Genetically Optimized Clustering Algorithm for MANET

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Abstract – In recent communication technologies and services the Mobile Ad-Hoc Network place an increasingly vital role, that dynamically establish the connection whenever required for the communication network resulting in a quickly changing in topology of the network and increase communication overheads. This dynamic topology, leads to significant routing overhead, scalability problems and battery power consumptions in MANETs. Consider this problem, in this proposal a clustering approach have been proposed for Ad-Hoc networks. In Clustering approach, the cluster head election is call upon for the constructing the path, reduce the communication overheads and increase the stability. In this paper, a distributed weight based clustering algorithm has been proposed for the MANET using Genetic Algorithm. Experimental analysis shows that our protocol is efficiently better as compare with the traditional approach.

Keywords – Ad-Hoc, Clustering, MANET.

I. INTRODUCTION

Mobile Ad-Hoc network, is a collection of autonomous mobile nodes communicating over a wireless medium without requiring any pre-existing infrastructure. These nodes are free to move about arbitrarily. MANETs exhibit very interesting properties: they are self-organizing, decentralized and support mobility. Hence, they are very good candidates for clustering networks in military applications. Military world integrates today new concepts which are NEB (Battlefield Digitalization), NCW (Network Centric Warfare), BOA (Aero-terrestrial Operational Bubble), Co-operative Engagement. The goal of these concepts is to create a total numerical network, amongst other things on tactical perimeter, which connects the various tactical pawns (Headquarters, soldiers). In the general context of military IP networks architecture (strategic, operative, tactical), with implementations on various types of technological supports, and through various networks (fixed, mobile, satellite), it is required for a MANET to be a full IP network [1]. As a MANET is generally multi-hop, and in order to allow the communication between any two nodes, a routing protocol must be used.

Traditional routing protocols based on the link-state or distance-vector algorithms are aimed at finding optimal routes to every host in the network, and topological changes of the network can only be reflected through the propagation of periodic updates. These protocols are not suitable for Ad-Hoc networks. Indeed, finding and maintaining routes to every host is too expensive and almost always not necessary as each host only communicates with a subset of the hosts in the network. Furthermore, the periodic updates cannot promptly reflect the frequent topological changes in Ad-Hoc networks, which in turn will cause a lot of undelivered packets and undermine the quality of communication. Today, a number of routing protocols have been proposed for Ad-Hoc wireless networks, derived from distance-vector or link-state routing algorithms. Such protocols are classified as proactive or reactive, depending on whether they keep routes continuously updated or react on demand. While each protocol has its own advantages and disadvantages, none of them can be claimed as absolutely better than the others. Routing in wireless Mobile Ad-Hoc Networks should be time efficient and resource saving. One approach to reduce traffic during the routing process is, to divide the network into clusters.

The primary objective of this paper is to analyse, implement and perform comparative analysis of cluster based routing protocol with the protocols that don’t use clustering as a routing mechanism to demonstrate how the cluster based routing results in time efficient and resource saving routing as well as what are limitations of cluster based routing in mobile ad hoc networks and how these limitations can be overcome by suggesting some of the improvements in the existing protocol.

Following tasks must be done to achieve primary objective.

- Get a general understanding of ad-hoc networks.
- Get a general understanding of simulation environment that could be used for analysing, evaluating and implementing ad hoc routing protocols.
• Implement some of the routing protocols for wireless ad-hoc networks.
• Analyse the protocols theoretically and through simulation based on some parameters.
• Based on the above analysis suggest some improvements in protocols design to overcome some of the limitations in routing protocol.

We develop a distributed weighted clustering algorithm to fulfill our objective. And also add the concept of genetic algorithm for proper weight selection in order to improve the efficiency of network as per our objective. As the network scenario is depends upon certain user defined distributions of certain values, that’s why optimization schemes like genetic algorithm is suitable in such conditions.

II. MANET

We can characterized the life cycle of mobile ad hoc network into first, second and third generation. Present ad hoc network are considered the third generation [2] [3]. The first generation of ad hoc network can be traced back to 1970’s. In 1970’s, these are called Packet Radio Network (PRNET) [4]. The Defence Advanced Research Project Agency (DARPA) initiated research of using packet-switched radio communication to provide reliable communication between computers and urbanized PRNET. Basically PRNET uses the combination of Areal Location of Hazardous Atmospheres (ALOHA) and Carrier Sense Multiple Access (CSMA) for multiple access and distance vector routing [5] [2] [3]. The PRNET is then evolved into the Survivable Adaptive Radio Network (SURAN) in the early 1980’s. SURAN provides some benefits by improving the radio performance (making them smaller, cheaper and power thrifty). This SURAN also provides resilience to electronic attacks. Around the same time, United State Department of Defence (DOD) continued funding for programs such Globe Mobile Information System (GloMo) and Near Term Digital Radio (NTDR). GloMo make use of CSMA/CA and TDMA molds, and provides self-organizing and self-healing network (i.e. ATM over wireless, Satellite Communication Network). The NTDR make use of clustering and link state routing and organized an ad hoc network. NTDR is worn by US Army. This is the only “real” ad hoc network in use. By the growing interest in the ad hoc networks, a various other great developments takes place in 1990’s. The functioning group of MANET is born in Internet Engineering Task Force (IETF) who worked to standardized routing protocols for MANET and gives rise to the development of various mobile devices like PDA’s, palmtops, notebooks, etc. . Meanwhile the Development of Standard IEEE 802.11 (i.e. WLAN’s) benefited the ad hoc network. Some other standards are also developed that provide benefits to the MANET like Bluetooth and HIPERLAN.

A mobile ad hoc network (MANET), is a dynamic self-configurable wireless network, which has no fixed infrastructure or central administration. These characteristics make MANETs suitable for mission-critical applications, such as disaster recovery, crowd control, search and rescue and automated battlefield communications, yet make the routing in MANETs very difficult. Nodes can move arbitrarily, network topology can change frequently and unpredictably, and the bandwidth and battery power are limited. For these reasons, the development of routing protocols in MANET is extremely challenging. Multicast plays an important role in MANET. Many ad hoc network applications need the nodes to work as a group to carry out a given job. This kind of application is efficient due to the broadcast nature of wireless network for it can improve the efficiency of the wireless links. As a result, multicast routing has become a research focus recently, and various multicasting protocols in MANET have been proposed.

III. PROPOSED METHOD

A Stable Distributed Clustering Algorithm for Mobile Ad-Hoc Networks Using Genetic Algorithm

Figure 1: Flow diagram of proposed work
In the larger networks which there are thousands of nodes, data reserve and details of routing in the nodes cause some problems in the development of the network. Therefore the clustering algorithms have been represented so that the development problem is solved through representing the hierarchical structure. Though grouping several nodes in one node, other nodes can have the information of one cluster rather than that of several nodes.

The network nodes can be clustered through different methods in which various clusters cover the total network. These algorithms organize the network in several groups as cluster dynamically. By organizing the nodes in the clusters, less topological data transferred in the network. Every cluster forms a correlated graph, and two clusters may have overlap. The best method of categorizing the clustering designs of the MANETs is their aim. So different designs have been proposed for clustering of the MANETs. One of them is clustering based on combining the various parameters which uses some parameters to form the cluster especially to determine the cluster head, like node degree, cluster size, speed, battery, etc. By studying more parameters, the cluster head can be selected rightly, furthermore, factors weighting can be used in different scenarios. The different approaches can be studied through these criteria, and the similarities and differences of various designs are studied for every scenario the best clustering is selected. In the proposed method, a weight is calculated for every node based on criteria of degree difference, movement angle difference, speed difference, distance from neighbours and remainder energy.

The node with the most weight between the neighbours is selected as cluster head. In the MANET, when the nodes are not distributed uniformly, the nodes density increases in a point of network. In the distributed clustering algorithm, considering that just one node select as cluster head between the neighbour nodes (that is two cluster head nodes cannot be neighbours), so the nodes density increases in one cluster. Increasing the nodes density will put more load on each of the cluster heads, even if these nodes are neighbours and be in its transmission range. Covering of the network area by the least number of cluster heads imposes more responsibility on every cluster head which necessitates using the most resources. This causes early death of the cluster head. To solve this problem, optimization algorithms are used.

In this work, a weight based distributed algorithm has been proposed which is calculated based on 5 criteria for every weight node. The node with the most weight among its neighbours is selected as the cluster head and the value of weight factors are calculate through Genetic algorithm to get the optimized results.

**Genetic Algorithm**

A genetic algorithm is a probabilistic search technique that computationally simulates the process of biological evolution. It mimics evolution in nature by repeatedly altering a population of candidate solutions until an optimal solution is found.

The GA evolutionary cycle starts with a randomly selected initial population. The changes to the population occur through the processes of selection based on fitness, and alteration using crossover and mutation. The application of selection and alteration leads to a population with a higher proportion of better solutions. The evolutionary cycle continues until an acceptable solution is found in the current generation of population, or some control parameter such as the number of generations is exceeded.

The smallest unit of a genetic algorithm is called a gene, which represents a unit of information in the problem domain. A series of genes, known as a chromosome, represents one possible solution to the problem. Each gene in the chromosome represents one component of the solution pattern.

The most common form of representing a solution as a chromosome is a string of binary digits. Each bit in this string is a gene. The process of converting the solution from its original form into the bit string is known as coding. The specific coding scheme used is application dependent. The solution bit strings are decoded to enable their evaluation using a fitness measure.

![Figure 2: Genetic algorithm evolutionary cycle](image-url)
Considerations

In wireless network with overlap and non-overlap communication various routing protocols have been proposed, where communication nodes play an important role for energy efficient routing scenario. This paper proposes an efficient node selection scheme with clustering based routing protocols. Nodes overheads is minimized by some cluster-heads and that cluster-heads are responsible for node selections and intercommunication with various nodes. This research also proposes genetically optimized cluster-heads selection for End-to-End communication in routing protocol. The sink and source communicate with each other and maintain the routing with enough residual energy so that clustered structure may claim for maximum lifetime in a particular routing protocol.

- This paper proposes a network scenario where network nodes are dead initially unless and until it is triggered.
- Number of nodes has to be define in a given network.
- Mobility check is required.
- Selection of nodes are random where source and sink are defined.
- Every node is initialized with common energy value (i.e. 1 Joule), later on the energy level of nodes may vary according to communication.
- Calculate the shortest distance from sink for selection of source.
- Create the cluster-heads for best selection of devices into the cluster which will be responsible for communication.
- Optimize the selection of cluster-heads using fitness function of genetic algorithm for maximum life-cycle in a network.

Hierarchical (Cluster-based) Routing

In this kind of routing method, nodes play different roles in transmitting and receiving data. Some of the nodes are responsible for processing and communication, while other nodes can be used for sensing the target area. Hierarchical routing is mainly considered as two layer architecture where one layer is engaged in cluster head selection and the other layer is responsible for routing. Cluster head in hierarchical routing is the node which is responsible for collecting data from other nodes in the cluster, aggregating all data and sending the aggregated data to the base station. Creating clusters and assigning communication task to cluster heads contributes to a more scalable and energy efficient network. The main goal of all the hierarchical routing protocols is to appropriately create clusters and choose cluster heads in order to reserve energy in the network.

Hierarchical Routing is a feasible solution for reducing energy consumption in MANETs. Within a cluster, cluster head manages the member nodes and assigns them tasks which lead to reduction in redundant data transmission. Moreover, cluster head has some responsibilities such as data collection and data aggregation from their respective cluster members. Energy consumption greatly reduced in this kind of routing method since the total data messages sent to the base station is minimized by data aggregation. Hierarchical Routing effectively assigns each node different task according to the ability of that sensor node. This approach offers balanced distribution of energy in the network. It can achieve by selecting higher energy nodes to perform the responsibility of cluster heads while lower energy perform sensing duties in the target area. After creating clusters, it is the responsibility of the cluster heads to create a transmission schedule for the member nodes and broadcast it to all the nodes in its respective cluster. By using the hierarchical routing protocol the number of data collision between the nodes would be reduced.

Genetically Optimized Cluster-heads

Selection of cluster-heads plays an important role while simulation and analysis of network model. The proposed work shows the optimal selection of cluster-heads based on weight values and considering various parameters like residual energy, average energy and shortest path. The energy frame of selected cluster-heads can be defined as follows: When the distance between a node transmitting data to other nodes or the base station is less than $d_0$, the free space ($f_s$) channel model is used ($d^2$ power loss). Therefore the energy dissipates by the radio to transmit one bit message to the distance of $d$ calculates as shown in formula (1):

$$ E_{tx}(l, d) = \begin{cases} lE_{elec} + l\epsilon_{fs}d^2 & d < d_0 \\ lE_{elec} + l\epsilon_{mp}d^4 & d \geq d_0 \end{cases} (1) $$

In formula (1) $l$ is number of bits, $E_{elec}$ is the energy dissipation to run the radio electronics, $\epsilon_{fs}$ and $\epsilon_{mp}$ are the energy dissipation values to run the amplifier for close and far distances respectively.

IV. SIMULATION AND RESULTS

The performance of proposed algorithms has been studied by means of MATLAB simulation.
V. CONCLUSION

This paper focused on the routing problem in ad hoc networks. Routing in wireless mobile ad-hoc networks should be time efficient and resource saving. One approach to reduce traffic during the routing process is, to divide the network into clusters. We have seen the structure and the working of the distributed weight based cluster routing protocol. Here we also described the working of Ad-hoc on demand distance vector (AODV) routing protocol. We have presented an extensive simulation study to compare Ad-hoc on demand distance vector (AODV) with our distributed weight based cluster routing protocol and distributed weight based cluster routing protocol with Genetic Algorithm, using a variety of efficiency parameters such as throughput, end-to-end delay, and network lifetime of Ad-hoc network. Our results indicate that the distributed weight based cluster routing protocol and distributed weight based cluster routing protocol with Genetic Algorithm, have very high throughputs while the distance-vector-based protocol, AODV exhibits a large end-to-end delay of data packets.

REFERENCE


