of Routing protocols of MANET

Reactive routing protocols also called On-demand routing protocols because the routes are firstly discovered on demand, when data needs to be transmitted and route is not discovered then route discovery will take place.

The Proactive routing protocols also called Table driven protocol because it maintains consistent, up-to-date routing information from each node to other node in the network in the form of table and protocols require each node to maintain one or more tables to store routing information, and they respond to changes in network topology by propagating updates throughout the network to maintain a consistent network view.

The Hybrid routing protocols are the combination of both Reactive and Proactive routing protocols. First, it perform Proactive , in which routing tables are maintained and when the route is not found in given table then initiate route discovery, it means it will perform Reactive routing protocol [1] [2] [3].

II. CLUSTERING

Clustering is a process of organizing objects into groups that are similar. The aim of the clustering is to provide a grouping of similar records. Clustering is a process of partitioning a set of data (or objects) into a set of meaningful sub-classes, called clusters. It helps users to understand the natural grouping or structure in a data set.

Basically, Clustering is an unsupervised classification means there is no predefined classes. It uses either as a stand-alone tool to get in sight into data distribution or as a pre processing step for other algorithms.

A technique of Data clustering, in which the information (which is logically similar) physically stores together. Fundamentally, the objects of similar properties are placed in one class of objects and access to a disk can retrieve the entire class of similar objects. The quality of a clustering method can also be measured by its ability to discover some or all of the hidden patterns[6][3].

A. Usage of Clustering:

- Statistical Data Analysis
- Machine Learning
- Data Mining
- Pattern Recognition
- Image Analysis
- Bioinformatics.

B. Applications of Clustering:

1) Data Mining:Clustering is one of the first important step in data mining analysis. It identifies groups of related records or find out the patterns that is used as a starting point for exploring further relationships.

2) Medical Database: Clustering is widely used in Medical Image Database. For example: In case of to detect disease like Tumor, scanned pictures or the x-rays are compared with the existing ones and the dissimilarities are recognized, CT-Scan images of brain are kept in one cluster.In this way a large image database is maintained using one type of clustering i.e. hierarchical.

C. Example of Clustering Application

1) Marketing area: In this area provides help the organizations to discover distinct groups in their customer bases, and then use this knowledge to develop targeted marketing programs.
2) Land use area: This area is used for Identification the similar land use in an earth observation database.
3) Insurance area: This area is used for identifying groups of motor insurance policy holders with a high average claim cost.
4) City-planning area: This area is used for identifying groups of houses according to their house type, value, and geographical location.

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D. Clustering Approaches

Clustering is broadly classified into two main categories as shown as in the figure 3.

1) *Hierarchical Clustering:* It creates hierarchy of clusters which may be represented by tree structure. The sequence of partition in such a way, that each partition is nestled into the next partition with the sequence. It creates hierarchy of clusters from big to small and vice versa. It can again be sub categorized into two types-
   - Agglomerative
   - Divisive clustering

2) *Partitioning Clustering:* It partitions the database into predefine number of clusters. Again sub categorized into-
   - K-mean algorithm
   - K-mediod algorithm

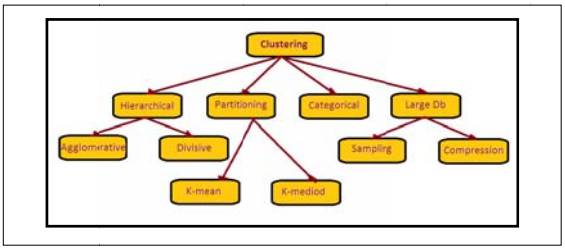

Figure 3.Classification of Clustering approaches

E. Types of Cluster

1) *Well-Separated Clusters:*A cluster is a set of points such that any point in a cluster is closer (or more similar) to every other point in the cluster than to any point not in the cluster is known as Well-Separated Cluster.

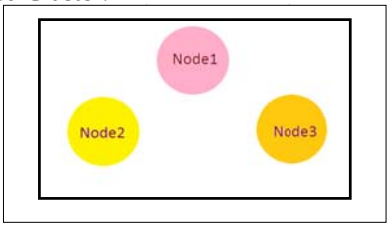

Figure 4.Example of 3 Well Separated groups of nodes seems as a cluster

2) Contiguous cluster (Nearest Neighbor or Transitive): A cluster is a set of points such that a point in a cluster is closer (or more similar) to one or more other points in the cluster than to any point not in the cluster is known as Contiguous cluster.

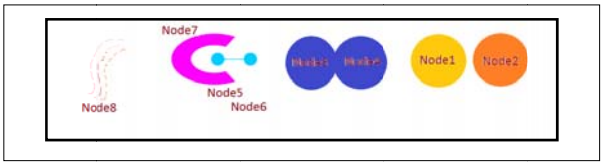

Figure 5.Example of 8 contiguous clusters

3) *Shared Property or Conceptual clusters:*A cluster is used for find the clusters that share some common property or represent a particular concept is known as Shared Property or Conceptual clusters.

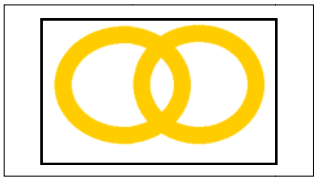

Figure 6.Example of 2 Overlapping clusters

III. CLUSTER BASED ROUTING PROTOCOL (CBRP)

Cluster Based Routing Protocol (CBRP) is a reactive routing protocol which is designed for use in Mobile Adhoc Network (MANET). In this paper clusters are mainly used for reducing

the overhead. Overhead occurs due to maintaining the up to date information of network. In such case of up to date information require when network topology changes time to time due to node movement, the effort to maintain. Keeping up-to- date information is not only expensive but also rarely justified as such global cluster membership information is obsolete long before they are used.

CBRP pick out the cluster formation algorithm, in which we also consider route discovery, route shortening & local repair for route improvement. To perform the working of CBRP it consists some steps which shown as follows:

1. Firstly it checks, there is any node comes into existence, firstly it actually enters in the "undecided" state which starts a timer and broadcasts a Hello message. The various states are decided for clustering process these are Undecided, Member and Cluster head.
2. If a cluster-head obtain the Hello message, then it immediately responds with a triggered Hello message.
3. If undecided node obtains this message then it sets to its new state i.e. "member" otherwise undecided node's time out. Then, it search for bi-directional link to neighbour.
4. Next condition will be checked that, if bi-directional link to neighbour exist then, it makes cluster-head itself otherwise it remains in undecided state and repeats the step 2.

   A neighbour table and cluster head maintains by the each node. For each neighbour, the neighbour table contains the information about the status of the link i.e. unidirectional or bidirectional and the state of the neighbour i.e. cluster-head or member and cluster-head keeps information about the members of its cluster and also maintains a cluster adjacency table that contains information about the neighbouring clusters.
5. If a source has some data and sends data to destination, then it floods route request packets but only to the neighbouring cluster-heads. On Other hand receiving the request a cluster-head checks to see if the destination is in its cluster. If it find Yes, then it sends the request directly to the destination otherwise if it finds No, it sends it to all its adjacent cluster-heads.

   Sometimes it may happen if the packets has already sent then it may be discard because cluster-heads address are already recorded in the packet.
6. When the destination receives the request packet, it replies back with the route that had been recorded in the request packet. If the source does not receive a reply within a time period, it backs off exponentially before trying to send route request again.

In CBRP, routing is done using source routing. It also uses route shortening that is on receiving a source route packet. The node tries to find the farthest node in the route and reducing the route as sends the packet to that node.

During the time of packet forwarding, if a node detects damage link then an error message is send back to the source and with the help of above error message we uses local repair mechanism [7][8][9].

A. *CBRP Terminology:*

1) *Node ID:* Node ID is just like a string which is used for to uniquely identify a particular mobile node. Node IDs must be totally ordered.
2) *Cluster:* cluster is usually consists a group of nodes with one of them take as a cluster head.
3) *Host Cluster:* A node regards itself as in cluster A if it has a bi-directional link to the head of cluster A. In this case, cluster A is a host cluster for this node. Several host clusters is possible for a node.
4) *Cluster Head:*A cluster head is choosing in the cluster formation process for each cluster. One cluster head can have for each cluster. The cluster head has a bi-directional link to every node in the cluster. A cluster head will have complete knowledge about group membership and link state information in the cluster .Conceptually, two cluster heads are not allowed to have a direct bi-directional link to each other. If such a link exists, one of the cluster head will relinquish its role as cluster head to the other.
5) *Cluster Member:* Instead of cluster head all nodes within a cluster referred as members of this cluster.
6) *Gateway Node:* When a cluster head communicate with an adjacent cluster is called a gateway node.
7) *HELLO message:* All nodes broadcast HELLO messages periodically every HELLO INTERVAL seconds. HELLO message node contains two types of table i.e. Neighbour Table and Cluster Adjacency Table.
8) *Neighbour Table:* Each entry in neighbour table contains ID of the neighbor, role of the neighbour whether it is a cluster head or a member and status of that link whether it is bi-directional or uni-directional.

B. *CBRP Routing:*

CBRP uses two data structures to support the routing process:

1) *Cluster Adjacency Table*

The Cluster Adjacency Table keeps information about adjacent clusters which is maintained by CBRP's Adjacent Cluster Discovery procedure.

Each entry of Adjacent Table contains:

1. The ID of the neighbouring cluster head
2. The gateway node (a member) to reach the neighbouring cluster head
3. The status of the link from the gateway to the neighbouring cluster head (bi-directional or uni-directional)

2) *Two-hop Topology Database*

In CBRP, each node broadcasts its neighbour table information periodically in HELLO packets. Therefore, by examining the neighbour table from its neighbours, a node is able to gather `complete' information about the network topology that is at most two-hops away from itself. This two-hop topology information is kept in a data structure in each node.

- Route Discovery: It is done by using source routing. In the CBRP only cluster heads are flooded with route request package (RREQ). Gateway nodes receive the RREQs as well, but without broadcasting them. They forward them to the next cluster head. This strategy reduces the network traffic. Initially,

node S broadcasts a RREQ with unique ID containing the destination's address, the neighbouring cluster head(s)—including the gateway nodes to reach them—and the cluster address list which consists of the addresses of the cluster heads forming the route.

If the RREQ reaches the destination node D it contains the loose source route [S, C1, C2 ... Ck, D] as shown in Figure 7. D sends a route reply message (RREP) back to S using the reversed loose source route [D, Ck. . . C1, S]. On Each attempt a cluster head receives this RREP it computes a strict source route, which then consists only of nodes that form the shortest path within each cluster. Figure: 7 show Source Routes as loose source route and the strict source route (from S to D).

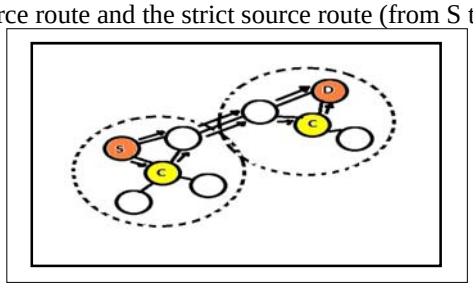

Figure 7.Source Routes

- Routing and Route Improvement: Problems due to node movements and disappearance of nodes or failures can be resolve by two mechanisms: First is Local Repair and second is Route Shortening.

➢ Local Repair:

If a connection between two nodes fails, the CBRP repairs the route. But route has to be in the two hop topology database of the node that discovered the broken link (as shown as in Figure 8). In the local repair mechanism, when a node finds the next hop is unreachable, it checks to see if the next hop (or hop after next hop) can be reach through any neighbour. If it finds the way, the packet can be sent out over the repaired path

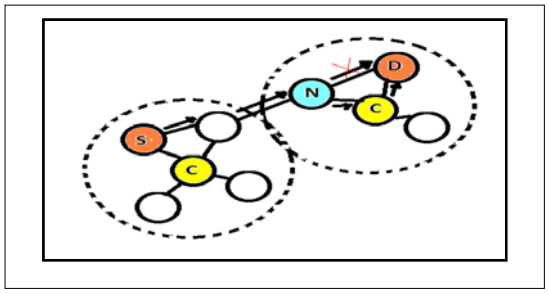

Figure 8 .Local Repair

➢ Route Shortening

Sometimes a node may discover a connection between itself and another succeeding node of the route that is not its direct successor or a connection between two following nodes, respectively. This can be done by examining the information stored in the two-hop topology database. If so, it shortens the route by excluding the redundant node(s) from the route. Figure 9 shows Route Shortening: Node N discovered a new connection between itself and D and shortened the route.

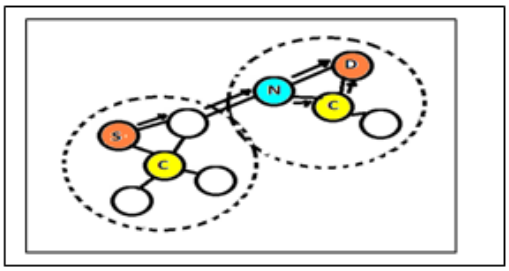

Figure 9 .Route shortening

In both cases, Local Repair and Route Shortening, the destination node is informed about the changes by receiving a gratuitous route reply packet from the node that performed the changes.

- Problems and limitation

CBRP has some limitations and problems which are disadvantages compared to other protocols. If a network and clusters become too big, the overhead per packet increases due to source routing. Every node of the route has to be stored in the routed packet. So the packet size raises proportional to the path length of the route. According to this, the transmission time increases as well. Also, if the cluster size grows the size of Hello messages and stored data structures increases. According to this rise of overhead and the flat two levels hierarchy the CBRP is scalable.

Another problem of the CBRP is its support of uni-directional links. When using a network with 802.11 link layer technology these links cannot be supported, because the 802.11 protocol knows only bi-directional inks. This could be solved by defining a new protocol that allows uni-directional links. From the view of the 802.11 protocol this would mean to permit that one node may forward Acknowledgement Packets. So, node would be able to send its acknowledgement back to the sender by using multiple hops. Address resolving by using the Address Resolution Protocol (ARP) 1 is also a problem. The ARP is a protocol to map network IP addresses to Medium Access Control (MAC) addresses. To resolve such a mapping ARP request messages (who is IPD tell IPS) are broadcasted throughout the network. If the destination receives such a request, it replies with an ARP response message (IPD is MACD). If two nodes are uni-directionally linked one of them cannot resolve the other's MAC address by using the conventional ARP [4] [5].

In this case a solution would be a modification of the protocol. So, if the uni-directional link is an intra-cluster linked, the cluster head could inform the upstream node of the MAC address of the downstream node. In case of an inter cluster link, the address could be resolved during the process of adjacent cluster discovery. Figure 10 shows Address Resolving: For node 3, the MAC address of 5 could be resolved by its cluster head. For node 2, the address of 1 could be resolved during the discovery of adjacent clusters [10][11].

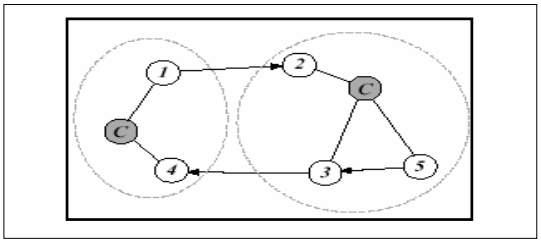

Fig.10. Address Resolving

CONCLUSION

The discussed algorithm is a Cluster Based Routing Protocol (CBRP) which performs quick routing for MANET. The analyzed reason of better routing is the address of cluster head (CH). By failing any node in the route, its CH may use another node to forward packets (if available). This research concludes the Cluster-based approaches on routing in mobile ad-hoc networks are good methods to decrease network traffic and routing overhead.

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