



HDU-ITMO Joint Institute
杭州电子科技大学 圣光机联合学院

NETWORK PROTOCOLS

LAB 3

A NETWORK ROUTING

Instructors

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PREREQUISITES

1. Computer Networking: A Top-Down Approach, 7th ed., J.F. Kurose and K.W. Ross
(Chapter 1 and Chapter 2)

REPORT

After completion the task the students need to submit:

- **The format of the report file is *pdf*.**
- Upload reports for the GitLab repository (to your personal project)
- Do not forget to write your name and ID inside the report



The goal: to study the principles of organizing the interaction of application programs using SMTP and POP3 e-mail protocols in the Cisco Packet Tracer simulation mode.

Plan:

1. Building a network topology, configuring network devices;
2. Configuring the mail server;
3. Research of applied mail protocols in simulation mode;
4. Sending an SMTP email to the server;
5. Receiving a POP3 message from the server;
6. Performing an individual task.

Theoretical information:

SMTP and POP3 protocols

Mail Transfer Agent (MTA) – mail transfer agent, which is the main component of the mail transfer system, represents this computer for a network e-mail system. Usually, users do not work directly with the MTA, but use the Mail User Agent (MUA), an email client.

To transmit messages over a TCP connection, most mail agents use the Simple Mail Transfer Protocol (SMTP).

SMTP is accepted as a standard method of transmitting e-mail on the Internet. The current protocol standard is described in RFC 2821. SMTP uses TCP as the transport protocol, the connection is established through port number 25. To service this connection, a special program is used, which is called a mail server. The user's mail program is used to generate a message and establish a connection. After the connection is established, information is exchanged through commands. These commands are not available to the user if he uses an email client when working.

The main purpose of the SMTP protocol is reliable and efficient delivery of electronic mail messages. To implement the protocol, only a reliable communication channel is required. The medium for SMTP can be a separate local network, a network system, or the worldwide Internet.

This transfer is usually carried out directly from the sender's host to the recipient's host when both hosts use the same transport service. If the hosts are not connected to a common transport system, the transfer is carried out using one or more intermediate SMTP servers. Today, it is common practice on the Internet to present the original message to an intermediate server, which performs some additional functions. In such cases, the intermediate server acts as a gateway to other transmission media and is usually selected using DNS MX records (Domain Name Service).

The SMTP protocol is based on the following communication model: in response to a user's request,



the mail program that sends the message establishes a two-way communication with the receiver program (mail server). The recipient can be a terminal or intermediate addressee. If necessary, the mail server can establish a connection with another server and pass the message on.

In order to receive a message from your mailbox, the user's mail program connects to the server no longer using the SMTP protocol, but using a special mail protocol for receiving messages. This protocol allows you to work with a mailbox: pick up messages, delete messages, sort them and perform other operations. The most popular protocol of this kind is currently the Post Office Protocol v.3 (POP3).

Many concepts, principles and concepts of the POP3 protocol look and function like SMTP: interaction occurs through commands. The POP3 server is located between the user agent and the mailboxes.

It provides a connection to a mail server based on the TCP transport protocol via port 110. The specification of ROR3 is defined in the document RFC 1939. RORZ is designed taking into account the specifics of mail delivery to personal computers and has the appropriate operations for this.

The design of the ROR3 protocol provides an opportunity for the user to access his mail server and withdraw the mail that has accumulated for him. The user can access the ROR3 server from any Internet access point. At the same time, he must launch a special mail agent operating under the ROR3 protocol and configure it to work with his mail server. Messages are delivered to the client via the POP3 protocol, and are sent using SMTP. That is, there are two separate agents on the user's computer-interfaces to the mail system – delivery (POP3) and sending (SMTP).

DNS

This laboratory work is devoted to the study of SMTP and POP3 e-mail application protocols. However, interaction with the email system is impossible without the Domain Name System (DNS). The tasks of the DNS service include:

1. Converting symbolic names to IP addresses;
2. Converting IP addresses into symbolic names.

An additional DNS function is mail routing.

The units for storing and transmitting information in DNS are resource records. There are many types of resource records, each of which consists of a certain number of fields. For mail routing, the “MX” record is used, if it is not present, the “A” record is used. Entry “A” (address entry) contains parameters: host domain name, corresponding IP address.

Example: aivt IN A 195.19.212.16, where “IN” is the record class (internet).

The “MX” record contains parameters: the name of the mail domain, the name of the mail server, priority.

Example: aivt IN MX 20 mail.stu.neva.ru , where “IN” is the record class (internet).

When receiving a letter, the MTA analyzes its service information, in particular the title of the letter, determining the recipient's domain (see Figure 4.83). If it belongs to a domain that is served by this MTA, the recipient is searched and the letter is placed in his mailbox. If the recipient's domain is not served by this

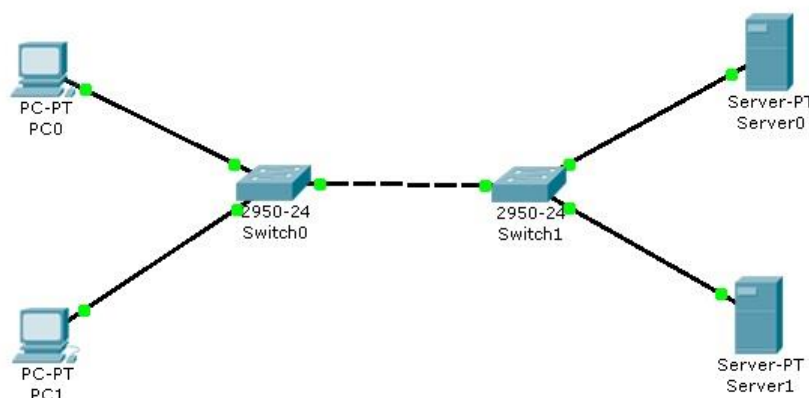


MTA, a DNS query is generated requesting MX records for this domain. An MX record is a special type of DNS record that contains the names of mail servers that process incoming mail for a given domain. There may be several MX records, in this case, the MTA tries to establish a connection sequentially, starting with the server with the highest priority. In the absence of an MX record, an A record is requested (an address record that maps a domain name to an IP address) and an attempt is made to deliver mail to the host specified there. If it is impossible to send a message, it is returned to the sender (placed in the user's mailbox) with an error message.

Workflow:

- **Building a network topology**

To study the specified application protocols, we will build a test network topology of the following type:



We configure network devices according to the specified parameters:

Nodes	IP	Mask	IP-address of DNS-server
PC0	172.16.0.90	255.255.0.0	172.16.0.20
PC1	172.16.0.100	255.255.0.0	172.16.0.20

Nodes	IP	Mask	IP-address of DNS-server
Server0	172.16.0.20	255.255.0.0	172.16.0.20
Server1	172.16.0.40	255.255.0.0	172.16.0.20



All devices are located in the same segment of the local network, so packet routing is not used, so it is not necessary to specify the default IP address of the gateway.

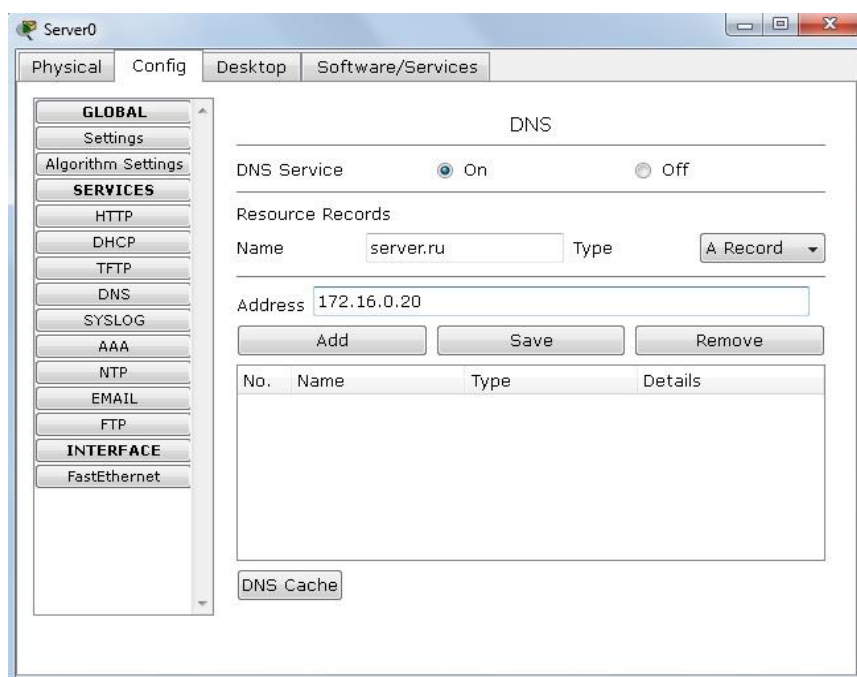
- **Setting up the mail server**

The email servers are server 172.16.0.20 and server 172.16.0.40.

smtp and **pop3** servers will be supported on each of the MTA. Any registered user can connect to the server. To send an email, the user on the server is authorized, after which the server is ready to send emails on behalf of the user. According to the destination address of the letter, the server determines who should pass it on to. The server determines the desired address using the DNS service, which contains the corresponding resource address record that converts the domain name into an IP address.

Let's connect the DNS service on the server 172.16.0.20:

- 1) One click on the selected device.
- 2) Select the Config tab, Services -> DNS. Entering data about a new resource record: domain name, IP address, type of resource record. The simulator does not support a resource record intended for mail servers, MX, but it can be replaced with an address record (type A).



Click on the “Add” button, a new record will be added to the DNS service



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Server0

Physical Config Desktop Software/Services

GLOBAL

Settings

Algorithm Settings

SERVICES

HTTP

DHCP

TFTP

DNS

SYSLOG

AAA

NTP

EMAIL

FTP

INTERFACE

FastEthernet

DNS

DNS Service ☒ On ☐ Off

Resource Records

Name Type

Address

Add Save Remove

No.	Name	Type	Details
1	server.ru	A Record	172.16.0.20

DNS Cache

Let's repeat the previous steps and add another resource record about the mail server 172.16.0.40

Server0

Physical Config Desktop Software/Services

GLOBAL

Settings

Algorithm Settings

SERVICES

HTTP

DHCP

TFTP

DNS

SYSLOG

AAA

NTP

EMAIL

FTP

INTERFACE

FastEthernet

DNS

DNS Service ☒ On ☐ Off

Resource Records

Name Type

Address

Add Save Remove

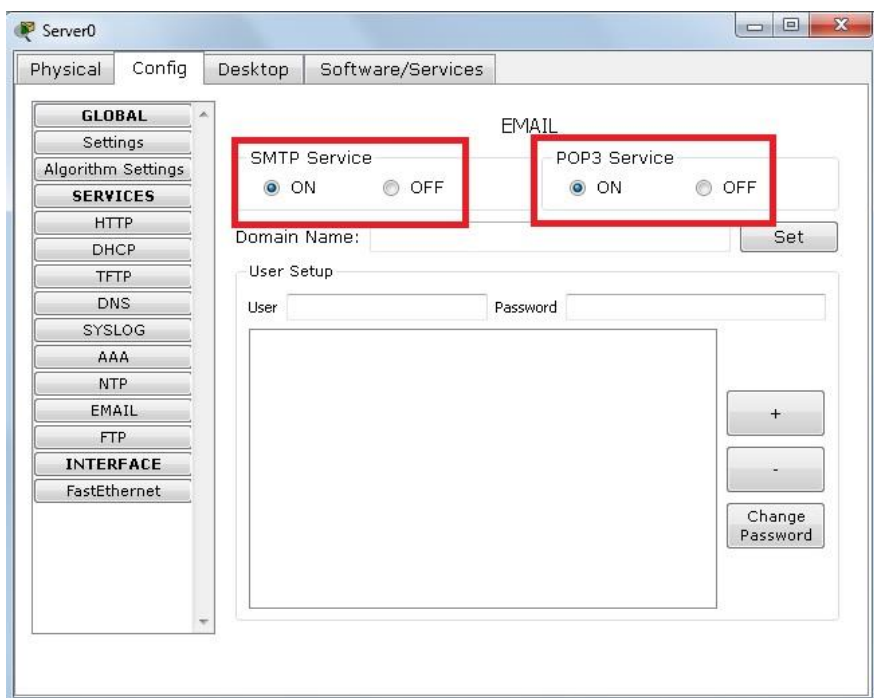
No.	Name	Type	Details
1	mail.ru	A Record	172.16.0.40
2	server.ru	A Record	172.16.0.20

DNS Cache



Now we will configure the mail server 172.16.0.20 with smtp and pop3 server support:

- 1) One click on the selected device.
- 2) Select the “Config” tab, Services -> EMAIL
- 3) Connect the SMTP and POP3 protocols and enter the email domain name. Press the “Set” button.



Create an account for one user, enter the username and password. You can add an entry to the service using the “+” button



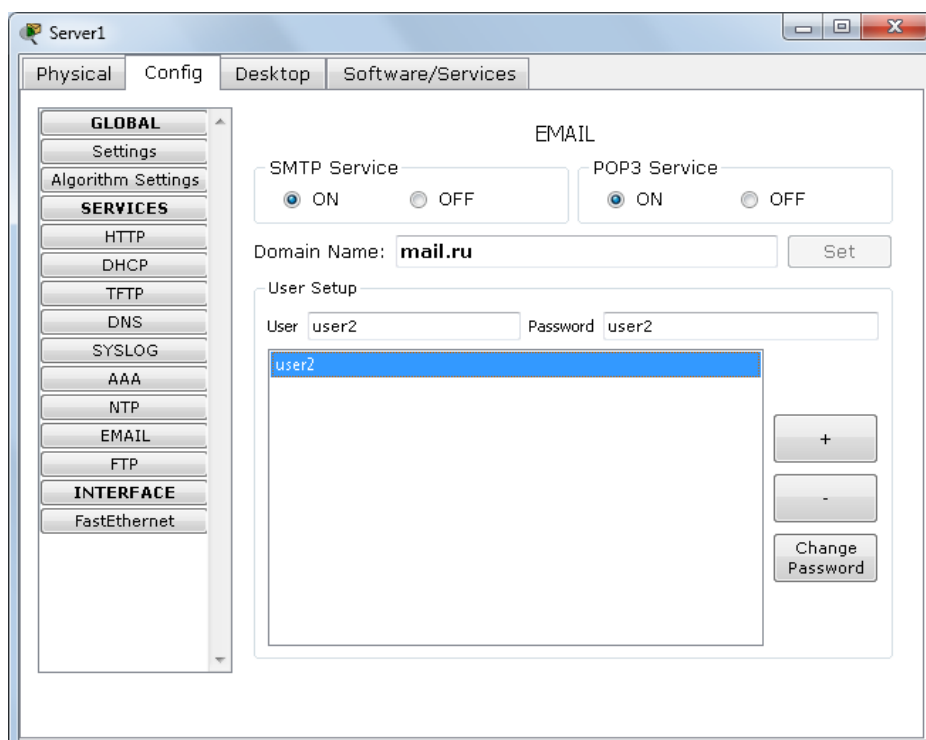
Smtp server and pop3 server on machine 172.16.0.20 are configured, have one registered user. It also supports the DNS service, which has two resource records.

On server 172.16.0.40, you also need to configure a mail server with SMTP and POP3 support. The DNS



server for it is 172.16.0.20.

- 1) One click on the selected device.
- 2) Select the “Config” tab, Services -> EMAIL
- 3) Connect the SMTP and POP3 protocols and enter the email domain name - mail.ru . Press the “Set” button.
- 4) Create an account for one user, enter the username and password. You can add an entry to the service using the “+” button.



Configuring the mail service on the end nodes

To work with an smtp or pop3 mail server, an email client must be configured on the user's computer, which will interact with the server.

Let's set up an email client on the host 172.16.0.90:

- 1) One click on the host with the IP address 172.16.0.90.
- 2) Select the Desktop tab, the "E-mail" program. The mail service configuration window will appear. We enter user data into the form.



Configure Mail

User Information

Your Name: user1

Email Address: user1@server.ru

Server Information

Incoming Mail Server: server.ru

Outgoing Mail Server: server.ru

Logon Information

User Name: user1

Password:
USER1

Save Clear Reset

Click the “Save” button, close the window, the configuration of the email client is completed. Now the mail service in the domain is available for the user user1 server.ru : sending and receiving emails.

We will configure the mail service on the host 172.16.0.100, following the previous steps. We enter the following user data:

Now the mail service in the domain is available for the user user2 mail.ru : sending and receiving emails.

Configure Mail

User Information

Your Name: user2

Email Address: user2@mail.ru

Server Information

Incoming Mail Server: mail.ru

Outgoing Mail Server: mail.ru

Logon Information

User Name: user2

Password:
USER2

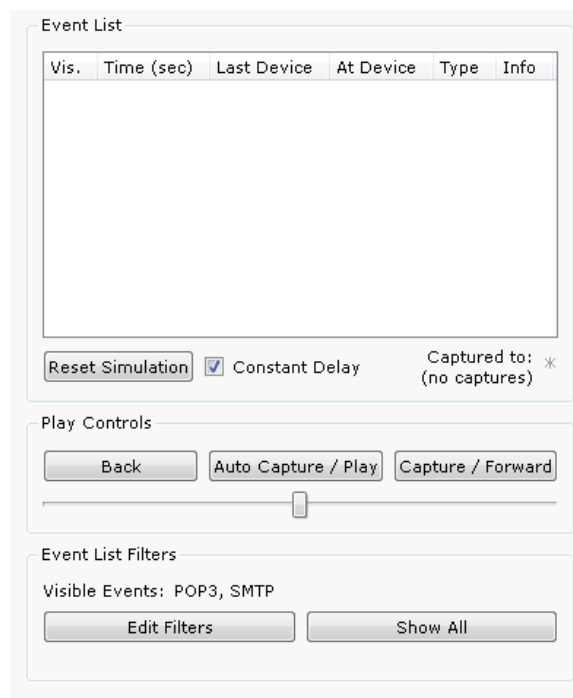
Save Clear Reset



Configuration of all devices and necessary services is completed.

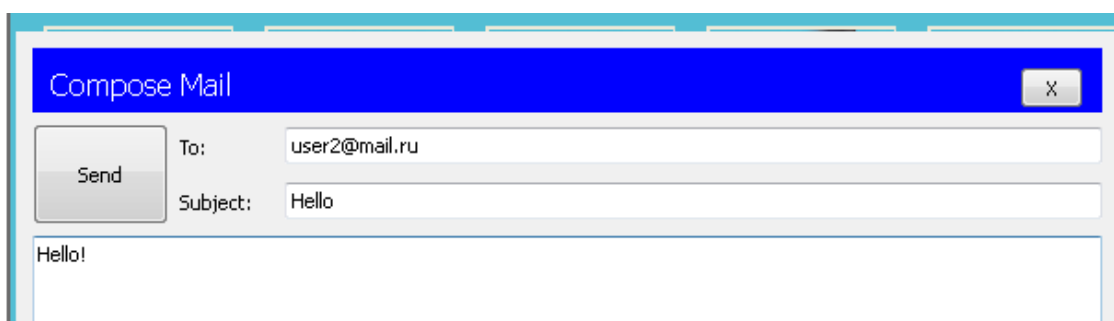
- **Research of applied mail protocols in simulation mode**

We switch to the Cisco Packet Tracer simulation mode. We add filters for 2 protocols: SMTP and POP3. This means that packets of only filtered protocols will be displayed on the network.



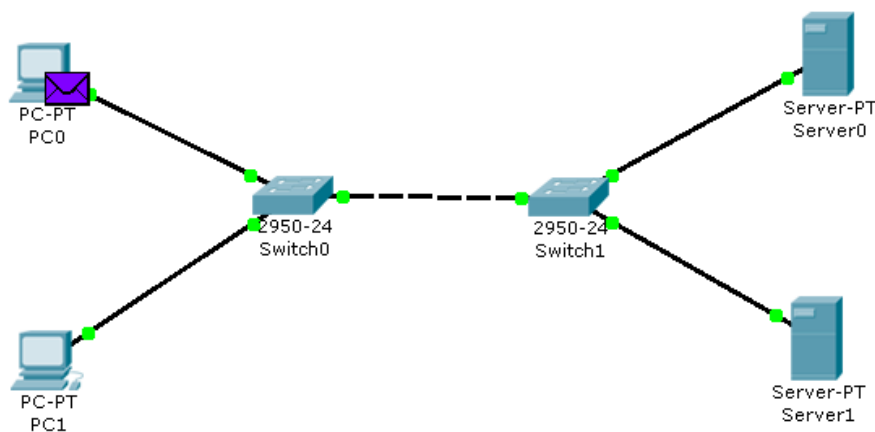
We will send an email from host 172.16.0.90 from user1 to host 172.16.0.100 user2:

- 1) One click on the selected node (172.16.0.90).
- 2) Select the “E-mail” program on the “Desktop” tab.
- 3) To write and send a letter, click on the “Compose” button. A form will appear that you need to fill out. The “To” field specifies the email address to whom you are sending the email. The “Subject” field contains the email title. You can compose the text of the letter yourself.

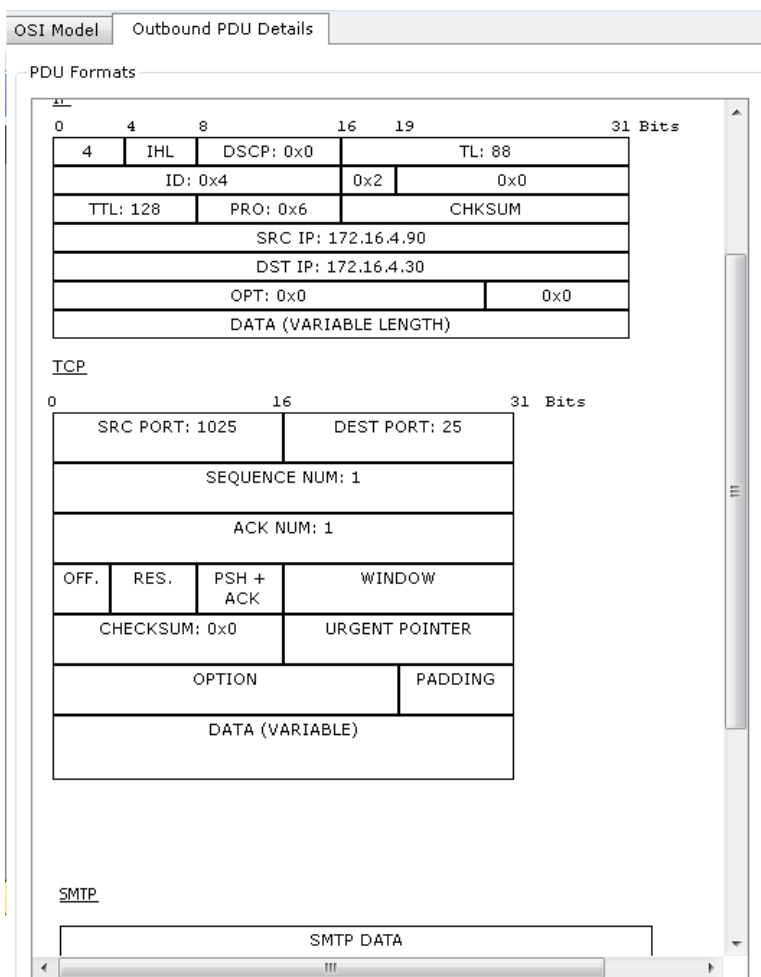


Click on the “Send” button, the sending of the letter will begin.

We see that an SMTP packet has formed on the host 172.16.0.90. Using the “Capture/Forward” button, we will follow the packet route from device to device.



Let's look at the contents of the package generated on the node.

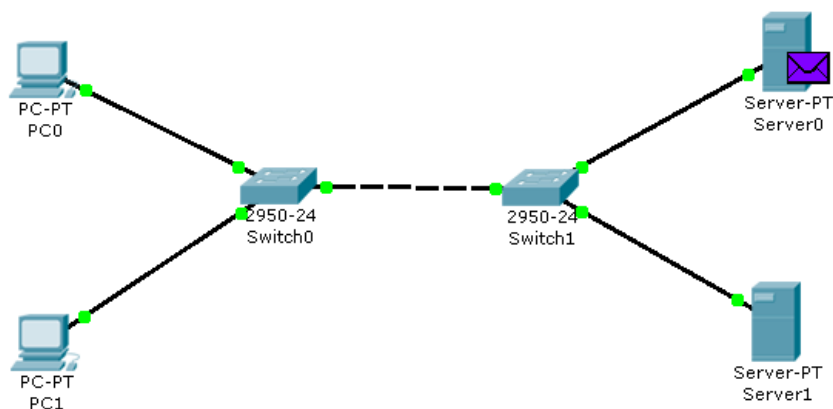


The packet is addressed to the mail server at the IP address 172.16.0.20. The TCP header contains the destination port – 25. It can be concluded that the packet is formed correctly. The packet passes through two switches on its way to the server. Make sure this is the case.

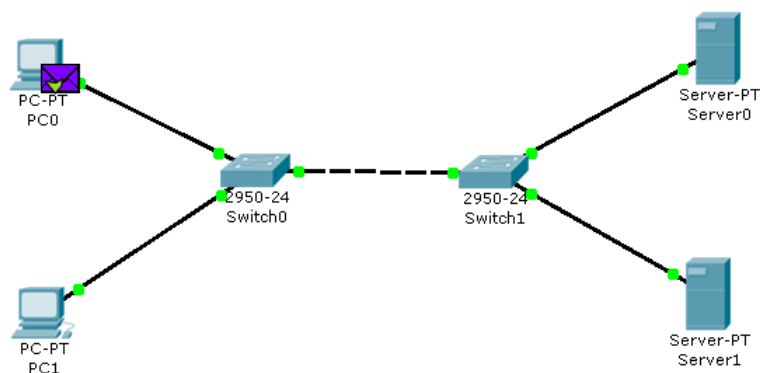


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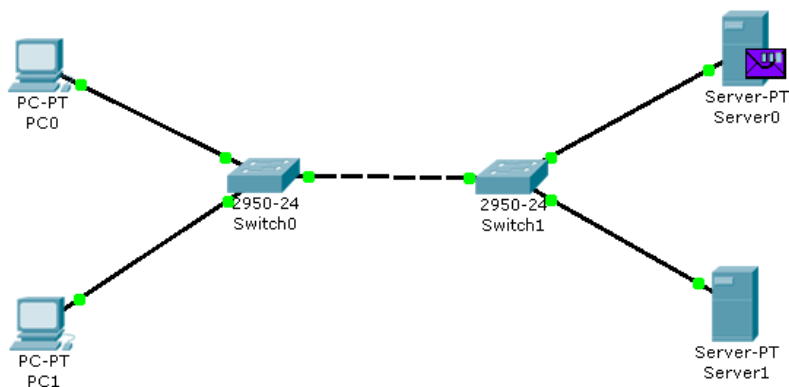
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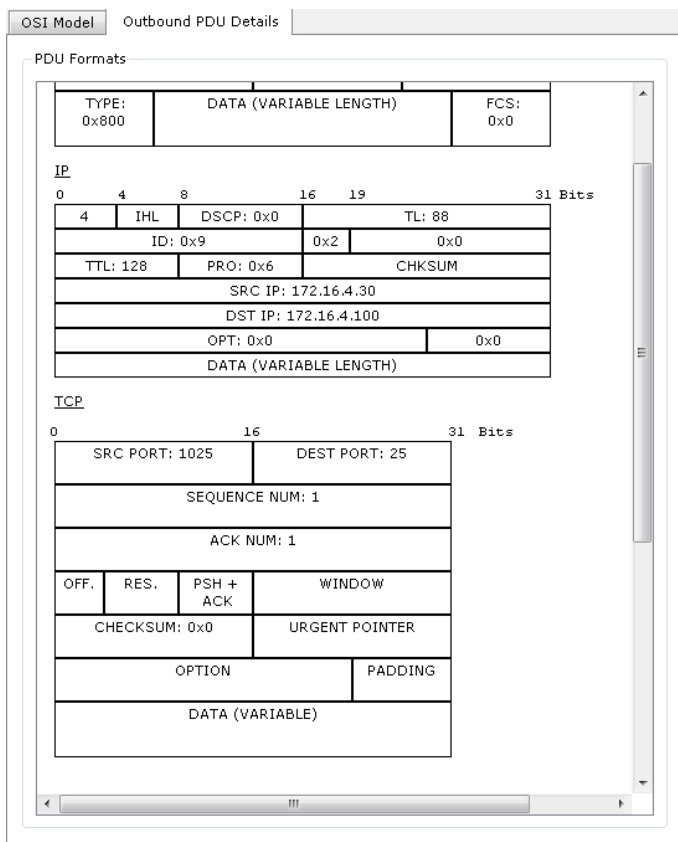
On the server 172.16.0.20, an SMTP response is generated to the client with the IP address 172.16.0.90 and sent to the specified address.



When a packet arrives at the server, the server, processing it, determines that the letter is addressed to the domain mail.ru . Server 172.16.0.20 accesses the DNS service for the IP address of the specified server. At the specified address, the message is redirected to the corresponding mail server

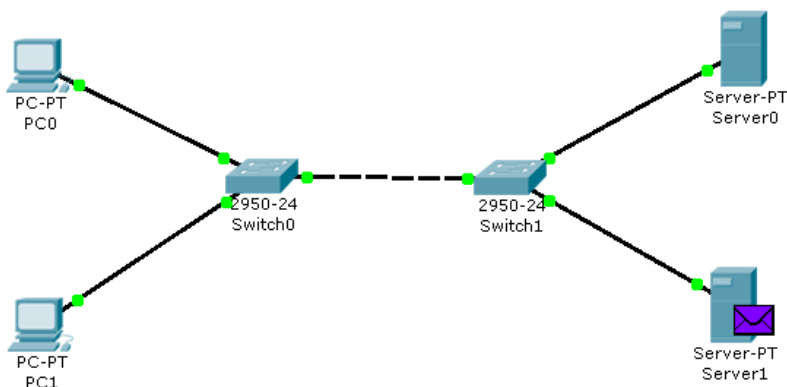


The SMTP packet generated by server 172.16.0.20 contains the following information: destination IP address – 172.16.0.40, destination port – 25

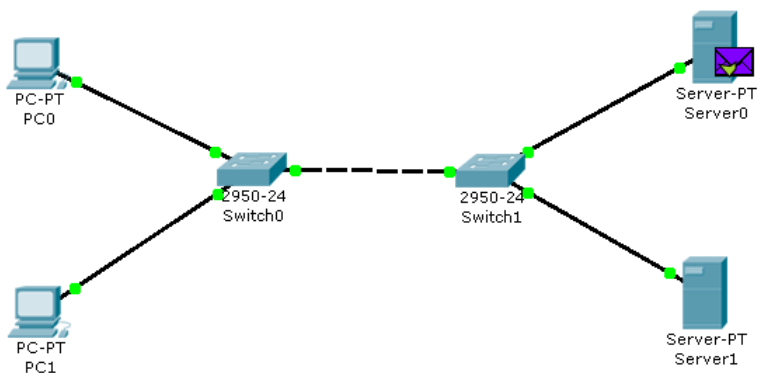




The packet passes through the Switch1 switch and is delivered to the server 172.16.0.40.



The SMTP response of the server 172.16.0.20 is generated on the server 172.16.0.40 and sent to the specified address



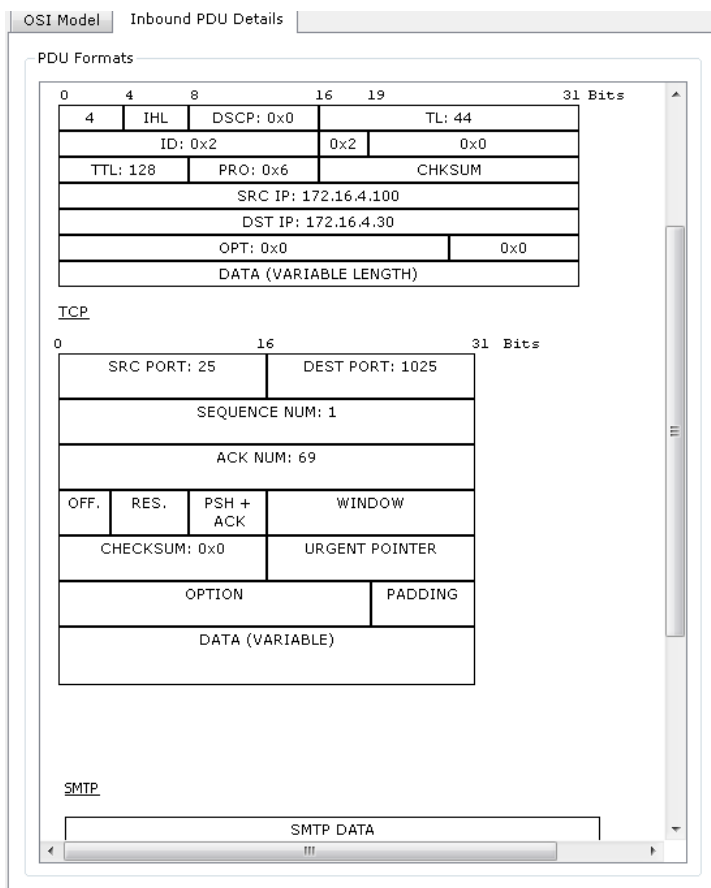
From the contents of the packet that came back to the server 172.16.0.20: source IP address - 172.16.0.40, source port – 25

Using the SMTP protocol, we sent an email to the server mail.ru , it is now stored there.

Our addressee (node 172.16.0.100) has not yet received the sent email, since he has not yet contacted

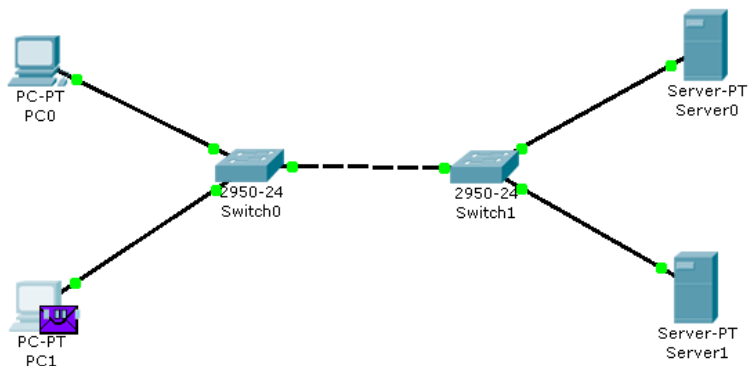


the server via POP3 protocol. To receive a letter, you need to do the following:

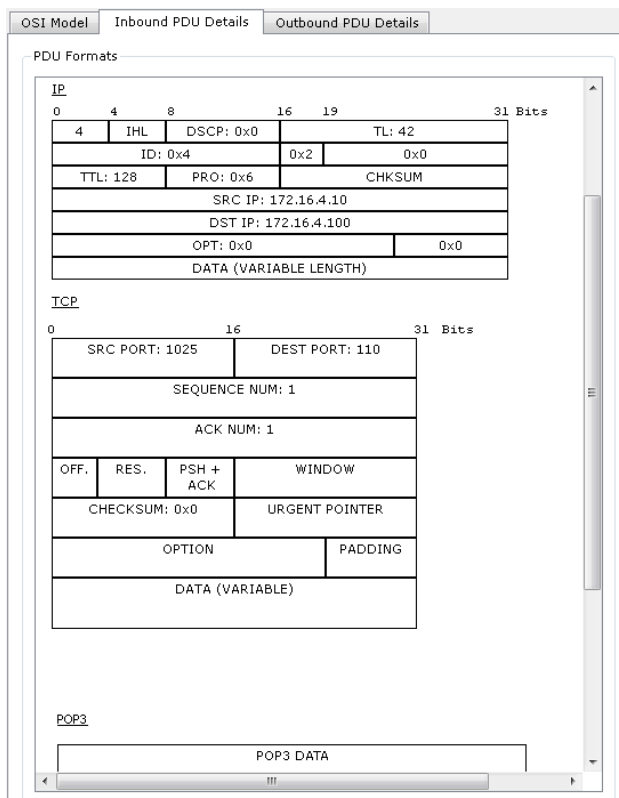


- 1) One click on node 172.16.0.100.
- 2) Select the “E-mail” program on the “Desktop” tab.
- 3) Click on the “Receive” button to read the letter.

A POP3 protocol packet is formed on the host. Using the “Capture/Forward” button, we will follow the packet route from device to device.



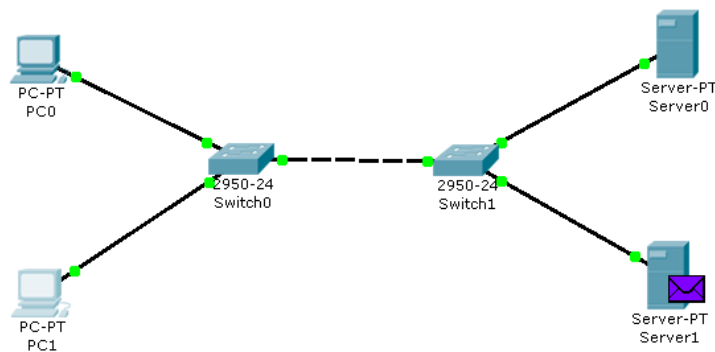
Let's look at the contents of the package generated on the node



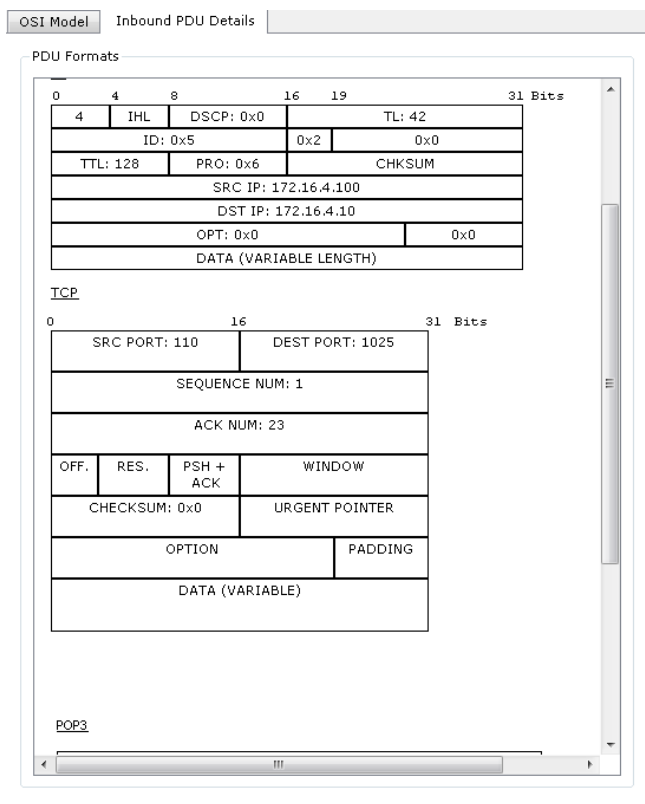
The packet is addressed to the mail server at the IP address 172.16.0.40. The TCP header contains the



destination port – 110. It can be concluded that the package is formed correctly. The packet passes through two switches on its way to the server. Make sure this is the case. When a packet arrives at the server, it processes it and forms a response packet



The packet on the same route returns to node 172.16.0.100 with a response (letter) from the server. Let's look at the contents of the response.



The source port is 110. The response came from server 172.16.0.40 with some POP3 data. Using the POP3 protocol, node 172.16.0.100 received an email from the server sent there by node 172.16.0.90.

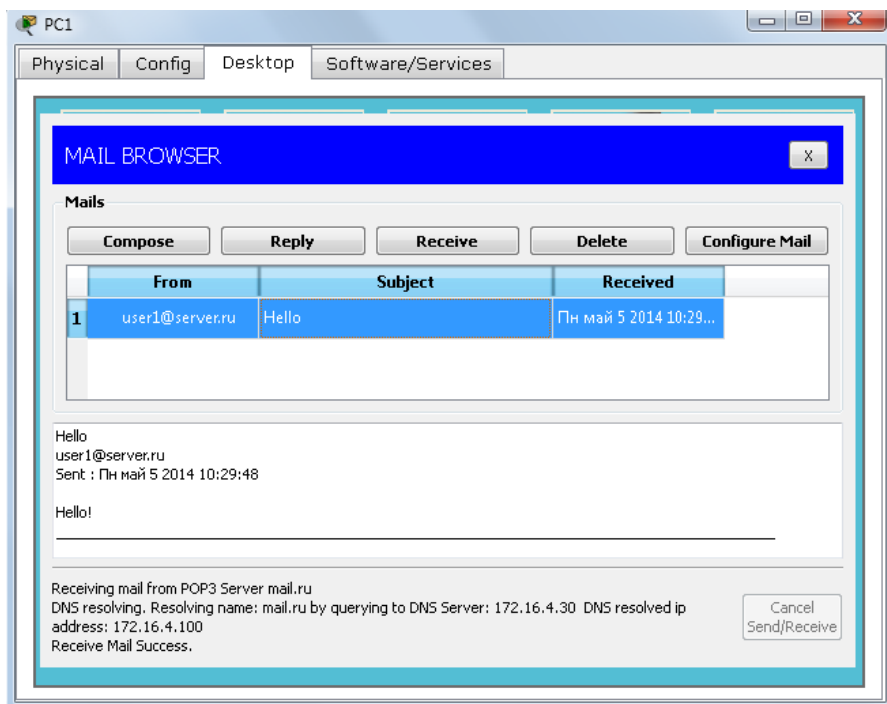


Рис. 4.108 Форма чтения входящих писем

As already mentioned in the theoretical information, SMTP and POP3 mail protocols exchange information using commands. To establish a connection with the server, send an email to the email client, and break the connection, it is necessary to send the appropriate commands to the server. The email server, in turn, processes these commands and generates responses for the client. smtp server responses contain a numeric response code: the command was processed successfully or with an error. Pop3 server responses also contain two types of messages: success or error.

Paying attention to the contents of the SMTP or POP3 protocol packet, it is clear that the package is not considered in detail at the application level.

1. Individual tasks

Explore the SMTP and POP3 email application protocols yourself. Leave the network topology for the study the same. Configure the network devices according to the option.

In the report, give the routes of the packages, their contents and explain the results obtained. Determine the sender and recipient yourself.



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REPORT

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- Upload reports for the GitLab repository (to your personal project)
- Do not forget to write your name and ID inside the report



Options for individual tasks.

Variant 1			
(Last HDU ID digit – 1)			
Nodes	IP	Mask	IP-address of DNS-server
PC0	172.16.1.90	255.255.0.0	172.16.1.20
PC1	172.16.1.100	255.255.0.0	172.16.1.20
Servers			
Server0	172.16.1.20	255.255.0.0	172.16.1.20
Server1	172.16.1.60	255.255.0.0	172.16.1.20
Variant 2			
(Last HDU ID digit – 2)			
Nodes	IP	Mask	IP-address of DNS-server
PC0	172.16.0.12	255.255.0.0	172.16.0.50
PC1	172.16.0.13	255.255.0.0	172.16.0.50
Servers			
Server0	172.16.0.50	255.255.0.0	172.16.0.50
Server1	172.16.0.10	255.255.0.0	172.16.0.50
Variant 3			
(Last HDU ID digit – 3)			
Nodes	IP	Mask	IP-address of DNS-server
PC0	192.168.3.1	255.255.255.0	192.168.3.8
PC1	192.168.3.3	255.255.255.0	192.168.3.8
Servers			
Server0	192.168.3.8	255.255.255.0	192.168.3.8
Server1	192.168.3.5	255.255.255.0	192.168.3.8
Variant 4			



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(Last HDU ID digit – 4)			
Nodes	IP	Mask	IP-address of DNS-server
PC0	172.16.2.90	255.255.0.0	172.16.2.25
PC1	172.16.2.10	255.255.0.0	172.16.2.25
Servers			
Server0	172.16.2.25	255.255.0.0	172.16.2.25
Server1	172.16.2.40	255.255.0.0	172.16.2.25
Variant 5			
(Last HDU ID digit – 5)			
Nodes	IP	Mask	IP-address of DNS-server
PC0	192.168.5.1	255.255.255.0	192.168.5.7
PC1	192.168.5.3	255.255.255.0	192.168.5.7
Servers			
Server0	192.168.5.7	255.255.255.0	192.168.5.7
Server1	192.168.5.5	255.255.255.0	192.168.5.7
Variant 6			
(Last HDU ID digit – 6)			
Nodes	IP	Mask	IP-address of DNS-server
PC0	192.168.4.1	255.255.255.0	192.168.4.9
PC1	192.168.4.3	255.255.255.0	192.168.4.9
Servers			
Server0	192.168.4.9	255.255.255.0	192.168.4.9
Server1	192.168.4.6	255.255.255.0	192.168.4.9
Variant 7			
(Last HDU ID digit – 7)			
Nodes	IP	Mask	IP-address of DNS-server
PC0	172.16.3.15	255.255.0.0	172.16.3.70
PC1	172.16.3.25	255.255.0.0	172.16.3.70



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Servers			
Server0	172.16.3.70	255.255.0.0	172.16.3.70
Server1	172.16.3.40	255.255.0.0	172.16.3.70
Variant 8 (Last HDU ID digit – 8)			
Nodes	IP	Mask	IP-address of DNS-server
PC0	172.16.4.90	255.255.0.0	172.16.4.30
PC1	172.16.4.10	255.255.0.0	172.16.4.30
Servers			
Server0	172.16.4.30	255.255.0.0	172.16.4.30
Server1	172.16.4.100	255.255.0.0	172.16.4.30
Variant 9 (Last HDU ID digit – 9)			
Nodes	IP	Mask	IP-address of DNS-server
PC0	172.16.5.20	255.255.0.0	172.16.5.10
PC1	172.16.5.40	255.255.0.0	172.16.5.10
Servers			
Server0	172.16.5.10	255.255.0.0	172.16.5.10
Server1	172.16.5.80	255.255.0.0	172.16.5.10
Variant 10 (Last HDU ID digit – 0)			
Nodes	IP	Mask	IP-address of DNS-server
PC0	172.16.6.20	255.255.0.0	172.16.6.40
PC1	172.16.6.10	255.255.0.0	172.16.6.40
Servers			
Server0	172.16.6.40	255.255.0.0	172.16.6.40
Server1	172.16.6.30	255.255.0.0	172.16.6.40