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A NEW ALGORITHM OF NODES PARTITION USING FOR AD HOC NETWORK MODEL

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Abstract

This paper proposes a novel algorithm of nodes partition for the Ad Hoc network mode. Firstly, we adopt Man Road sub-cluster algorithm to discuss the clustering for a square region with 926 random nodes. Secondly, we establish the central moving model based on the simulated annealing algorithm and the least circle overlay model, which are used to remove the redundancy of the circle number and the circle radius. Then a better Ad Hoc Network model based on nodes partition can be obtained. Simulation results show that the algorithm can effectively maintain the stability of the sub-cluster structure and increase balancing capabilities of network load. At the same time, it can overcome the defect of the information packet loss in communications.

Keywords: Ad Hoc network; nodes partition; sub-cluster algorithm; central moving model; least circle overlay model

1 Introduction

As people have a desire to get rid of the shackles of wired networks and to communicate freely at anytime and anyplace, wireless networks communications have been rapidly developed in recent years [1]. In order to achieve communications in areas without fixed base station, a new network technology--Ad Hoc network technology come into being. Mobile Ad Hoc network is a self-organizing wireless network that without the support of fixed infrastructure, and is built up by mobile nodes. The emergence of Ad Hoc network promotes the course to achieve free communications in any circumstances, and also provides an effective solution for military communications, disaster relief and temporary communications [2-4].

The most effective way to achieve rapid distribution of the entire network and dynamic reconstruction after changes of network topology is to use clustering mechanisms [5-6]. Currently, clustering algorithms have been researched deeply at home and abroad, but each method only considered one aspect of network performance, so we need an integrated clustering algorithm which considers various factors. Literature [7] presents a simple clustering algorithm: the smallest ID algorithm, which chooses the adjacent node with a minimum ID as a cluster head, and the one-jump adjacent nodes as the members of this cluster. The advantages of this algorithm includes: it is simple, convenient to achieve and its convergence speed is rapid, but equally the disadvantages are clear: the number of cluster heads is large, the update frequencies is high and it doesn't consider the load balancing of networks. Literature [8] uses the highest degree algorithm and chooses the adjacent nodes with the highest degree as a cluster head. The advantages includes: the number of cluster heads is correspondingly small, the delay of packet delivery is decreased, simultaneity, it lowers the reuse rate of channel space, but the disadvantages are: the cluster heads distribution are unreasonable, the renewal rate of cluster heads will rise when nodes mobility is strong, and will result in expenses increase of network maintenance.

This paper proposes an Ad Hoc network model based on nodes partition. Firstly, it adopts Man Road sub-cluster algorithm for nodes clustering. Secondly, it establishes the central moving model and the least circle overlay model, which are used to remove the redundancy of the circle number and the circle radius. Then a better Ad Hoc Network project based on nodes partition can be gained.

2 Instruction of the new algorithm

2.1 The analysis of node density impact on the network

As for Ad Hoc networks, node density is important [9]; it has significant impacts on network partition. The general reasons are as follows: on one hand, if the nodes in the network are too intensive, there will be too many connection jumps between source node and destination node, and this produces redundancy, thereby increases the burden on the network, this is not conducive to the security of the network. On the other hand, if the nodes in the network are too sparse, as the distance between

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source node and destination node is too long, maybe source node can't find destination node in a period of time, and this may cause long delay or packet loss.

2.2 The algorithm description

In Figure 1 there are 926 nodes specific randomly dispersing in square region (1000 × 1000), we have to use circles of certain radius to overlapped cover the nodes in this square region. The adopted circles' radius can not be too large or too small. If the radius is too large, the fired power of source node must be increased, in Ad Hoc network, the total energy of nodes is limited, so this will inevitably lead the survival cycle of the network become shorter, and along with the increase of radius, the number of nodes that connecting the neighboring region will be fewer, it may result in a greater packet loss or time delay. If the radius is too small, the nodes connecting the neighboring region will be too dense, this will inevitably increase connection jumps between the source node and destination node, and increase network burden.

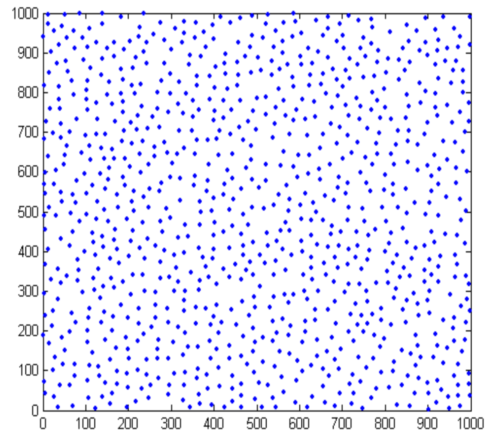

Figure 1 The 926 random nodes within the region

This paper uses circles whose radius are 75～100 to overlapped cover the square area, and proposes Ad Hoc network model algorithm based on the node partition. The core idea of the algorithm is that first we use Man Road sub-cluster algorithm to make 926 nodes into clusters, find 926 cluster heads, then we establish one-jump coverage area respectively using every cluster head as the centre of a circle. This partition will produce a lot of redundancy, which mainly consists of two parts: circle number redundancy and circle radius redundancy. Then we set up the central moving model based on the simulated annealing algorithm and the least circle overlay model to remove the redundancy. The algorithm is described as follows:

1) Use Man Road sub-cluster algorithm to make 926 nodes into clusters, find 926 cluster heads.
2) Set up the central moving model based on the simulated annealing algorithm, adjust the centre of one-jump coverage area, remove the redundancy of the centre.
3) Set up least circle overlay model, adjust radius of every one-jump area, and remove the redundancy of radius.
4) After adjusting check up the connectivity of network in one-jump area. If it is satisfied, go to step 5); if not, increase the radius, then check up again.
5) Calculate the number of circles and the radius of every one-jump area, and then calculate the sum of all the radiuses.

3 Implement process and the performance of the new algorithm

3.1 Man Road sub-cluster algorithm

1) First rank the randomly generated 926 nodes (as shown in Figure 1) according to the size of abscissa. This forms a 926×2 nodes matrix A. Initialize zero-matrix B (50×2) and zero-matrix C (926×2), initialize the radius $R_0 (R_0 = 100)$ of one-jump coverage area and the number of nodes $N(N=926)$.
2) Put the first node A_1 of A into B, the gravity center O of B is node B_1. Compare the distance between A_k (node k in A, $k=2,\cdots,N$) and gravity center O with R_0, if $d \le R_0$, A_k will be put into matrix B, then recalculate all the nodes gravity center O in B; If $d > R_0$, A_k will be put into C, at the same time, record the number N of elements in C.
3) Estimate all the elements of C, if all the elements are 0, go to 4); if not, assign matrix C to matrix A, go to 2);
4) Make the gravity center in matrix B as the centre of every one-jump area, educe the number of centre.

Nodes partition using Man Road sub-cluster algorithm is shown in Figure 2: it was built up by 48 circles whose radius are 100, the sum of radius are 4800. After clustering, we can see that using circles whose radius are $R = 100$ to coverage the area is unreasonable, and there are circle location redundancy and the radius length redundancy in one-jump areas between clusters. Therefore, we have to adopt the following two methods to remove the redundancy.

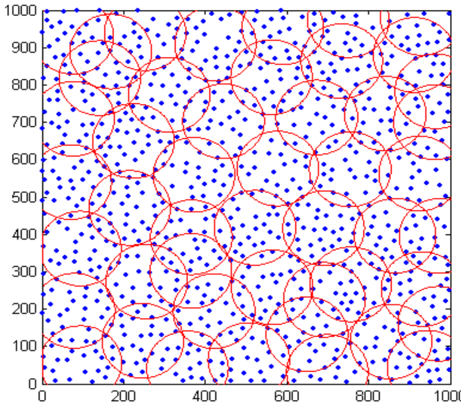

Figure 2 The nodes partition by Man Road sub-cluster algorithm

3.2 Central moving model based on the simulated annealing algorithm

Maintain the same radius $R = 100$ of the one-jump coverage area M, for certain one-jump coverage area, the centre coordinate is (x_m, y_m), the number of internal nodes is m (respectively as $k_1, k_2, \cdots, k_m$). We produce a small increment Δx_m, Δy_m randomly, the centre coordinate of the coverage area M relocates to ($x_m + \Delta x_m$, $y_m + \Delta y_m$), take this centre as the centre of a circle and the radius $R = 100$, and then calculate the number of nodes in this circle. If the new circle can not contain the original m nodes, abandon the current adjustment; if the new circle contains the original m nodes, analyze the relationship between m and m_0. If $m_0 \le m$, remove the centre to ($x_m + \Delta x_m$, $y_m + \Delta y_m$) with a small probability;

If $m_0 \ge m$, make $m_0 = m$, remove the centre to ($x_m + \Delta x_m$, $y_m + \Delta y_m$) with a big probability.

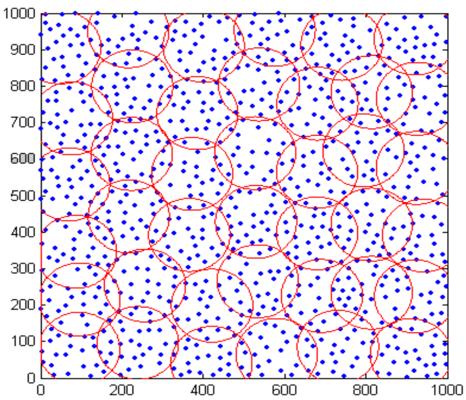

Figure 3 The result of central moving model based on the simulated annealing algorithm

The result after the treatment of central moving model based on the simulated annealing algorithm is shown in Figure 3, it only needs 40 circles whose radius are 100, and the sum of radius is 4000. We can see that, central moving model based on the simulated annealing algorithm removes the redundancy which is brought in by circle positions' overlapping, and reduces the number of circles.

3.3 Least circle overlay model

Analyses a one-jump coverage area M, whose centre is o_m (x_m, y_m), radius is R_m, connect o_m with nodes $k_1, k_2, \cdots, k_m$, intersect with circle on $P_i (i = 1, 2, \cdots, m)$,

$$d_i = |o_m P_i - o_m k_i| = |R_m - o_m k_i| \tag{1}$$

Then set up aim function

$$d = \sum_{i=1}^{m} d_i \tag{2}$$

Calculate centre (x_m, y_m) and radius R_m when (2) is minimum.

3.4 Solve for the restrict condition

After the above treatments, we need to add restrictions to the partition results: all nodes must have connectivity. A one-jump coverage area M intersects with around n coverage areas $M_i (i = 1, 2, \cdots, n)$, the intersect areas are $A_i (i = 1, 2, \cdots, n)$, we define B_i = {note number in A_i}, then

$$B_1 \cup B_2 \cup \cdots \cup B_n \neq \varnothing \tag{3}$$

If equation (3) is true, the restrictions can be satisfied. If not, increase the radius of one-jump coverage area M, to make equation (3) true. If equation (3) can not be satisfied although the radius has been increased to 100, extract M_i randomly until equation (3) can be satisfied.

After the above treatments, we can gain the nodes partition algorithm, the result is shown in Figure 4. There are 30 circles whose radius are 100, 8 circles the radius of each two is 98, 95, 85 and 77, 3 circles the radius of each is 83, 72, 60, the sum of these circles' number is 41 and the sum of these circles' radius is 3925.

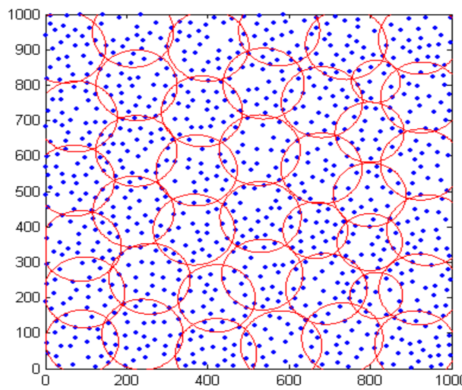

Figure 4 The result of least circle overlay model

4 Conclusions

The rapid rise of computer networks and the development of LAN are inseparable, now the number of users and the scale of networks become so big, this makes the disadvantages with wired LAN become outstanding, such as cabling cumbersome and nonsupport of moving terminal. Under these circumstances, mobile wireless LAN has some advantages such as its operating cost is low and time is short, it is easy to be expanded, the impact of natural disasters is small, and it can be built up fast and flexibly. Ad Hoc network has no fixed center, and the nodes of it can be rapidly moved, and it has the capability of self-organizing and can move freely. With these features, it has a big application potential and will get the attention of industry increasingly.

This paper presents an Ad Hoc network model based on nodes partition, it can make the dynamic and real-time partition of random nodes better, improves the performance of Ad Hoc network in a large extent. The next step is to study how to improve the adaptability and invulnerability of Ad Hoc network based on nodes partition, and then we can gain a faster, dynamic and steady partition plan for complicated areas.

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