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Autonomous Connectivity Using Mesh Networks

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Abstract: Mobile ad hoc networks (MANETs) are ideal for situations where a fixed infrastructure is unavailable or infeasible. The growth in wireless communication technologies attracts a considerable amount of attention in mobile ad-hoc networks. Since mobile hosts in an ad-hoc network usually move freely, the topology of the network changes dynamically and disconnection occurs frequently. These characteristics make a mobile ad-hoc network be likely to be separated into several disconnected partitions, and the data accessibility is hence reduced Today's MANETs, however, may suffer from network partitioning. This limitation makes MANETs unsuitable for applications such as crisis management and battlefield communications, in which team members might need to work in groups scattered in the application terrain. In such applications, intergroup communication is crucial to the team collaboration. To address this weakness, we introduce in this paper a new class of ad-hoc network called Autonomous Mobile Mesh Network (AMMNET). Unlike conventional mesh networks, the mobile mesh nodes of an AMMNET are capable of following the mesh clients in the application terrain, and organizing themselves into a suitable network topology to ensure good connectivity for both intra- and intergroup. We proposes HEF algorithm for the cluster head selection.

Keywords: Mobile mesh networks, dynamic topology deployment, client tracking, HEF algorithm, mesh client.

INTRODUCTION

MANETs are among the most popularly studied network communication technologies. In such an environment, no communication infrastructure is required. The mobile nodes also play the role of the routers, helping to forward data packets to their destinations via multiple-hop relay. This type of network is suitable for situations where a fixed infrastructure is unavailable or infeasible. One great challenge in designing robust MANETs is to minimize network partitions. As autonomous mobile users move about in a MANET, the network topology may change rapidly and unpredictably over time; and portions of the network may intermittently become partitioned. This condition is undesirable, particularly for mission-critical applications such as crisis management and battlefield communications. We address this challenging problem in this paper by proposing a new class of robust mobile ad hoc network called Autonomous Mobile Mesh Networks (AMMNET).

In a standard wireless mesh network, stationary mesh nodes provide routing and relay capabilities. They form a mesh-like wireless network that allows mobile mesh clients to communicate with each other through multi hop communications. When a mesh node fails, it can simply be replaced by a new one; and the mesh network will recognize the new mesh node and automatically reconfigure itself. The proposed AMMNET has the following additional advantage. The mobility of the mesh clients is confined to the fixed area serviced by a standard wireless mesh network due to the stationary mesh nodes. In contrast, an AMMNET is a wireless mesh network with autonomous mobile mesh nodes. In addition to the standard routing and relay functionality, these mobile mesh nodes move with their mesh clients, and have the intelligence to dynamically adapt the network topology to provide optimal service. In particular, an AMMNET tries to prevent network partitioning to ensure connectivity for all its users. This property makes AMMNET a highly robust MANET.

RELATED WORK

We classify the works related to AMMNET into three categories: 1) stationary wireless mesh networks: AMMNET is a new type of mesh networks, but supports dynamic topology adaptation, 2) sensor covering: the techniques for sensor covering is related to the design of covering mobile clients in AMMNET, and 3) location tracking: tracking mobile clients in AMMNET is an application of location tracking. In the last few years, stationary wireless mesh networks have been developed to enable last-mile wireless broadband access [1]. Past work on stationary mesh networks focuses on routing traffic in a mesh topology to best utilize the network capacity [2]. Some literatures further study how to utilize non overlapping channels [3], [5], [6] and explicitly control the network topology [7], [8] to improve the network capacity of a stationary mesh. Our work builds on the concept of such a stationary mesh-based infrastructure, and extends it to enable communication among partitioned mobile clients. We improve the security inside the network. We study dynamic deployment of an AMMNET in this work, and leave utilizing non overlapping channels to improve network capacity as our future study. A self-deployment protocol is proposed in [9] to enable randomly scattered sensors to automatically move to the target planned positions. Instead of deploying stationary sensor nodes to cover the entire monitoring field, an alternative is proposed in [10],to use mobile mules to move around different monitoring areas and gather data along the traversed paths performance of sensor covering.

AUTONOMOUS MOBILE MESH NETWORK

Similar to stationary wireless mesh networks, an AMMNET is a mesh-based infrastructure that forwards data for mobile clients. A client can connect to any nearby mesh node, which helps relay data to the destination mesh node via multi hop forwarding. For ease of description, in this paper we use the terms "mesh node" and "router" interchangeably. Like stationary wireless mesh networks, where routers are deployed in fixed locations, routers in an AMMNET can forward data for mobile clients along the routing paths built by any existing ad hoc routing protocols, for example, AODV. Unlike stationary wireless mesh networks, where routers are deployed at fixed locations, routers in an AMMNET are mobile platforms with autonomous movement capability [11]. They are equipped with positioning devices such as GPS, to provide navigational aid while tracking mobile clients. Clients are not required to know their locations, and only need to periodically probe beacon messages. Once mesh nodes receive the beacon messages, they can detect the clients within its transmission range. With this capability, mesh nodes can continuously monitor the mobility pattern of the clients, and move with them to provide them seamless connectivity.

Our design considers applications where clients follow group mobility patterns [12] to move toward different directions in smaller groups. That is, the clients belonging to the same group have similar movement characteristics. However, different groups of clients might move in different directions, as illustrated in Fig. 1. The group mobility model has been verified as a realistic mobility model [13] and applied to many practical scenarios, such as campus networks [14] and ad hoc networks [15], [16]. Our goal is to dynamically allocate a finite number of mesh nodes to cover as many mobile clients as possible, while maintaining the connectivity between the groups of clients. Even though we describe the operation of AMMNET using the group mobility model, AMMNET can actually support a more general mobility model, where clients might move independently. In an extreme case, each client can be thought of as a group that contains only one user, and the design of AMMNET can still be applied to support connectivity for those independent clients.

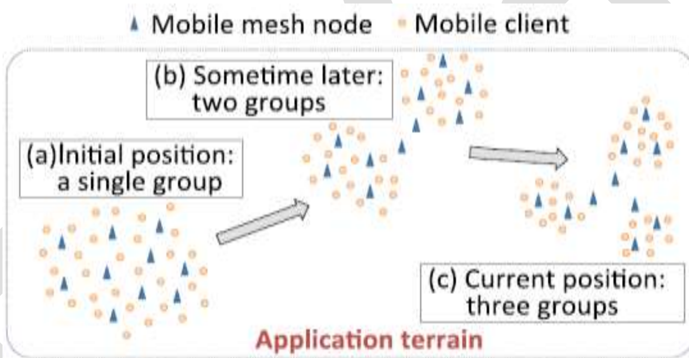

Fig 1: Topology Adaptation

Cluster Head Selection

To reduce the work load, we are dividing our project into small modules, they are given as below.

1. Grid sensor network deployment
2. Cluster formation
    a. Collecting grid information
    b. Energy calculation
3. Cluster head changes

Grid sensor network deployment

In sensor network, we can deploy the sensor in two types. One is random deployment and optimal grid deployment. Whenever we used random deployment, the network will get many of the problems like as coverage problem, energy reduction problem and interferences. To avoid this many problems we are going to use optimal grid sensor deployment. Grid sensor network deployment is nothing but deployment of sensor in fixed and optimally calculated senor placement in certain distance. Using grid sensor deployment we can improve the coverage area and also we can avoid the high cost.

Cluster Formation

Cluster formation is the process of grouping sensor devices by collecting the grid location information and gathering energy information. In our paper, we are using the grid sensor deployment, so we are defining cluster formation will be done within the grid. So initially we are calculating the each and every node location information and energy of the node. We are initializing the network with same energy level so initial cluster head selection is done randomly. And remaining node in that grid is joining with that cluster head.

Cluster head changes

In sensor network, if we forming the clustering mean we can improve the network life time is possible but the constant cluster head mean that particular node will lose more energy. To avoid this problem we need to use cluster head changes. There is the different cluster head changing algorithm is available like as LEACH. In that algorithm cluster head changes will be in random manner, so that may chances to reduce the some particular node energy. To avoid this problem we are using the HEF algorithm.

Each and every second calculated energy is going to store in energy list, whenever cluster head duration is over then we are comparing energy of each and every node in that list. And which one having high energy in that list we are selecting that node as the cluster head for that period.

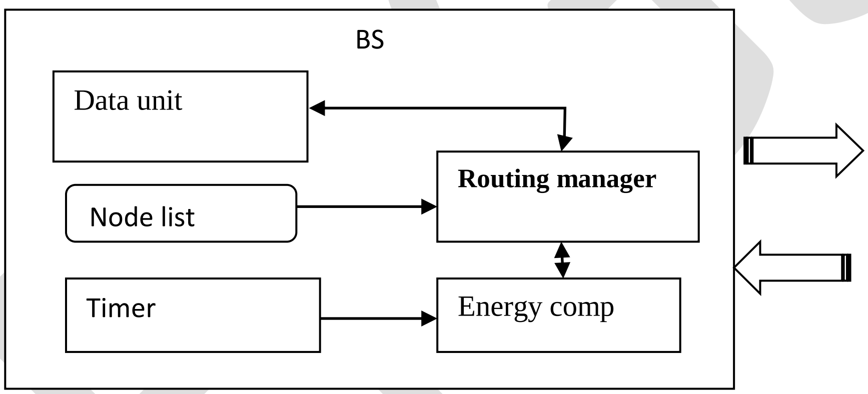

Fig 2: Energy comparison

In our paper, we are considering only the communication part; we are not implementing any sensing part. The data unit is used to generate the data. Each and every node has the energy unit. Energy unit has the current energy level. Routing manager controls the all events such as sending, receiving and data transmission. In base station, node has the node list and energy compassion unit and data unit. Data unit collects all info. Energy comparison unit compare the energy level and gives high remaining energy node name. Routing manger will selects CH by HEF. And timer used for trigger the event to compare the energy level. In our method we reduced the changes for repeated node as cluster head, in our model high energy node only going to act as CH so energy loss is less.

HEF(High Energy First)

In this HEF (High Energy First) is employed for electing cluster head. This algorithmic program selected the best ranking residual energy node as cluster head. HEF may be a centralized cluster choice algorithmic program. It also can be enforced during a distributed manner by suggests that of synchronization approach. The interactions and operations between parts in HEF algorithmic program area unit as follows:

1. HEF selects the cluster head in step with the residual energy of every device node. Then the" setup" message (with cluster ID) is distributed to the cluster heads of alternative clusters.
2. The cluster head broadcasts the "set up" message to all or any the neighboring device nodes to hitch this cluster.
3. When receiving these messages regular nodes send the "join" message to the corresponding cluster head. Then those regular nodes are related to this cluster.

4. Every cluster head acknowledges the commitment and sends TDMA schedule to regular nodes.
5. The device nodes perform sensing, process and communication tasks co- operatively at their corresponding clock cycle. The energy data is additionally transmitted at this clock cycle.
6. The cluster head transmits all collected data to sink node or base station.

Simulation Results

This can achieved by network simulator 2. Here the tool command language (TCL) is used.

Number of nodes - 50

In intra group communication

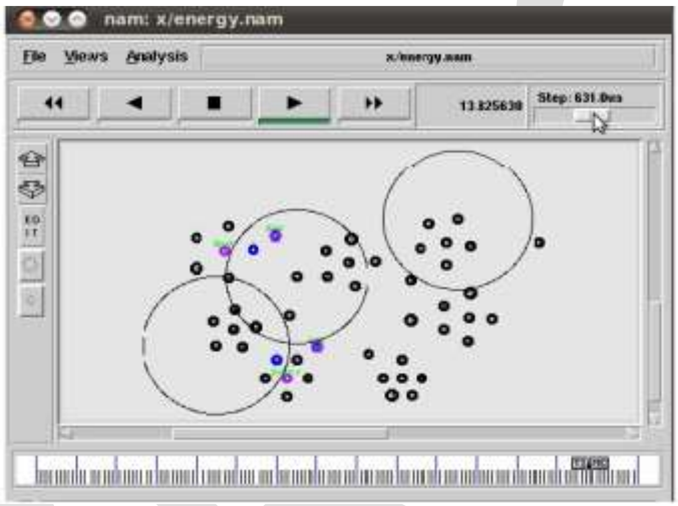

Fig 3: Cluster head selection and data transfer

Energy loss and Delay

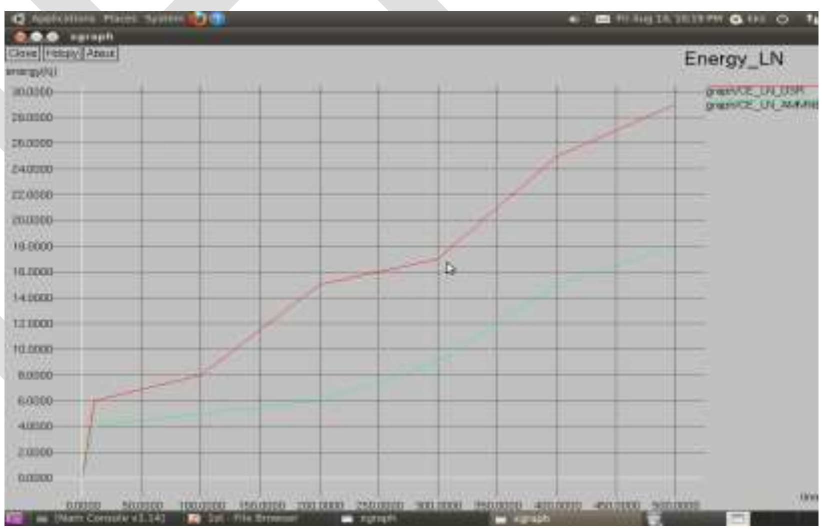

Fig 4: Energy loss

In this scenario (Fig 4. Energy loss) shows that energy loss is less in proposed method. Fig 5 shows that delay in proposed method is less than that of the previous method.

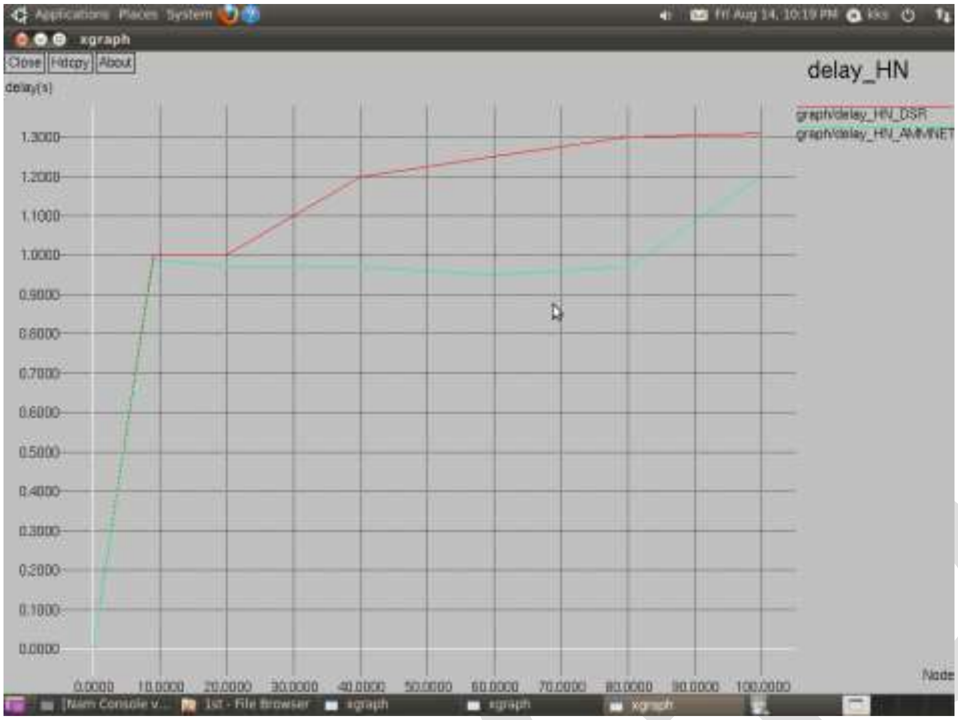

Fig 6: Delay

Conclusion

In our project we improved network life time compare than previous method, in previous model there may be chances to repeated node may act as cluster head so energy loss of that certain node is high. But in our method we reduced the changes for repeated node as cluster head, in our model high energy node only going to act as CH so energy loss is less. In this work we not considered any security level in our future work we can consider security by double encryption of message in the source node and at the cluster head .

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