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Method for Determining the Number and Location of a Domain of Agents in Mobile Networks

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Abstract-A method for increasing the efficiency of routing based on a system of agents. The analysis of the variation of the distribution network environment first and second order network topology and the location of the agents. It is shown that with a change in the topology of the density distribution varies in a nonlinear law.

1. Introduction

The hierarchical model allows the network to create the most stable structure of the network and allocate resources more efficiently[1]Also, the hierarchical model of network advantage is a higher level of data protection. All nodes in a network of mobile and communicate with each other dynamically in an arbitrary manner without centralized management and base stations.

In[2,3]the problem of scalability is to provide hierarchical routing by grouping neighbor nodes in the domain, as well as through the use of a hybrid routing schemes: classic proactive approach within each domain and reactive approach between domains. Such an organization demonstrates multiple benefits, such as synchronization of the stations in a group or an easier identification of new service areas. However, has some drawbacks, one of them is to change the structure of the topology, which leads to the need to change the routing tables in the formation of routes subscriber systems, leads to increased service traffic.

Of particular relevance are taking the problem of optimizing the traffic in mobile networks associated with the use of dynamic routing algorithms, where the amount of control traffic depends on the frequency of changes in the network. In[4]addressed the issues of multilevel network structure and the optimization procedure of routing in scalable mobile networks. Further development of these issues have received in [5].

The main factor that affects the process of information transmission in mobile computing networks is their dynamic topology, so the effective functioning of these networks is largely dependent on the solution of the routing. In addition, to ensure quality of service in mobile networks, the most effective approach is to integrate the elements to maintain quality of service routing protocols.

2. Review and analysis of existing solutions

For large-scale computer systems there is no single effective routing algorithm. In connection with this computer system are divided into separate sub - domains. In this routing problem is divided into[6]and the problem of
intra-inter-domain routing.

Most of the intra-routing algorithms use traffic for avalanche distribution information for each router complete information about the network topology, network metrics across all channels. In contrast, when inter-domain routing traffic control reduces the level of utilization of channels by sending a single data stream to a group rather than individually to each recipient with the use of multicast routing.
As a result, the problem of inter-domain routing is to construct the most stable minimum spanning tree.

Tools of the traditional route does not meet the requirements of QoS, the request load balancing of communication channels do not provide enough speed when you change routes on the network caused by the movement of subscriber systems[7]Another drawback is the need to send regular updates of routing information even with a slight vibration load channels or by changing the topology of the system[8]

One approach to solving this problem is to optimize the network by dynamic allocation of traffic, ie in real time to solve the problem of the dynamic assignment of routes that meets the requirements to the parameters of QoS, and to ensure uniform loading of the network.

In this case, the efficiency of the routing problem and, in general, the task of constructing the traffic is largely dependent on the formation of an optimal network structure.
The next task is to create a virtual path between the agents in charge of the specified requirements of stability and minimum delay.

In[9]proposed a mechanism for inter-domain traffic engineering based on the technology MPLS, which satisfies the requirements for the parameters of QoS, and to ensure uniform loading of the network.

In[10]for the solution of TE expansion is proposed to use a routing protocol running on the basis of link-state algorithm, these are the protocols OSPF and IS-IS, which spread like an avalanche information for each router contains the complete information about the network topology, network metrics across all channels in order to provide the shortest path computation to the addressee.

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As one of the main conditions to reduce the complexity of intra-routing[11]a restriction on the number of hops between any two subscriber systems domain. It is assumed that within each domain subscriber systems can communicate with each other at most two charges. In this algorithm should divide the network into non-overlapping domains. However, the existing structure of the formation of non-overlapping domains do not allow for dynamic reconfiguration of the network.

3. Problem statements

One characteristic feature of modern computer systems is their dynamic reconfiguration. This is reflected in the structure of the domain of computer systems[12]and, in most cases, the impact on the effectiveness of traffic engineering

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In fact, during the dynamic reconfiguration of the reconstructed structure of the domains, which leads to the need for reconfiguration of the system construction traffic, and existing methods of traffic engineering does not allow you to do it.

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Due to the fact that the dynamical system is rigidly divided into static subnet not need to explicitly renounce the partition and you want to propose a mechanism of distributed traffic control. In this regard, a method for organizing distributed control system, in which the intermediate nodes is given an opportunity to perform reconfiguration of the channel. For this purpose a system of distributed traffic control agents.

This problem is NP-complete and can be solved using linear programming

.

The problem of finding a route to the permissible capacity is reduced to finding a route with the value of the minimum bandwidth that exceeds a certain amount of bandwidth required for the entire route.

Suppose that the network is represented as a graph of a loaded restricted bandwidth node and system-wide data.

Graph of the network is denoted as $G = (V, E)$, where V denotes the set of nodes, and many links. As an alternative, we use the representation (i, j) to communicate with the node i node j. The capacity of links from node to node is defined as

Let the set of nodes is partitioned into subsets. Assigns to each a set of nodes, $V_1 = \{v_1, v_2, ..., v_i\}$, and k2 is associated with V={V1,V2,V3} a set v2 of nodes, $V_2 = \{v_i, ..., v_{i+k}\}$. Suppose that there is any node that can occur in different sets with different probability, $v_i \in V_1,\ v_i \in V_2$.
In [13] analyzed the formation of domains of known algorithms and propose a distributed algorithm for DDR (Distributed Dynamic Routing Algorithm) for networks with fixed structure. In this paper we propose a modified algorithm for the formation of domains, whose main purpose is to determine the number of agents. Must take into account the dynamic nature of the network, and that the location of the agents depends on the amount of transmitted traffic control.

Thus, we determine which of the subscriber systems domain can act as agents and be able to share the burden among themselves.

As an additional condition of user's choice of vi as an agent aj define the following condition:

aj = {vi | (1– p′j)= max ∀ vi ∈ Vj }, (1)

where p - the probability that the selected system can be a subscription agent.

Given the stability of the site, the probability of choosing an agent can be represented as:

$$K_1 = K_0 \cdot \delta + K' \cdot a_j , \quad (2)$$

Where K_1 - coefficient of selecting an agent;
K_0 - Weighting factor of degree;
K' - Weighting factor a_j .
Equations (1) and (2) provide the most stable form of wood from the same sender information to one or more recipients of information, thus can be used in the algorithms presented in[14,15]To split the graph into domains fill the incidence matrix MI, and use it to define the maximum degree of vertice v_m of the graph, and determine whether one of these peaks become an agent.

To determine the density of the top network environment first and second order, δ_{v_m} according to the formula:

$$\delta_{v_i} = \frac{S + \sum_{S} E_{i,j}}{S} ,$$

provided that $E_{i,j} \neq 0$ в MI, (3)

where the S-maximum degree of connected vertices;

Eij - the connection between the adjacent edges of vertices with maximum degree. Of all the obtained δ_{v_m} maximum values are selected first and second order, and this peak becomes the agent.
In agent-based organization structure of the computer network routing total time consists of the routing within the domain of time and the time inter-domain routing. Depending on the partition of the network into domains, the total time will be different routing. In this regard, as a criterion for partitioning the network into domains will be considered during routing.

It should be noted that among the agents forming a single virtual channel. However, the exchange of information between the agents will be implemented through the same channels as the transmission of information, and therefore less efficient. To do this, perform resource reservation, and load balancing.

Load balancing manages bandwidth channel logical route, thereby adjusting the bandwidth of the proposed traffic. Due to unforeseen changes in the network, some logical routes can be used is not rational, while others may be overcrowded. In this case, and there arises the problem of load balancing, for example, when bandwidth is loaded low priority traffic, at a time when important data have been rejected due to lack of bandwidth.
The logical separation of the bandwidth at the data link enables you to split the traffic control algorithms, simplifying management functions. It is proposed to implement a logical division of the bandwidth for control traffic and information flow. In this connection it is necessary to determine the cost of data transmission channels, which will be equal to

$$Q_{\Sigma} = Q_{out} + nKQ_{in}, \quad (4)$$

where: n - is the diameter of the network; Q_{Σ} - the average cost of data transmission channels - Q_{out} - channel at the cost of routing between clusters; the cost of channel routing in the cluster K - the channel load factor, which depends on the graph. We define the load factor of channels

$$K = \frac{Q_n + Q_{сл}}{Q_n} > 1 \quad , \qquad (5)$$

where: Q_n - the amount of information transmitted; $Q_{сл}$ - The amount of control information.
As a result, we can say that the coefficient of utilization of channels increases the nonlinear dependence.

During operation of the mobile network is reconfigured domain in order to reduce transmission time and to optimize network traffic
.
As a criterion for selecting the structure and size of clusters is the data transfer efficiency, which is equal to:

$$K_{ef} = \frac{Q_n}{Q_n + Q_{сл}} \qquad (6)$$

where: Q_n - Cumulative number of transmitted packets, $Q_{сл}$ - number of proprietary information, K_{ef} - coefficient of performance data.
As one of the criteria for the effectiveness of dynamic routing is the volume of service traffic, which should seek to minimize. Define the factors that influence the amount of routing traffic in mobile networks. The volume of service traffic is a function of:

$$Q_{сл} = f(F_r, N_{V_i}, V_0) \qquad (7)$$

where: Fr - frequency of cluster reconfiguration; NVi - number of nodes in the cluster Vi; Vi – Information transmitted by one node at the time of reconfiguration. With the increase in the number of reconfigurations domain, the volume of service traffic in a domain increases in non-linear law, thereby drastically decreases the efficiency of data transmission. Under certain circumstances this can lead to unstable operation of the network.
Therefore, in order to reduce the amount of routing traffic in a cluster at a given frequency of reconfigurations period of time ΔT and the number of nodes in the cluster must be committed to a minimum:.

$$F_r \to \min, \quad V_0 \to \min$$

Thus, the optimal size of the cluster can be characterized by the coefficient (8)

$$k = \frac{F_r \times V_0}{\Delta T}$$

Thus, the volume of service traffic depends on the frequency of cluster reconfiguration and the number of nodes in the cluster. On the other hand, the amount of overhead depends on the diameter D of the cluster and the degree of connectivity of mobile nodes

,

$$Q_{сл} = f(D, S) \qquad (9)$$

where D - diameter of the cluster; S - degree of connectivity of mobile nodes.
Thus, the main parameters influencing the choice of size and structure of the domain are: the number of nodes in the domain, the number of reconfigurations domain, the diameter of the domain, the degree of connectivity of nodes domain.

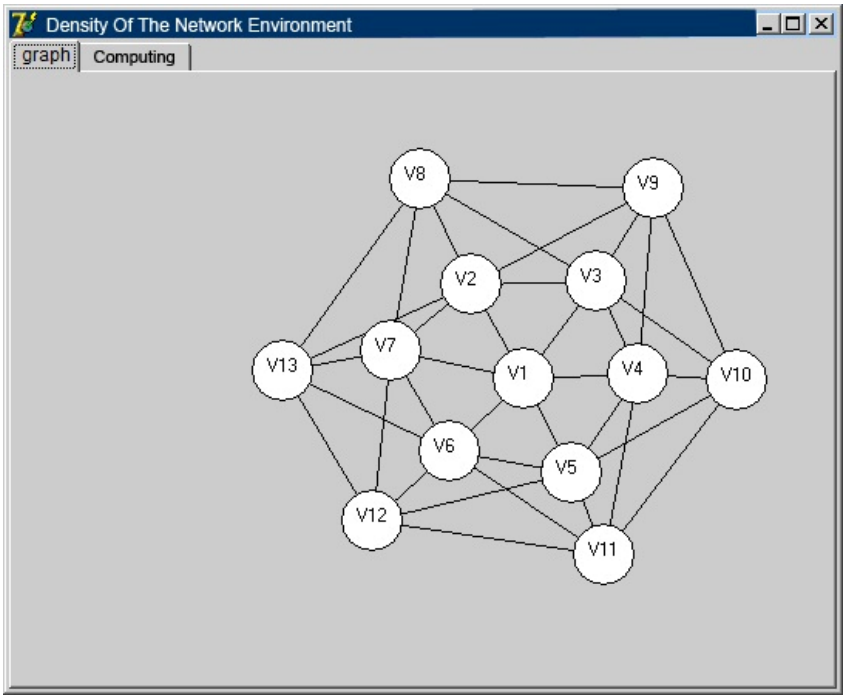
In [16] shows the average number of packets that are distributed in a single cycle of the algorithm avalanche:

$$H_{t_r}^{ср} = S^2(r-1) - S(2r-3) \qquad (10)$$

Then the average volume of control traffic avalanche distributed across the network when you move a node is equal to:

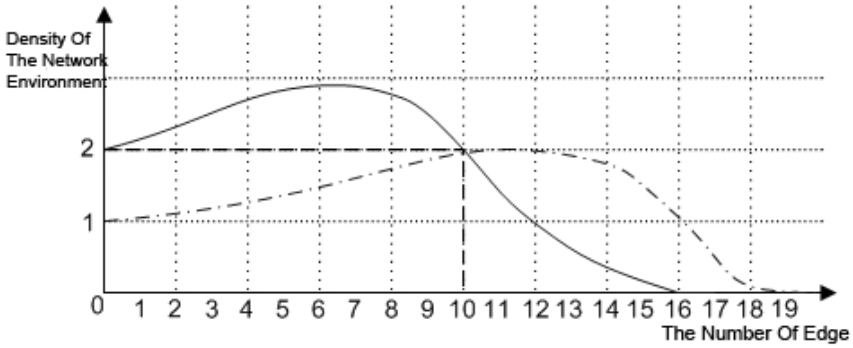
$$Q_{сл\,v} = \sum_{r=1}^{\infty} (S^2(r-1) - S(2r-3)) \qquad (11)$$

To determine the number and location of agents has been developed modeling program, which recruited a network graph is presented in Figure 1. In Fig. Two. an example of a calculation graph modeling program.



In Fig. 1 An example of a network, represented in the form of a regular graph.

We estimate the efficiency of the topology in Figure 2.



In Fig. 2. The ratio of the average density of the network environment

to the number of broken ribs

4. Conclusions

In this paper we propose a method for increasing the efficiency of routing based on a system of agents. It requires less amount of information related to the reconfiguration of the network. The advantage of this approach is the ability to hold two adjacent agents in their area adjacent nodes, or adjacent nodes may be located at the border.

The analysis of the variation of the distribution network environment first and second order, depending on the type of network topology. According to the results of modeling the graphs showing that the agent should be selected not only from the top of which the maximum degree of connectivity, as well as the top, in which the density of the network environment, first-and second-order maximum. It is shown that with a change in the topology of the density distribution varies in a nonlinear law.

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