ANALYSIS ON CLUSTERING APPROACH IN MANET

[1]Himanshu Richhariya, [2]Amit Sinhal, [3]Sanjay K Mishra
[1]M.Tech scholar, [2]Professor and Head, [3]Assistant Professor
[1]Department of Information Technology,
[1]Technocrats Institute of Technology, Bhopal, India

Abstract- The term mobile ad hoc network is used for the moving nodes in the network to communicate with each others. MANET is a system of mobile nodes interacting without the support of central communications or access points. The best approach for communication in MANET till now is clustering. And there are so many routing protocols are proposed to make transmission better. The function of these protocols is to select the cluster head which is a normal node and is selected on the basis of some criteria's defined in each protocol. The different areas for election of cluster head in proposed work which are taken into consideration for research is battery power, mobility and transmission range.

Index Terms - MANET, Clustering, Mobility, Transmission Range, Battery Power, Cluster head.

I. INTRODUCTION

MANET is generally used everywhere as compare to wired networks because of its flexibility, low cost and powerful wireless transceivers. Mobile Ad hoc networks have reward such as fast and effortlessness of deployment, improved flexibility and compact costs. Mobile ad hoc networks are appropriate for mobile applications either in friendly environments where no infrastructure is available, or in those applications which are established temporarily and are cost crucial.

Mobile networks can be classified into infrastructure networks and infrastructure less networks considering their dependence on fixed infrastructures. In a mobile network which is infrastructure based, mobile nodes have base stations in their transmission range. The access points form the backbone for a network with infrastructure. In contrast to this, mobile Ad hoc networks are autonomous in nature. They are self-organized networks without any infrastructure support. In a mobile Ad hoc network, movement of nodes is arbitrary; therefore the network may experiences rapid and unpredictable changes in topology. Additionally, since the nodes in a mobile Ad hoc network have a confined transmission range, there are a number of nodes which cannot communicate directly with each other. Hence, the routing paths consist of multiple hops in, and each node in mobile Ad hoc networks also has an additional responsibility of acting as a router itself.

A. Routing Protocols

There are basic three types of protocol categories used in the wireless sensor network for finding routes between nodes.

Proactive MANET protocols regularly update network topology information and make sure that it is accessible to all nodes [1]. That means it ensures routes to all destination are up to-date and ready for use when required. These protocols trim down network latency but enlarge data overhead by constantly updating routing information. This leads to consuming of large amount of bandwidth. Examples of proactive protocols are DSDV (Destination-Sequenced Distance Vector Routing) protocol and OLSR (Optimized Link State Routing) protocol.

DSDV [2] is developed on the basis of classical distributed Bellman–Ford routing [3] algorithm with some modifications. The modifications made here is bypassing of routing loops in mobile network of routers. All the nodes in the network keep a routing table. The table records all of the possible destinations from the node and also the number of radio hops to each destination. Hence, a route to all the nodes in the network is readily available whether it is needed or not.

Wireless routing protocol is different from other proactive in the way that it achieves loop freedom. In this protocol, routing nodes communicates the second to last hop information and the distance for each destination in the network. Count to infinity problem is avoided by performing consistency check of predecessor information. This eliminates looping situation and provides faster route convergence. In WRP, all the nodes must periodically send hello messages to its neighbours even if it has no data to send [4].

Reactive MANET protocols [5] [6] decide routing paths only when it is required. These protocols posses the characteristic such as lower protocol overheads and longer packet delays. In reactive routing protocols additional control traffic have to be dealt with which is caused due to flooding. This in turn again put strain on the scarce bandwidth. Examples of reactive protocols are AODV (Ad hoc Distance Vector Routing) protocol and DSR (Dynamic Source Routing) protocol.

AODV is an on demand routing protocol that adopts a purely reactive approach. It supports unicast and multicast routing. A route is established on demand at the time when communication starts and is used till it breaks, after which a new route is setup [7]. AODV adopts a very different mechanism to maintain routing information. It makes use of routing tables, one entry per destination. AODV relies on entries in the routing table to send back a route reply (RREP) to the source. Protocol makes use of sequence numbers at each destination to distinguish between fresh and stale routes and to prevent routing loops [8].

DSR is an on demand routing protocol based on the concept of source routing. All the mobile nodes maintain a route cache which contains source route of which mobile is aware. Continuous updating of entries in the route cache is performed as the new routes are added. There are two major phases in this protocol route discovery and route maintenance. When a node has some data to transmit it first checks for the route to destination in its route cache [9].

The protocol which combines the advantages of proactive and reactive routing is referred to as hybrid protocol. The routing is initially established with some proactively generated routes and then reactive flooding is used for additionally activated nodes which serve the demand. The choice for proactive or the reactive method requires predetermination for typical cases. Advantage of these protocols depends on the amount of nodes activated. Reaction to traffic demand depends on gradient of traffic volume. Examples of hybrid protocols [10] are

ZRP (Zone Routing Protocol) protocol and TORA (Temporally Ordered Routing) protocol.

ZRP [11] divides the complete network topology into zones. Different routing protocols are used within the zones and between the zones based on their weaknesses and strengths. Each node in ZRP belongs to one or more than one zone.

B. Characteristics

The mobile nature and lack of fixed infrastructure, MANET has added a number of characteristics as defined below:

- Infrastructure less
- Autonomous Terminal
- Multi-hop Routing
- Dynamic Network

CHALLENGES IN MANET

The key challenges faced at different layers of MANET are :-

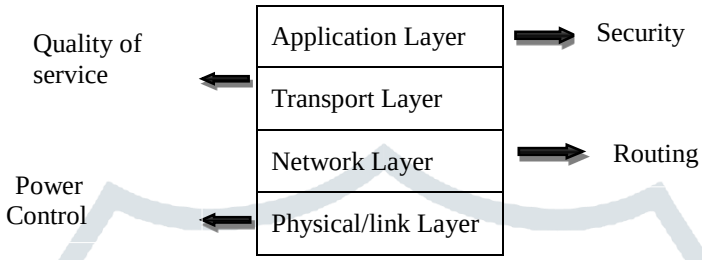

Figure 1.1 Challenges of MANET

***Routing*:** Mobile nodes of MANET are free to move randomly in any direction and the topology of the network is constantly changing therefore the communication between any pair of mobile nodes is challenging task. Most of the routing protocols have been developed to recover the path.

Limited wireless transmission range: Wireless networks have limited radio bandwidth and it can offer data rates much less than as compared to wired networks. The limited transmission range also affects the routing protocols to maintain the topological information.

***Packet losses due to errors in transmission*:** Ad-hoc wireless network suffers a packet loss problem due t**o** many reasons such as high bit error rate in a wireless channel, hidden terminal problem, presence of interference problem, location dependent, unidirectional link, path break etc.

***Security and Reliability*:** Due to the feature of distributed operation, ad-hoc network requires the security of connection between mobile nodes in the network. It is easy for malicious hosts to eavesdrop during communication session and this could lead to service degradation unauthorized access, jamming, information theft and interference. Wireless links also have a reliability problem due to the confined wireless transmission range, the broadcast nature of wireless medium e.g. hidden terminal problem; mobility causes packet loss and data transmission errors.

Quality of Service: Providing quality of service in constantly changing environment will be difficult task. MANET has dynamic environment and does not provide the guarantee of services during transmission.

Energy Constrained: All of the nodes in MANET may rely on batteries then the most important criteria of system design are based on energy conversation.

II. LITERATURE SURVEY

During the last few years various authors had worked on clusters in MANET in order to make routing more efficient. This section covers every detail regarding the work on given domain. It gives the study of various papers and articles to identify the current area of working and will help in futuristic directions of work related to location updates.

A. Background

Clustering is a means of grouping nodes using some approach to forward data effectively. In clustering a cluster head is elected for each cluster. A cluster head maintains a list of nodes that belong to the same cluster. It also maintains a path to each of these nodes. The path is updated in a proactive manner. Similarly a cluster head maintains a list of gateways belonging to the neighbouring clusters.

Clustering improves the performance of system by reducing battery power (expenditure of energy). As MANETs have a limited battery power, cluster formation is expensive in respect of power depletion of nodes. This is due to the large number of packets sent and received during cluster formation. Various clustering algorithms have been proposed for ad hoc networks. For better understanding of this cluster based networks we need to deeply study the existing algorithms. Clustering algorithms are mainly used for the purpose of cluster head selection. Cluster head is any node which coordinates different tasks within the cluster. Ordinary nodes that wish to send packet, first send those packets to the cluster head of their cluster. Now it is the responsibility of the cluster head to deliver the packet correctly to its destination. If destination lies within the same cluster it can be delivered directly as cluster head has the information about other ordinary nodes which are in its cluster. But if the destination node lies in some other cluster it takes help of a special node known as a Gateway.

Various clustering algorithms have been proposed. The task of clustering algorithm is election of cluster head. Cluster head coordinates and manages the ordinary nodes belonging to its cluster. Some of these algorithms are discussed below.

Lowest ID cluster algorithm

In this algorithm a unique ID is assigned to each node in the network. It is known that IP address assigned to the network are unique. Therefore in class full addressing host id is used as the unique ID. This scheme is concerned with only lowest id which is assigned arbitrarily. Meaning no other metrics of the node are taken into account such as its battery power, its connectivity, etc for the selection of

cluster head. Hence certain number of nodes is prone to power depletion because of serving as cluster heads for longer period of time.

- If a node hears only from the nodes with higher cluster Id than itself is a cluster head.
- The lowest Id node that is heard by a node becomes its cluster head.
- A node which can hear from more than one cluster head becomes a gateway.
- If a node is neither chosen as a gateway nor a cluster head it becomes an ordinary node.

Drawbacks of Lowest ID algorithm

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Highest Degree Algorithm

The highest degree algorithm also known as connectivity based clustering algorithm, was proposed by Gerla and Parekh [12] [13], in this algorithm the degree of node is computed based on its number of neighbours. The goal of this algorithm is to minimize the number of clusters. All the nodes in the cluster are aware of the number of its neighbours through exchange of control messages. One of the major drawbacks of this algorithm is that there is no upper limit on the number of nodes that a cluster can have. As there is increase the number of nodes in the cluster, a drop in throughput is observed and hence a there is a degradation in the system performance. Another drawback is that the re-affiliation count of the cluster head is high due to node movement as a result the node with highest degree may not be re-elected as a cluster head even if it loses one neighbour.

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Node - Weight Algorithm

In node-weight algorithm [14] each node is assigned weights on the basis of its suitability of becoming cluster head. A node which has highest weight than any of its neighbour is chosen as cluster head. There are no optimizations on the parameters such as throughput and power control.

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Weighted Clustering Algorithm

The weighted clustering algorithm was originally proposed by M. Chatterjee et al. [15]. It selects and maintains the cluster head more reasonably. It considers four factors for election of cluster head which are node degree, distance summation to all of its neighbouring nodes, mobility and remaining battery power. Weights are assigned to each of the above mentioned factors.

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Enhanced Weighted Clustering Algorithm

In this algorithm election of cluster head is on demand and invoked based on the mobility of nodes [16] or changing the relative distance between the nodes and cluster head. In order to elect the cluster head we follow the following procedure-

- Calculate degree of all the nodes.
- Compute the degree difference for all the nodes.
- Calculate the distance summation to its neighbour nodes.
- Calculate the average running speed of every node till current time. It gives a measure of mobility.
- Compute the remaining battery power for each node.
- Taking the node with smallest weight as the cluster head, all the neighbours of the chosen cluster head are not allowed to participate in the election procedure.

Clustering for Energy Conservation

This scheme assumes two types of nodes: master and slave. A master node can have a predefined number of slaves but one slave node can only be connected to one master node only. A master node starts functioning as a cluster head after establishing connection with the slave node. This scheme reduces the transmission energy consumption by making the cluster head to serve as many slaves as possible [17].

B. Related Work

Rekha Basavraju, et al [18] proposed an enhanced geographical based minimal gateway selection method to improve connectivity in MANET. In MANET enabling efficient communication among different domains is a basic networking problem and one of the areas of research topics. Gateways are to be selected to support connectivity of the nodes present in different domains. Due to mobility of nodes gateway assignment has to be done dynamically. Only a subset of nodes qualifies to become gateway nodes but we cannot use all of them

simultaneously. Because they would generate a lot of network overhead since all the gateway nodes may forward the packet and hence there will be a number of redundant copies in the network. In this paper minimum number of gateways is selected by considering the neighbour distribution, geographical distance, minimum hops and least load path.

Starsky H.Y Wong et al [19] propose a dynamic gateway assignment algorithm to support inter domain networking in MANET. In current scenario inter domain networking rely on gateway for inter domain route update, protocol translation. Previously the gateway functionality was assigned statically to a subset of nodes. This may be effective for static networks but may not work well in MANET where the nodes are mobile. This paper presents a distributed mechanism to elect minimal number of gateways and also ensures that all network partitions are connected. In the distributed algorithms a node decides whether it becomes a gateway or not according to the connectivity information gathered from its neighbours.

Ben Alla, et al [20] proposed a new protocol for cluster head and gateway election in wireless sensor network by making use of clustering. It makes use of different fuzzy parameters for cluster head and gateway election. In order to elect cluster head two fuzzy parameters are used. These are efficiency and cluster distance. The efficiency is obtained by taking the ratio of residual energy of each node and average energy of cluster. Cluster distance is the summation of distance between the node and the other nodes which are within the cluster. Gateway election is performed on the basis of nodes energy and their proximity to base station.

You Lu [21], proposed a gateway election algorithm for inter domain routing in MANET. It describes I-GIDR (Improved geographical inter domain routing protocol). A key innovation in this paper is a gateway election algorithm that makes use of neighbour's number and distribution to select a gateway that can adapt to multiple domain scenarios. Another key innovation is neighbour's priority, a concept based on the geographical distribution and density of neighbour. Hence we can summarize the key characteristics as follows-

- Balanced distribution assisted gateway election mechanism
- Neighbour priority assisted gateway election
- Neighbour priority assisted control overhead reduction

MANET is a collection of mobile nodes. Mobility is an inherent feature of this type of networks. In cluster based network, we know that huge responsibility lies on cluster head and gateway for broadcasting packet. So if the selected cluster head is highly mobile it has to be re-elected frequently. Therefore Sapna Pal, et al [22] proposed a cluster head and gateway selection algorithm based on mobility. The distinct dynamic character of MANET cannot be reflected as most of the clustering schemes assume low mobility. The algorithm considers the mobility characteristics of a node as a metric for gateway calculation. Clustering has several advantages. One is increased resource utilization, because nodes within the clusters can communicate with each other without affecting the nodes in other clusters. It optimally manages network topology by dividing the task among cluster head and gateways.

Seung-Hoon Lee [23], proposes a scheme for election of gateways in which many attributes of the border nodes have been considered for selecting them as gateways. In this paper four parameters are considered for gateway election. They are as follows-

- Network connectivity
- Secure routing
- Resource balancing
- On demand

Ahmed Mustafa Mahmoud [24], proposed gateway selection algorithm for NEMO. NEMO stands for network mobility. Existing mobile ad hoc configuration for NEMO is vaguely defined and varies according to the scenarios in which they are deployed. No standard method can ensure optimum gateway selection that maximizes internet connection performance and robustness. The proposed model proposes four tasks in order to achieve its design goals, these tasks being:

- Capability measurement
- Capability information dissemination
- Optimum route selection
- Route enforcement

Foroohar Foroozan [25], proposed a high performance cluster-based broadcasting algorithm for wireless ad hoc networks based on a novel gateway selection approach. In this paper control message exchange has been reduced by using a novel traffic isolation method. The broadcasting traffic is divided into external and internal flow. By internal flow we mean flow inside the cluster and by external flow we mean flow among the clusters. Cluster head and gateways are responsible for re-broadcasting internal flood traffic for external traffic border nodes may perform the forwarding function as well.

III. PROPOSED METHODOLOGY

Broadcasting is done in MANET for communication but direct broadcasting is costly, unsecure and is not so efficient. To overcome this now broadcasting is done through cluster heads of the cluster, which means cluster head is the most important part of MANET. There are so many algorithms used for selection of cluster head, but some cons are their till now. Some of the main issues which is identified are transmission range, mobility and energy of nodes. In proposing method, the selection of cluster head should be done on the basis of these factors.

IV. CONCLUSION

Aim of the proposed study is to design and implement a novel cluster head election algorithm for clusters in ad hoc network, so that packet delivery ratio should be increase and routing overhead decrease.

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