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SECURITY ROUTING SIMULATION THE LOCAL AREA NETWORK OF ACADEMIC DEPARTMENTS USING A LINK-STATE ROUTING PROTOCOL - OSPF

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ABSTRACT:

In this paper a summarized simulation and providing security communication in the local area network of academic department using a link-state routing protocol - OSPF is made. Most of the professional system administrators and IT specialists have to use and apply static and dynamic methods of information routing. Thereby, each network system administrators, security professionals and network architects can use the free of charge software network program Cisco Packet Tracer in order to design and simulate various types of computer networks.

KEY WORDS: *Cisco, Computer and network administrators, Dynamic routing, Information, IPv4, LAN, Protocols, OSPF, Routing, Security, Switch, Router.*

1. Introduction

Securing the transmitted routing information in the local area network of academic departments is very important task and aim for each network system administrators, security professionals and network architects. Building and maintaining a specific local area network (LAN) of academic departments has to be simulated using the specialized software program called “Cisco Packet Tracer”. This program consists of many network tools that can simulate the transmitting network process of secured routing information between the hosts

in small or large computer networks [13, 14, 33, 35, 37, 39]. The software program is designed and implemented primarily for students and academic lecturers who use different network devices of Cisco Systems Corporation [4, 5, 14]. Thereby, each academic lecturer or student have to possess in-depth knowledge and skills in the designing and maintaining of various types of computer network using the a link-state routing protocol - OSPF [8, 15, 41, 44].

This paper is structured as follows. First, in section 2, a related work for the use the routing protocol OSPF is made. After that, in section 3, a sophisticated implementation of the software program called "Cisco Packet Tracer" version 6.2.0.0052 into the server operating system Windows Server 2008 R2 Enterprise is performed. The achieved results are presented in section 4. The conclusions and recommendations are made in section 5.

2. Related work

In [42] a survey on the RIP, OSPF, EIGRP routing protocols by Vetriselvan, V., Pravin R. Patil, and M. Mahendran is made. In [5] method and system for exchanging routing information by Boden, Edward Barnes, Paul Albert Gebler Jr., and Franklin Alfred Gruber is analyzed. In [3] analysis of RIPv2, OSPF, EIGRP configuration on router using cisco packet tracer by Archana, C. is made. In [14] evaluation of OSPF and EIGRP routing protocols for IPv6 by Hinds, Alex, Anthony Atojoko, and Shao Ying Zhu is made. In [47] simulation based performance analyses on RIPv2, EIGRP, and OSPF Using OPNET is comparative analyzed. In [46] performance analysis of dynamic routing protocol EIGRP and OSPF in IPv4 and IPv6 network by Chandra Wijaya is illustrated. In [40] dynamic routing protocol implementation decision between EIGRP, OSPF and RIP based on technical background using OPNET modeler by Thorenoor, S. G. is made. In [48] performance analysis of RIP, EIGRP, and OSPF using OPNET by Xu, Don, and Ljiljana Trajkovic is made. The other citations in this paper are based on specific performance analyses, IP configuration and network solutions.

3. Experiment

The experiment in specialized computer network laboratory in the Faculty of technical sciences is made. The used free of charge software program called "Cisco Packet Tracer" version 6.2.0.0052 which is owned by Cisco Systems, Inc. The host has used server operating system - Windows Server 2008 R2 Enterprise x64. Initially was necessary to be enumerated the network devices and hosts. The simulated local area network using a link-state routing protocol - OSPF has consisted of the following items [9, 12, 15, 30, 31, 32, 33]:

- 8 personal computers (PC-PT).
- 7 Server machines (Server-PT).
- 13 Laptops (Laptop-PT).
- Several Copper Straight-Through UTP cables cat.5e
- Two Copper crossover UTP cables cat.5e.

- 3 Serial Smart DCE DB60 cables;
- One router - Cisco 2911 Modular Router.
- One router - Cisco 2621XM Modular Router.
- One router - Cisco 1841 Modular Router.
- One router - Cisco 2901 Modular Router.
- One router - Cisco 2811 Modular Router.
- 4 Generic Printer machines.
- 1 switch - Cisco Multilayer Switch WS-C3560-24PS.
- 4 switches - Cisco Switch WS-C2960-24TT.
- 1 IP phones - Cisco IP Phone 7960.
- Four academic departments (CCT, IL, Geodesy and MSS).
- One Central Equipment Room (CER).
- 3 racks for the CER.
- Six working table for the staff.
- One complete scheme of the entire network.
- One Packet Tracer Cloud Server for Internet.
- One Access Point-PT-N.
- One generic Smartphone-PT.
- One generic TabletPC-PT.

The computer network in the program environment of Cisco Packet Tracer 6.2.0.0052 is simulated. On fig.1 the common logical scheme of the whole computer network is shown. The link-state routing protocol - OSPF [41, 42, 43, 44, 46, 47, 48] was activated in the configuration of the routers [1, 2, 16, 29, 30, 31, 32, 33, 45].

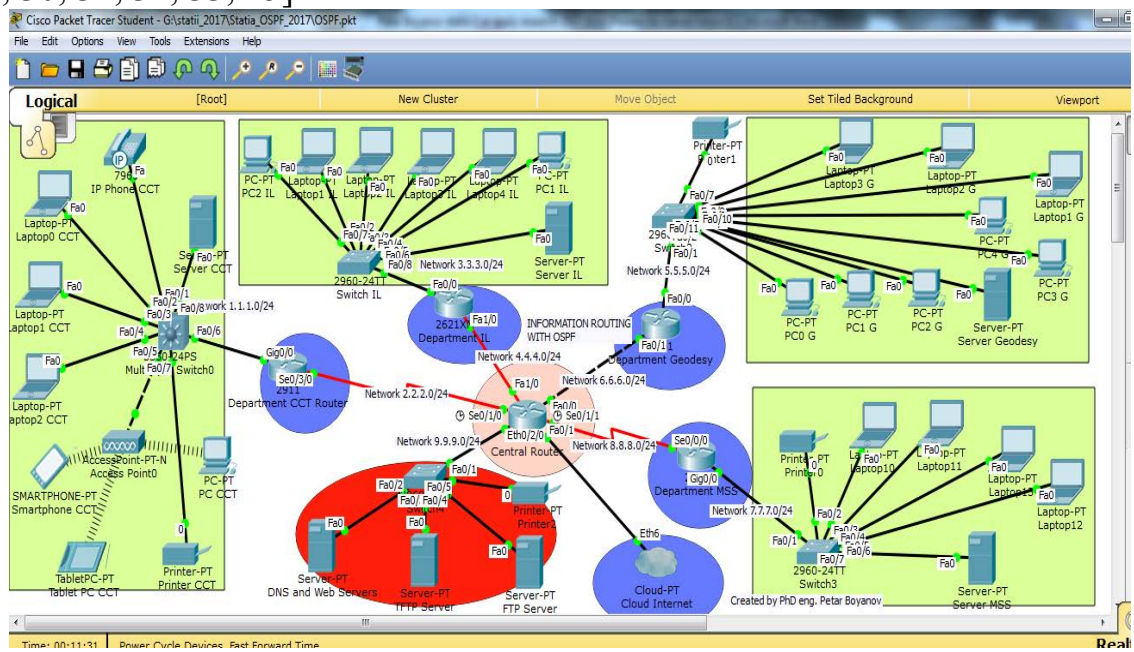

Fig.1. Common logical scheme of the whole computer network of the academic departments

As is known in the network practice each network device as a router consists of determinate numbers of network interfaces [21, 22, 23, 25, 32,]. In this communication scenario the router called "Central Router" has got configured interface Fast Ethernet (Fa0/0) with network number ID (Net ID) - 6.6.6.0/24 and interface Fast Ethernet (Fa0/1) with network number ID (Net ID) - 9.9.8.0/24. The third interface is Serial (Se0/1/0) with network number ID (Net ID) - 2.2.2.0/24. The fourth interface is Serial (Se0/1/1) with network number ID (Net ID) - 8.8.8.0/24. The fifth interface is Serial (Se0/3/0) who is directly connected to the Internet Cloud. The last configured interface is Fast Ethernet (1/0) with network number ID (Net ID) - 4.4.4.0/24 [7, 21, 33, 35, 36, 40].

The router called "Department CCT Router" has got configured interface Serial (Se0/3/0) with network number ID (Net ID) - 2.2.2.0/24 and second configured interface Gigabit (Gig0/0) with network number ID (Net ID) - 1.1.1.0/24. The name CCT is an abbreviation of Communication and Computer Technologies [9, 10, 14, 15, 16, 19, 22, 23].

The router called "Department IL" has got configured interface Fast Ethernet (Fa0/0) with network number ID (Net ID) - 3.3.3.0/27 and other interface Fast Ethernet (1/0) with network number ID (Net ID) - 4.4.4.0/24. The name IL is an abbreviation of Engineering Logistics.

The router called "Department Geodesy" has got configured interface Fast Ethernet (0/0) with network number ID (Net ID) - 5.5.5.0/24 and other configured interface Fast Ethernet (0/1) with network number ID (Net ID) - 6.6.6.0/24 [1, 2, 3, 4, 30, 39, 41].

The router called "Department MSS" has got configured interface Serial (Se0/0/0) with network number ID (Net ID) - 8.8.8.0/24 and other configured interface Gigabit (Gig0/0) with network number ID (Net ID) - 7.7.7.0/24. The name MSS is an abbreviation of Management of Security Systems [4, 41, 48].

The network with Net ID 1.1.1.0/24 consists of one Cisco Multilayer Switch WS-C3560-24PS and one Cisco 2911 Modular Router. In this switch are connected three Laptops (Laptop-PT), one Generic Printer machine, one Cisco IP Phones 7960, one Access Point-PT-N with connected to it one generic smartphone, one tabletPC and one personal computer with wireless card. The Server CCT is also connected to the multilayer switch. The network 1.1.1.0/24 is private local area network and its IPv4 Default Gateway is 1.1.1.1/24 and in this case this is the configured network address of interface Gigabit (Gig0/0) in router called "Department CCT Router". The capacity of this network is 254 real hosts. The connection between the Cisco multilayer switch and the hosts with several Copper Straight-Through UTP cables cat.5e and one copper crossover UTP cable cat.5e is made. The connection between the router „ Department CCT Router" and the multilayer switch again with Copper Straight-Through UTP cable cat.5e is made [11, 13, 14, 21, 26, 27, 28,].

The network with Net ID 3.3.3.0/24 consists of one Cisco 2621XM Modular Router and one Cisco Switch WS-C2960-24TT. In this case in the

switch are connected two personal computers, four laptops and one server machine called “Server IL”. The capacity of this network is 254 real hosts. The connection between the Cisco switch and the hosts with several Copper Straight-Through UTP cables cat.5e is made. The connection between the router called „Department IL” and the switch again with Copper Straight-Through UTP cable cat.5e is made [6, 36, 37, 45, 46, 47].

The network with Net ID 5.5.5.0/24 consists of one Cisco 2811 Modular Router and one Cisco Switch WS-C2960-24TT. In this case in the switch are connected five personal computers, three laptops, one generic printer machine and one server machine called “Server Geodesy”. The capacity of this network is 254 real hosts. The connection between the Cisco switch and the hosts with several Copper Straight-Through UTP cables cat.5e is made. The connection between the router called „Department Geodesy” and the switch with Copper crossover UTP cable cat.5e is made.

The network with Net ID 7.7.7.0/24 consists of one Cisco 2901 Modular Router and one Cisco Switch WS-C2960-24TT. In this case in the switch are connected four laptops, one generic printer machine and one server machine called “Server MSS”. The capacity of this network is 254 real hosts. The connection between the Cisco switch and the hosts with several Copper Straight-Through UTP cables cat.5e is made. The connection between the router called „Department MSS” and the switch with Copper crossover UTP cable cat.5e is made. The configured network devices and the third racks in Central Equipment Room (CER) are illustrated in fig. 2.

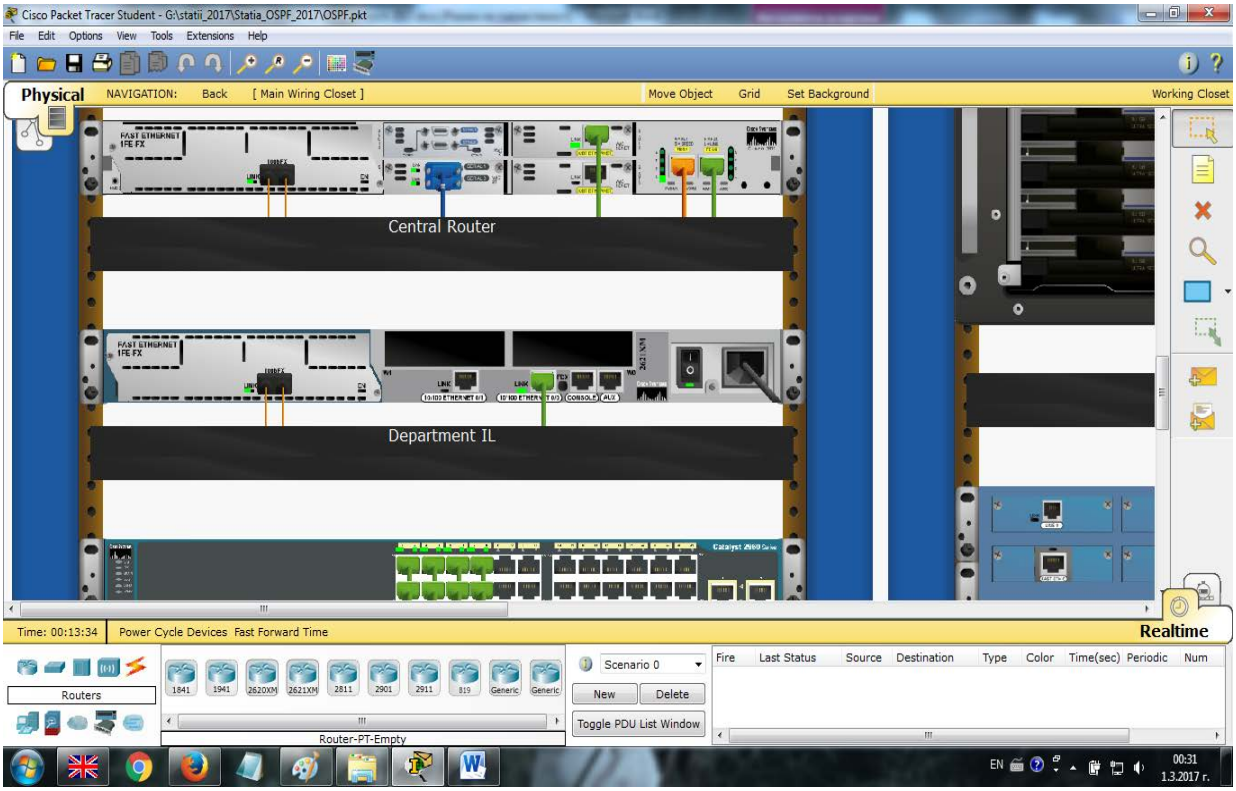

Fig. 2. The physical network devices installed in the racks

4. Results

The name OSPF is an abbreviation of Open Shortest Path First protocol. Its aim is to replace the Routing Information Protocol (RIP). It consists of following important features [45, 46, 47, 48]:

- classless routing protocol;
- very fast convergence;
- scalability;
- Dijkstra's shortest path first (SPF) algorithm;
- Administrative Distance (AD) of 110.

One of the most important features of this routing protocol is related to the fact that OSPF can be configured to transmit routing information with authentication process between its neighbor's routers. Other very important feature is the encryption of the transmitted routing information [28, 30, 31, 36, 38]. Most of the network system administrators, security professionals and network architects must know that process of the authentication does not encrypt the whole routing table of each router [20, 24, 26, 27, 29].

The encapsulated OSPF message includes data link frame header, IP packet header, OSPF packet header and OSPF packet type-specific data. The OSPF packet types are:

- 0x01 Hello;
- 0x02 Database Description (DD);
- 0x03 Link State Request;
- 0x04 Link State Update;
- 0x05 Link State Acknowledgement.

In the command line interface of each router the network administrators must enter the command "router ospf 11229". The number 11229 means that is the number selected process ID [9, 10, 18, 19, 20, 35]. After applying other specific network commands in the command line interface of each host, then all routers are able automatically to discoverer each other although there is additional subnetting in the whole local area network of the academic departments [5, 6, 7, 8, 11, 12, 13, 16, 17].

The successful executed command ping from host called "Laptop12" located in department MSS to host called "Tablet PC CCT" with IPv4 address 1.1.1.8/24 located in department CCT on fig. 3 is shown. From host called "Laptop12" has sent 8 ICMP Echo request packets to the target host. The following ICMP Echo reply packets have arrived back to host called "Laptop12":

Request timed out;
Reply from 1.1.1.8: bytes=32 time=8ms TTL=125;
Reply from 1.1.1.8: bytes=32 time=22ms TTL=125;
Reply from 1.1.1.8: bytes=32 time=34ms TTL=125;
Reply from 1.1.1.8: bytes=32 time=25ms TTL=125;

Reply from 1.1.1.8: bytes=32 time=9ms TTL=125;
Reply from 1.1.1.8: bytes=32 time=38ms TTL=125;
Reply from 1.1.1.8: bytes=32 time=43ms TTL=125;

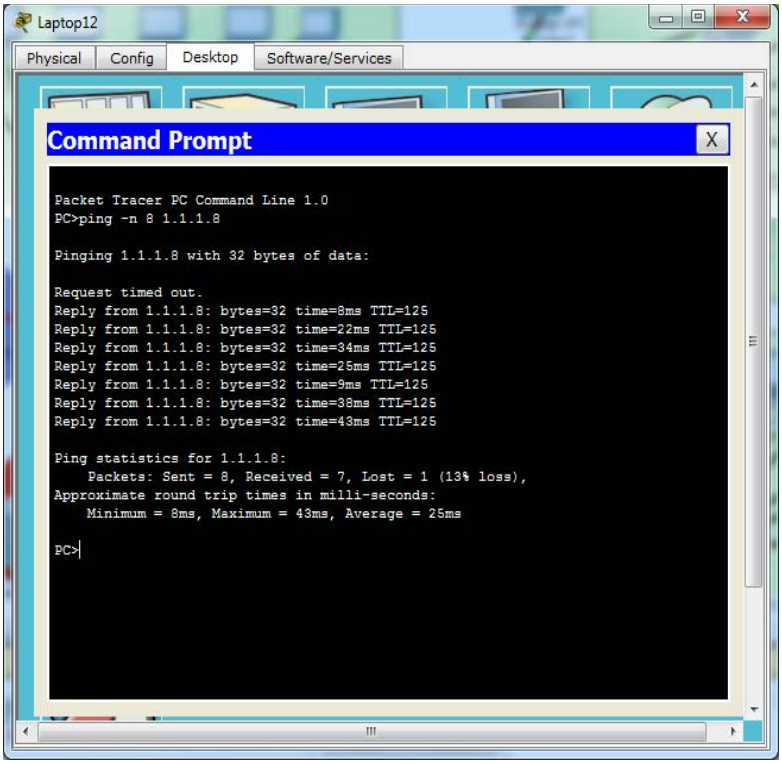

Fig.3 Successful executed command ping from host called “Laptop12” to host called “Tablet PC CCT” with IPv4 address 1.1.1.8/24

In order to verify that configuration of the routing protocol OSPF is correctly applied each network administrator must enter the following commands [47, 48]:

- OSPF process ID number ;
- OSPF border and boundary router information;
- OSPF database summary;
- OSPF interface information;
- OSPF neighbor list of the routers;
- OSPF virtual link information.

The first command OSPF process ID number shows the following information:

- routing process “ospf 11229” with ID 9.9.9.1;
- supporting only single TOS routes;
- minimum and maximum LSA arrival times;
- external flood list length;
- number of areas in the selected router;
- number of interfaces in this area;

- authentication process and etc.

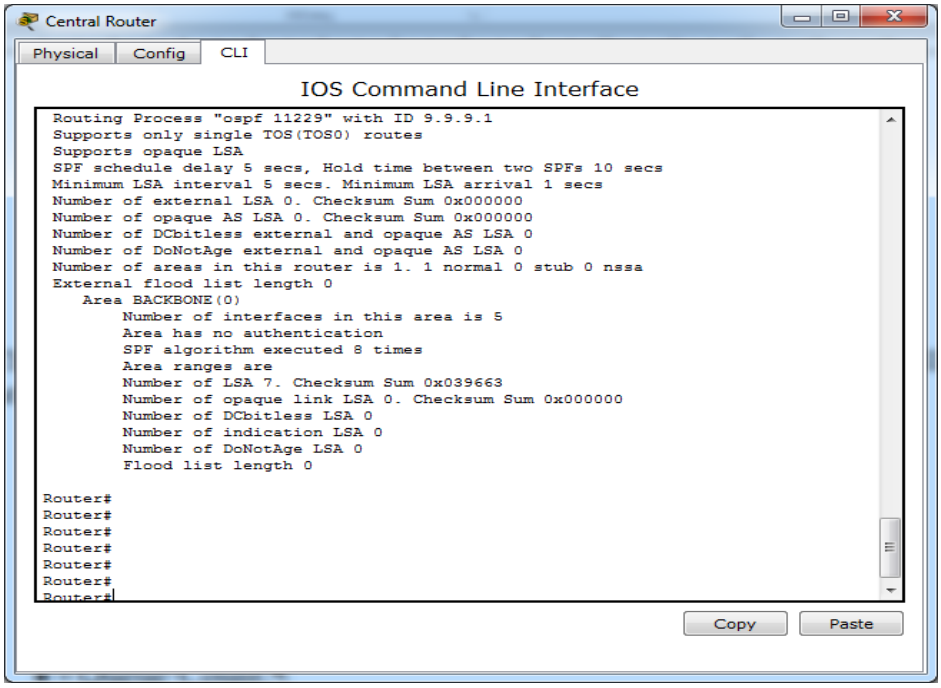

Fig. 4. Successfully execution of OSPF process ID number command

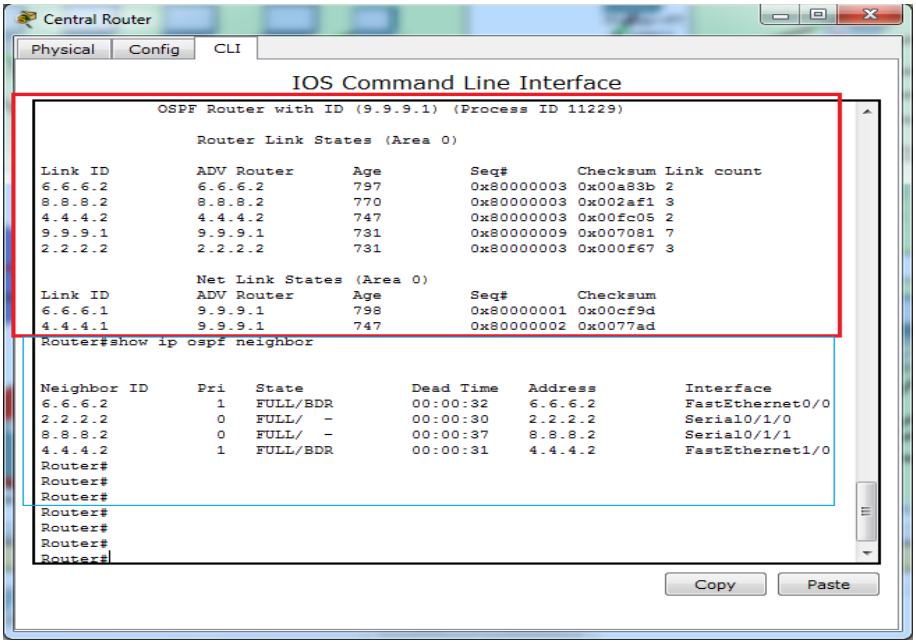

Fig. 5. Successfully execution of OSPF database summary and OSPF neighbor list of the routers commands

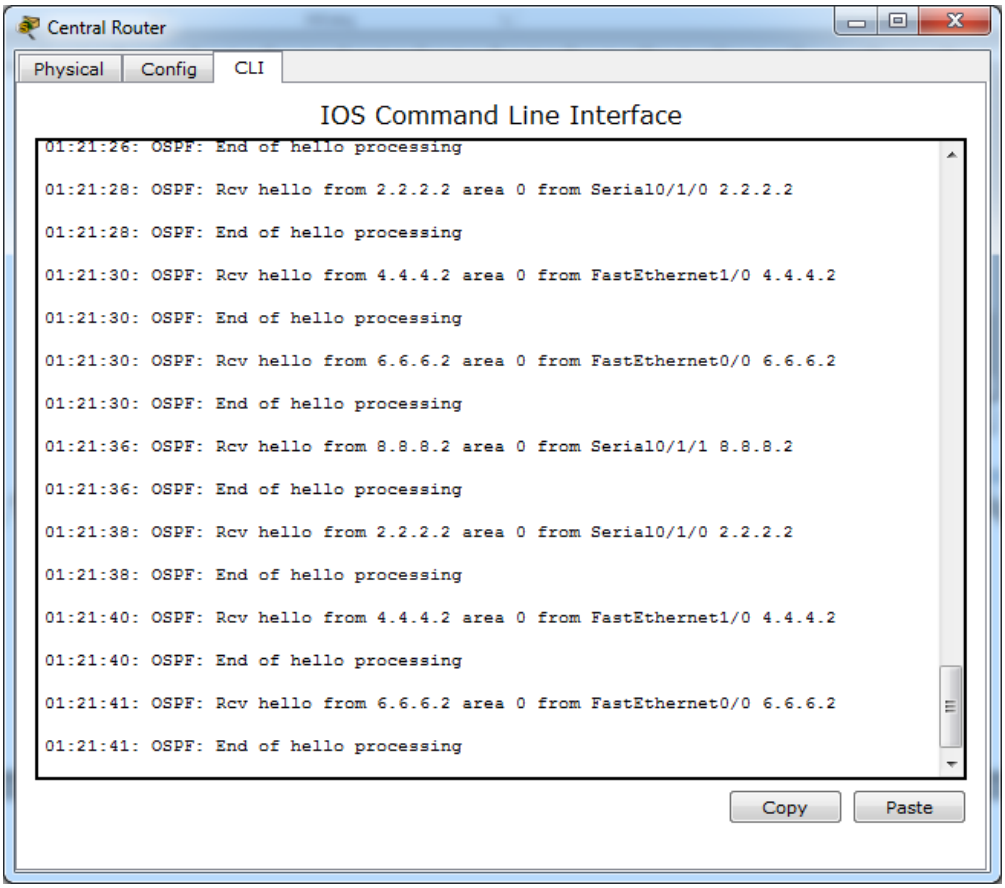

Fig. 6. Monitoring the successfully transmitted control information about the adjacency events between the routers

5. Conclusion

Thanks to the achieved results of the conducted research experiment in this paper each network system administrators, security professionals, network architects and IT experts can obtain detailed statistical information for the transmitted routing information among all hosts and network devices in the simulated local area network of academic departments using a link-state routing protocol - OSPF. On the other hand the program called cisco packet tracer is a powerful tool for designing and simulating small and large computer networks with different routing protocols.

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