UDC 621.002

*PEI PING, YURY N. PETRENKO*

# MESH NETWORK SIMULATION

*Belarusian National Technical University*

*A Mesh network simulation framework which provides a powerful and concise modeling chain for a network structure will be introduce in this report. Mesh networks has a special topologic structure. The paper investigates a message transfer in wireless mesh network simulation and how does it works in cellular network simulation. Finally the experimental result gave us the information that mesh networks have different principle in transmission way with cellular networks in transmission, and multi – hop routing could provide robustness and load balancing to communication in wireless mesh networks.*

## Introduction

The traffic routing and Internet gateway selection play important role in determining when mesh networks primarily used for internet access. The gateway may easily become a bottleneck to limiting the achievable capacity of the entire network. Each mesh node need to distribute the traffic loads among multi – hope gateways in older to ensure evenly utilization of Internet connections.

To model the mesh network as a queuing network, it is necessary to characterize each mesh node with a correspondent queuing system, which should capture the most important aspects of the queuing and forwarding processes. Since we consider mesh networks composed of three types of mesh nodes, we have introduced three different classes of stations in our equivalent queuing network, which are shown in Fig 1, [1]. First of all,

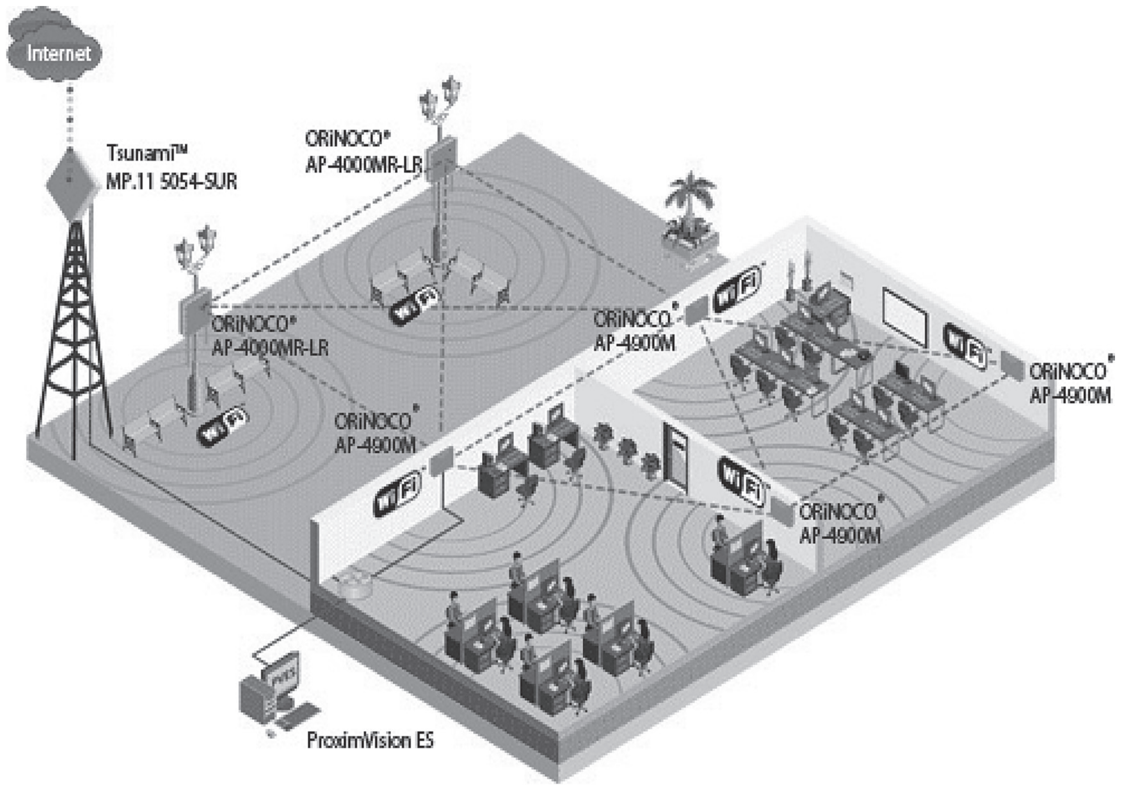


Figure 1. - Proxim Orinoco AP-4900 MR Indoor, Mesh Network Access point (Keison Internation Ltd, 2013)

let us assume that in the mesh network there are *nO* mesh routers, *nP* provider gateways, and *nR* residential gateways, being $N = nO + nP + nR$ the total number of nodes in the mesh network. Each mesh router will receive user-generated traffic with an average rate $\lambda e$, $i$, and packets from the other stations of the queuing network.

For instance, if too many mesh nodes select the same gateway as adress point to the Internet, congestion may increase excessively on the wireless channel, the Internet connection of the gateway can get overloaded. This is especially important for the heterogeneous mesh networks considered in this study, because low-speed Internet gateways may easily become a bottleneck to limiting the achievable capacity of the entire network. In addition a load-unaware gateway selection can lead to an unbalanced utilization of network resources.

Wireless mesh networks are primarily used to provide Internet access by sharing the networking connections of a limited number of gateways. If traffic is routing in the mesh without considering load distribution, it will causes a significant reduction of the network capacity. To address this issue, in this paper we first develop a queuing network model that accurately predicts the residual capacity of paths in heterogeneous mesh net works, and precisely identify network bottlenecks. By taking advantage of this model, we design a novel Load-Aware Route Selection algorithm, named LARS, which improves the network capacity. This objective is obtained by allowing each mesh node to distribute the traffic load among multi- hop gateways in order to ensure evenly utilization of Internet connections. Simulation results show that LARS significantly outperforms shortest path routing using contention aware link costs, achieving throughput improvements of considered network scenarios.

**Construction a mesh network simulation**

Wireless Mesh Network (WMN) has become one of the important technologies for human being. It has increased to a role in coverage of Internet. Several cities already used Wireless Mesh networks during the researching time.

In this section, we discuss the design and different structure between cellular network and Wireless Mesh network in an experiment. In the past years, experiment was a method which very popular in wireless mesh network simulation. In a simulation, network could be easily constructed and test. The data also could collected in an easily way.

At first we using Packet tracer to construct a mesh network simulation parameters to observed in the real networks. It should be notice that the cable which in packet tracer is real line. But it should be wireless in a mesh network. The cable used here only easy for simulation test. We can see the mesh network topologic as same as a spider mesh. It is a point to point measurement, Fig 2, [2]. We design the topologic structure in

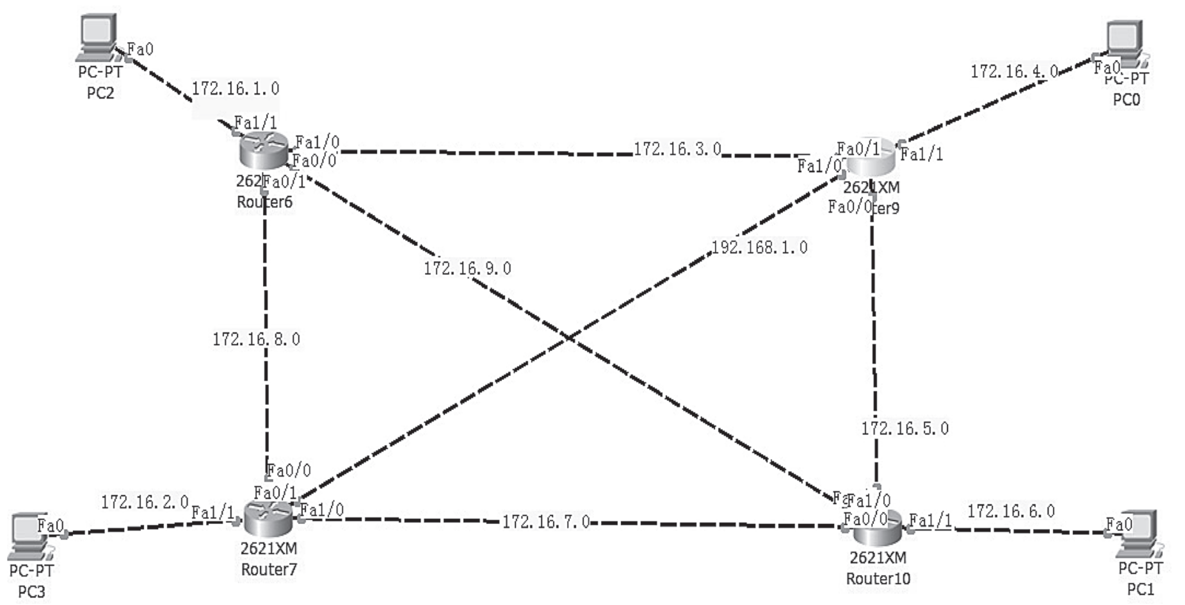


Figure 2. - Mesh Network topology

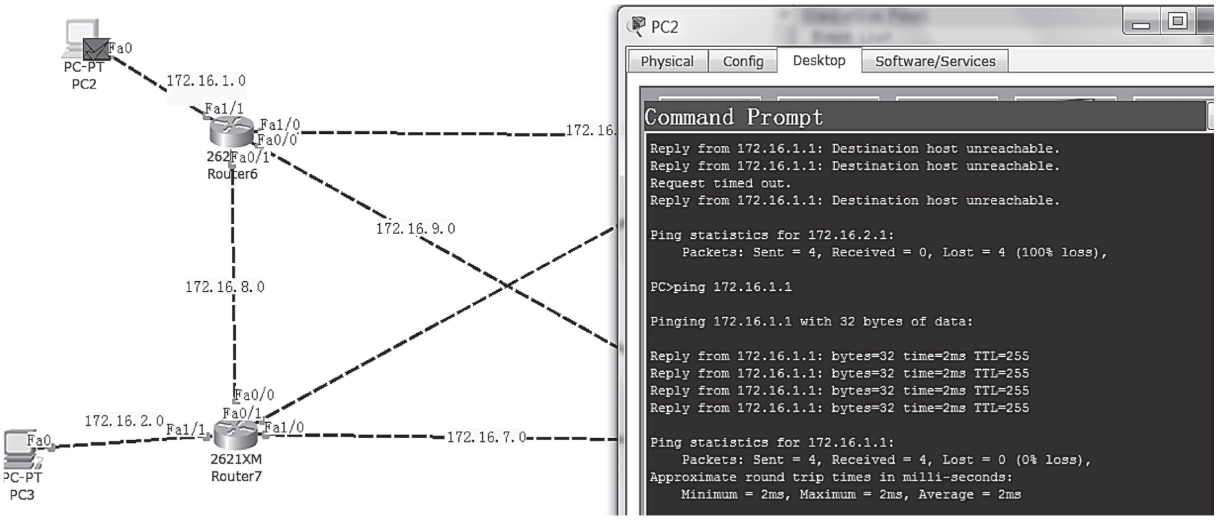


Figure 3. - Mesh Network testing

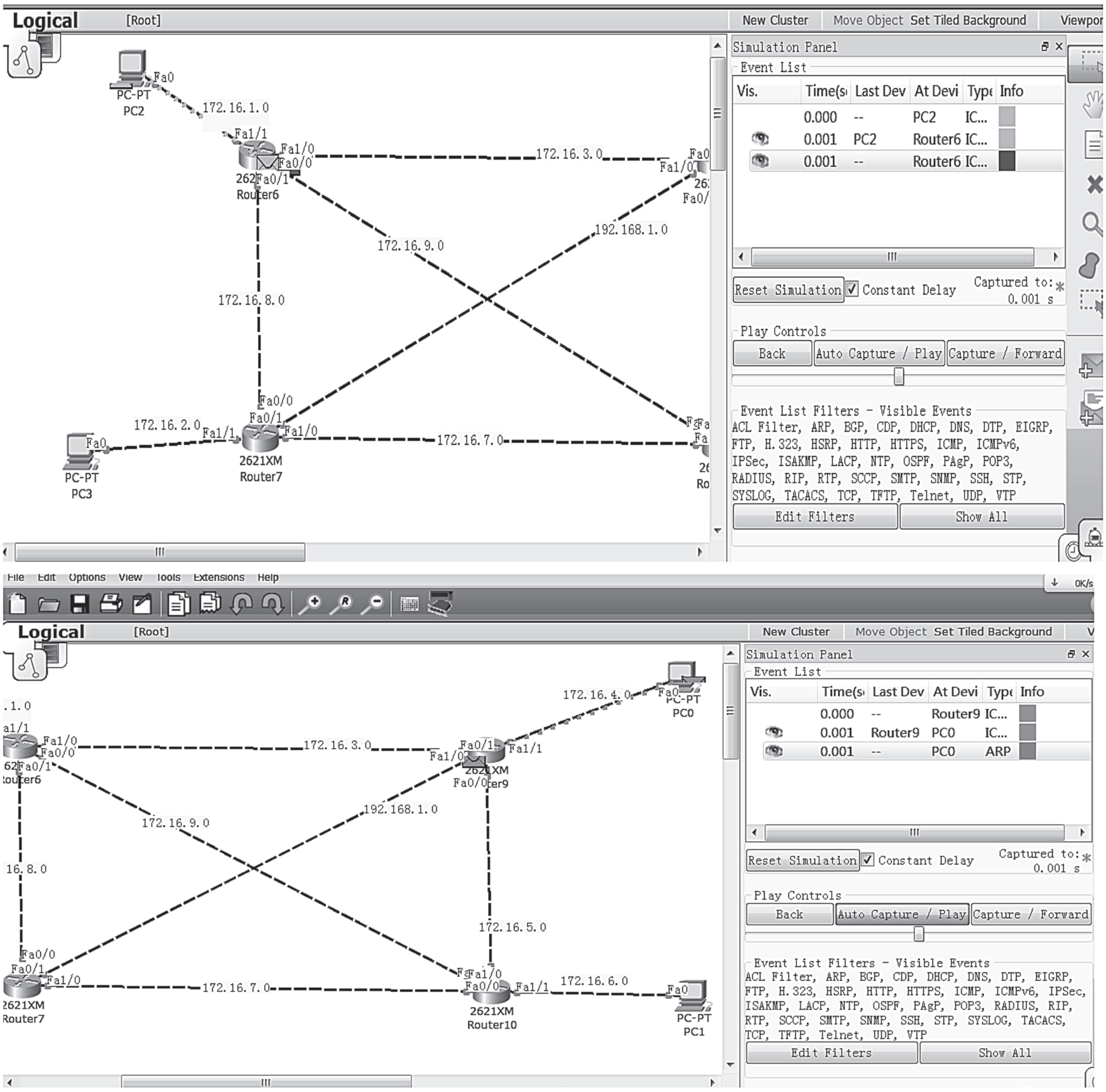


Figure 4. - Message transform in a Mesh Network

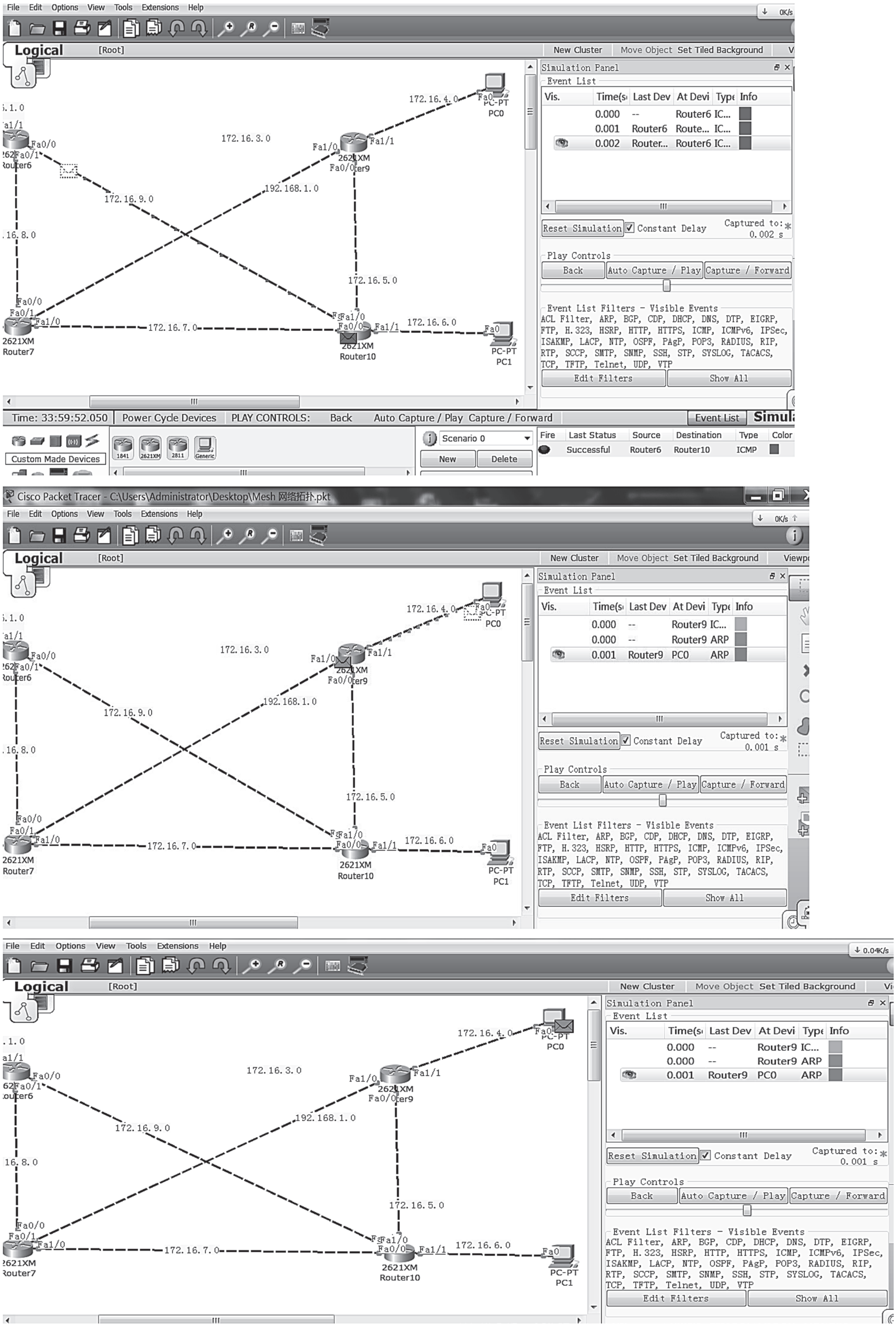


Figure 5. - Automatic choosing pass way

the next step, and distribute the IP address for each network segment.

After the configuration work finished, we need to do a test for networking to make sure each point could transfer information fluently. In this case, we are doing the test in «ping» Fig 3, [3]. The information package has send by original host to the destination host in 4 times, then the destination host will reply the information package to original host in 4 times if the network configuration is correct.

As we have shown, the networking has successfully in construction. For example, we used PC-PT (PC2) as a host original sending the message to P C-PT (PC0). The information is transforming way as it is shown in Fig 4. Message is going to Router 6 in the first, passing to router 9 in the second. Finally the host P C-PT (PC0) will get the message which comes from the original host.

We did the test about Mesh network in a perfect state. However the biggest different from cellular network is how does it work when there is a link between each router broken or if the nearest node due to high information flows and congestion. Data can be re-selected a small flow path for transmission in automatically [5]. According to

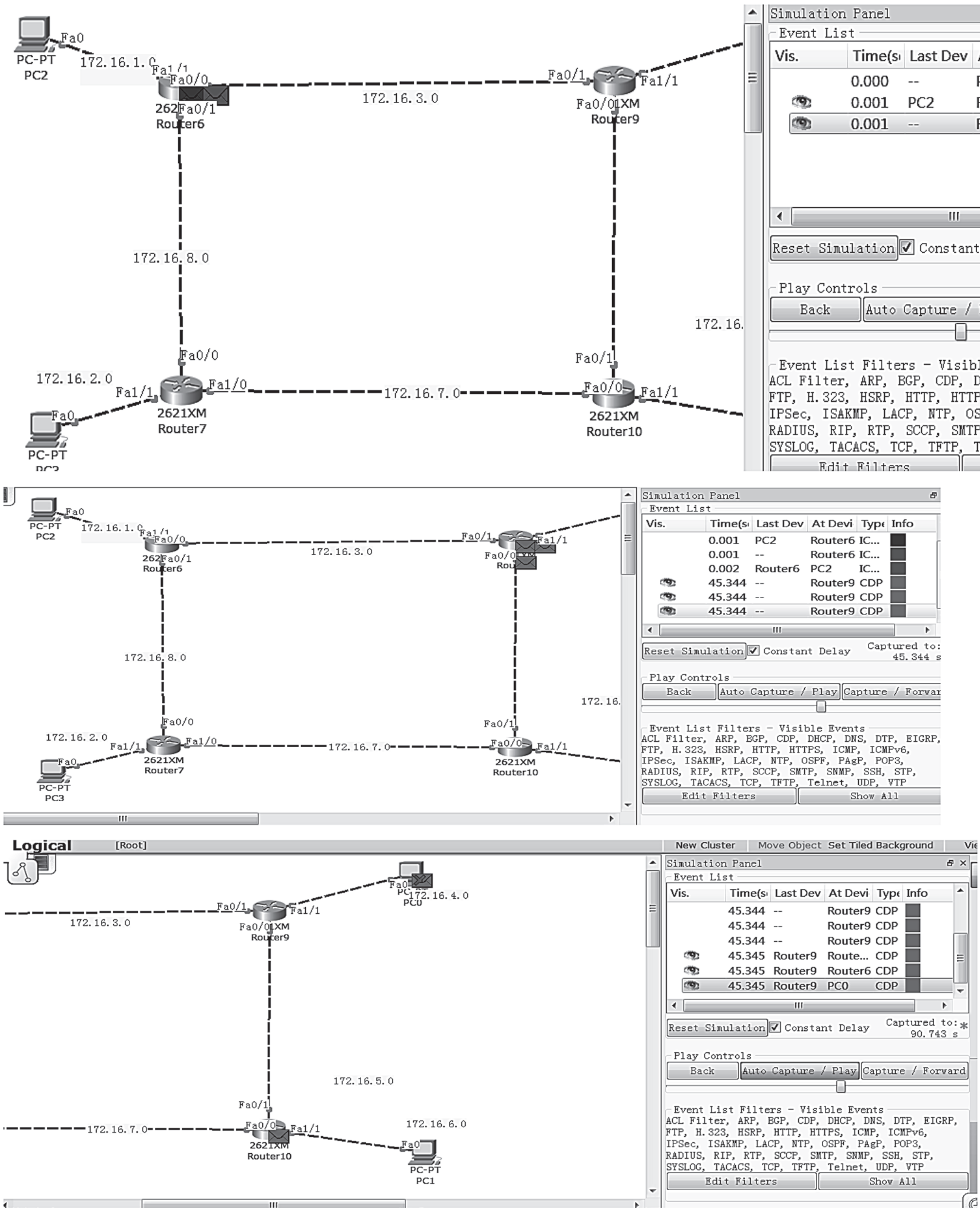


Figure 6. - Message passing in a normal network

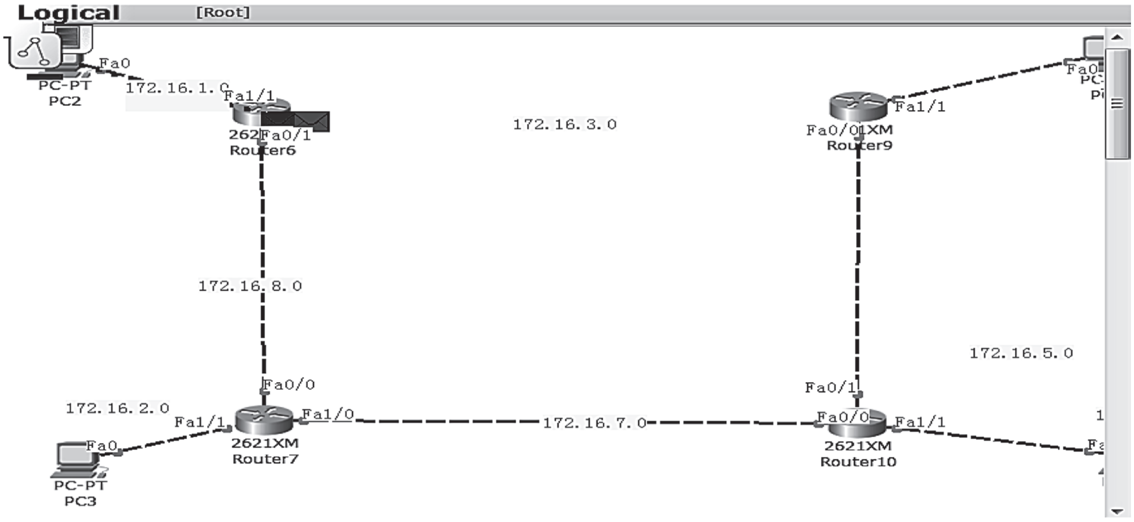


Figure 7. - Message passing way in a cellular network

the network situation, the data packets could from one node transmit to a few multiple nodes, finally arrived to the destination from these multiple nodes. We cut down the link between the Router 6 and Router 9. Of course the message could transform between these two devices. The message passing on Internet is the same as the Fig. 5.

### Construction a cellular network simulation

As the experiment shown, we can see the message passing way from router 6 to router 10, then from router 10 to router 9. Finally the PC-PT (PC 0) will get the message which from the original host. In a normal networking, the message transforms in different way [6]. As we have mention before, the message is transformed in router 6 to router 9 if PC-PT (PC2) as a host original sending the message to PC-PT (PC0), Fig. 6. However, when the link between router 6 and router 9 has broken, the message transform has changed. The message directed first from the host PC-PT (PC2) to router 6, then passing router 7 and router 10, finally arrived to router 9. It means that there are two more routers than a mesh point to point topologic, Fig 7, [7].

### Conclusion

As a result of provided computer experiment and simulation we understand that the cellular network will totally does not work if there will be a main link broken. In single-hop network, if one node fails, the entire network will subsequently paralyzed. However, Mesh network does not depend on a particular performance of a single node. Mesh networks support many different ways from the original host to destination host. When a router fails in mesh network, the information is transfer through an alternate path to other routers. As a result mesh network has more robust structure than single-hop network.

### REFERENCE

1. **Thomas, S.** Experimental Evaluation of Multi –path Routing in a Wireless Mesh Network Inside a Building / S. Thomas, O. Stefan, B. Torsten. – Bern: University of Bern, 2009. – 13 pp.

2. **Hossain, E.** Wireless Mesh Networks: Architectures and Protocols / E. Hossain, K. K. Leung. – Manitoba: Department of electrical & computer engineering, university of Manitoba, 2008. – 333 pp.

3. **Lan, A.** Wireless Mesh Networks / A. Lan, X. D. Wang. – John Wiley & Son Ltd, 2009. – 324 pp.

4. **Gilbert, H.** Wireless mesh networks / H. Gilbert – Taylor & Francis, 2005–144 pp..

5. **Gkelias, A.** Multiple Antenna Techniques for Wireless Mesh Networks / A. Gkelias, K. K. Leung. – London: Department of electrical & computer engineering Imperial College – 33 pp.

6. **Ping, P.** Mesh networks / P. Ping // [электронный ресурс]. режим доступа: http://rep.bntu.by/handle/data/12210 – дата доступа:15.01.2015.

7. **Ping, P.** Mesh Network Simulation / P. Ping // [электронный ресурс]. режим доступа: http://rep.bntu.by/handle/data/122208 – дата доступа: 15.01.2015.

*Поступила 10.01.15*

*Пей Пинг, Юрий Н. Петренко*

## МОДЕЛИРОВАНИЕ ЯЧЕИСТЫХ СЕТЕЙ

*Рассматриваются основы моделирования ячеистой сети, которые обеспечивает достоверное и краткое представление сетевой структуры. Эти основы имеют специфичные топологические структуры. Моделирование позволяет выявить отличие беспроводной ячеистой сети и сотовой сети. Эти две сети, имеющие различный принцип работы, проанализированы экспериментальным путем с помощью разработанной модели. Представлен эксперимент, который позволил определить задержку при передаче сообщения «точка-точка» и определить путь маршрутизации. Мульти – хоп маршрутизации может обеспечить робастность и балансировку нагрузки для связи в беспроводных сетях.*