ANALYSIS OF THE CHARACTERISTICS OF ROUTING PROTOCOLS AND ALGORITHMS

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Abstract. *This study examines the characteristics of routing protocols and algorithms in data communication networks, focusing on their convergence time, packet loss, and resource utilization. Using the OPNET Modeler environment, the research compares protocols such as RIP, OSPF, and EIGRP, with results indicating that EIGRP outperforms others in efficiency but is limited to Cisco devices. The findings suggest OSPF as a practical alternative for broader applications.*

Keywords. *Data communication networks, routing protocols, route metrics, convergence time*

The development of data transmission networks is inextricably linked with the complexity of their topology, which leads to an ever-growing routing problem, and the quality of the solution to this problem directly affects the performance and efficiency of the entire network. One of the promising ways to improve the efficiency of data transmission networks is to analyze the characteristics of routing protocols and algorithms and select a routing protocol suitable for the planned network. The routing process in data transmission networks is distributed and is based on the use of routing tables [1].

Routing is carried out using protocols for creating and updating tables and the corresponding routing algorithms. Routing algorithms are used to determine the most efficient route from the sender of data to the destination.

The routing algorithm is a multidimensional random process X(t), reflecting the current network topology at time t, the length of the processing queues in the switching nodes, the transmission time over the communication channel, the level of use of network resources, the values of input flows and other network parameters are described [2]. The purpose of the routing algorithm is to determine the current control based on the network state X(t), which is understood as a set of directions for further transmission of packets. One of the main functions of the routing algorithm is the calculation of the routing table, the accuracy and relevance of which directly affects the performance and reliability of data transmission networks.

Routing algorithms can base the choice of route on many indicators. As a result, one separate indicator (criterion) is obtained - the route metric. The route metric is a unique information structure, which includes indicators of the quality of the data transmission channel. Therefore, the metric components (indicators) also vary in range of values and size, so the route metric is a dimensionless quantity.

The parameters used to calculate the metric depend on the routing protocol, and the route with the lowest metric is selected as the best path and placed in the routing table. Dynamic routing protocols in data networks include RIP, IGRP, EIGRP, IS-IS, OSPF, and BGP. These routing protocols differ from each other in convergence time, packet loss, voice and video delay, router CPU load, scalability, link utilization (%) and many other characteristics.

In this study, a network simulation model was developed in the OPNET Modeler environment to analyze the characteristics of routing protocols. The OPNET environment allows users to perform a wide range of tasks, such as modeling communication networks and analyzing protocol interactions, network optimization, and planning. The network model under study in the OPNET environment is shown in Figure 1.

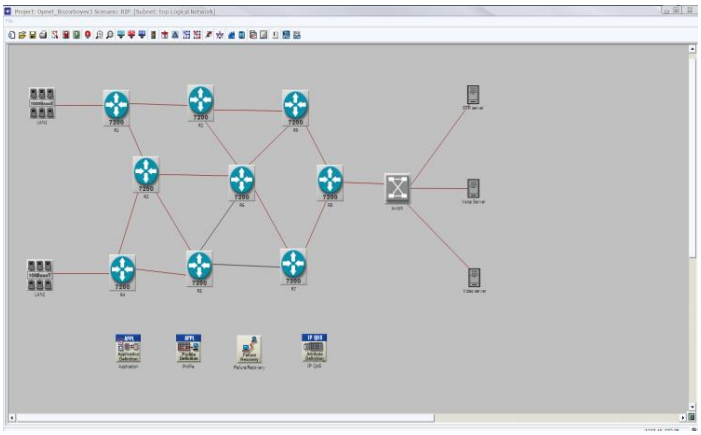
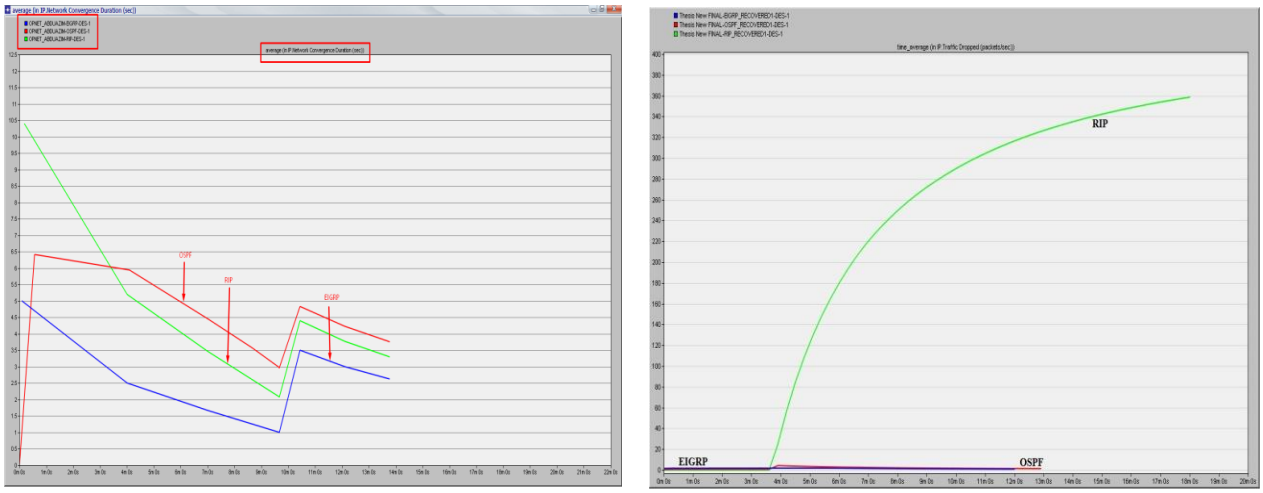


Figure 1. The network model under study in the OPNET environment

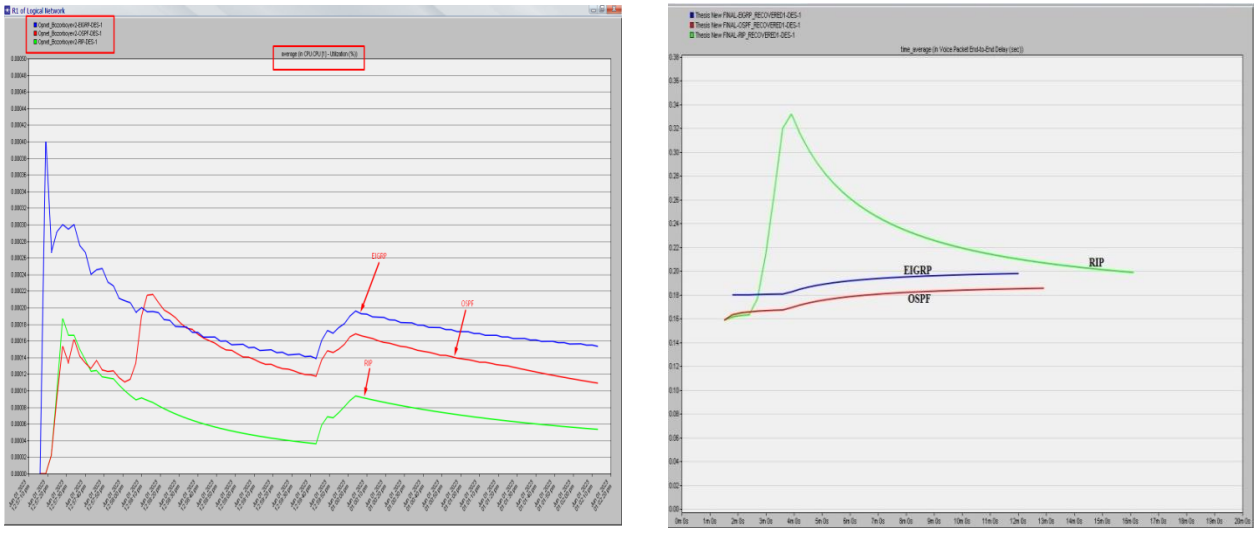
Figure 2 shows the results of the research on the convergence times and packet loss of routing protocols in the OPNET environment, according to which the convergence time of EIGRP is the least compared to other protocols. In addition to that, OSPF and EIGRP have their own packets, not RIP.



a) b)

Figure 2. Routing protocols RIP, OSPF and EIGRP a) convergence time b) packet loss graphs

RIP is the most efficient dynamic routing protocol in terms of router CPU load. Figure 3 shows the experimental results of router CPU load and voice packet delays.



a) b)

Figure 3. Graph of a) router CPU load (%) and b) voice packet delay (sec).

Figure 4 shows that EIGRP and OSPF have better performance than RIP in terms of packet delay in videoconferencing communication service.

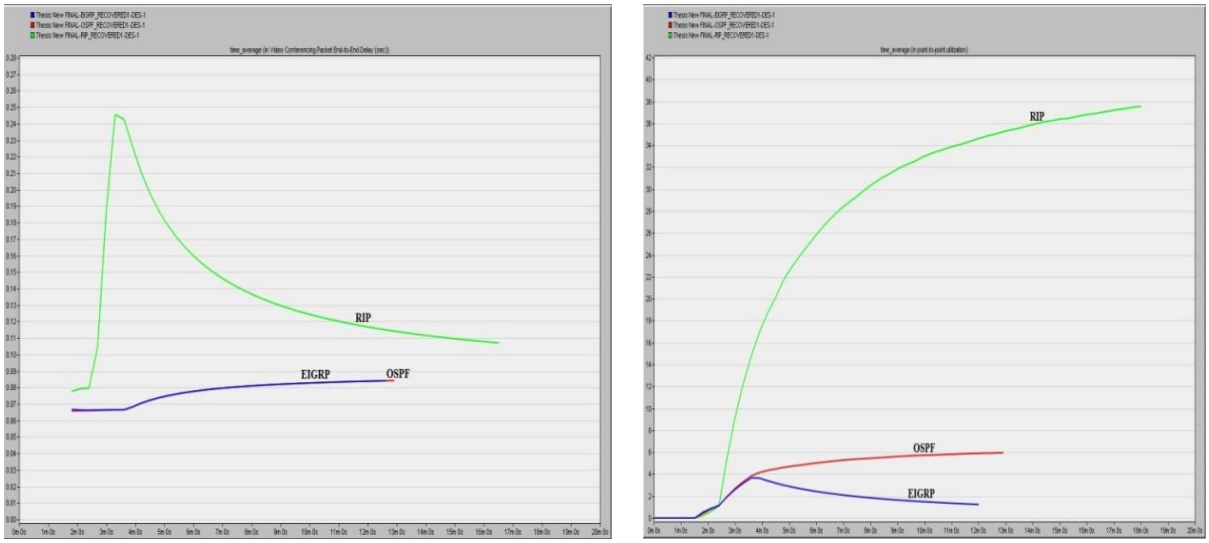


Figure 4. Graph of a) packet delay (sec) and b) channel utilization factor in videoconferencing service

According to the analysis results, the packet delay and the channel utilization coefficient in the network showed the minimum result in the EIGRP protocol. Table 1 shows the parameter values obtained during the simulation.

Table 1

Parameter values obtained from the simulation results

Parameter	RIP	OSPF	EIGRP
Convergence time (sec)	5.8355	8.4854	5.1124
IP traffic loss (packets/sec)	375.25	1.3547	0.8861

Voice packet delay (sec)	0.1982	0.1855	0.1979
Video conference packet delay (sec)	0.1071	0.0842	0.0841
Router CPU-Utilization (%)	9.13	17.546	22.9524
Interface buffer queue delay (sec)	0.00024	0.000160	0.000090
Channel utilization rate (%)	37.560	5.951	1.239

According to the simulation results, EIGRP has higher performance than RIP and OSPF in terms of link efficiency, convergence time, packet loss probability, and delay, but this protocol is only supported by Cisco devices. Therefore, in many cases, OSPF is used in data networks.

If their optimality and convergence time are not taken into account when choosing a routing algorithm, then it is recommended to choose the distance vector algorithm. However, if convergence time, flexibility, optimality, and cost-effective network design factors are important, then routing by the link state algorithm is required.

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