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An Energy Efficient Cluster Based Multipath Routing In Wireless Sensor Networks

P.Rathiga[1] , Dr.N.Balajiraja[2]

[1]*Research Scholar, PG and Research Department of Computer Science, J.J. College of Arts and Science (Autonomous),Pudukkottai*
[2]*Research Advisor, PG and Research Department of Computer Science, J.J. College of Arts and Science (Autonomous),Pudukkottai*

A B S T R A C T

MANET is a decentralized network using a dynamic topology of wireless links and without the need for any cellular infrastructure. MANETs can be created using different networks like Vehicular Ad hoc Network (VANET) or Body Area Network (BAN). These networks need to cater a variety of challenges in deployment, connectivity, security, scalability and coverage. Since MANETs infrastructure is not static, the nodes move freely. The performances of the proposed technique show that it can work even on complex networks. Since, the proposed method is based on mutual information share between neighbors, it increases the segmentation robustness and drives the architecture towards a more rational topological/semantic map. The proposed algorithm can be applied to existing networks for upgrades or while creating a new networks and is its architecture is scalable, energy efficient and robust and live for longer periods.

Keywords: Cluster, Energy, Multipath, WSN, Routing, MANET, Protocol

1. Introduction

Computers in daily life have increased the new demand for connectivity. Wired solutions have existed for a long time, but the demand for wireless solutions for connecting to the Internet, reading and sending e-mails, changing meeting information, and so on is growing. In Latin, ad hoc means “for this” and also means “only for this purpose” (Al-Omari and PutralSumari, “Ad hoc mobile network overview of existing protocols and applications”) and why A good description of the idea requires self-organizing networks. They can be installed anywhere without the need for external infrastructure (such as cables or base stations). They are usually mobile, which is why the term MANET is often used when talking about self-organizing mobile networks.

The increase in availability and universality of different types of access networks is driving the evolution to a "network of networks", which consists of self-organizing mobile networks but interconnected core and access network technologies. The network allows users to “connect better” anytime, anywhere without having to think too much about the back-end technology used to maintain and protect the connection. The proliferation of MANET wireless technology and the need for powerful and efficient communication systems require ubiquitous integrated wireless infrastructure.

Therefore, the motivation of this paper is to consider the problem of transmission power allocation in MANET with multiple cells, and to select the correct cell. The technique formulated on the non-linear score optimization problem can be transformed into two sub-domains of the power allocation and MANET unit selection problem. Therefore, the design of the best cell selection scheme is particularly important because it can significantly improve the quality of service (QoS) and network performance. As the architecture and algorithms in the MANET network become very complex, it seems that new models and methods must be paid attention to, as well as mechanisms that allow the network to perform adaptive behaviors. This is the main motivation for this research work.

* *Corresponding author.*
E-mail address: kartikeyan.u@gmail.com

2. Problem Statement

The main goal of this research work is to create a complete solution for MANET, from dynamic topology creation to extending the life of the network. Since MANET routing is also a problem, the secondary scope of this research is to create an efficient and fast protocol for MANET. Due to the power limitation of nodes and limited computing resources, MANET routing technology needs to be improved. Optimal routing technology can help make better use of resources, thereby increasing the service life of the MANET network.

The basic MANET topology after deployment helps maximize the use of resources or optimize its lifespan. The scope of this research is also to save the energy of MANET to extend its service life. This research focuses on these technologies. The scope of this investigation is detailed below.

- Effectively evaluate the outgoing MANET topology for improvement through reconfiguration.
- Effective suggestions for configuring network mobile access points to improve efficiency.
- Understand and adjust the dynamic topology to achieve efficient routing applications.
- Propose new plans in the main areas of MANET, namely
- Dynamic configuration of MANET network
- Efficient and fast MANET routing
- MANET saves energy to extend its service life

3. Literature Review

The self-organizing network is an example of a distributed network, in which mobile nodes are connected to each other through wireless links. It is a temporary network without infrastructure. No matter whether the user is mobile or not, wireless communication provides services. A computer network is an interconnected collection of independent computers that assists communication in many ways (C. Siva Ram Murthy, BS Manoj. "Ad-hoc wireless network", architecture and protocol. Pearson publications 15 impressions, 14 impressions ,2012).

Ad-hoc mobile network is a collection of wireless nodes with wireless and network functions. It is a mobile device with a lot of infrastructure. It is essentially self-organizing, self-configuring, self-sufficient and self-adapting. This means that each device in MANET can move independently in any direction freely. Due to the mobility of nodes, the topology in MANET often changes. In MANET, mobile nodes are connected via wireless links. MANET supports dynamic network topology. MANET can be divided into two parts, namely VANET and IMANET (Ghassan Samara, Wafaa A.H. Al-Salihy, R. Sures, "Security Analysis of Vehicular Ad Hoc Networks (VANET)" Second International Conference on Network Applications, Protocols and Services, 2010).

Similarly, the previous hole processing also compared their molds in terms of nodes and dimensions. The comparison information is also provided in Table 2.3, which is also available in the publication (Paul and Indra, 2009), to study the topological properties of silicate and oxide networks.

Handover decision algorithm is a key part of vertical handover. The research in (Akyildz et al., 2004) introduces the next-generation mobility management in current wireless systems based entirely on IP, while the trend and technology in (Jun-seok et al., 2007) introduces the implementation of 4G mobile technology The current trends of the company and show some possible scenarios that are conducive to the fourth generation of technology.

4. Methodology

4.1 Dataset

The data set used in the current study is the IPv4 Routed/24 topology data set implemented on the NS2 simulator. NS2 is used in many studies, and the NS simulator originally developed at the Institute of Information Science is also used. The number of nodes used in the demand phase is 100 grouped nodes. In this research work, in order to obtain higher accuracy, simulation is used instead of simulation, because as the number of nodes increases, the simulation becomes complicated.

4.2 Phase 1 - Defining topology

All nodes and links with router queue rules can be used to define the topology. A TCP connection can be created and attached to a node as a proxy call. Applications such as FTP or BULK Transfer that generate intermittent random packets are attached to the agent in the simulation. Defines router capacity, propagation delay and queuing rules. The node is first connected to the defined topology. This work finds thresholds between nodes to split them before constructing dynamic and reconfigurable topologies.

4.3 Phase 2 - Protocol formation

The next step is to establish a unique routing protocol for data transmission from source to destination. The routing protocol is the process of selecting the correct route for data transmission from the source to the destination. This process will encounter various difficulties when choosing a path, which depends on the network type, channel characteristics and performance indicators.

4.4 Phase 3 – Energy efficiency

In order to extend the life of these power-consuming mobile nodes, a power management scheme is proposed in the literature to maintain the vitality of mobile nodes and make the network more operable and efficient. At present, the focus has been on energy harvesting, energy transmission, and energy-saving methods as the main means to maintain the service life of the network. These power management technologies are designed to balance power across the grid.

5. Experimental Results

The main feature of the proposed protocol is that it divides adjacent cells into different priorities according to the distance between adjacent cells and nodes. This classification helps to select the packet forwarder and each hop; adjacent cells closer to the target cell are preferred. As the next step in the protocol formation of this method, a hash table is created. Hash tables are used because they help to efficiently retrieve information from mobile nodes (Bose et al., 2001).

The cluster head selection protocol based on dynamic grouping proposed by MANET (DCCHSM) in the second stage aims at reducing power consumption and faster information transmission between nodes. It is an efficient protocol that defines its routing path by evaluating the location of nodes on the network, using distance metrics to connect these nodes, and reaching the shortest route between clusters. The hierarchical process of clustering and cluster head recognition is shown in Figure 5.1, abbreviated as DCCHSM workflow.

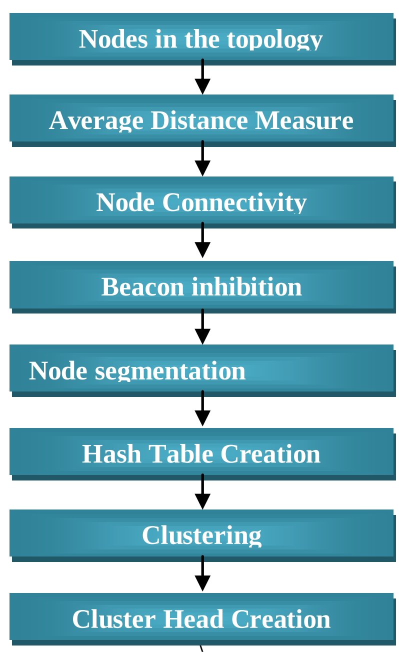

Fig.1. DCCHSM (phase – 2) Work flow

The hash table creation in DCCHSM is based on the beacon value. In the neighbor table, if the beacon value of the node is less than the average threshold of the node range, the node moves to build a hash table for each node. Then a hybrid technique involving K-Means and K-Medoids algorithms is used to apply grouping to the attributes of the node. Then use the average beacon value range of a set of clusters on the node to create a cluster map. Therefore, the cluster distribution head forms the main point of action of the DCCHSM protocol in MANET communication. The DCCHSM algorithm and its pseudo code are as follows

5.1 DCCHSM Algorithm

Input : Given the data points (node locations), choose the number of clusters 1 < c < N.

Output : Selection of Cluster Head (CH) from data points

Step 1 : Initialize with random cluster centers chosen from the data set.

Step 2 : Repeat for l = 1; 2; : : :

Step 3 : Compute the distances

$$D_{ik}^{2} = \left(x_{k} - v_{i}\right)^{T}\left(x_{k} - v_{i}\right), \qquad 1 \leq i \leq c, \qquad 1 \leq k \leq N.$$

Step 4 : Select the points for a cluster with the minimal distances, they belong to that cluster.

Step 5 : Calculate cluster centers

$$v_{i}^{(l)} = \frac{\sum_{j=1}^{N_i} x_{i}}{N_{i}}$$

Step 6 : Until

$$\prod_{k=1}^{n} max\left|v^{(l)} - v^{(l-1)}\right| \neq 0$$

Step 7 : Calculate the partition matrix

Step 8 : Set the point energies.

$$f(i) = \sum_{i=1}^{N} \text{point}(1:\text{dim\_num}, \text{i}) - \text{cluster\_center}(1:\text{dim\_num}, \text{j})^2$$

Step 9 : Set the cluster energies.

$$\text{cluster\_energy(j)} = \text{cluster\_energy(j)} + \text{f(i)}$$

Step 10 : Adjust the point energies by a weight factor.

$$f(i) = f(i)\frac{cluster\_population\,(j)}{cluster\_population\,(j) - 1}$$

Step 11 : Assign weighted node f(i) as Cluster Head (CH).

Where x= data point (node location) ; v = neighbor distance node ; N= total number of nodes

5.2 DCCHSM PSEUDO CODE

Calculate the mean and sum of squares for each cluster.

```
cluster_center(1:dim_num,1:cluster_num) = 0.0;
for i = 1 : point_num
  j = cluster(i);
  cluster_center(1:dim_num,j) = cluster_center(1:dim_num,j) ...
    + point(1:dim_num,i);
end
for i = 1 : cluster_num
  if ( 0 < cluster_population(i) )
    cluster_center(1:dim_num,i) = cluster_center(1:dim_num,i) ...
      / cluster_population(i);
  end
end
```

Calculate point energies.

```
f(1:point_num) = 0.0;
for i = 1 : point_num
  j = cluster(i);
  f(i) = sum ( ( point(1:dim_num,i) - cluster_center(1:dim_num,j) ).^2 );
```

```
 end
Calculate Set the cluster energies.
 cluster_energy(1:cluster_num) = 0.0;
 for i = 1 : point_num
  j = cluster(i);
  cluster_energy(j) = cluster_energy(j) + f(i);
 end
```

5.3 DCCHSM results

DCCHSM connects nodes according to the minimum average distance between nodes to build a cluster group, and finally builds a connection mode. To verify the cluster pattern you generate, you can use the beacon threshold. The use of beacon suppression is used to reduce collisions and improve transmission efficiency, because any node can send out many beacon messages based on the threshold. DCCHSM estimates the threshold based on Equation 5.1 listed above and the relationship between the beacon range and the time required to send the beacon. This is shown in the screenshot here. There are 5 team leaders. Each is indicated by a black circle arrow at the head of the group

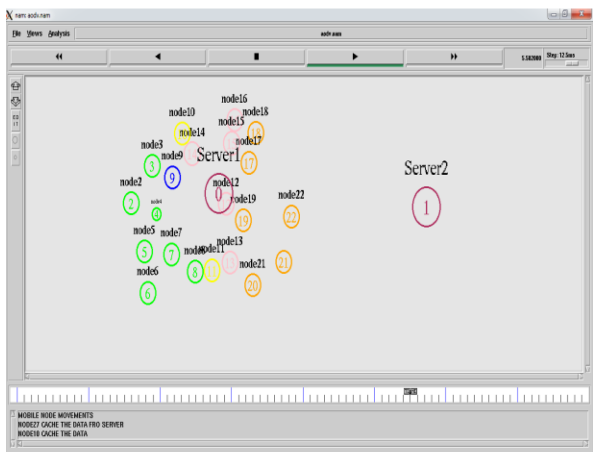

Fig. 2. DCCHSM threshold value

When the total number of beacon messages is less than the threshold, the node stops detecting, thereby reducing the power consumption of the node. Nodes may waste power when they are idle listening or conflicting or listening or controlling. The proposed topology node only communicates with the listener node or is in sleep mode. The hibernation mechanism determines the node that enters the listener and the beacon interval. In this case, one would expect to know the efficiency of the current DCCHSM. The time (in seconds) required for group leader identification reflects a quantitative indication of speed and accuracy. Here we review the DCH and WCA algorithms in current practice from the literature. Table 5.1 provides the comparative topology time data of DCH, WCA and the proposed DCCHSM.

Table 1 - Comparative flooding times of protocols in networks

No. of Nodes	LCC	DCH	WCA	DCCHSM
20	0.610	0.513	0.354	0.211
40	0.451	0.414	0.421	0.257
60	0.614	0.654	0.452	0.354
80	0.734	0.638	0.532	0.352
100	0.792	0.761	0.698	0.301

It can be clearly seen from the above table that as the network scale becomes more complex, the performance of the DCCHSM topology will be better. Compared with the DCH flooding time of 0.761 seconds on 100 nodes, WCA-based beacons consume less time at 0.698 seconds, but DCCHSM takes less time, at 0.301 seconds, which is at least three times faster than WCA-based technology Times. In the latter part of the flood time, it scored very high compared to the directional diffusion technique shown in Figure 5.3.

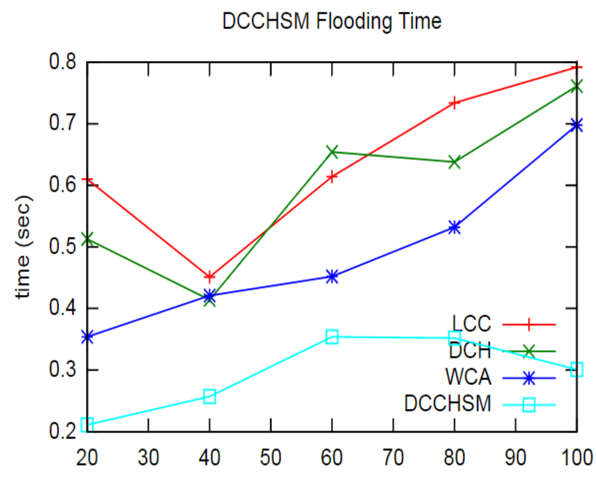

Fig.3 DCCHSM flooding time comparisons

6. Conclusion

Optimal maintenance of the MANET network for the full mobility of nodes is a difficult task. This research aims to propose and demonstrate a topology generation method that can adapt to changing mobile locations by maximizing data transmission speed and efficiency, and can be implemented in complex MANET networks. Compared with the weighted clustering algorithm, the algorithm used in this study shows better performance in dynamically changing MANET networks. Analysis and results show that it can be used as a basis for future expansion to MANET dynamic configurable topology design. Although simulated in NS2, it can adapt to MANET in real time to improve energy efficiency and speed. It can also be assumed that the algorithm is a feasible technology that can be applied to the existing WCA in MANET for upgrading or planning new networks.

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