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Service discovery and load balancing on mobile ad hoc networks using a clustering approach with optimal performance.

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Abstract: The basic goal of this research was to provide a Clustering algorithm and service discovery system with load distribution for mobile ad hoc networks (CSLBMANET) to fulfil service requests from nodes. Clustering is an issue that has to be solved in Mobile Ad hoc Networks. The network is partitioned into several subnetworks by the clusters, each of which is made up of a different set of nodes and ordered hierarchically according to certain criteria. In this research, we find ways to boost crucial cluster metrics including packet delivery ratio and network lifetime. To do this, we provide a streamlined approach to clustering by using a mathematical model with many tiers from which to choose the cluster's leader. This model is then used to boost the cluster's efficiency. As part of the self-organized clustering strategy, we propose and implement an Optimised Cluster Head selection using Analytical Hierarchy Process and Particle Swarm Optimisation (OC-AHPPSO). Particle swarm optimisation (PSO) and the Analytical Hierarchy Process (AHP) were utilised specifically to create this method. Both of these techniques for optimising performance are commonplace and well-known.

Keywords: mobile ad hoc network, Analytical Hierarchy Process and Particle Swarm Optimization

Introduction

Nodes in an ad hoc network may be anything from computers to various embedded devices, but they are all the same otherwise. These nodes may freely roam the network's structure and communicate with each other and other nodes over a wireless medium. In reality, such networks take the form of a swarm, with nodes clustered together if they are either geographically close or indirectly linked by a wireless link. When numerous nodes in a wireless network come together, a cluster forms. As their name implies, Cluster Heads are the nodes that can reach every other node in their immediate vicinity. Cluster Heads may act as a virtual backbone by routing traffic between the nodes in their cluster. It is generally accepted because nodes in an ad hoc network do not relocate according to any predetermined policy. Many distinct procedures are used by the various heuristics for choosing Cluster Heads. There is a substantial bias in many of these rules that favours certain nodes over others. Since these nodes are now responsible for additional tasks, the increased volume of network traffic may rapidly drain their power and force them to drop out of the network. Therefore, load-balancing among Cluster Heads must be implemented to provide each node an opportunity to serve as a Cluster Head. In order to prevent the uneven distribution of nodes under the Cluster Heads and to lengthen the active life of a node in a network, I would like to recommend a few enhancements to the algorithms that are now in use. [1] The term "mobile ad hoc network" (MANET) refers to a group of autonomous mobile nodes that have banded together to form a single system and are wirelessly connected to one another to establish a communication network. Dynamic topologies, variable wireless connection capacity, constrained energy resources, and security services are just a few of the elements that distinguish mobile ad hoc networks apart [2]. Obtaining scalable performances with respect to these characteristics is one of the most critical challenges faced by ad hoc networks. We visualise in terms of mobility models to mimic the real-world repositioning of nodes. Routing methods are a crucial component of ad hoc network architecture [3], and are heavily impacted by mobility characteristics including speed, direction, and affiliation with other nodes.

The acronym "MANET" stands for "Mobile Ad hoc Network," which is a group for cell nodes that may set up a temporary communication network wherever it is needed. Each node in a network not only acts as the computer that hosts it but also as a router, discovering and maintaining connections to other nodes. This makes it challenging to find and keep connections in a MANET operational. The field of mobile ad hoc networks has seen a plethora of proposed routing algorithms, including AODV [1, DSR [2, DSDV [3, and WRP [4], among others. Ad hoc networks have unique challenges when it comes to developing quality-of-service routing due mostly to congestion. Congestion may be brought on by a shortage of everything from bandwidth to buffer space to battery life to RAM. The nodes on the shortest path will see more traffic than the nodes on the longer routes because they are likely to be chosen as the routing path. Unfair traffic allocation increases the likelihood that heavily laden nodes may experience power loss and fail. When a large number of networks in a system fail, the degree to which the nodes are linked to one another diminishes, eventually leading to the partitioning of the network. In addition, end-to-end latency, efficiency, and the absence of transport connections may be negatively impacted by congestion at individual nodes due to packet loss and buffer overflow.

Therefore, it is crucial for a routing protocol to have some kind of load balancing mechanism to distribute traffic evenly across the many nodes. Load balancing is useful because it extends the life of nodes, reduces latency, and evens out power consumption throughout a network. Congestion on the roads might potentially be reduced as a result.

This problem may be avoided and resolved if the route maintenance stage of the protocol includes the approach for anticipating connection breakdown prior to its actual occurrence. In this research, we investigate these challenges and propose a Load balance and Link Breakage Prediction (LBALBP) Transport Protocol for Mobile Ad hoc Networks as an extension of the AODV protocol. RREQ packets now include a path count metric. The number of live connections that go via a given node is measured by this statistic.

This represents the weight that a node is carrying. A node's route count is incremented whenever it receives an RREQ packet, and the path with the lowest traffic is chosen by the destination.

Using this strategy, the burden is dispersed to the network nodes with fewer neighbours. To better predict when a connection may break, AODV is updating its route maintenance phase to use the average rate of change in signal strength. Before the connection actually fails, a prediction is established as to when it will fail, and a backup route is found. Any time a node in an active route detects an impending break in communication with the step before it, it will issue a warning to the node upstream. If the upstream node detects an impending link failure, it will look for a backup route locally before the breakdown occurred to ensure the delivery of any data packets. Since the signal strength is greater than the threshold value, the newly identified route is a good one. If the upstream node is unable to find an alternate path, the weak connection will be broken and the AODV link failure module will be triggered. The protocol is tested and compared to AODV using the NS2 simulator. The simulation results show that the proposed protocol outperforms AODV in many ways. This includes packet delivery proportion, end-to-end latency, throughput, number of link breakages, etc.

MANET may be conceptually represented as a series of clusters by collecting nodes that can be managed by a clusterhead. Each cluster has a single "clusterhead" that is linked to all of the other nodes in the group. Clustering is a technique that is crucial to the structure and organisation of a Mobile Ad Hoc Network. It lessens the network congestion that arises and makes it easier to manage data pertaining to mobile nodes. Once clusters are formed, the signal's transmission range of the clusterheads will establish the size of each cluster (the number of nodes involved in that cluster). The size of a cluster fluctuates over time because nodes may freely move across clusters, and because the activity of individual nodes varies. If the cluster is too large and contains too many busy nodes, the clusterhead might get overloaded. Conversely, there might be some empty space in the cluster heads. Overcrowding causes a clusterhead's batteries to drain more rapidly, which might lead to a new leader being elected and frequent data being shared among the nodes. This increases the overall cost of computation and communication. If the Ad Hoc Network's service distribution and routing method depends on the cluster's architecture, then an overcrowded clusterhead will have a negative effect on service and routing performance. Because to the overloaded clusterhead issues, network performance worsens.

Literature Review

Jay Kumar Jain et.al (2020) Mobile ad hoc networks have surpassed all other types of communication networks due to their flexibility and lack of installation requirements. Despite this, routing in MANETs is difficult because of the network's inherent volatility, the absence of a unified architecture, and the sequential nature of its failures. The major goal of this exploratory piece is to analyse and improve the way certain system procedures are carried out. Due to the massive amount of messages generated at each host and switch during the process of changing the course, traditional directing calculations place a significant burden on the system's resources. This is because information dispersal occurs when routing data is broadcast or flooded. To address these issues, we propose a novel low-power Multipath Progressive Routing protocol. Reduced asset overhead from routing calculations and the formation of a diversified technique with load balancing are the driving forces behind this solution. In contrast to earlier on-demand multipath protocols, this one provides three distinct perspectives. First, it drastically lessens the burden of routing overhead. Second, it employs a number of hub disjoint guiding techniques. In the end, it achieves a variety of hub disjoint guiding methods. The protocol has a heap balancing mechanism. One of the main factors in better overall system performance is the heap balancing feature, which helps alleviate traffic bottlenecks. The availability of the necessary part allows for this to occur. This technique was developed with both reactive and proactive approaches in mind. The proposed Protocol improves upon previous methods in terms of both packet delivery ratio and end-to-end delay.

Sunil Kumar Singh et.al(2020) The network has progressed to accommodate the most recent styles as rapidly as it has adopted new technology. Mobile nodes (MN) are the building blocks of Mobile Ad hoc Network (MANET), a kind of network technology. While there are connections between them for communication, there is no centralised administrative centre. Multiple-access network (MANET) technology has many applications beyond only communication and warfare. Many problems, including as load balancing, energy efficiency, packet loss, and connection failure, arise with MANET because of these applications. Due to the intricate nature of MANETs, routing has a more decisive role in determining the effectiveness and scalability of the network than any other factor. The difficulty in recharging the batteries used by mobile nodes is a barrier for MANETs in terms of energy management. Several methods for improving MANET's energy efficiency and load balancing are discussed in this article. In addition, the survey results are summarised with a comparative analysis..

Munshi Navid Anjum et.al.,(2019) A mobile ad hoc network is a short-lived grouping of disparate nodes that share few commonalities and suffer from resource constraints. Load balancing allows for more efficient use of the nodes' resources, increasing throughput and extending the life of the network while decreasing response times and protecting against resource overload. This paper thus proposes a load balancing technique that employs mobile agents to address this issue.A mobile agent is a piece of software that can move from one environment to another and then be executed there. Agents are more appropriate for MANET than other applications because of their decentralised nature. This is the case because the agent may go about its business without constant communication with the host computer. Therefore, mobile agents may prove more beneficial to MANET applications than message transmission does. The proposed technique has been shown to be resilient against any changes that may be made to the mobile agents. This project is being run using the Aglet platform. The results show that the method is effective.

Sangwoo Jung et.al.,(2019) We provide a new approach to load balancing by using multi-criteria decision making (MCDM) to choose reliable relay unmanned aerial vehicles (UAVs). Buffer occupancy, residual energy, and network performance as measured by the number of retransmissions are all factors that must be considered for MCDM to perform correctly. Using simulation data, we demonstrate that the proposed method may significantly reduce congestion, hence improving the rate of packet delivery and end-to-end latency.

Multi – Clusters Architecture

In mobile radio networks, hierarchical clustering solutions are often built around the concept of the Cluster Head. The Cluster Head's principal function is as the group's regional communications coordinator. In contrast to the base station concept utilised in modern cellular networks, this one is selected at random from a pool of stations and does not need any specialist gear. On the other hand, it has the potential to become the cluster's bottleneck due to the greater number of jobs it does compared to standard stations. To overcome these obstacles, we developed a strategy that does away with the necessity for a centralised ClusterHead and instead uses a distributed system for both cluster creation and data dissemination. The network's nodes are often classified into many groups in cluster-based systems [9] [19]. Each group has one node designated as the cluster leader and the others function as ordinary nodes. The size of a cluster is determined by the strength of its communication range, or the transmission power of its cluster head. The ClusterHead is in charge of ensuring that all packets with a destination inside the cluster are successfully delivered, as well as coordinating communications within the cluster and handling traffic between clusters. It may also interact with nodes that act as gateway to wired networks, exchanging data with them. In clusters-based network topologies, the demise of the Cluster Head directly correlates to the demise of the network. Therefore, Cluster Heads use more power than typical nodes and run out of juice considerably more quickly.

Cluster Head Load-Balancing Technique (CLBT)

Clustering's straightforward architecture makes it easy to manage resources. Code segregation, channel access, routing, and power management are just some of the many valuable tasks it can do. In addition to routing communication between nodes in a cluster, cluster-head nodes are responsible for power management and service delivery. Communication between network nodes is much improved when led by a cluster head. If the cluster heads are overloaded with information, the performance of other protocols that rely on the clustering architecture may suffer. The nodes' mobility and the diversity in activity levels among the nodes are two examples of the factors that put more responsibilities to the cluster chiefs' shoulders. Clusters head Load-Balancing Technique (CLBT) is a method proposed to enhance network performance. Taking use of the flexible gearbox range, this strategy is used in MANET to distribute the burden on the cluster nodes. The clusters with the most nodes and the ones with the fewest have reached an agreement to share the load and allocate their nodes fairly. A cluster head's transmission range is reduced when it is crammed full of items, whereas it is enhanced when the cluster head is empty.

CLBT Protocol

BT Protocol The CLBT operates on two levels: the local level, which is between the clusterhead and the members of the cluster, and the general level, which is between the clusterhead and the cluster heads that are near to it.

The functionality of the general level may be broken down as follows:

1. Each clusterhead stores a parameter representing its current load as well as a load threshold that has been established.

2. The information (clusterheads' ID and parameter load) is traded between clusterheads either on a regular basis or when it is requested.

3. The parameter load of each clusterhead is compared to the load of the clusterheads that are next to it.

4. The CLBT method is called into play by the cluster heads if the difference parameter load of the clusterheads is greater than the threshold for that load.

5. The clusterhead that is only lightly laden will work together with the clusterhead that is heavily loaded in order to transfer the burden between them.

The following describes how the local levels function:

1. Each node stores a parameter that indicates the current load it is carrying as well as its location.

2. A node will periodically send a message to its clusterhead detailing its current load and whereabouts.The simulator was developed using Java as the underlying programming language. An ever-changing topology characterises the virtual ad hoc network. The layout is a square with a length and width of 200 metres each. The network's nodes are placed at completely arbitrary coordinates. The entire amount of energy available at the network's inception (Work Budget) is 5000. Each node's range of 25 units is entered into the software as an input. The pace at which a node may travel can be ranging from zero to half of its communication range. The location of the mobile nodes is calculated using the "random waypoint" principle. During the first pause in the simulation, all mobile nodes come to a complete halt. After that, it picks a point anywhere inside the topological area at random and begins travelling towards it at a random speed. The random velocity ranges uniformly from 0 to a maximum velocity that is no more than half of a node's communication range. Once the mobile node has arrived at its destination, it will rest for the allowed length of time before moving on to another destination using the same methodology. For the duration of the simulation, this pattern of movement will be executed again..

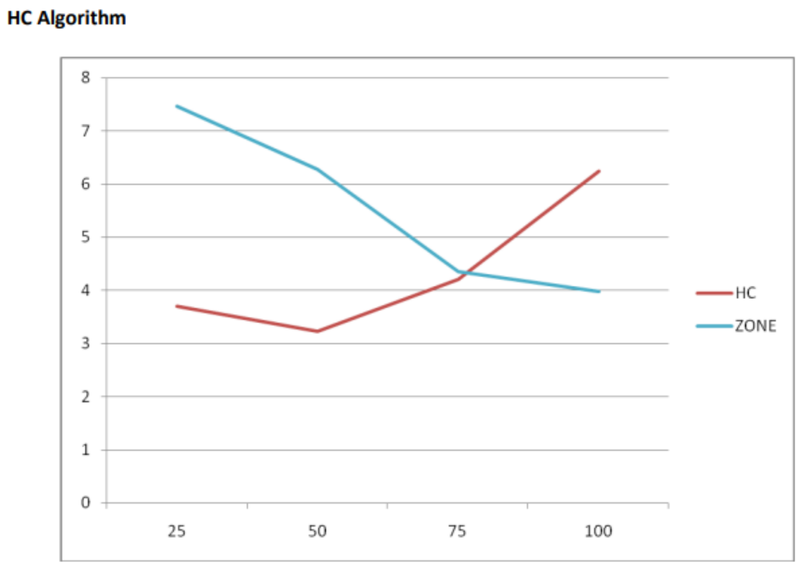

Figure 2: HC vs Proposed Enhancement

The initial network lifetime in HC is low due to the smaller number of nodes. A shorter lifetime is to be expected for a network with fewer nodes. As a result of the update, we can now see that the lifetime of the original network, which had a less number of nodes to begin with, has lengthened. The reason for this is because the number of nodes directly subsumed by each ClusterHead was much higher..

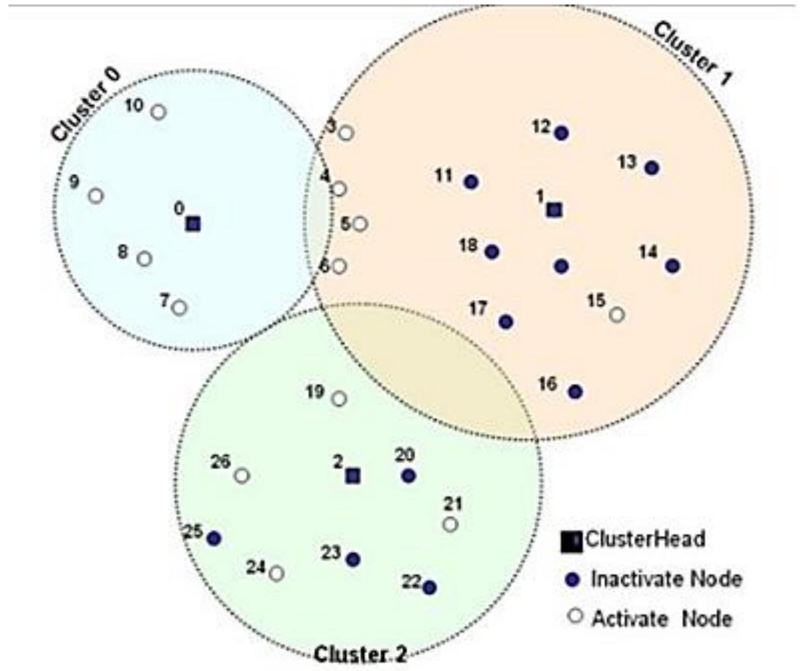

Figure 4: Clustered Mobile Ad Hoc Network without CLBT.

Conclusion

Nodes in mobile ad hoc networks are autonomous and able to roam the network while still maintaining wireless connectivity and sharing information. These nodes are all equal contributors to the network as a whole. One such strategy for facilitating more effective communication between nodes is the grouping of nodes into clusters. One node within each cluster will be identified as the clusterhead; this node will be in charge of service distribution and route definition. None of the existing Mobile Ad Hoc Network clustering algorithms account for the individual node's level of activity. Once the clusters are set up, they are vulnerable to either an overloaded clusterhead or an underloaded clusterhead, depending on the current traffic load. This is because each clusterhead isn't carrying more than its fair share of traffic. Our team came up with a solution to this issue that we call the Clusterhead Load-Balancing Technique (or CLBT for short). The CLBT uses the wide variety of available gearboxes to distribute the force evenly across all of the clusterheads. We plan to focus our attention on the CLBT canopy in the near future.

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