DOKUZ EYLÜL UNIVERSITY
ENGINEERING FACULTY
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CME 3204

Data Communication & Computer Networks

Metropolitan Area Network Simulation

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INTRODUCTION

1.1 Project Definition and Problem Formulation

Metropolitan Area Network Simulation is a project to simulate and virtualize a Wide Area Network (WAN) system, which creates a network field for two branches of an office with 3 facilities each. Elaborately, the MAN project creates a network space to be able to make file transfer, e-mail operations, voice conferences, web usage etc. possible for these said branches. Essentially, MAN project connects local facilities internally in a wide range of area.

1.2 The Purpose and Motivation of the Project

An office with multiple branches will need a network system to be able to coordinate their workspace and stay updated with each facilities. In a world where communication is key, the need for a better way to create a network is a necessity. One of the main benefits of the project is to minimize the effort for technical operations. Also, with this project, it is possible to monitor the entire branch easily, as it is a local and isolated network within the office branches. There are currently no foreseen cons or negative outcomes of the project.

1.3 Term Definitions

Network: A data network is a system designed to transfer data from one network access point to one other or more network access points via data switching, transmission lines, and system controls. Data networks consist of communication systems such as circuit switches, leased lines, and packet switching networks.[1]

Architecture: Computer Network Architecture is defined as the physical and logical design of the software, hardware, protocols, and media of the transmission of data. Simply we can say that how computers are organized and how tasks are allocated to the computer.[2]

Protocol: Protocols define rules of communication between network devices.[3]

Server: A server is a computer or system that provides resources, data, services, or programs to other computers, known as clients, over a network. In theory, whenever computers share resources with client machines they are considered servers.[4]

IP: The Internet Protocol (IP) is the principal communications protocol in the Internet protocol suite for relaying datagrams across network boundaries. Its routing function enables internetworking, and essentially establishes the Internet.[5]

DNS: The domain name system (DNS) is a naming database in which internet domain names are located and translated into internet protocol (IP) addresses. The domain name system maps the name people use to locate a website to the IP address that a computer uses to locate a website.[6]

Router: A router is a networking device that forwards data packets between computer networks. Routers perform the traffic directing functions on the Internet. Data sent

through the internet, such as a web page or email, is in the form of data packets. A router is connected to two or more data lines from different IP networks.[7]

Switch: A switch is a device in a computer network that connects other devices together. Multiple data cables are plugged into a switch to enable communication between different networked devices. [8]

Wireless: Wireless data communication is a technology that uses the radio spectrum to transmit signals through the atmosphere. It may carry analog or digital signals and can be used on LANs or WANs in one- or two-way networks.[9]

Ethernet: Ethernet is primarily a standard communication protocol used to create local area networks. It transmits and receives data through cables. This facilitates network communication between two or more different types of network cables such as from copper to fiber optic and vice versa.[10]

Node: In telecommunications networks, a node is either a redistribution point or a communication endpoint. A physical network node is an electronic device that is attached to a network, and is capable of creating, receiving, or transmitting information over a communication channel.[11]

Channel: A channel is a communication medium, the path that data takes from source to destination. A channel can be comprised of so many different things: wires, free space, and entire networks. Signals can be routed from one type of network to another network with completely different characteristics.[12]

Packet: A packet is a bit of data that is packaged for transmission over a packet switched network. It is a small amount of data sent over a network, such as a LAN or the Internet.[13]

METHOD AND SIMULATION

2.1 Simulation and Modeling Concepts

The intended simulation modeling is based on divide and conquer standard in which first the smaller components are designed and created and then the project is advanced hierarchially. i.e. First the nodes (endpoints) are selected and implemented to the simulation and then the connections are made via routers and switches. Finally, all endpoints are interconnected, therefore a wider range of network is created from a local range of devices. This method does not only provide a more convenient solution approach but it also prevents further error tracing and unit testing protocols.

A simulation also creates a solid surface for a possible real-life implementation, which can be tested real quick within the simulation. Also devices which will provide connection to the network are selected according to the most optimal cost-efficiency scale.

2.2 Simulation Environment/Tool

Packet Tracer is a cross-platform visual simulation tool designed by Cisco Systems that allows users to create network topologies and imitate modern computer networks. The software allows users to simulate the configuration of Cisco routers and switches using a simulated command line interface. Packet Tracer makes use of a drag and drop user interface, allowing users to add and remove simulated network devices as they see fit.[14]

Using Packet Tracer made creating simulations, keeping track of the protocol flow, testing scenarios, previewing logical and phsyical design of the system possible throughout the project.

2.3 Network Design Requirements

The project is oriented on star topology from the smallest component to the largest structure. Using client/server architecture, the system consists of 3 routers, 2 wireless routers, 2 access point, 7 switches, a hub and a server farm that includes HTTP, FTP, WEB, DNS, MAIL (SMTP, POP3) and a DHCP server protocols. All of these components are used regarding the cost and the efficiency status. E.g. a hub is used to connect 5 workstations instead of a switch because it costs less and is enough to do the same connection.

2.4 Requirements Analysis

Servers require specific configurations for each. Each of them has unique IP addresses. Web servers must have HTTP service to be able to operate. DNS servers must store these web server IP addresses and domain names via DNS service to operate. This will allow web servers to operate and function correctly with the corresponding url.

Mail servers use SMTP and POP3 services to operate. The clients that will use e-mail functionality throughout the system must be registered within the mail server.

FTP servers use FTP and TFTP services to make data transfer possible and give access (rwdnl) to reach out to these files from clients.

DHCP server uses DHCP service with initial dynamic IP configurations.

All endpoints (mobile devices, workstations, wireless users) are configured and implemented into the system within the demanded constraints and expectations.

The VoIP voice conference system needs an additional router to connect phone signals and requests to be sent to the requested phone and redirect the response from them. These VoIP devices all share the same IP domain.

The connections are made using Gigabit Ethernet cables instead of Fast Ethernet cables for faster connections at the important junctions.

2.5 Definitions of the System/Model

Topology Star Architecture Server/Client	1st Branch 1st Facility	1st Branch 2nd Facility	1st Branch 3rd Facility	2nd Branch 1st Facility	2nd Branch 2nd Facility	2nd Branch 3rd Facility
IP Address	192.168.1.2-6 192.168.1.201-215	192.168.1.20-29 192.168.25.2-16	192.168.1.7-14	192.168.2.100-149	192.168.2.2-16	192.168.2.17-31
Devices	5 PC 5 Laptop 5 Smart Phone 1 Switch 1 Wireless Router 1 Hub	10 PC 1 Router 5 VoIP 1 Switch	1 DNS 3 WEB 2 FTP 1 DHCP 1 MAIL 1 Switch	5 Wireless PC 5 Tablet 10 Laptop 1 Wireless Router	10 PC 5 Smart Phone 1 Switch 1 Access Point	10 PC 5 Tablet 1 Switch 1 Access Point

Table 1: System Summary

IP addresses of facilites and branches are monitored based on the top-most device's IP configuration. The main router of the first branch has the domain address of 192.168.1.1, thus endpoint devices that are connected to this router, has the IP address in the range of 192.168.1.x, with default gateway of 192.168.1.1. The other main router of the second branch has the domain address of 192.168.2.1, which enforces the conditional rule that

was applied in the first branch; the endpoints ae configured with the address range of 192.168.2.x, and with a default gateway of 192.168.2.1.

These two routers that interconnects two branches are connected via a serial cable with a specified range of clock. These two routers have the configuration of allowed data flow dependencies on IP address domains, e.g. if there's a signal coming from the first branch towards the second branch, a configuration is made on the second main router to accept incoming data request.

The system is designed to work with minimum of 75 workstations, thus the connection speed is configured accordingly.

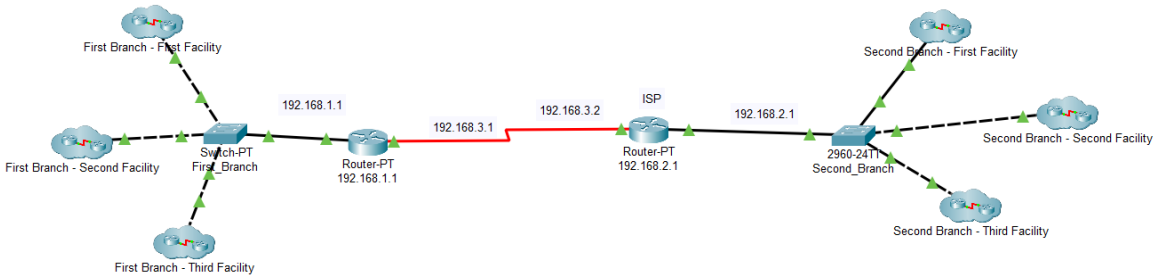

Figure A.1: Network.

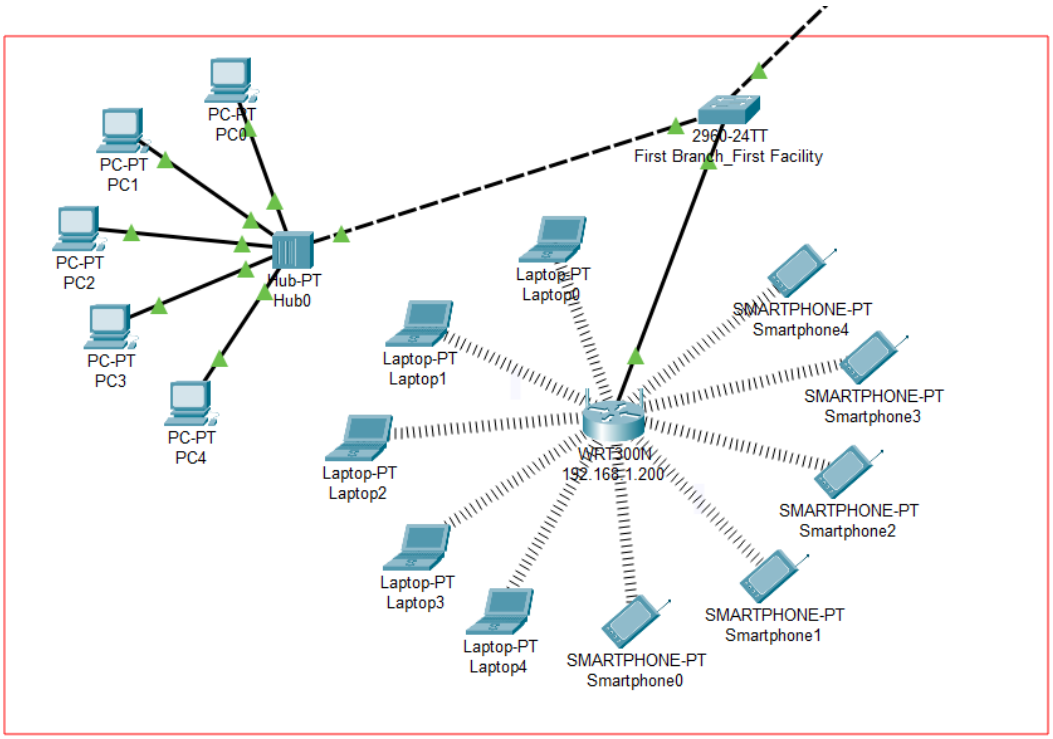

Figure A.2: First branch, first facility.

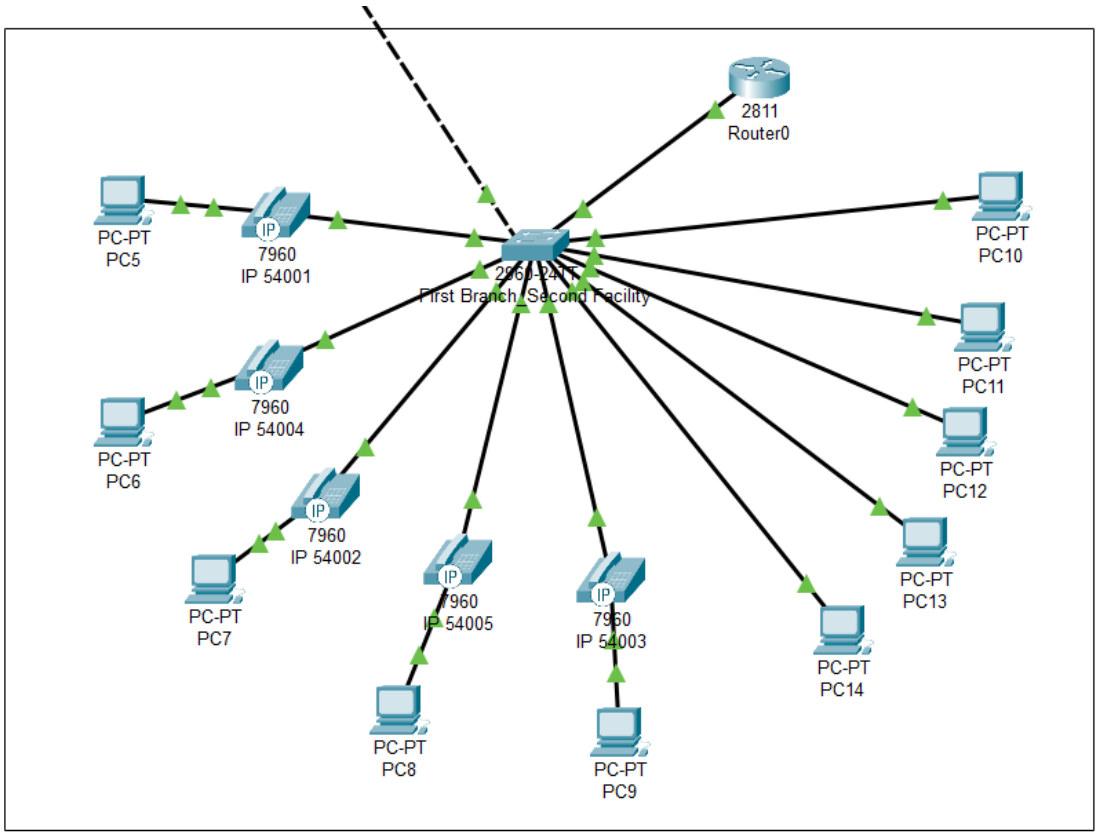

Figure A.3: First branch, second facility.

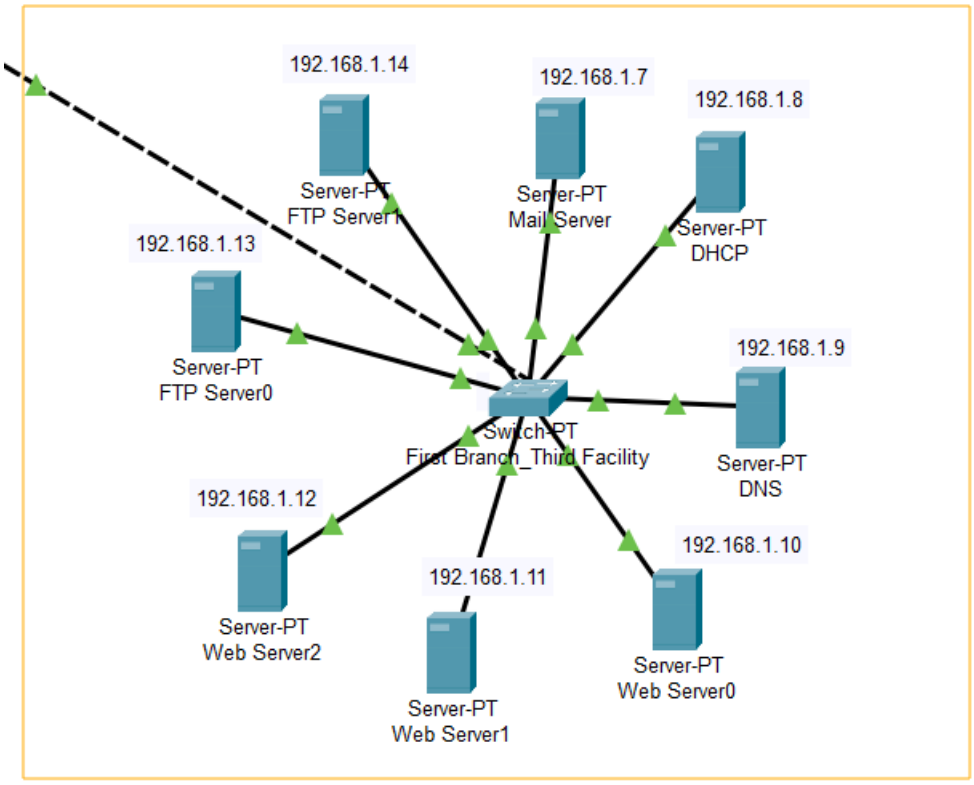

Figure A.4: First branch, third facility.

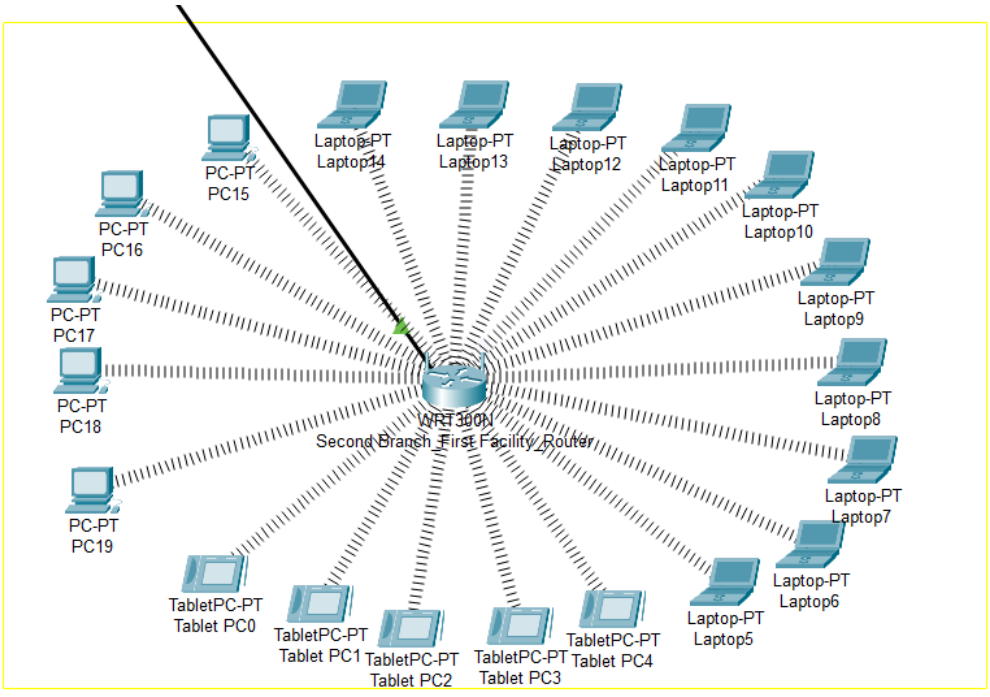

Figure A.5: Second branch, first facility.

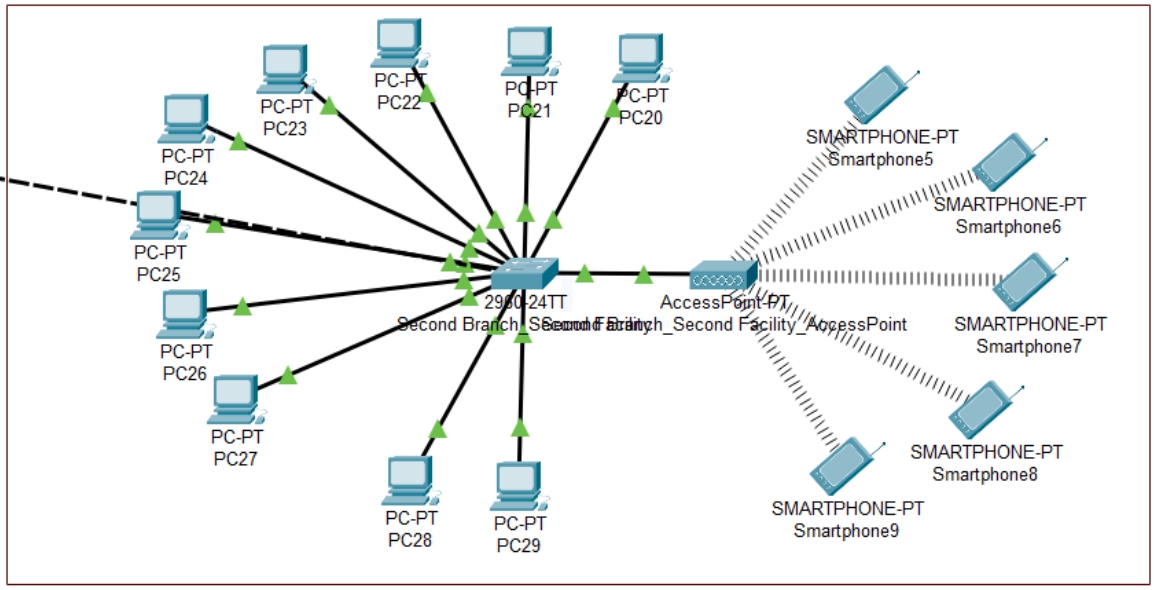

Figure A.6: Second branch, second facility.

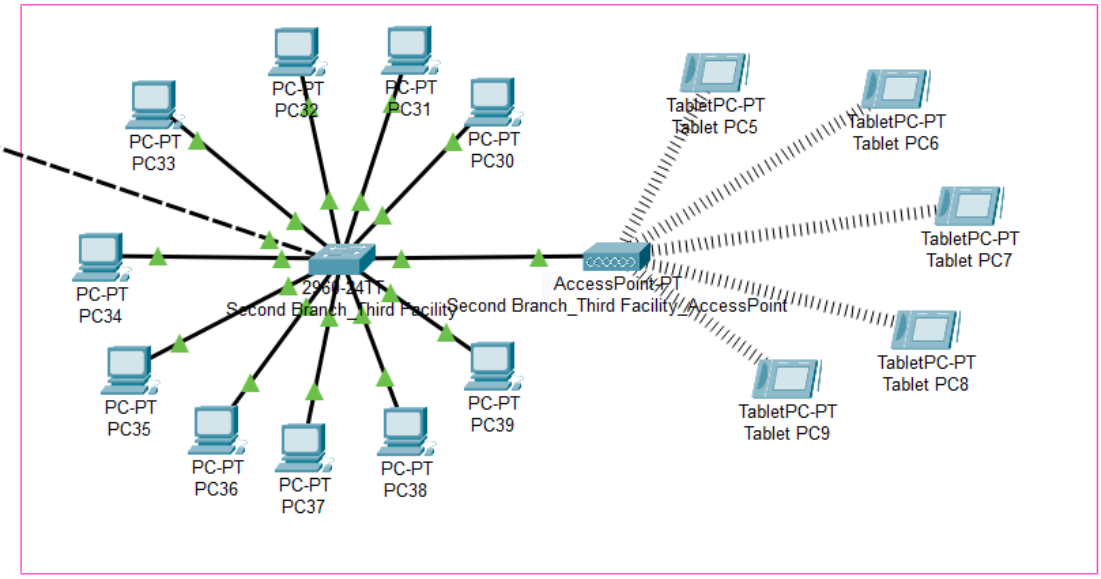

Figure A.7: Second branch, third facility.

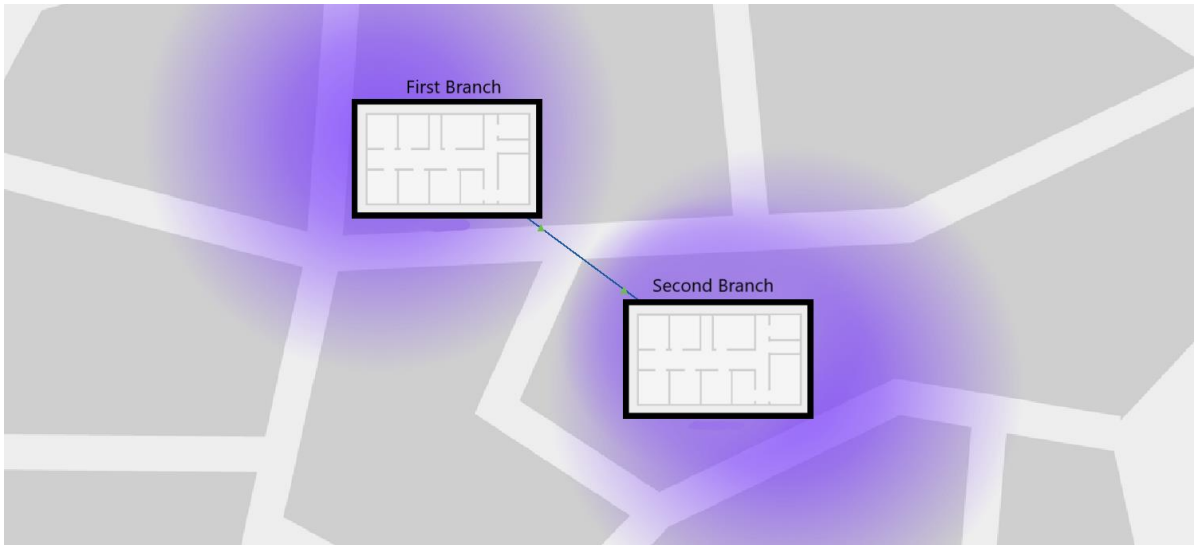

Figure B.1: Physical branches preview.

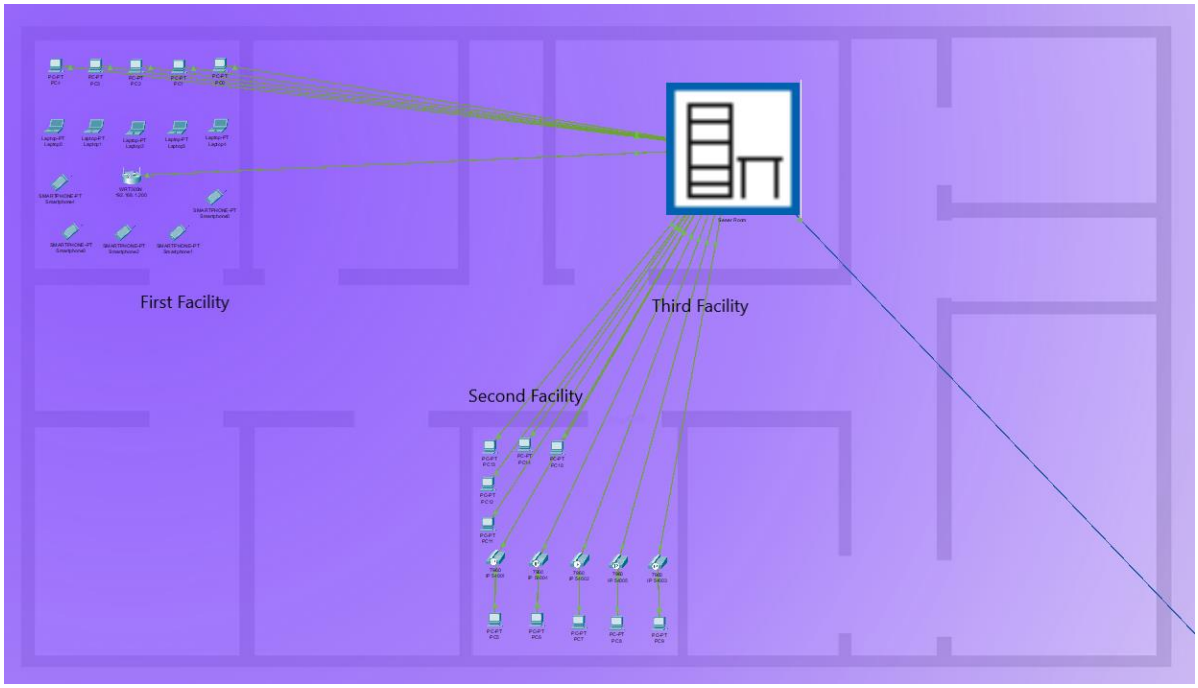

Figure B.2: First branch.

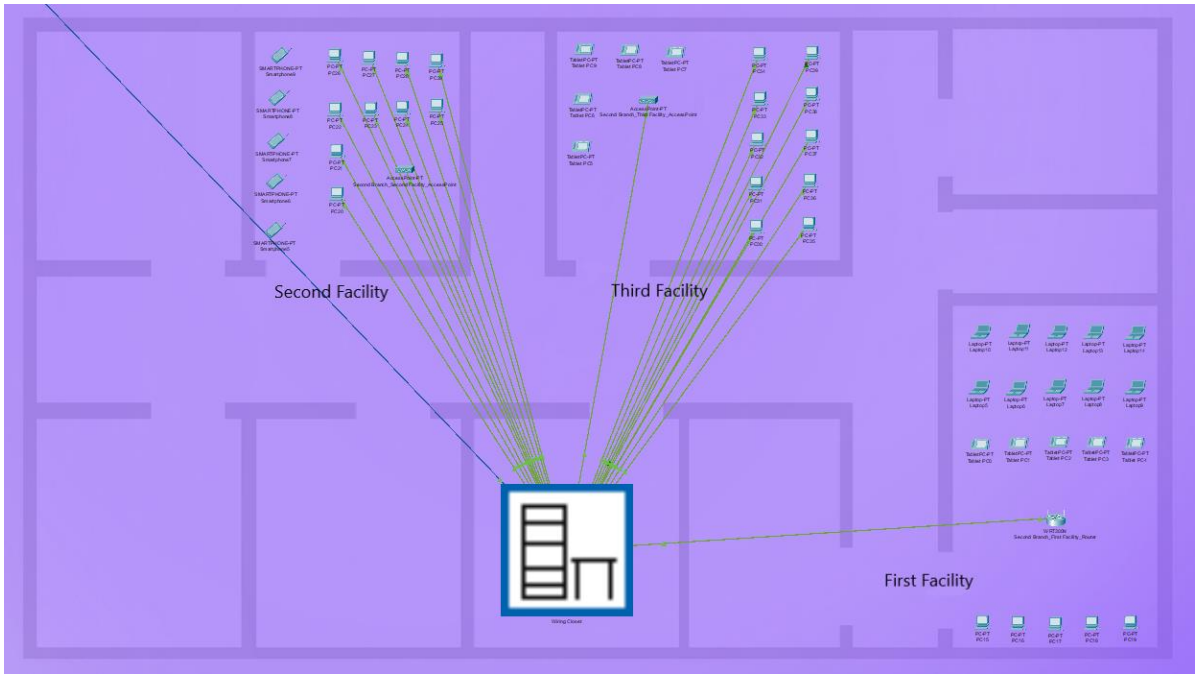

Figure B.3: Second branch.

2.6 Simulation Elements

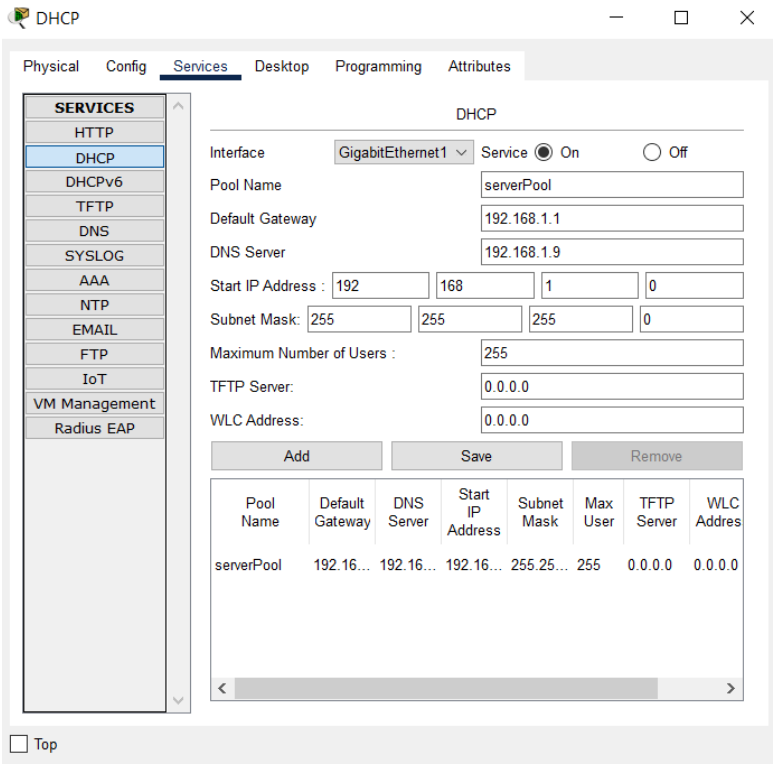

Figure C.1: DHCP server.

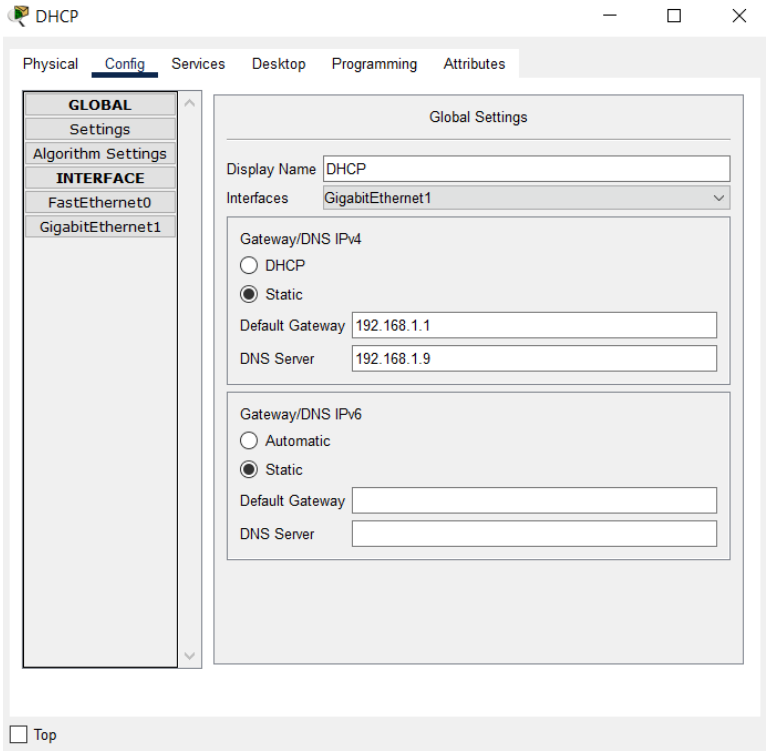

Figure C.2: DHCP Configuration.

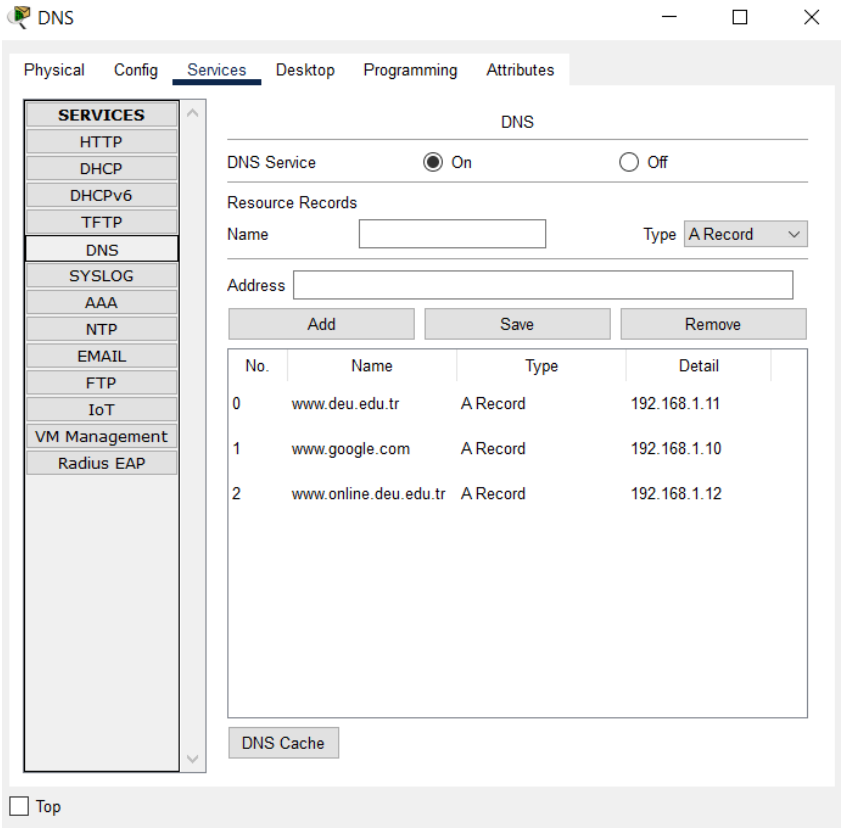

Figure C.3: DNS server.

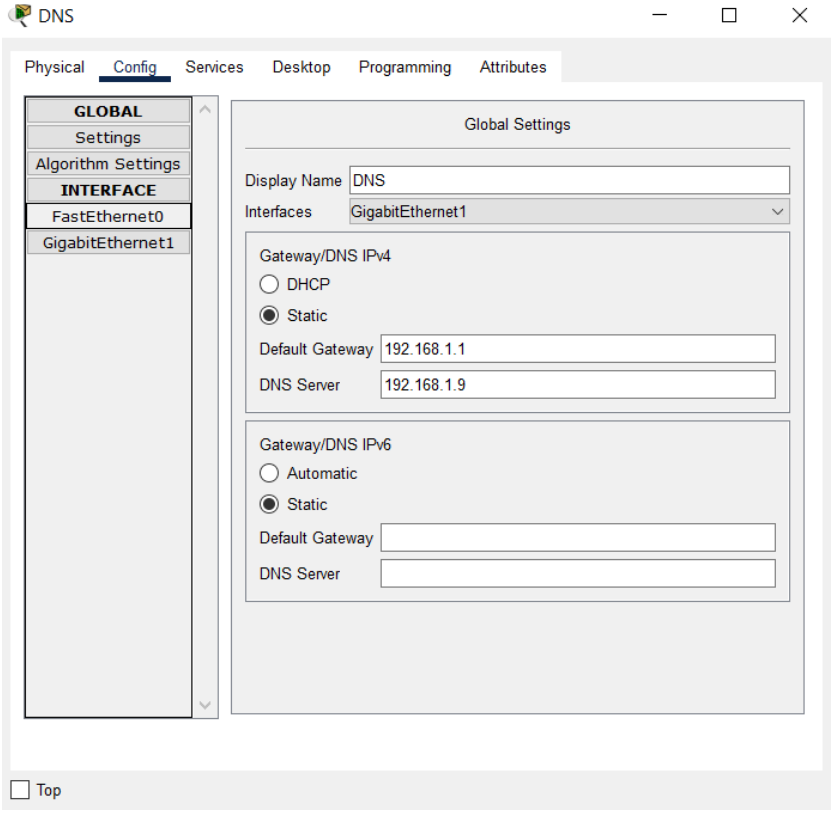

Figure C.4: DNS Configuration.

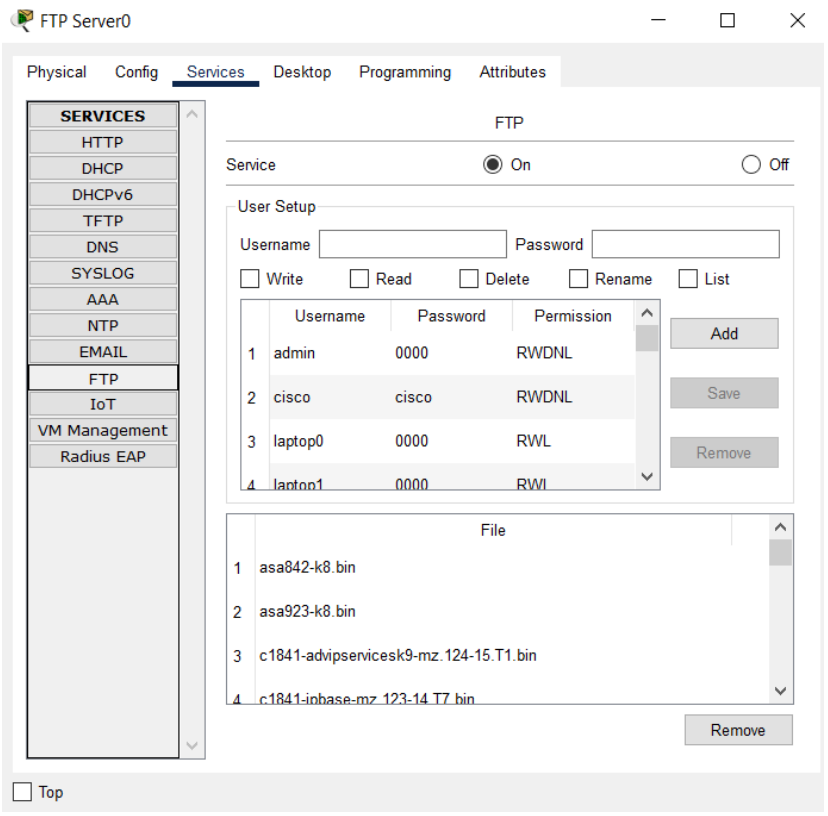

Figure C.5: FTP Server (FTP0).

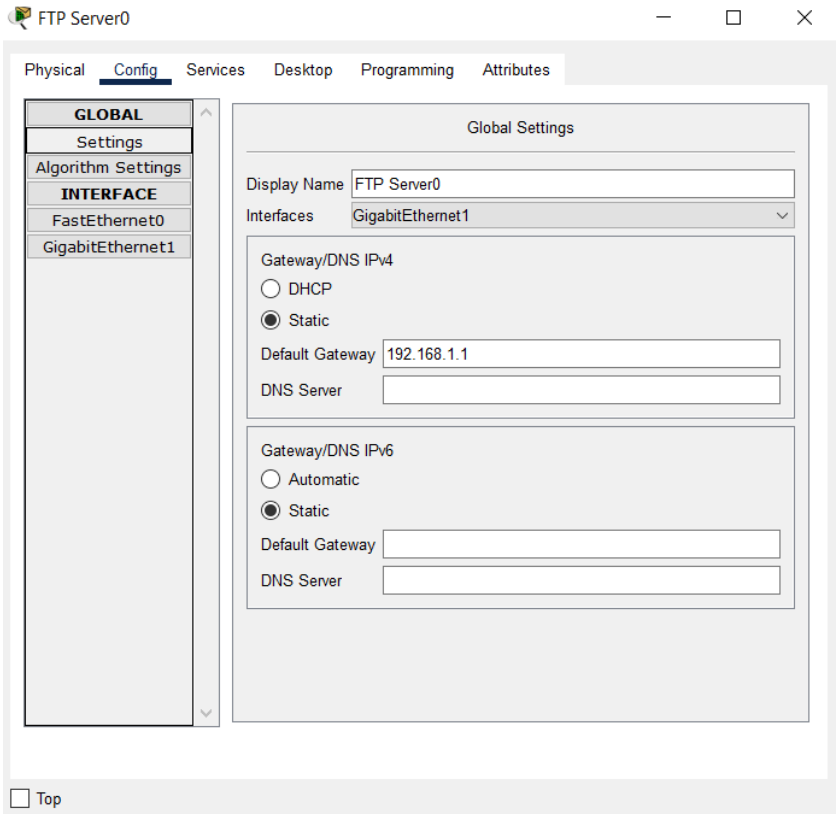

Figure C.6: FTP Configuration.

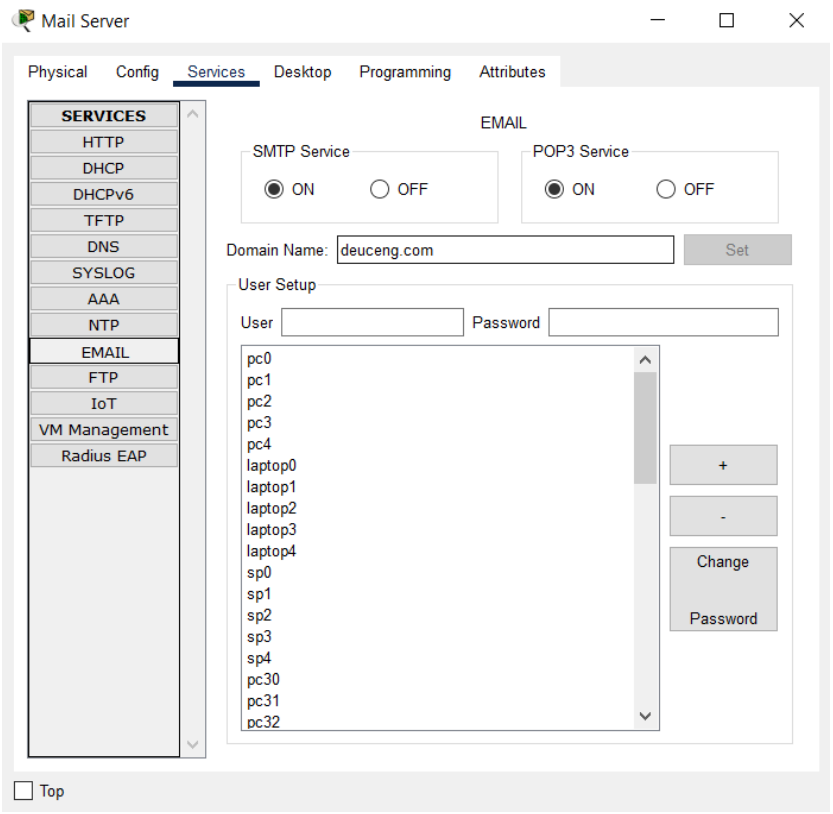

Figure C.7: Mail server.

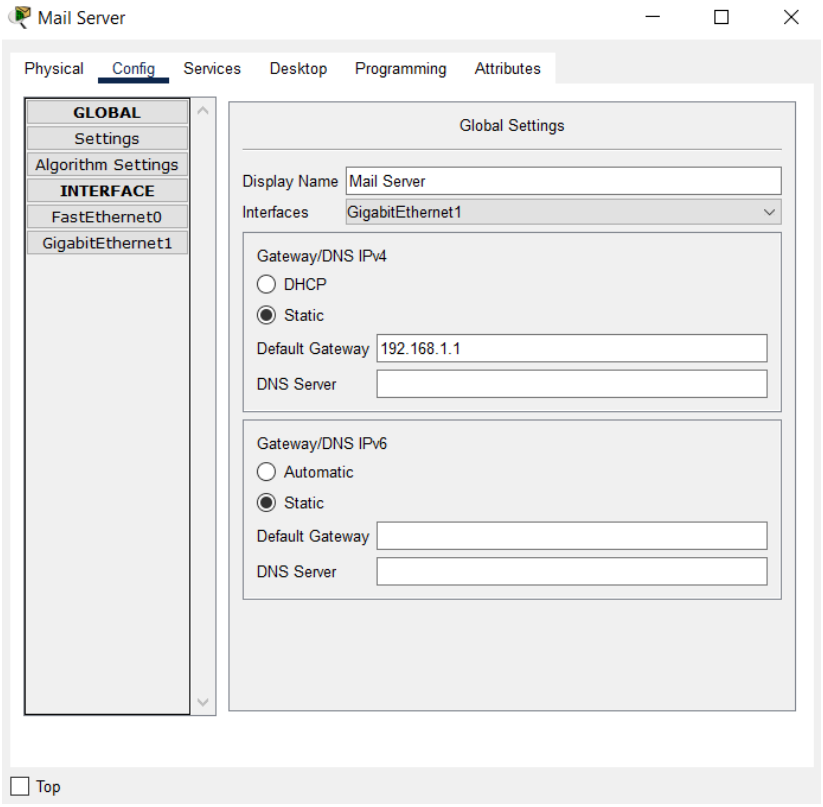

Figure C.8: Mail Configuration.

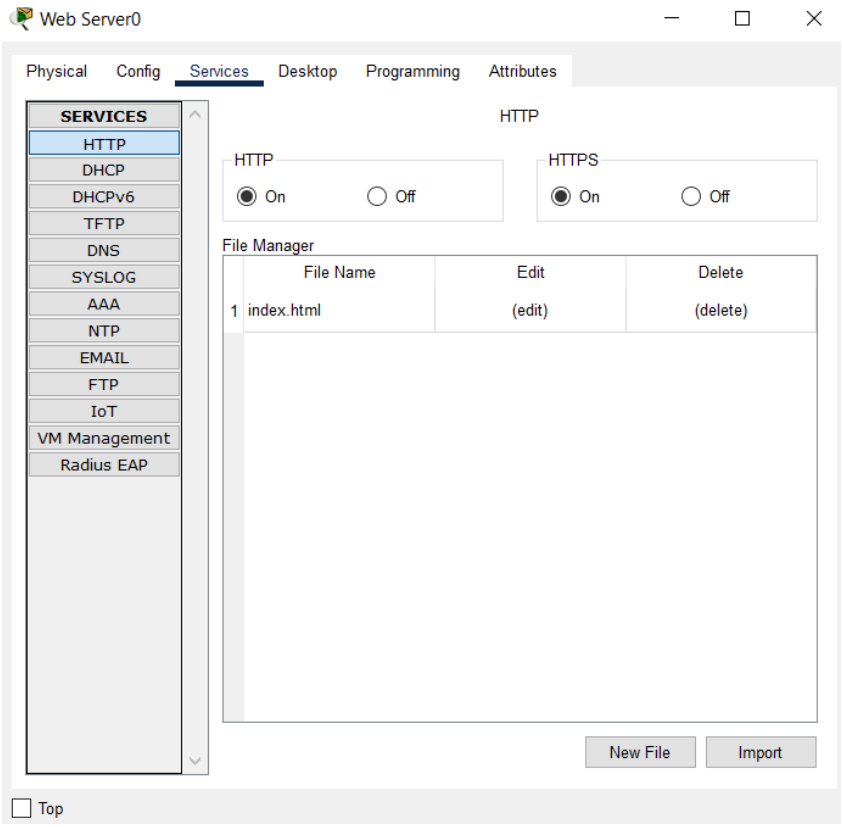

Figure C.9: Web server.

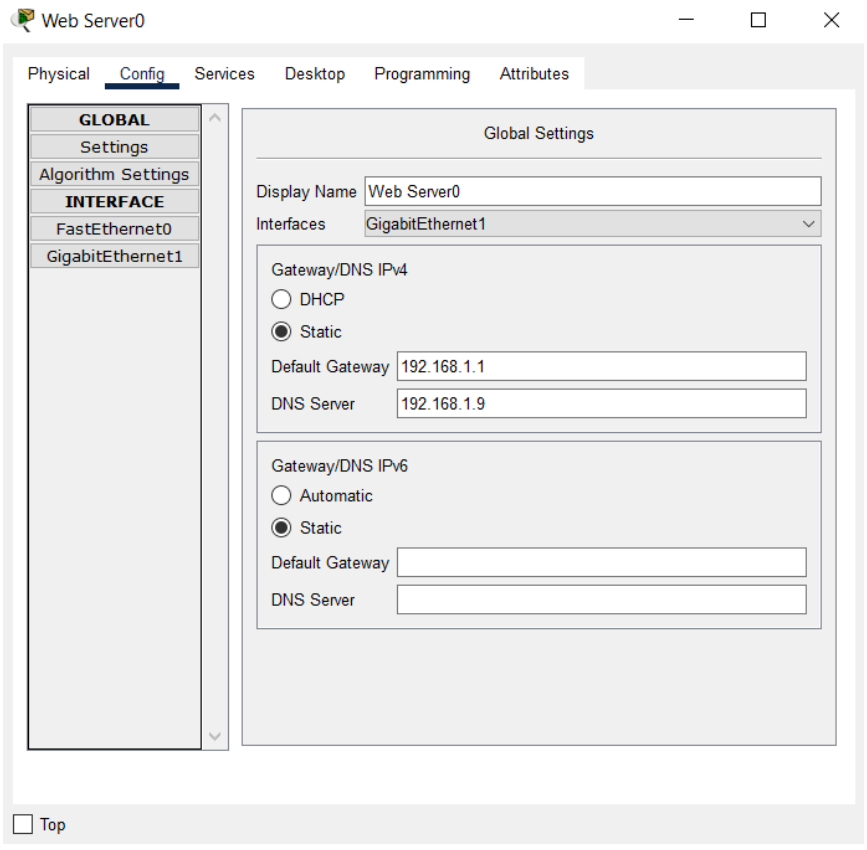

Figure C.10: Web Configuration.

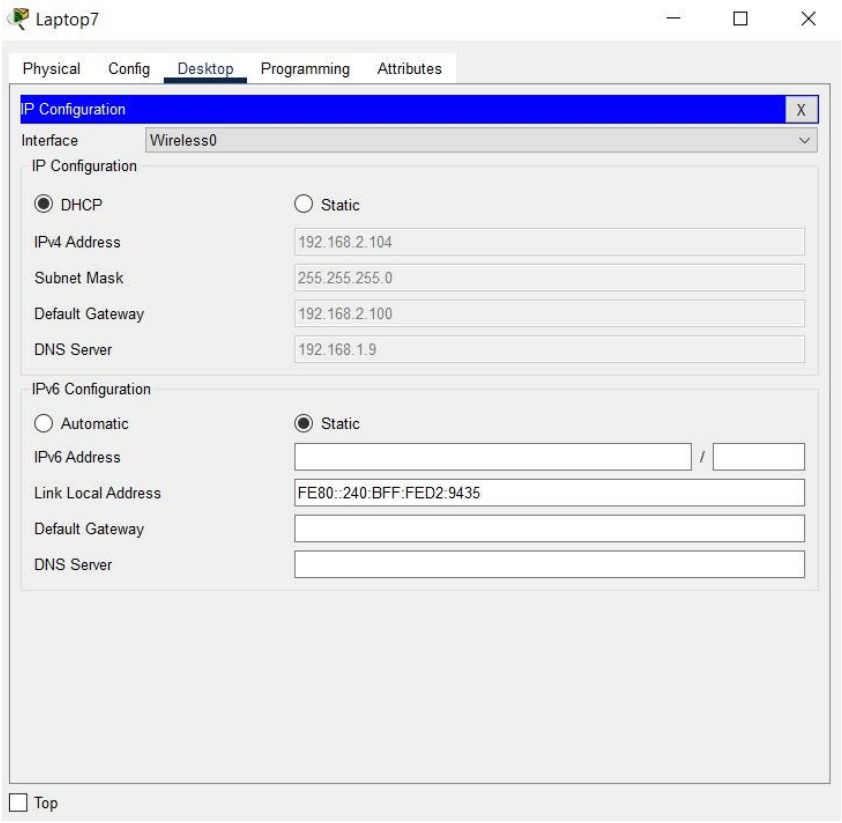

Figure C.11: Endpoint IP Configuration.

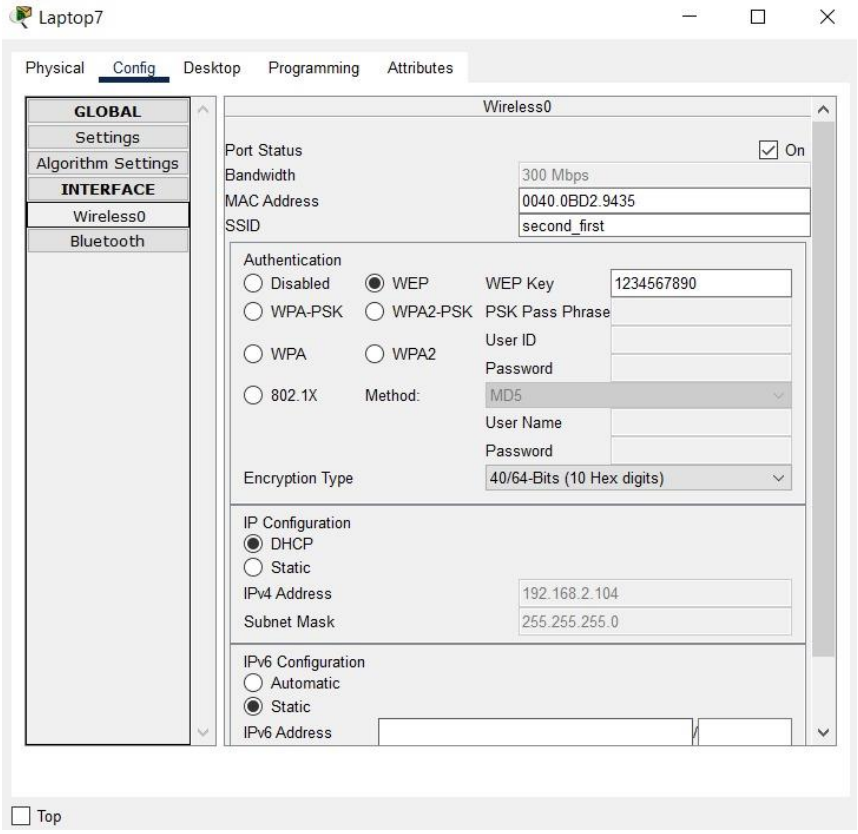

Figure C.12: Endpoint Wireless Configuration.

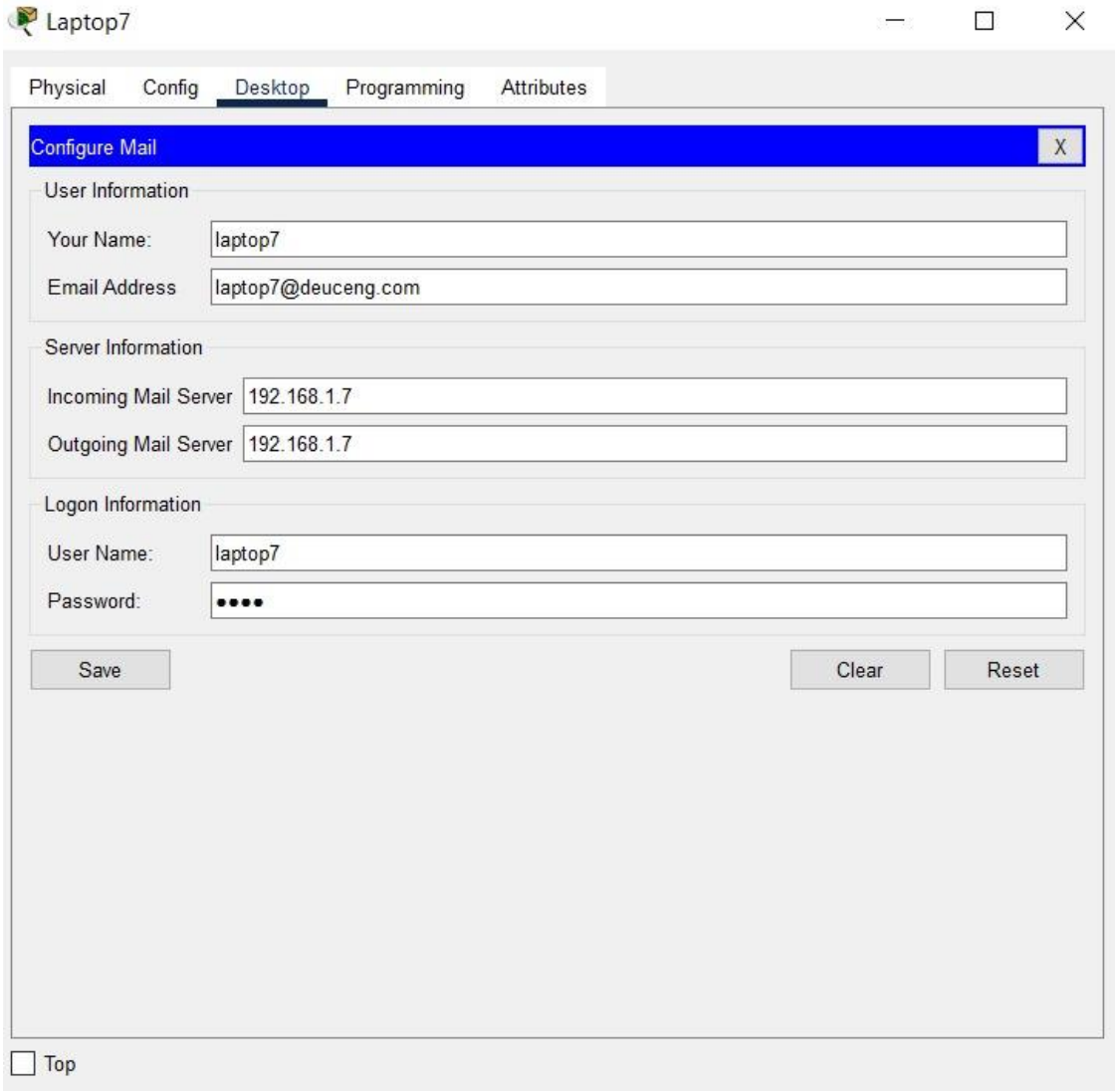

Figure C.13: Endpoint mail configuration.

METHOD AND SIMULATION

Simulation 1: A wireless user from first facility of second branch wants to read emails and browse Web.

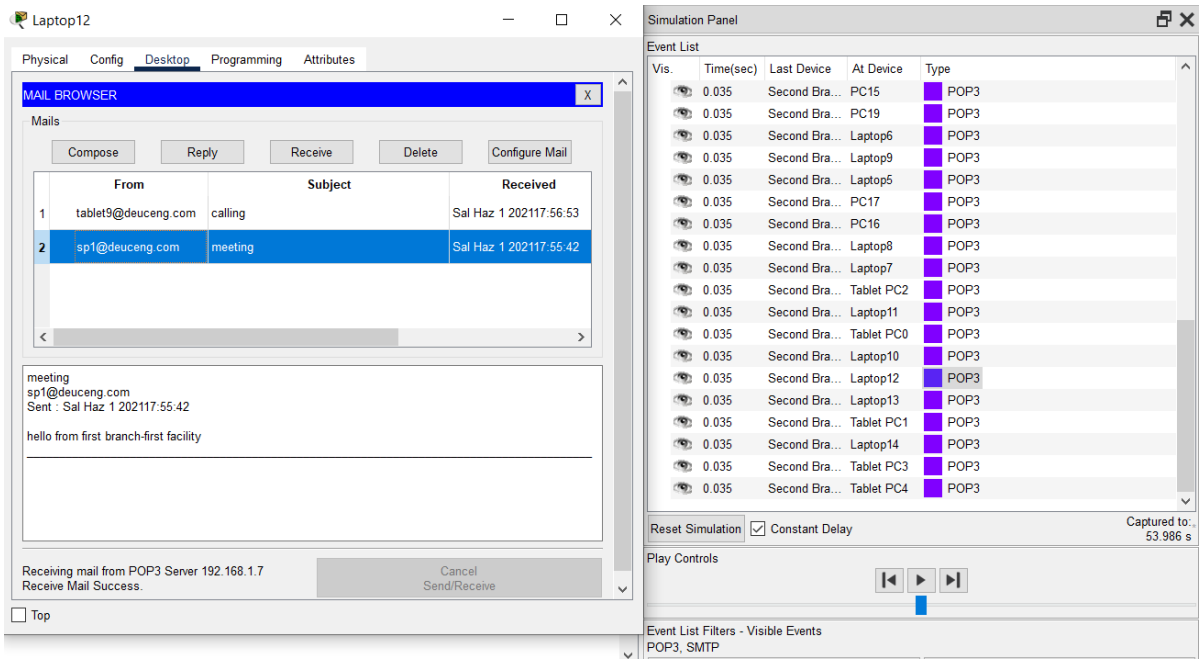

Figure 1.1.1: Read email event list.

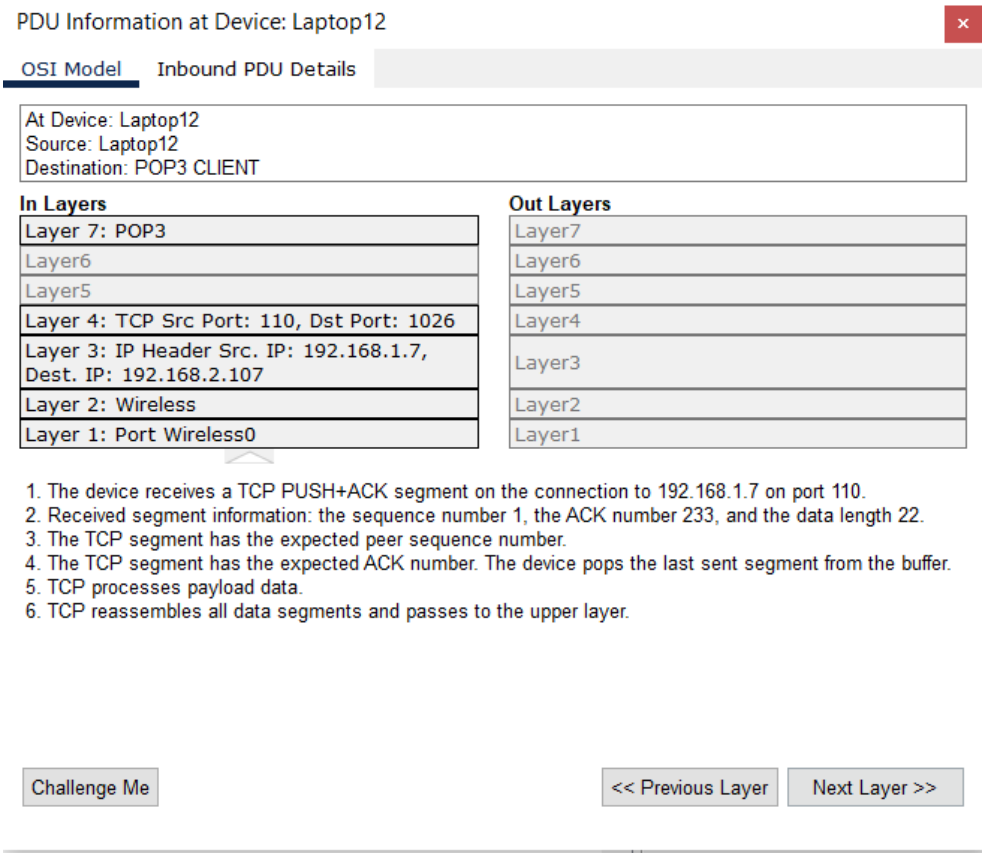

Figure 1.1.2: Read email layers.

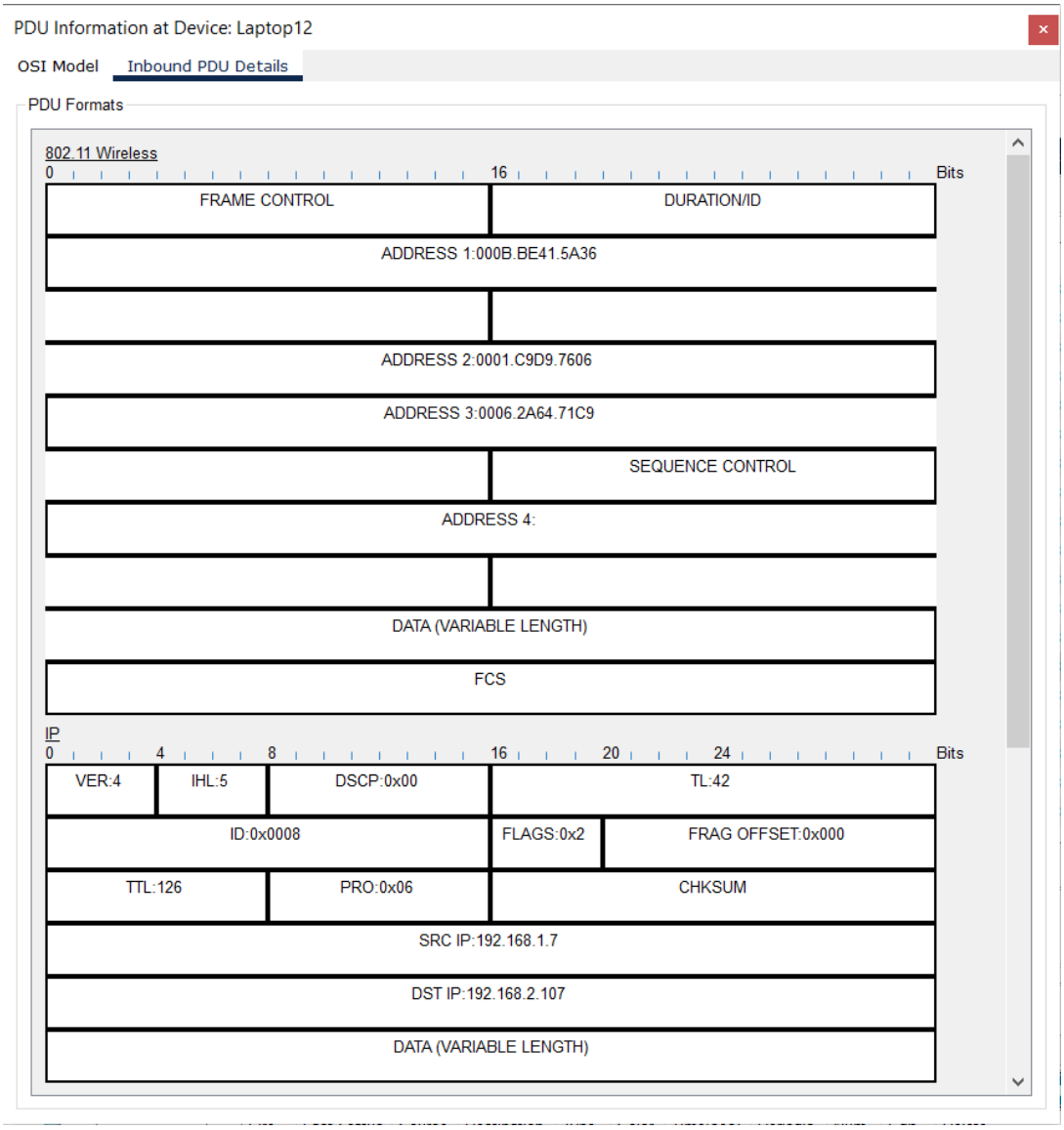

Figure 1.1.3: Read email PDU.

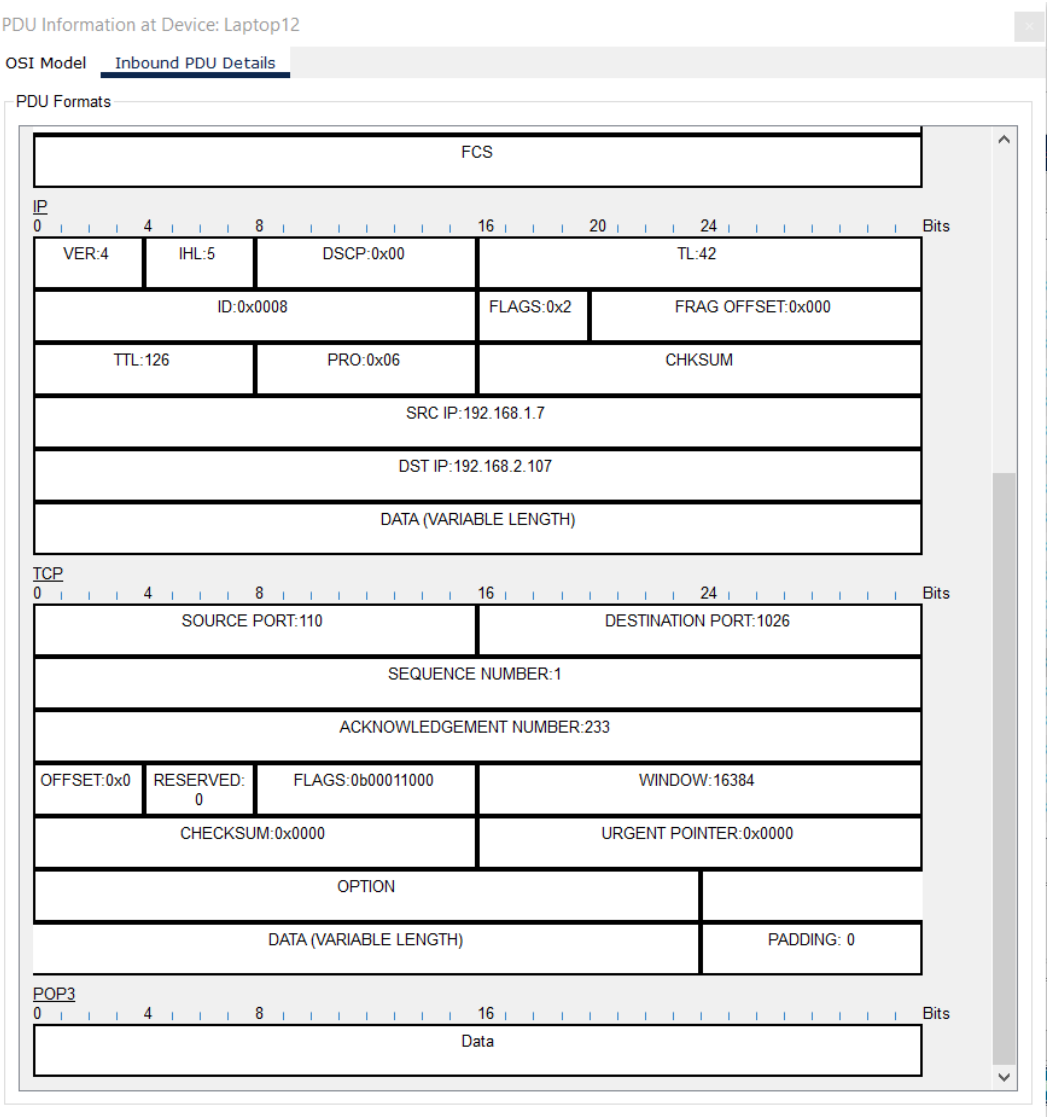

Figure 1.1.4: Read email PDU alt.

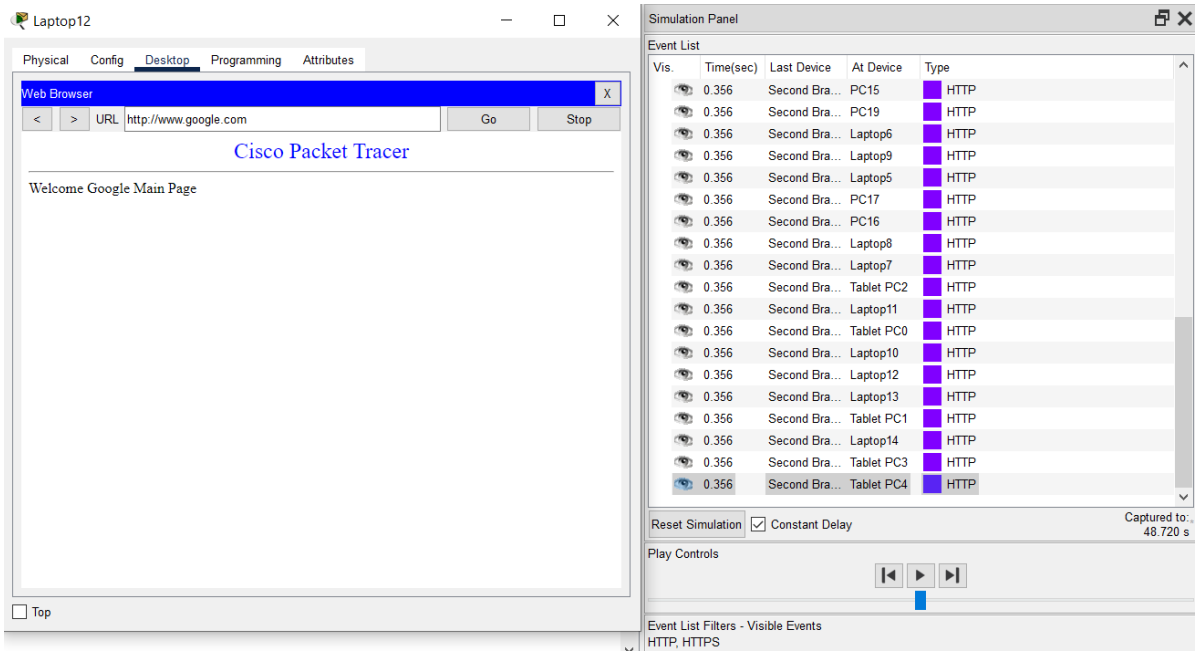

Figure 1.2.1: Browse Web event list.

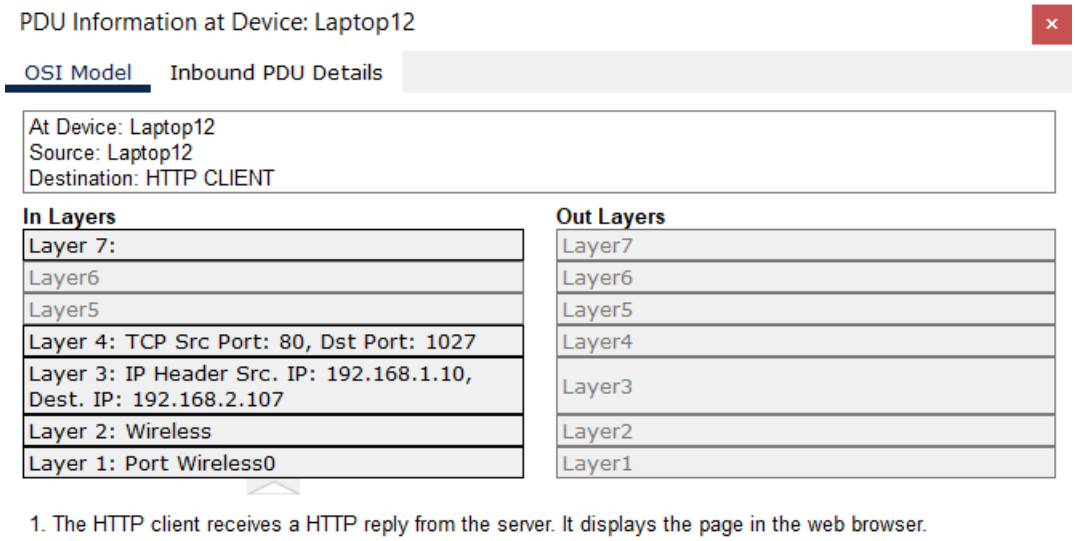

Figure 1.2.2: Browse Web layers.

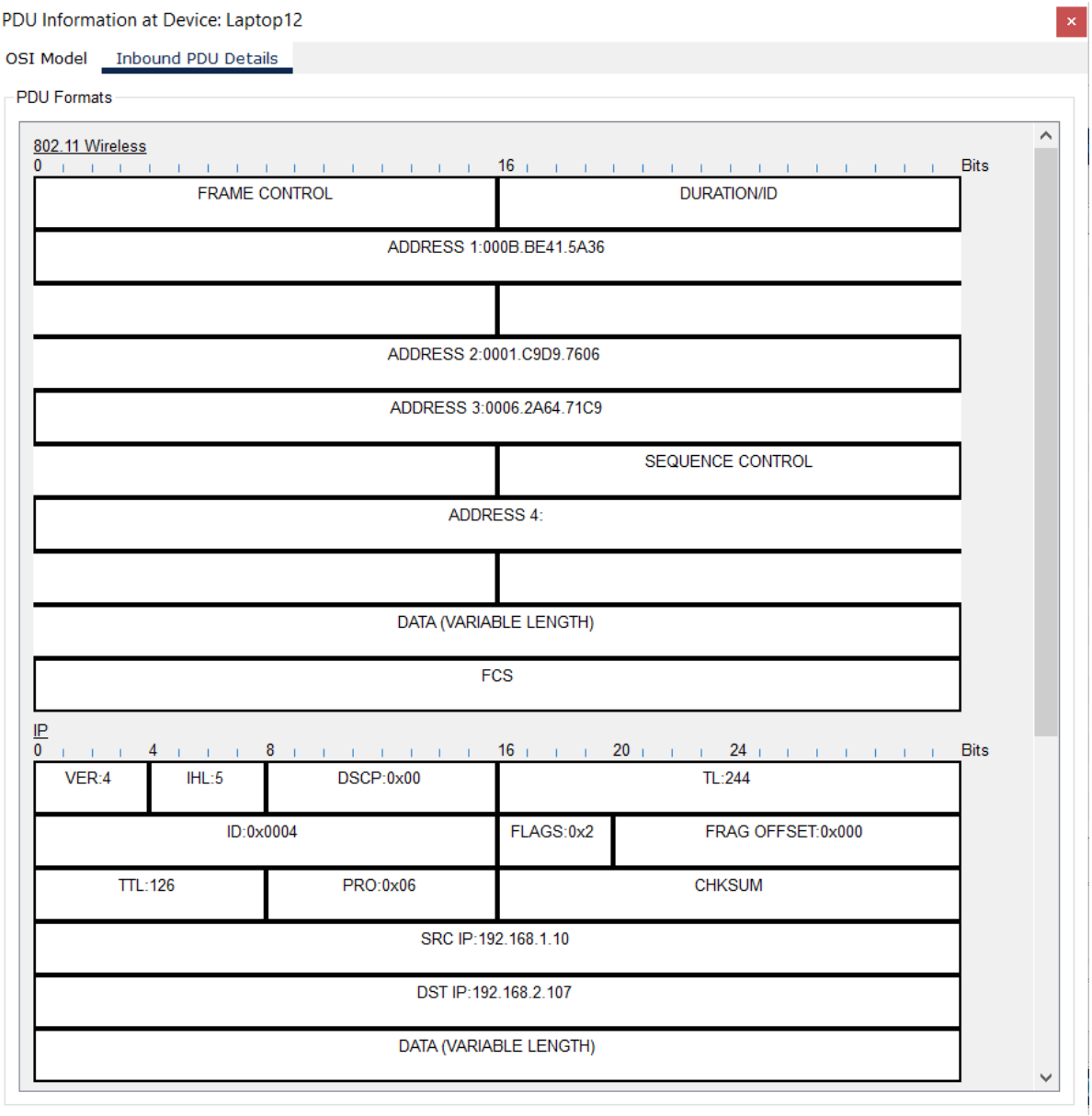

Figure 1.2.3: Browse Web PDU.

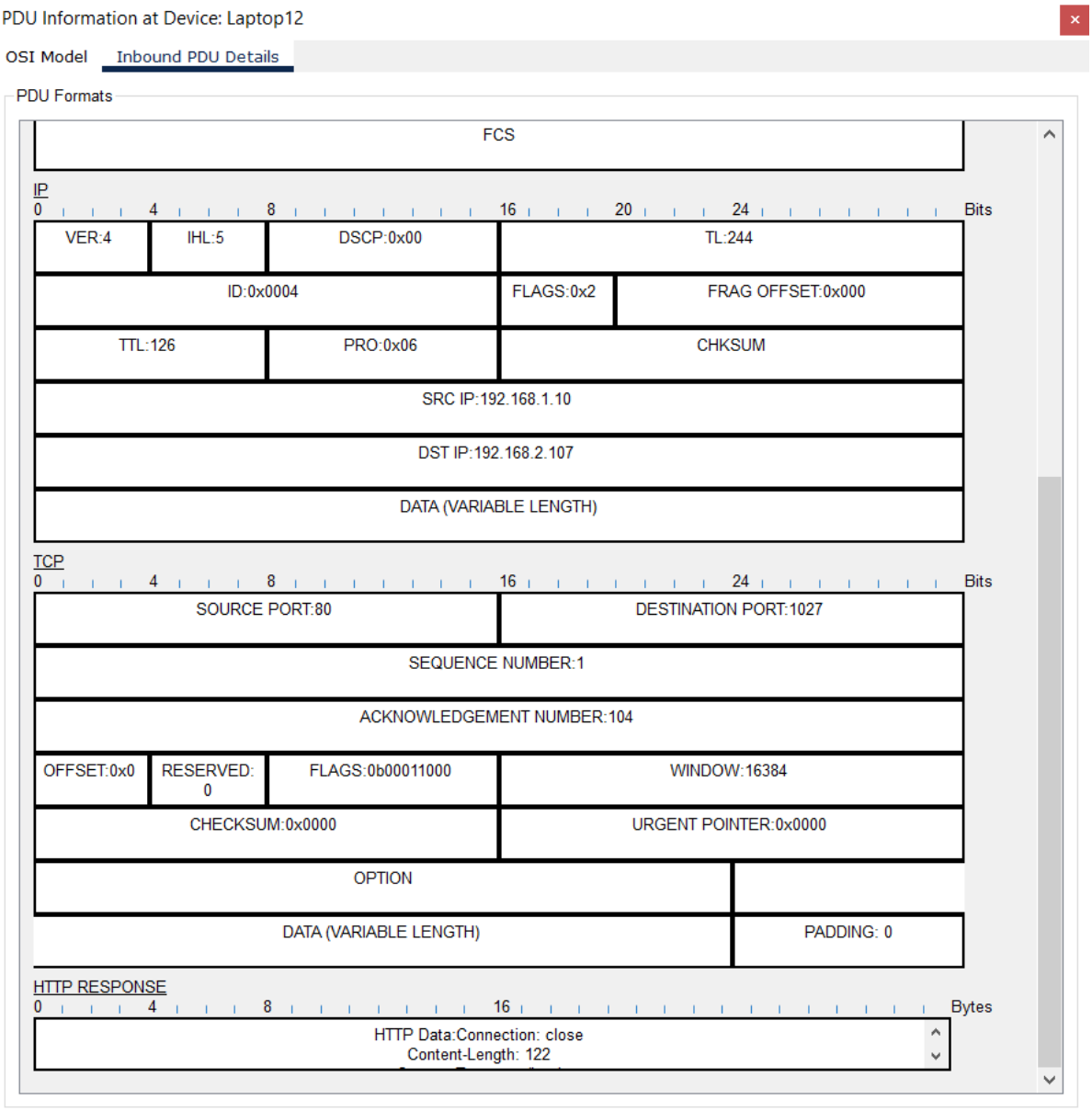

Figure 1.2.4: Browse Web PDU alt.

Simulation 2: A computer engineer from second facility of second branch developed a web application and wants to send her code files to FTP server in the third facility of first branch.

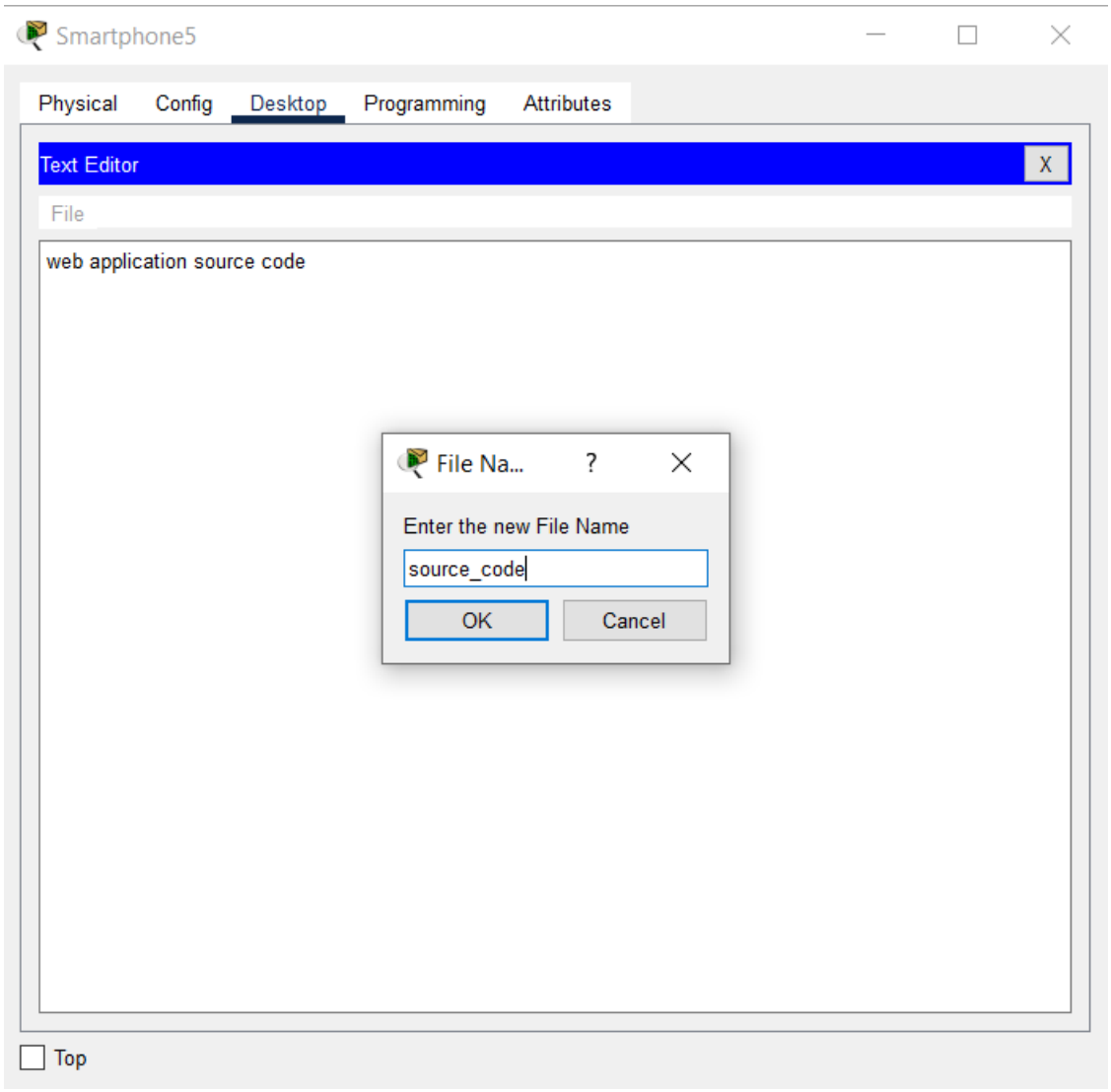

Figure 2.1: Create File on a workstation.

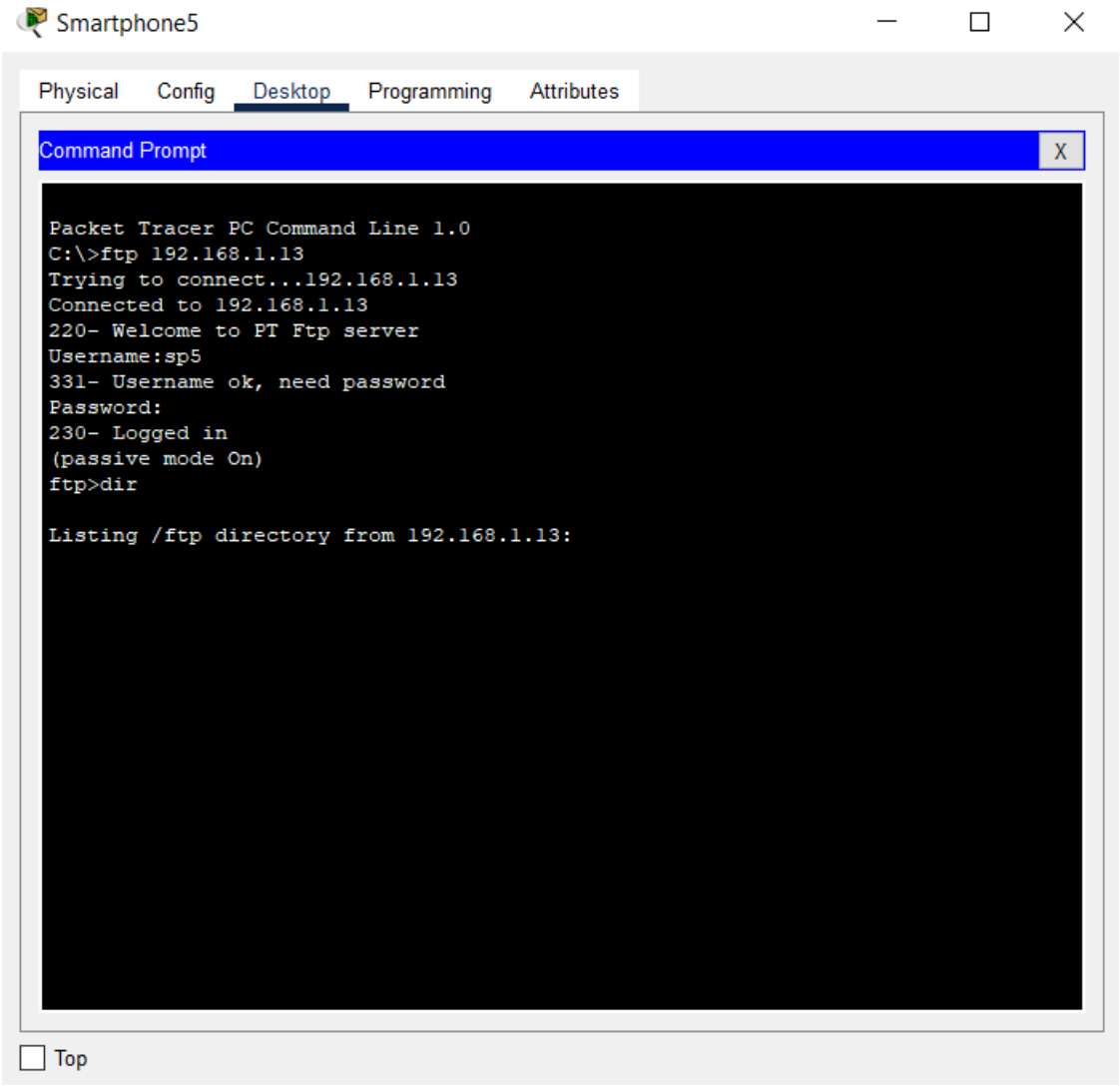

Figure 2.2: Connected to FTP server.

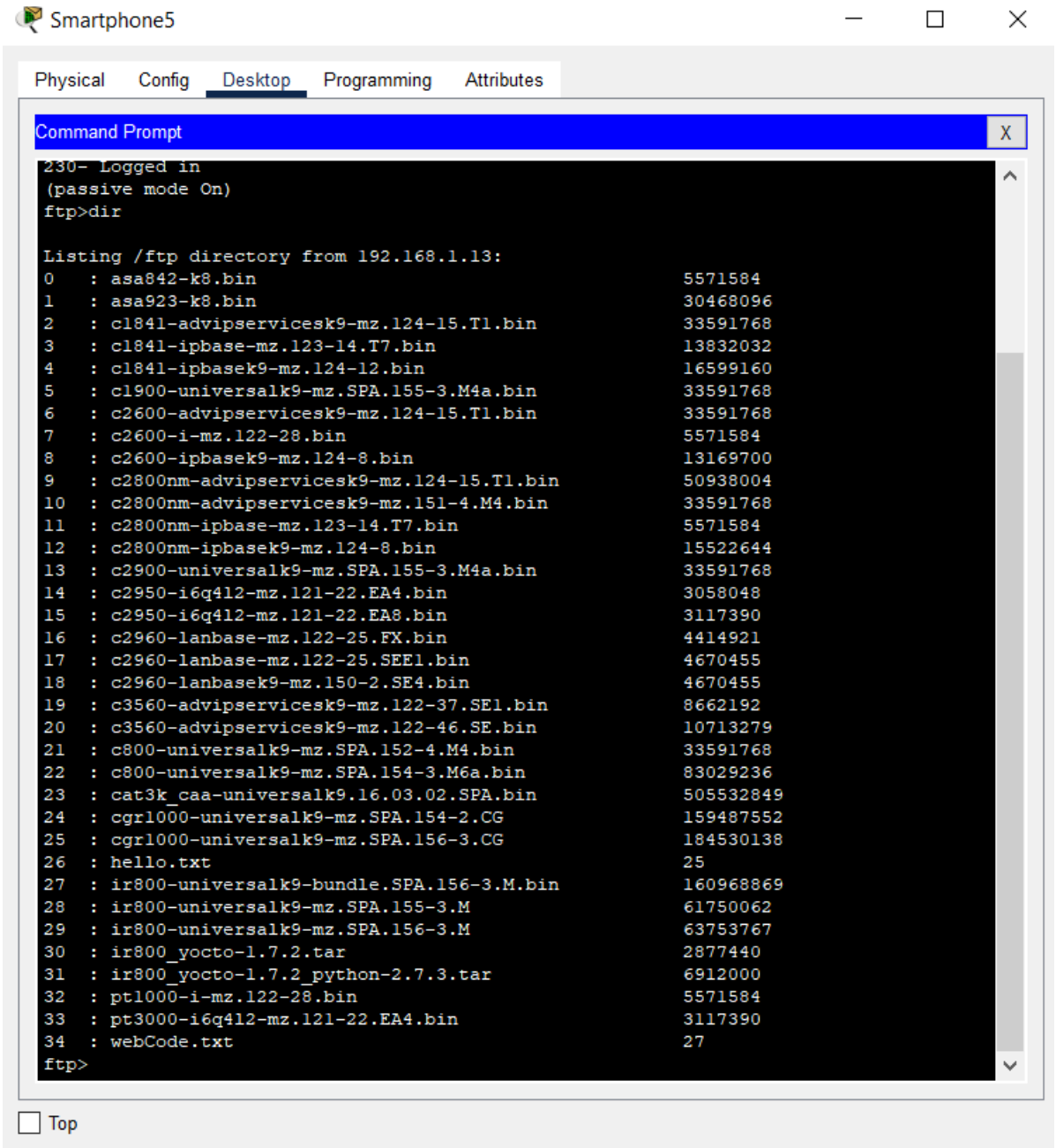

Figure 2.3: List files from FTP server.

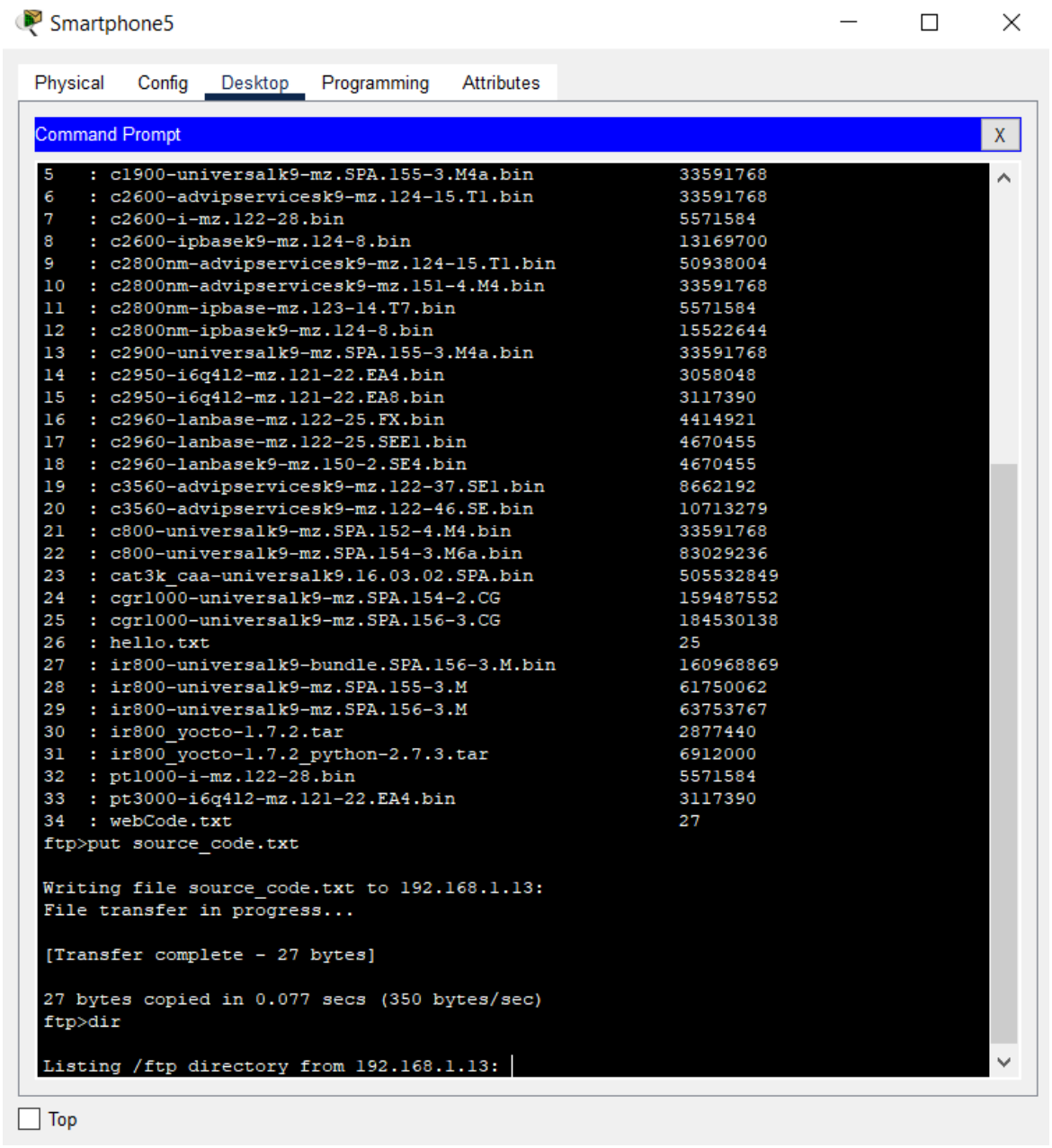

Figure 2.3: Upload created file to FTP server.

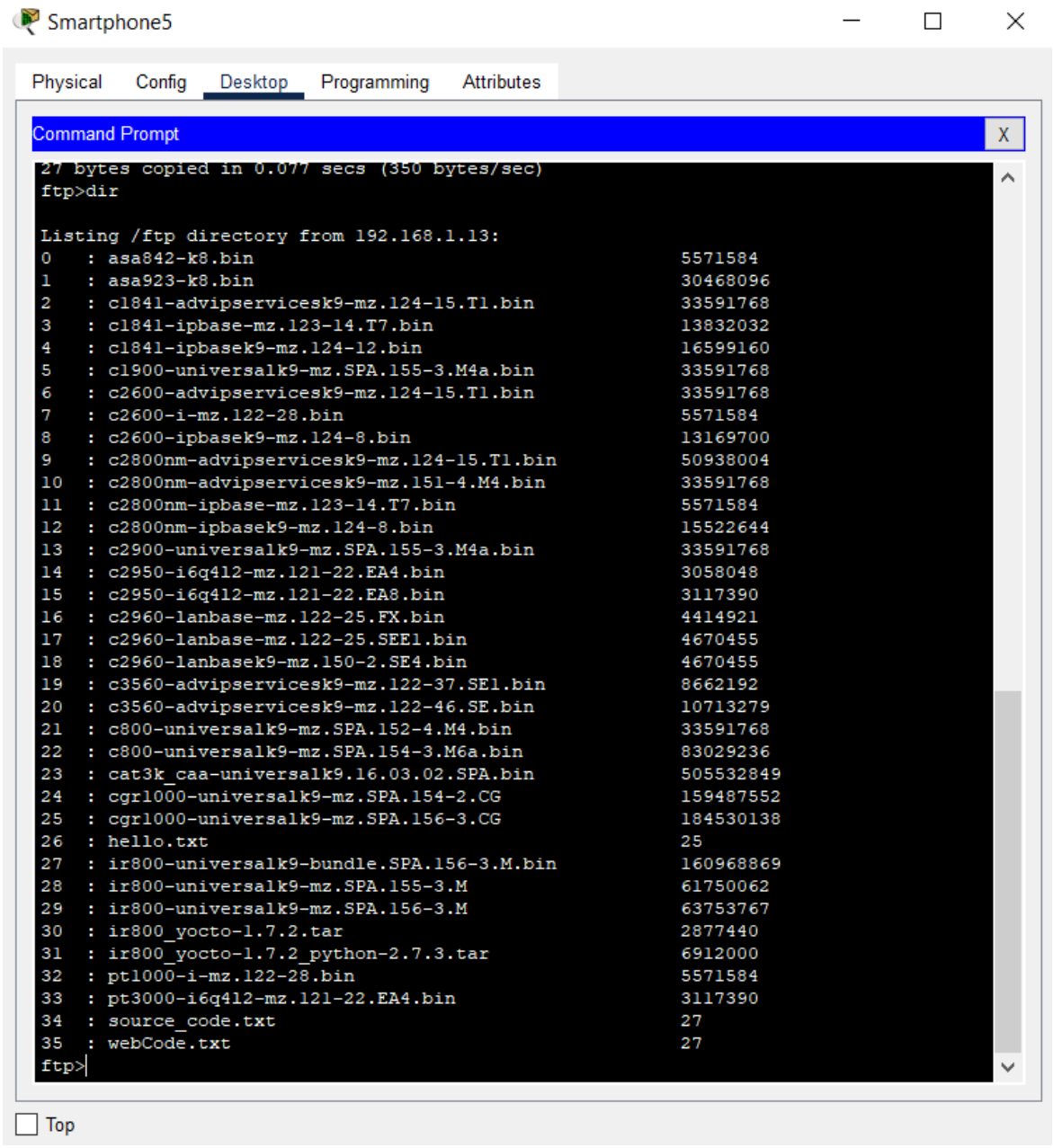

Figure 2.4: Uploaded file (source_code.txt) is now in the FTP server.

Simulation 3: Two users from second facility of first branch want to talk via VoIP.

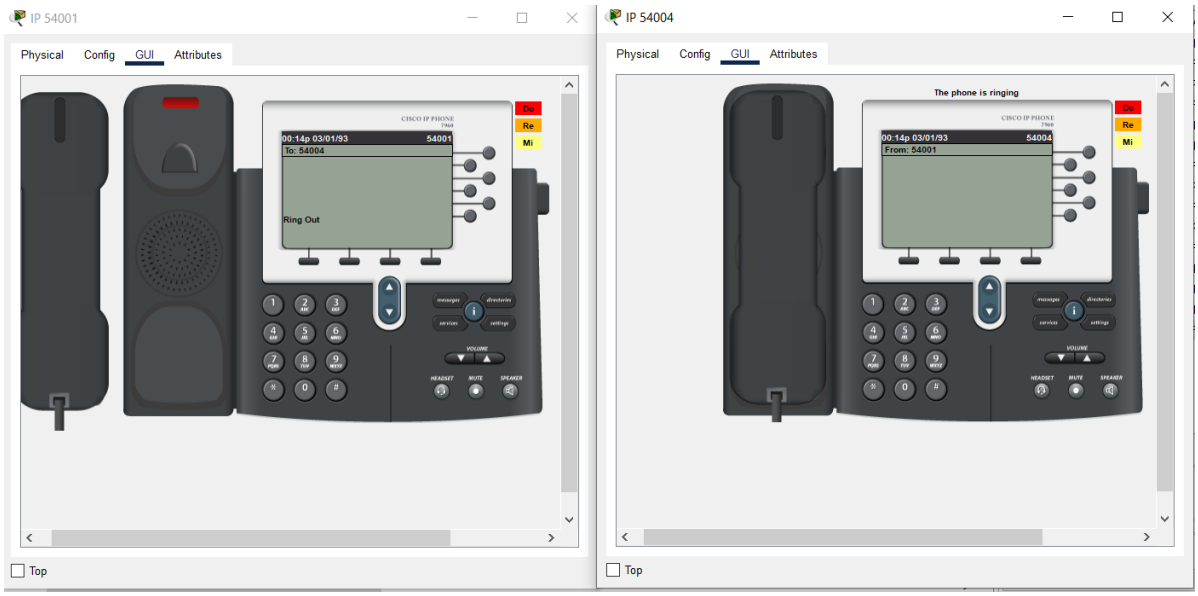

Figure 3.1: Making a call in GUI.

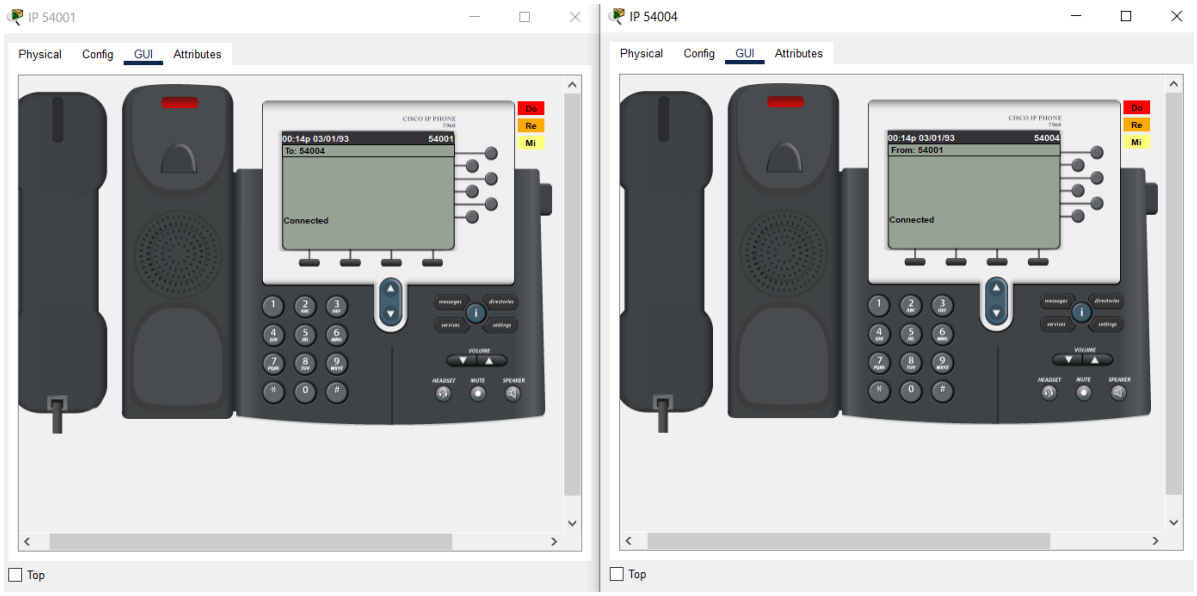

Figure 3.2: Voice conference is live, both devices are connected.

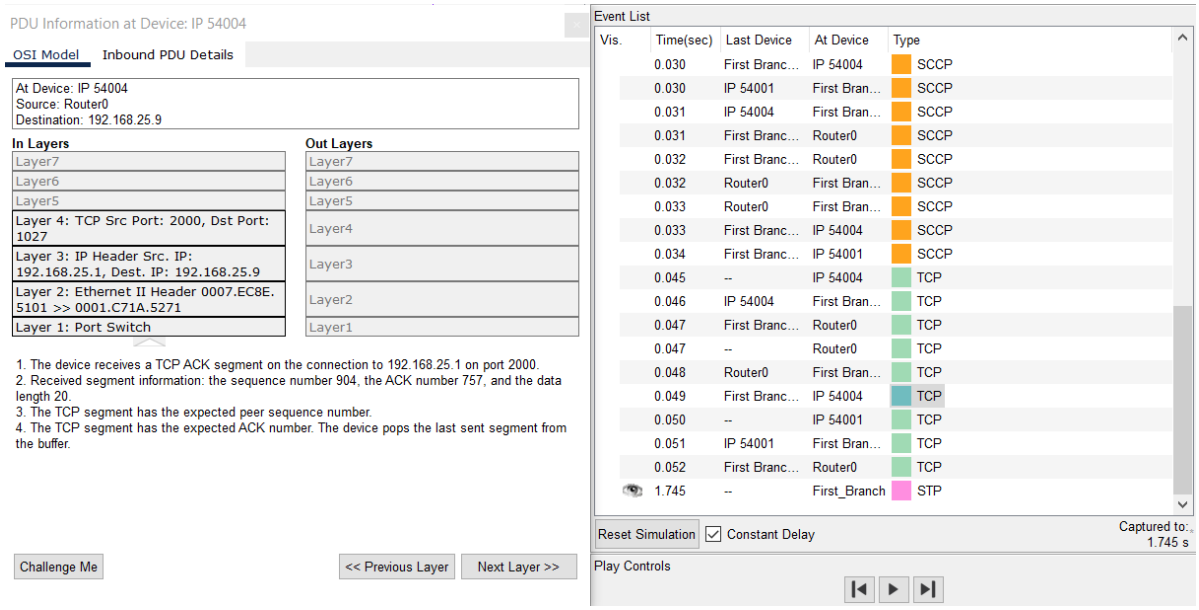

Figure 3.3: VoIP event list and layers.

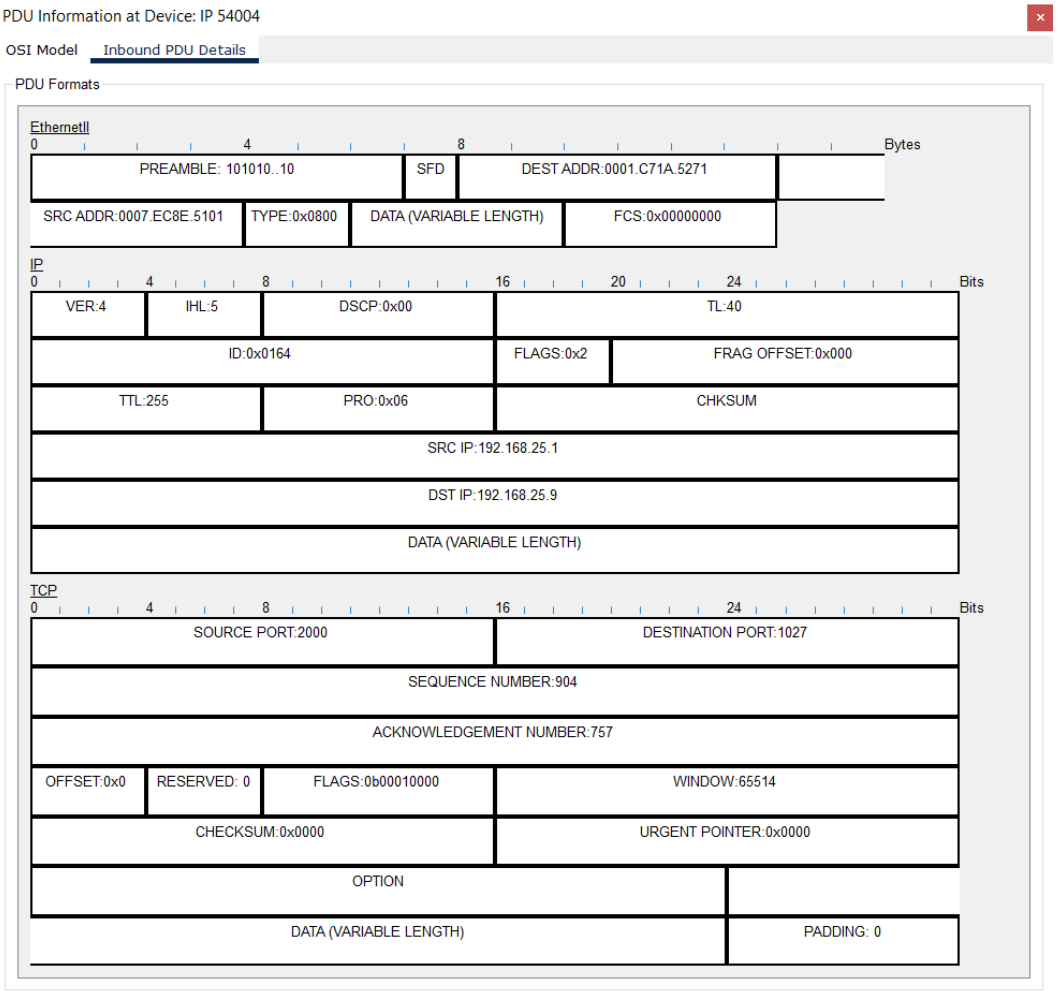

Figure 3.4: VoIP PDU.

Simulation 4: A user in the second facility of first branch wants to send an email message to his friend in the second facility of second branch.

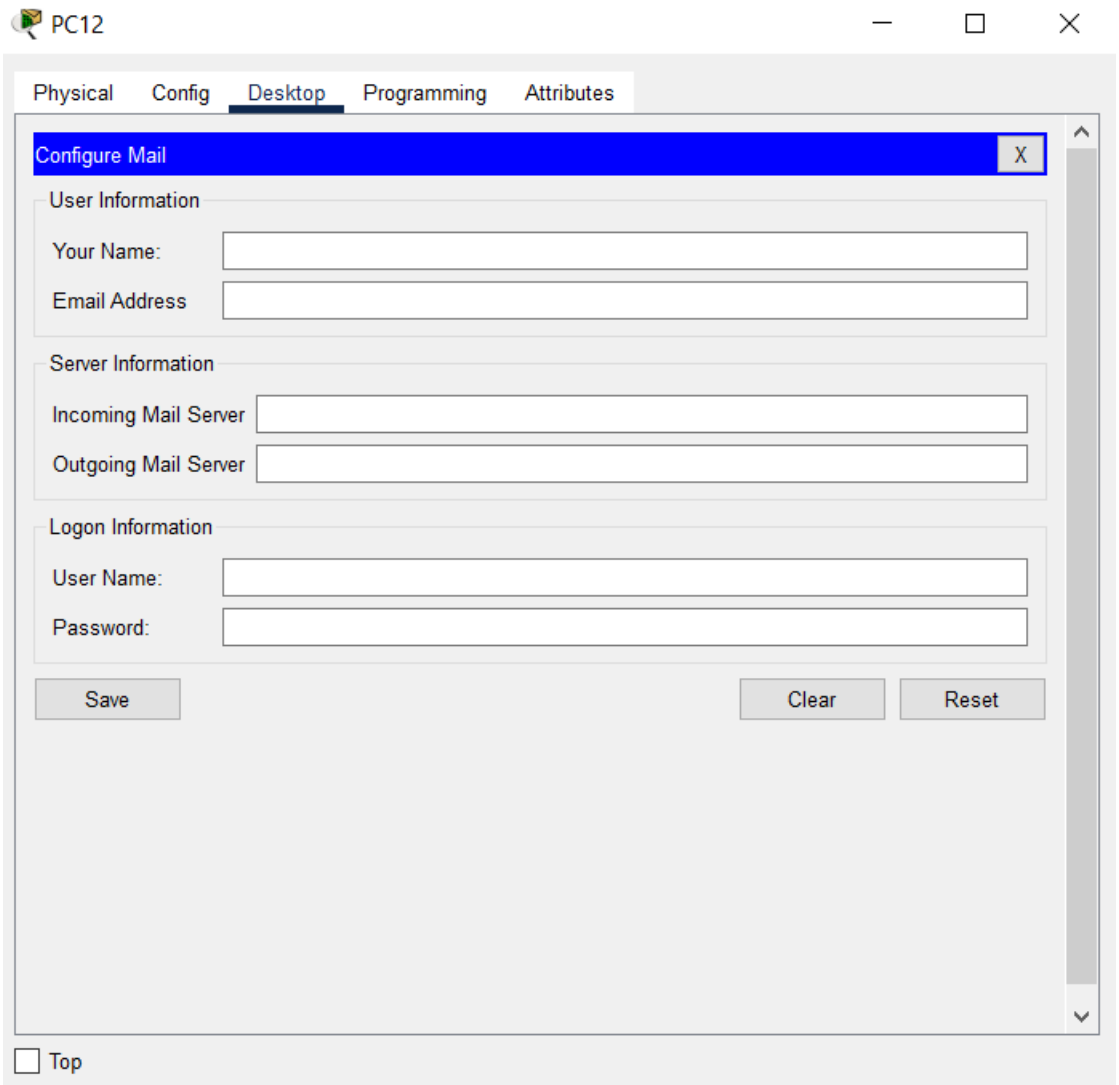

Figure 4.1: No email configuration due to lack of email service access.

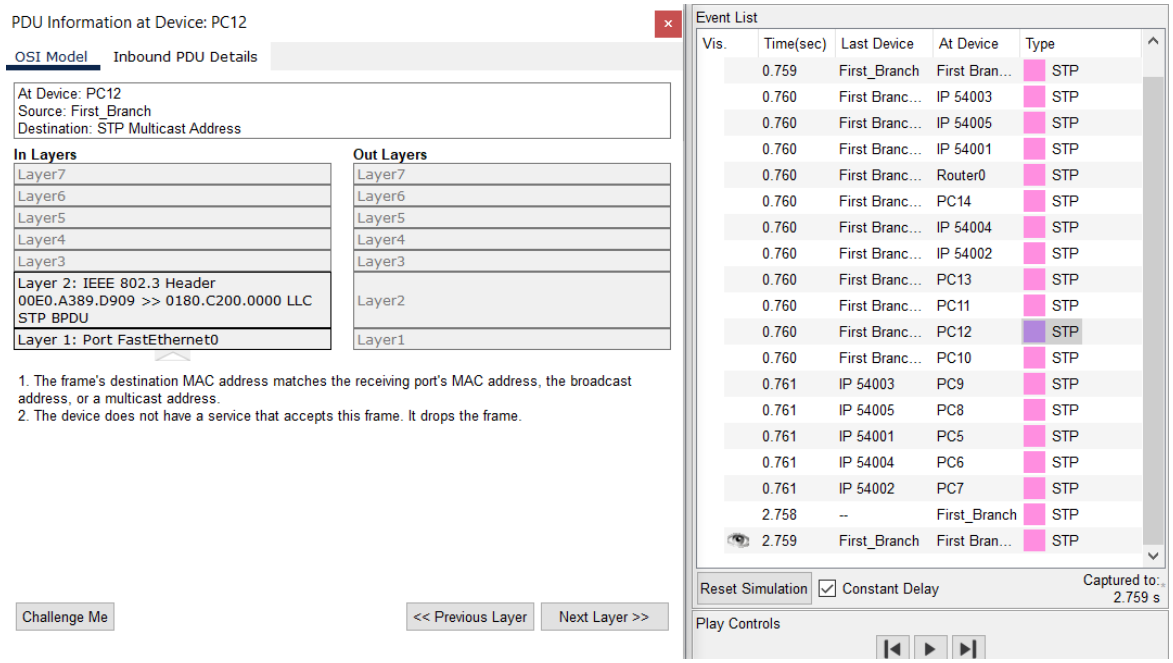

Figure 4.2: Event list and layers that display email will not function.

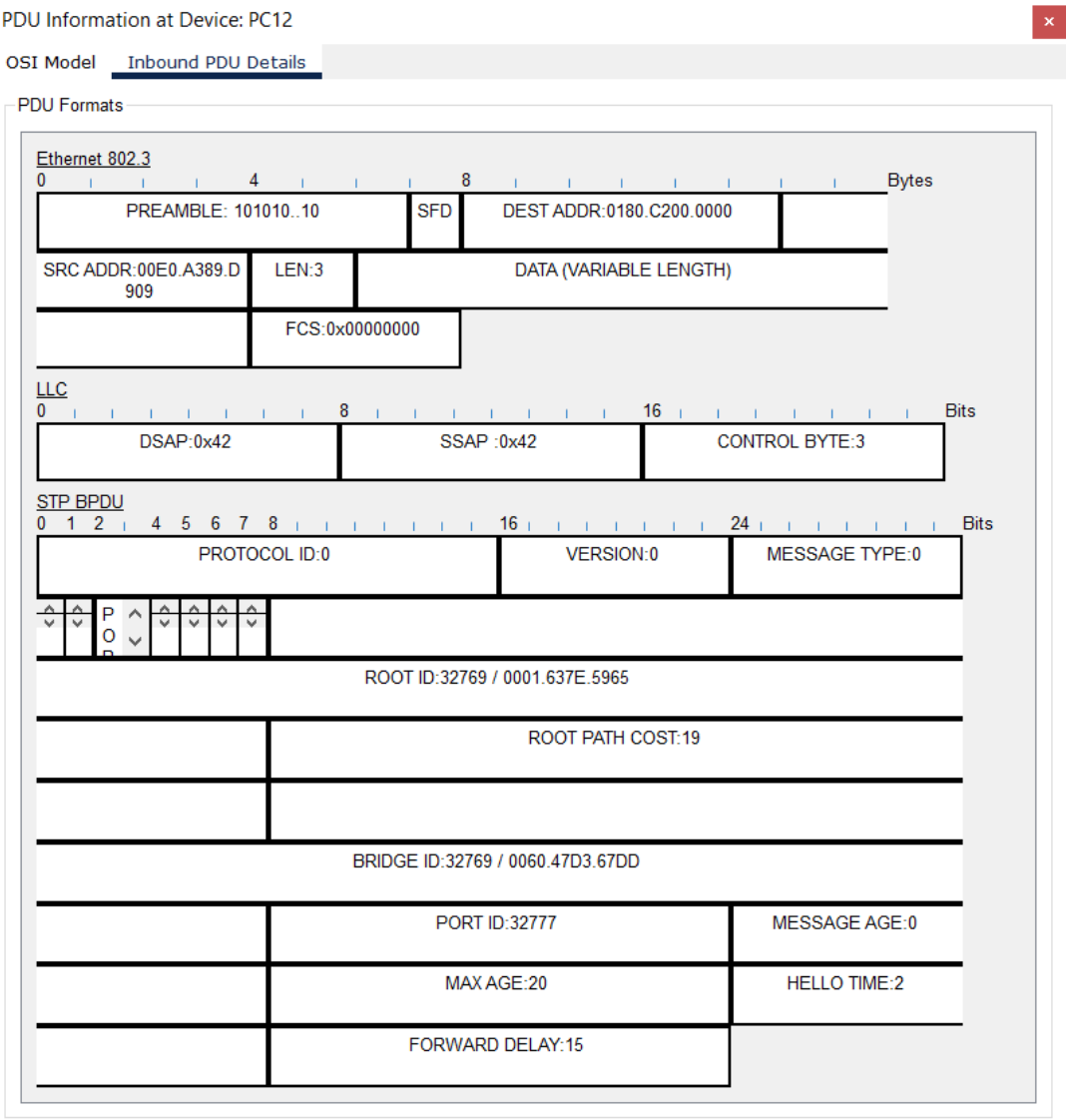

Figure 4.3: Simulation 4 PDU.

Simulation 5: A user from first facility of second branch pings Web server of second facility of first branch.

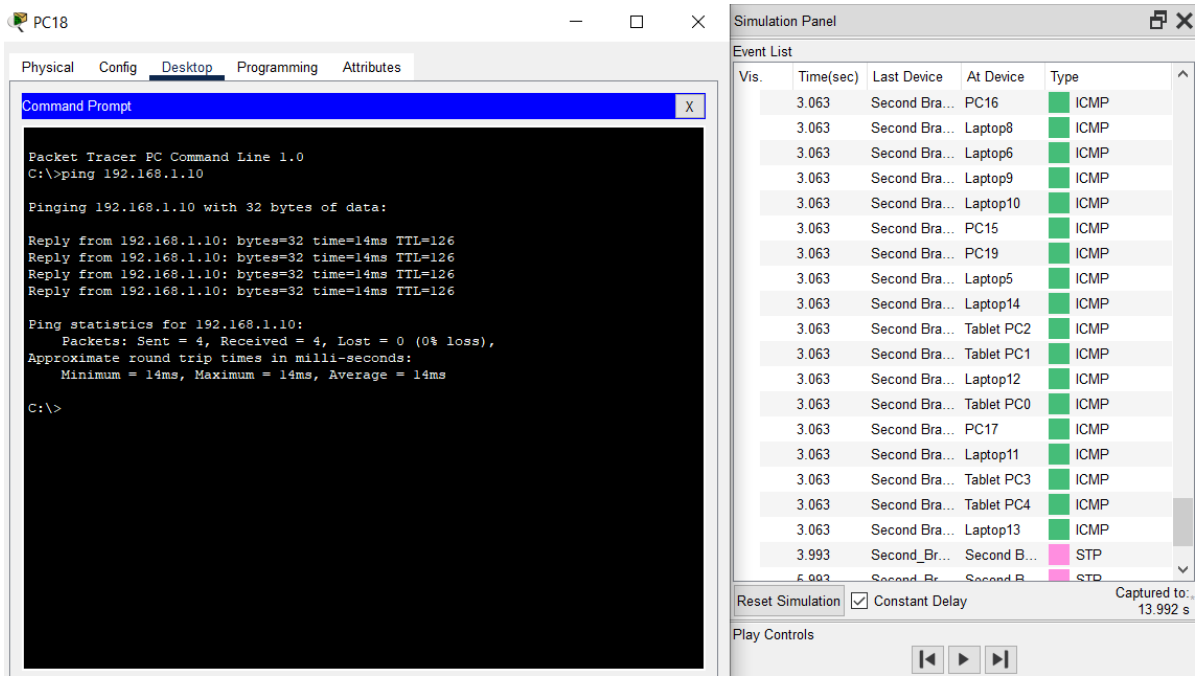

Figure 5.1: Ping Web server event list and command prompt.

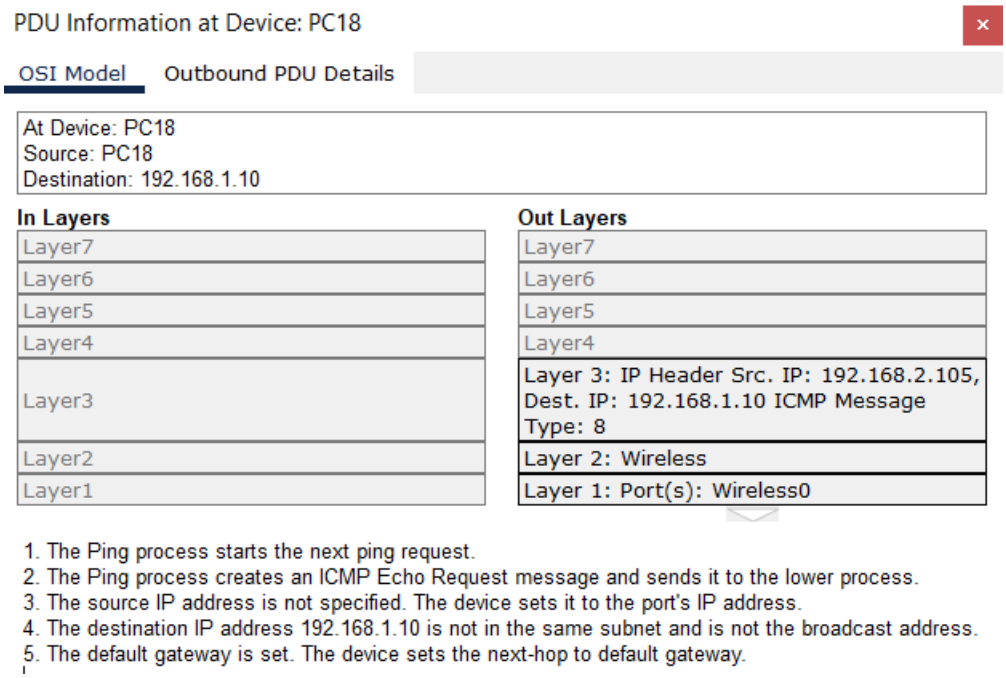

Figure 5.2: Ping Web server layers.

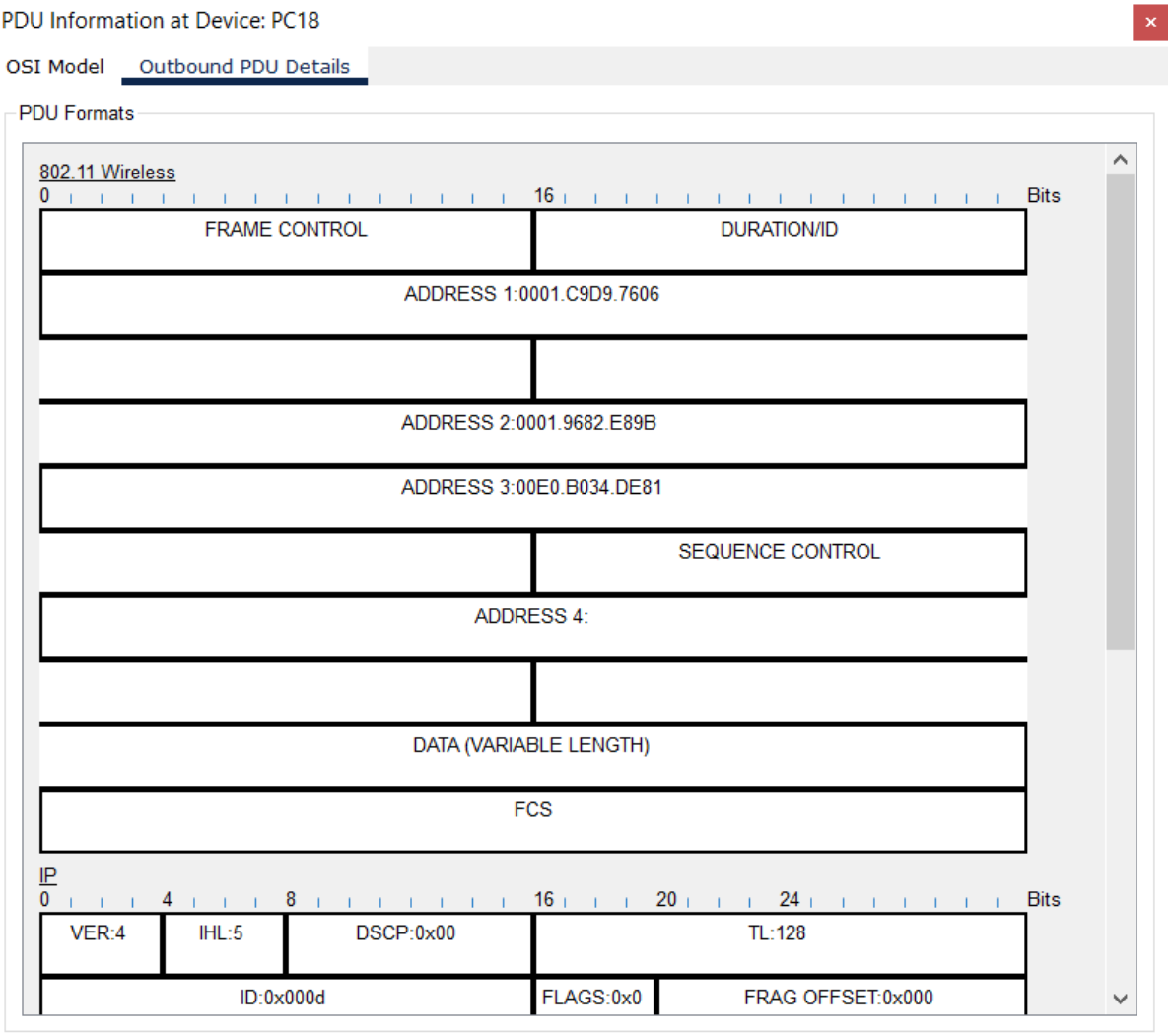

Figure 5.3: Ping Web server PDU.

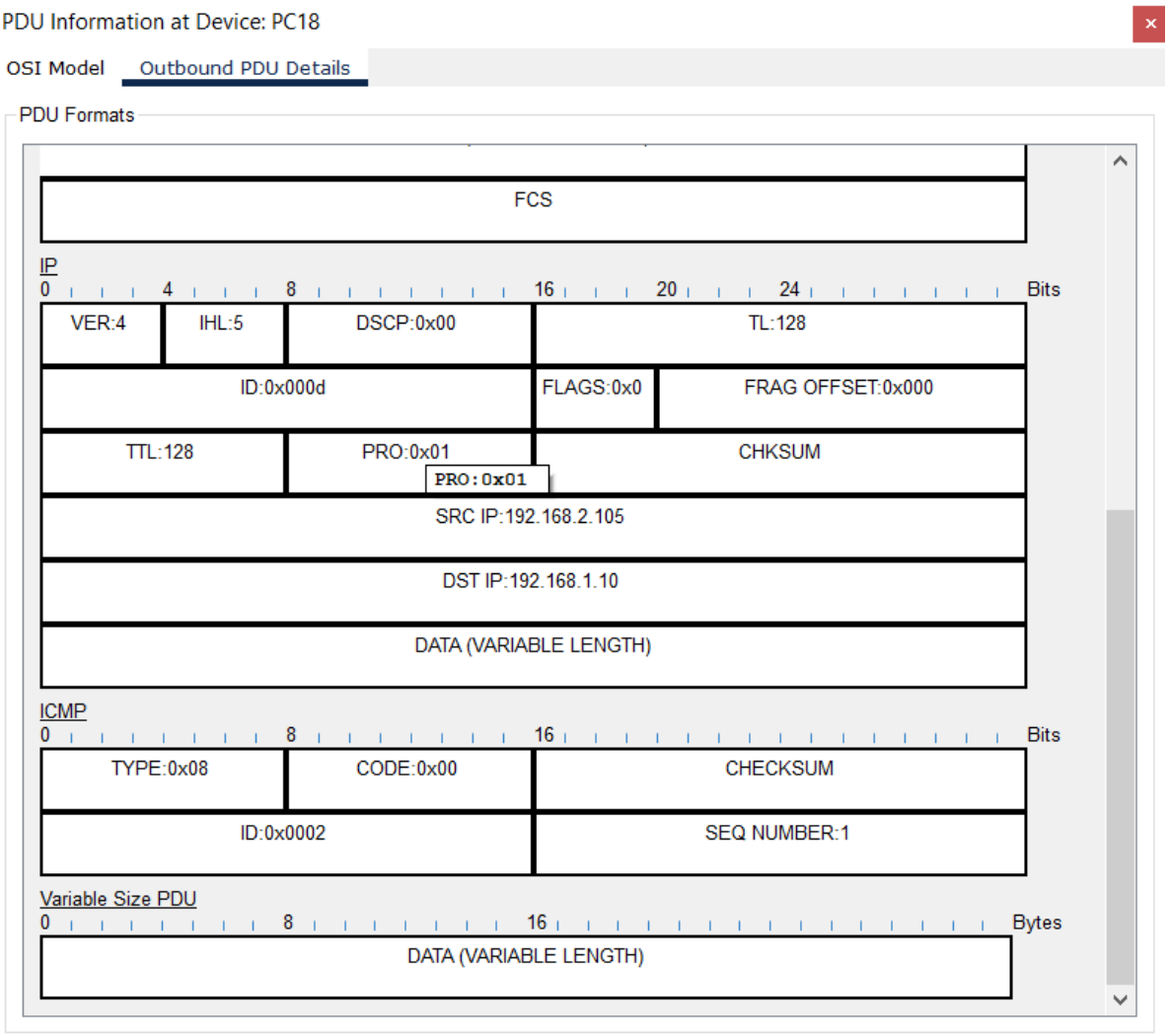

Figure 5.4: Ping Web server PDU alt.

Simulation 6: A laptop user from first facility of first branch office wants to send email to her friend in the first facility of second branch office.

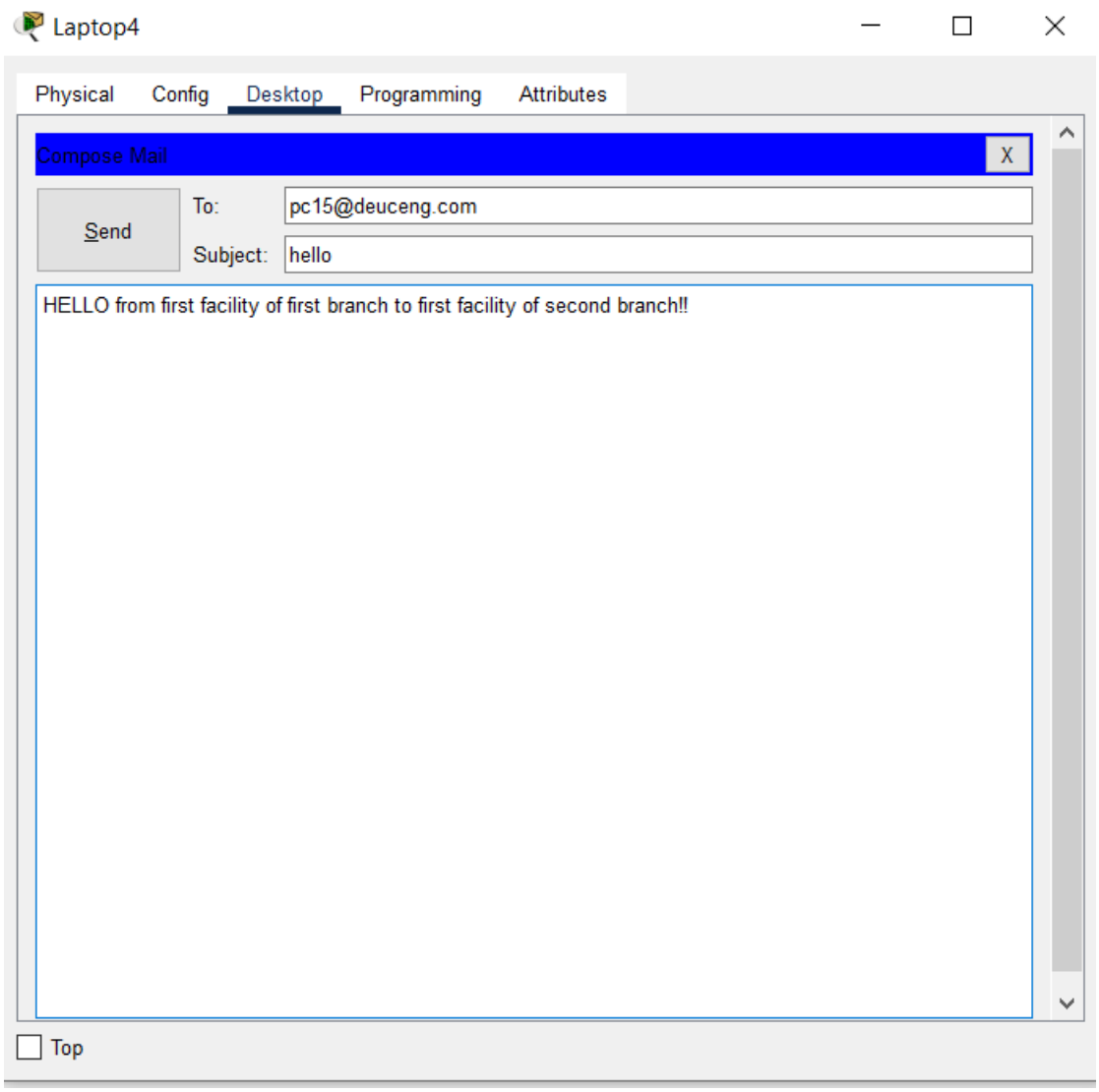

Figure 6.1: Create and send email.

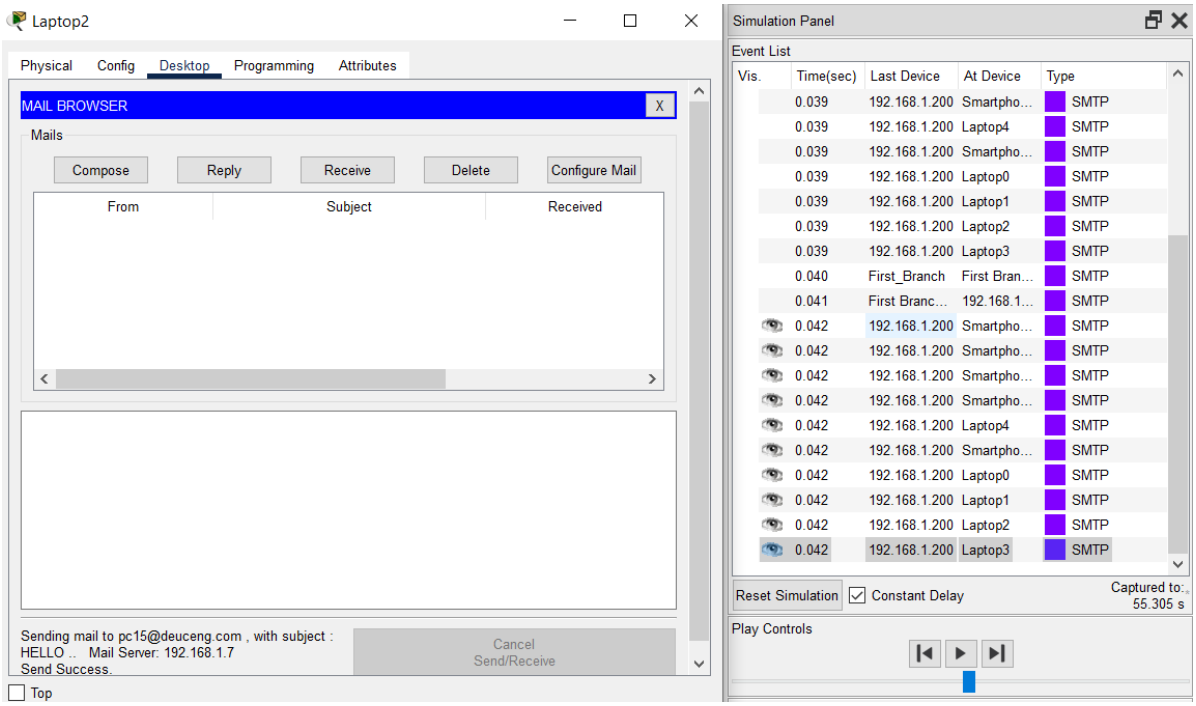

Figure 6.2: Send email success message and event list.

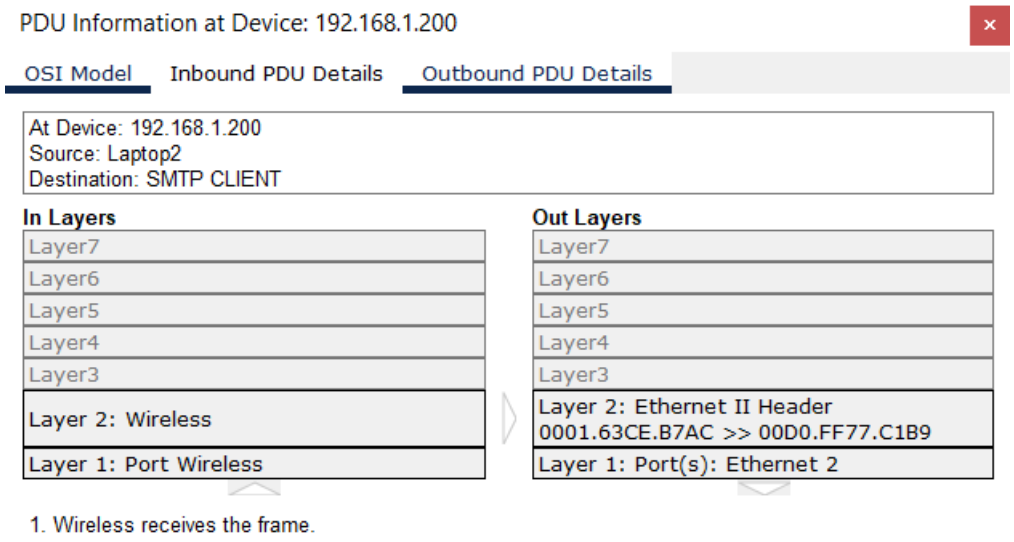

Figure 6.3: Send email layers.

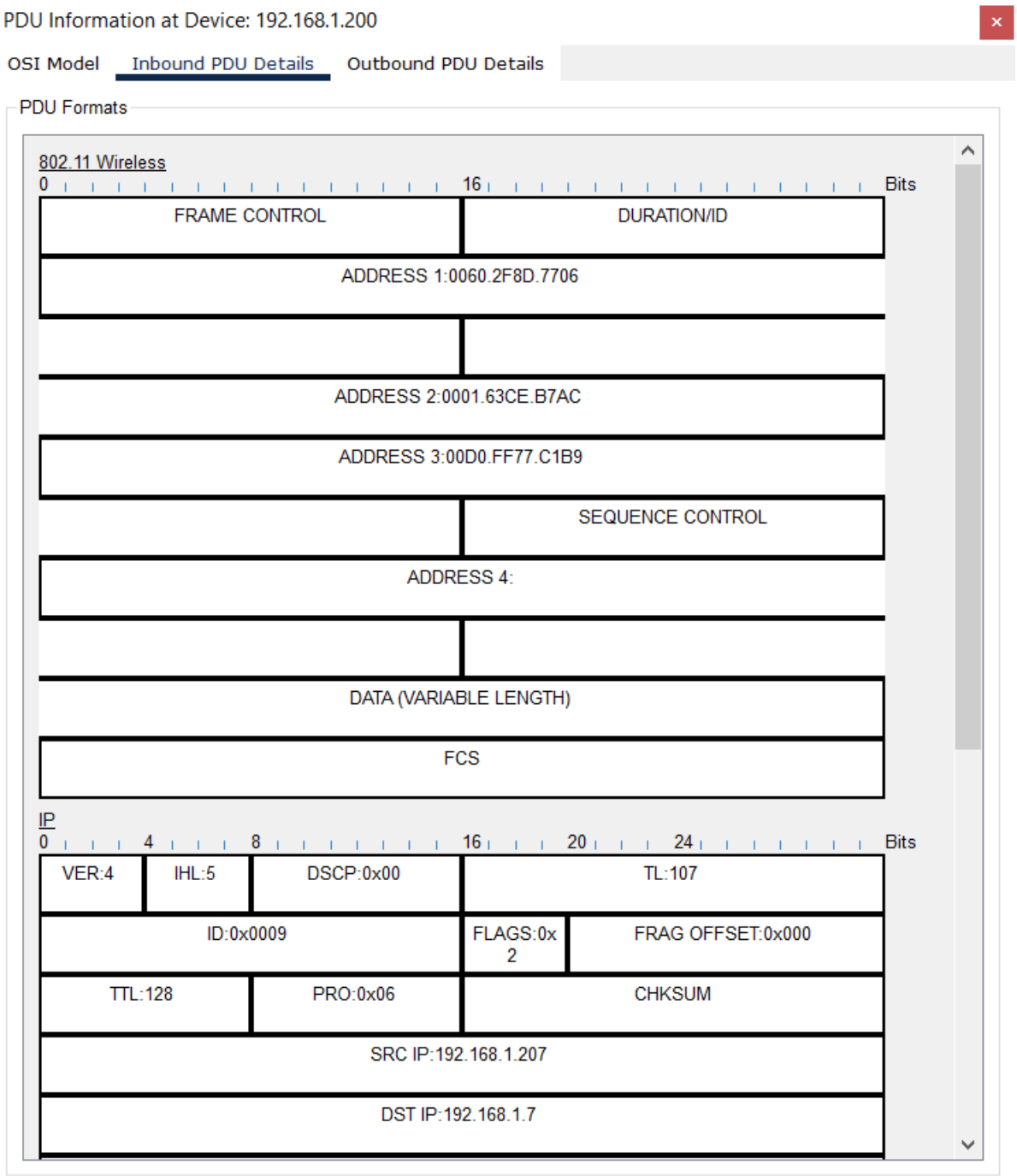

Figure 6.4: Send email inbound PDU.

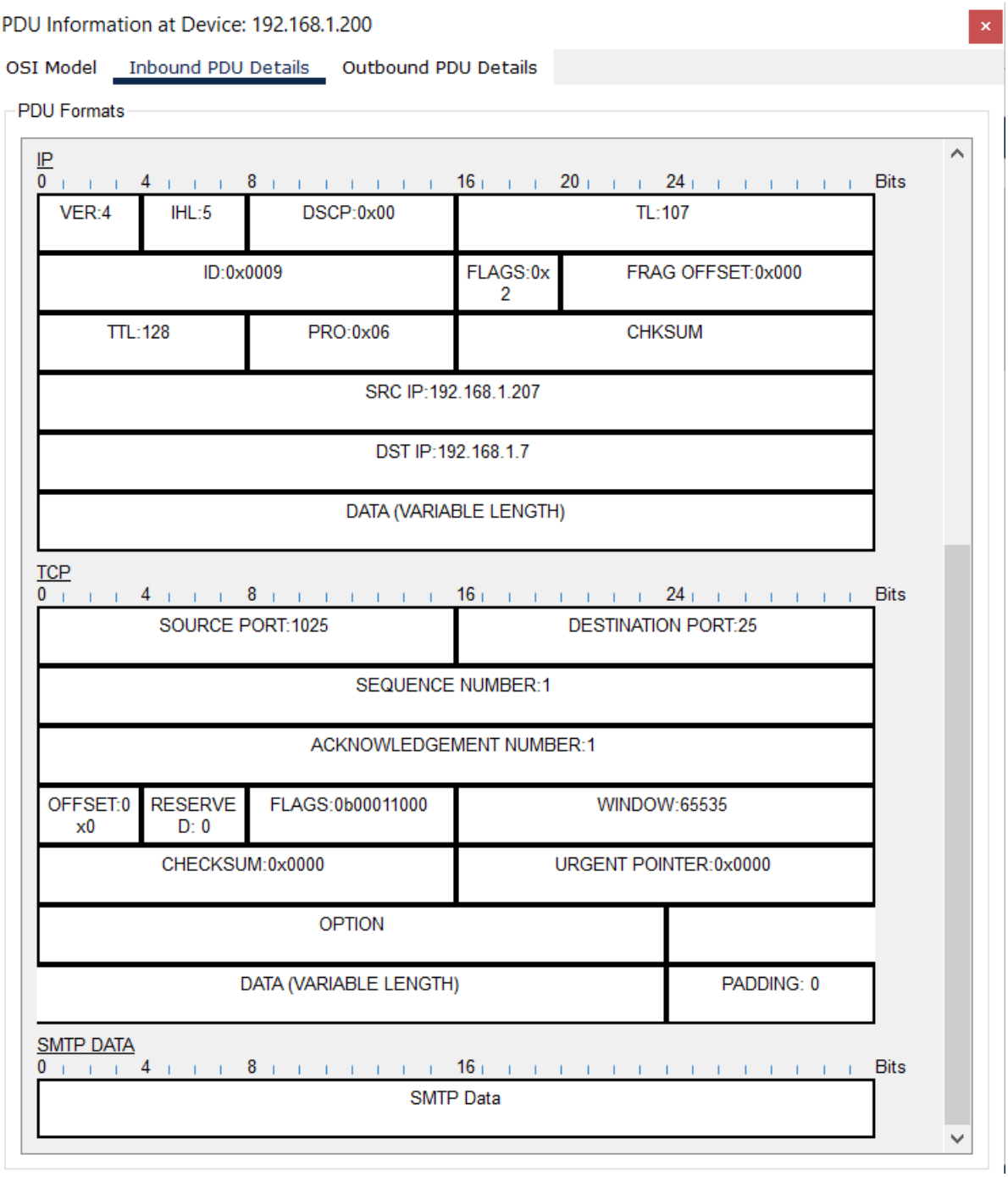

Figure 6.5: Send email inbound PDU alt.

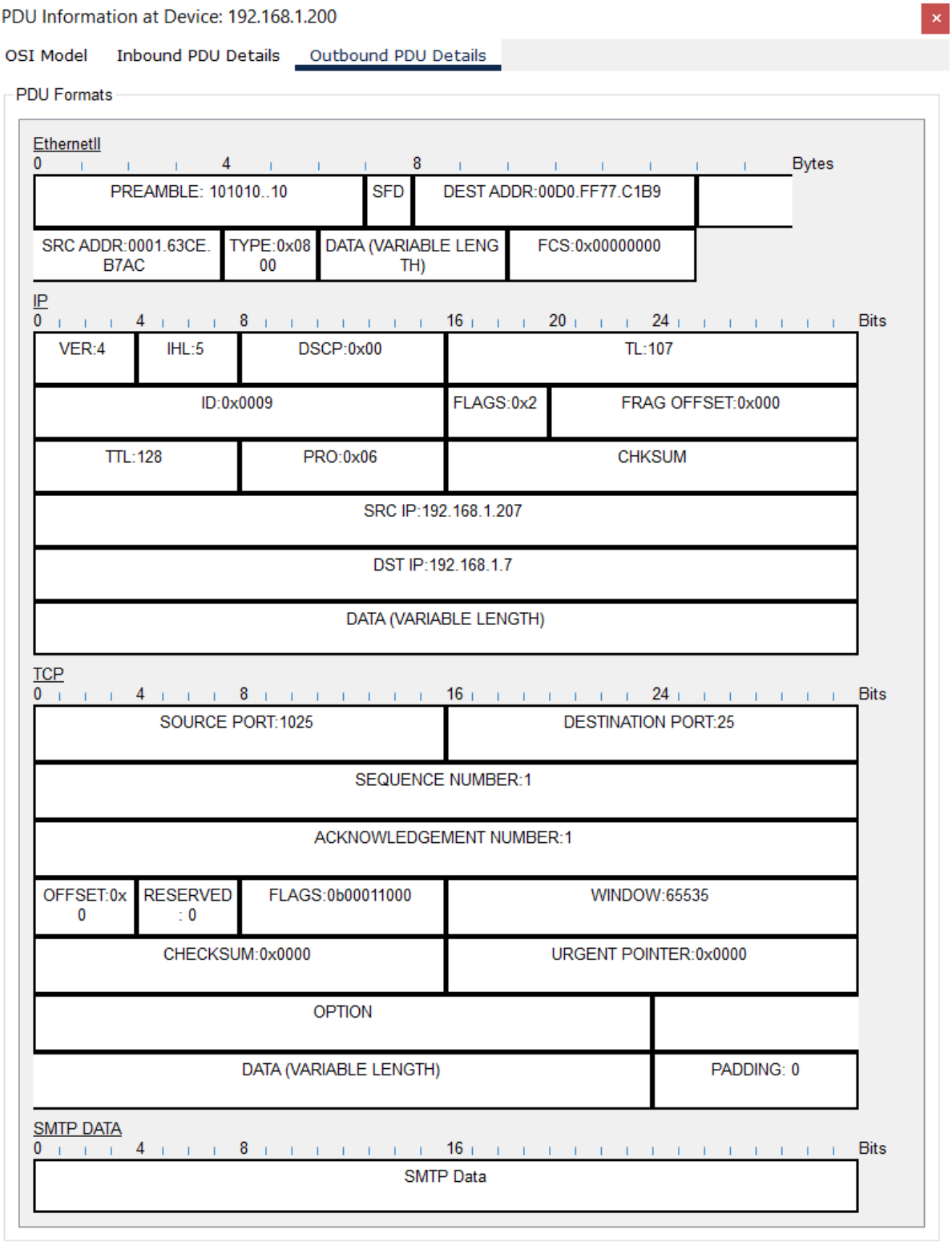

Figure 6.6: Send email outbound PDU.

Simulation 7: A smartphone user from third facility of second branch office wants to use ssh to connect to a Web server in the third facility of first branch office.

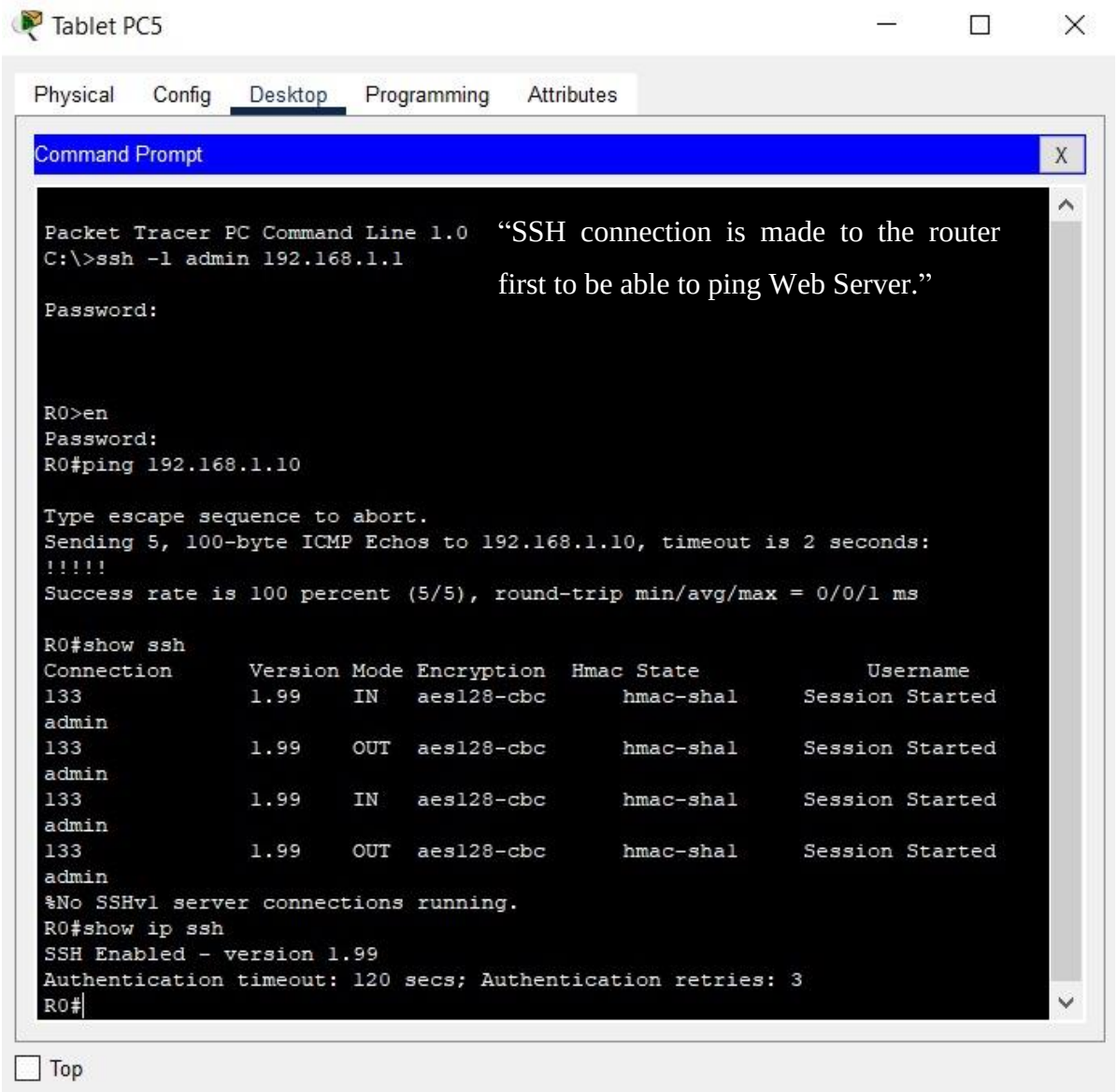

Figure 7.1: SSH Connection demonstration.

Simulation 8: First facility of first branch downloads a file from the FTP server to the workstation.

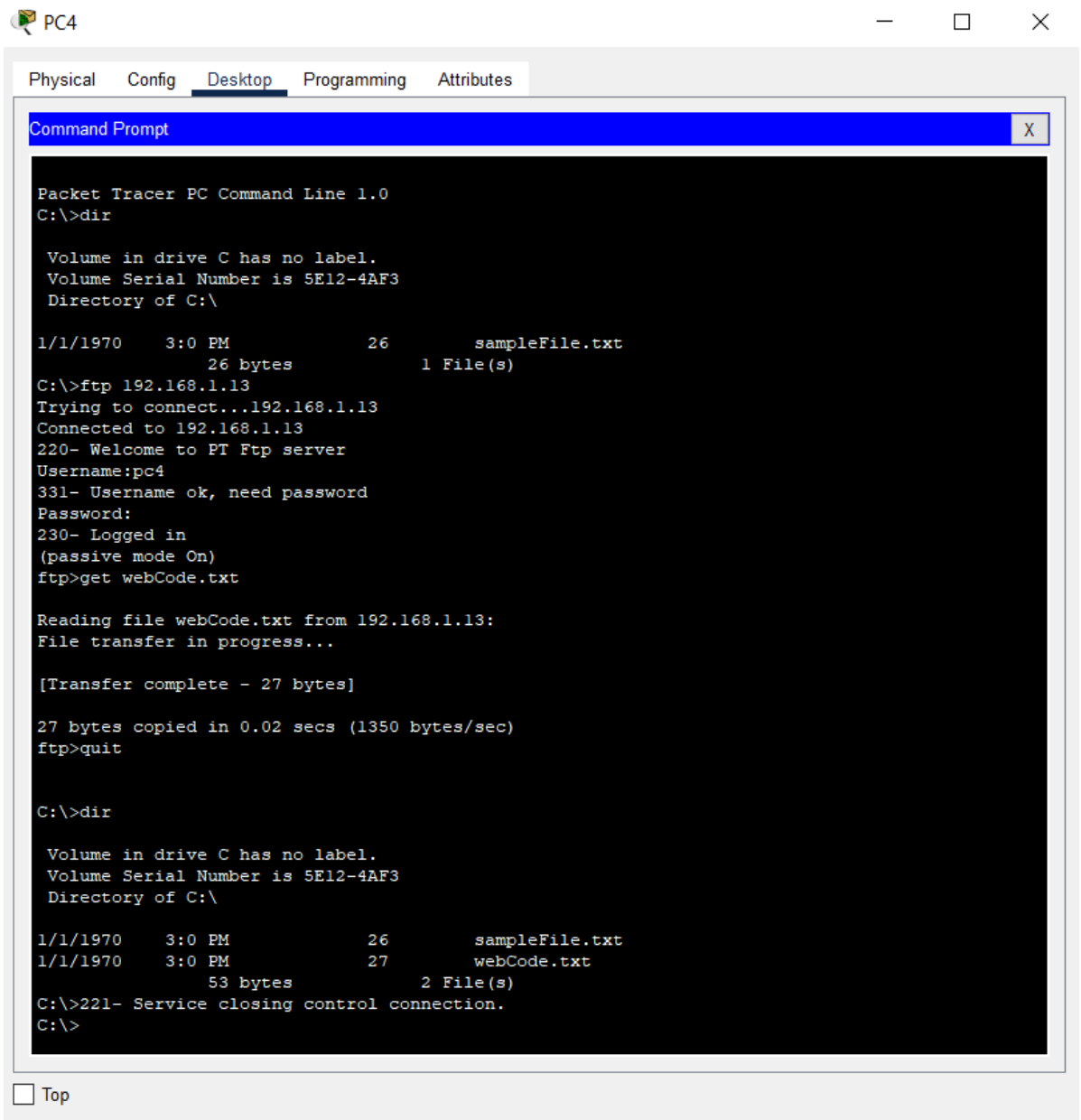

Figure 8.1: Connect to FTP server and download file.

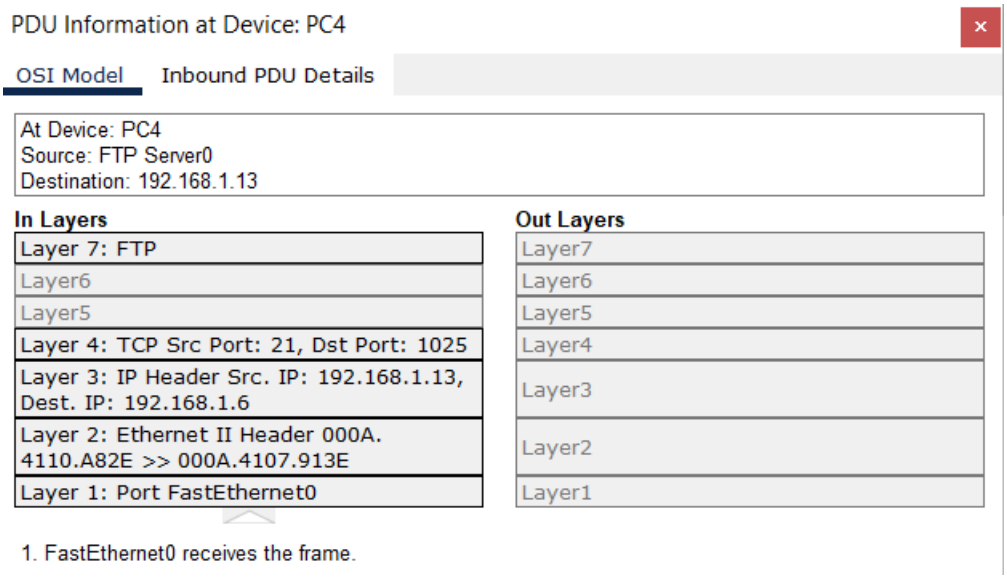

Figure 8.2: Download from FTP - layers.

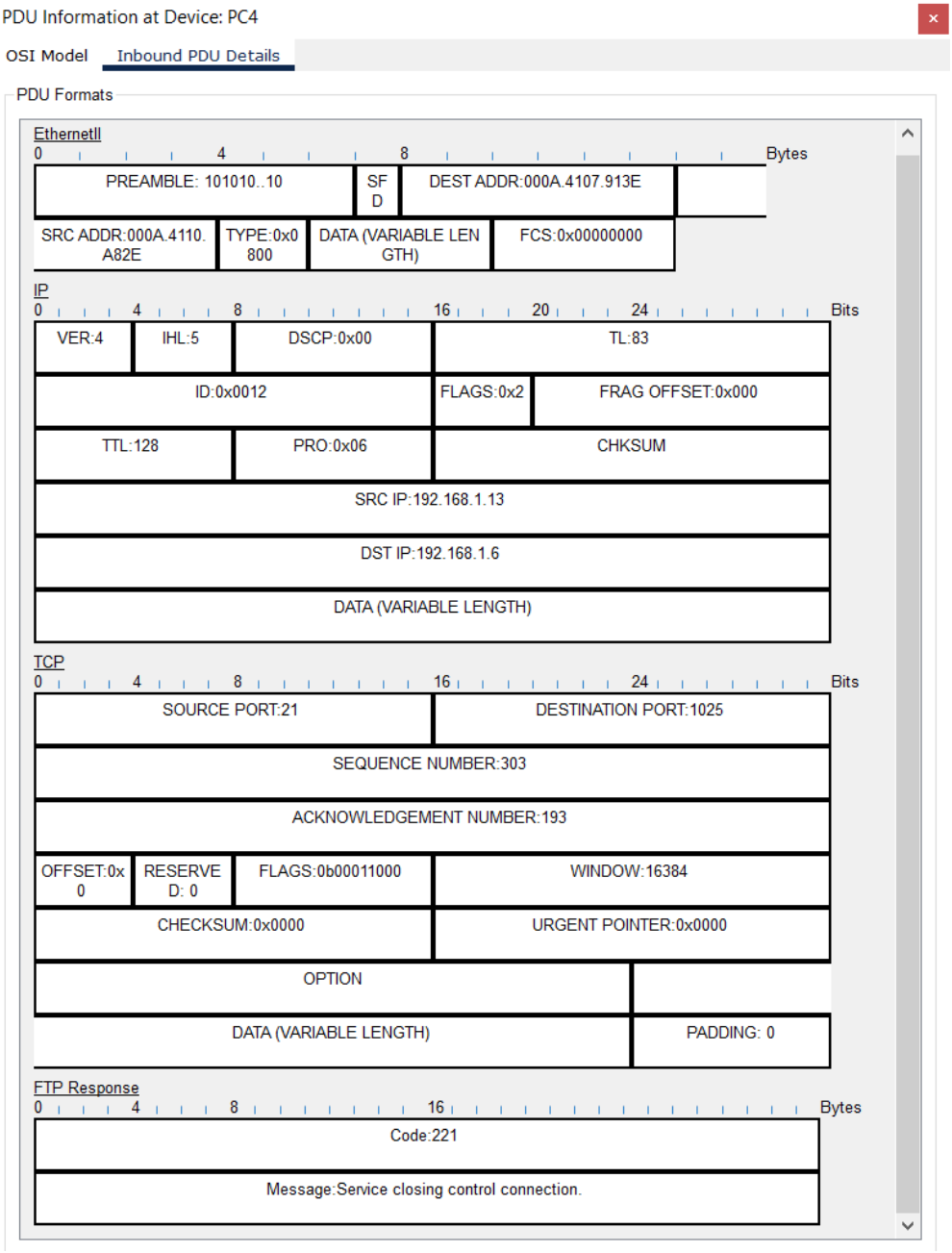

Figure 8.3: Download from FTP – PDU.

Simulation 9: Second facility of first branch changes the file name in FTP server.

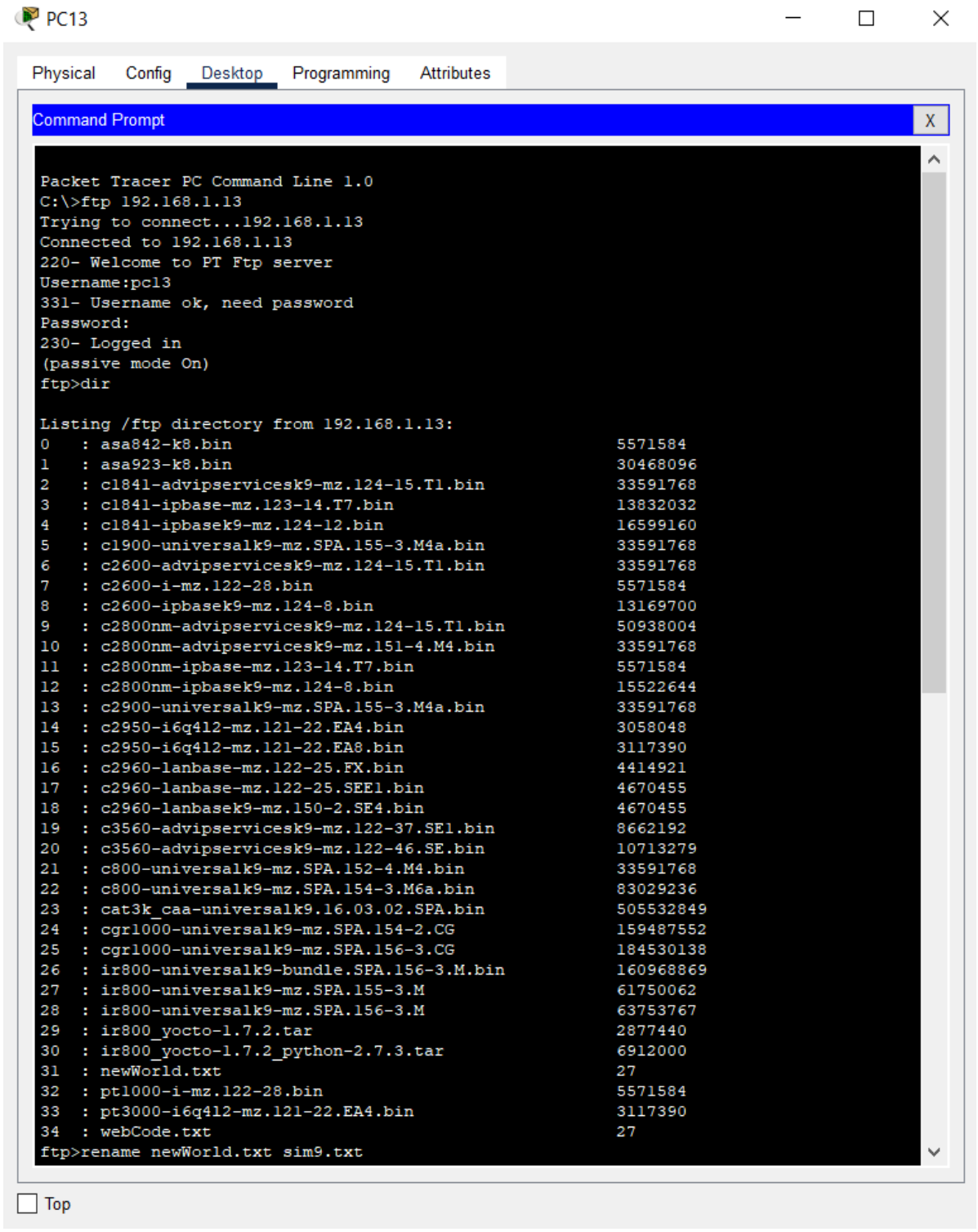

Figure 9.1: Connect to FTP server and change the name of the file “newWorld.txt”.

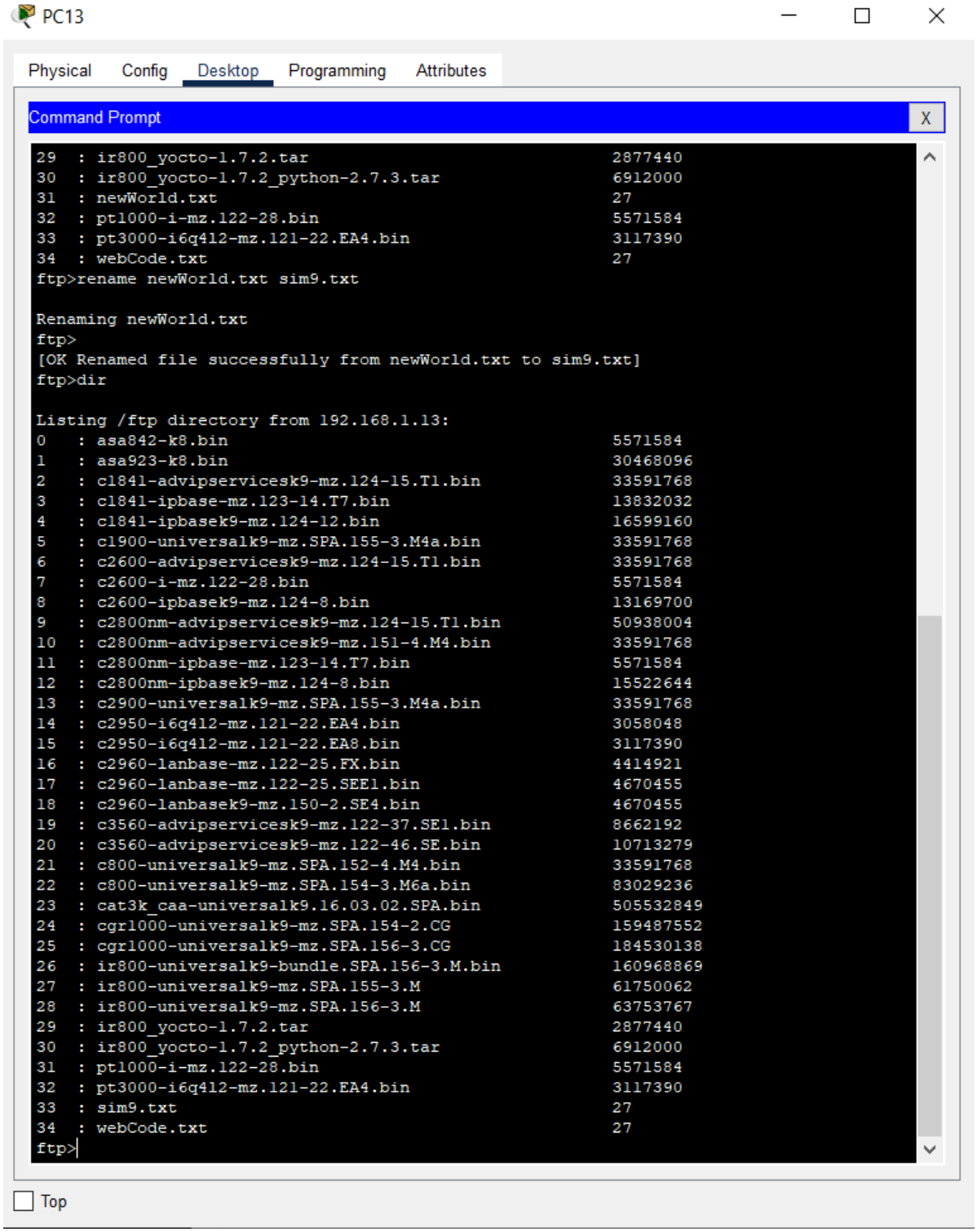

Figure 9.2: Display the FTP server with the new file name "sim9.txt".

Simulation 10: Third facility of second branch pings DHCP and DNS servers.

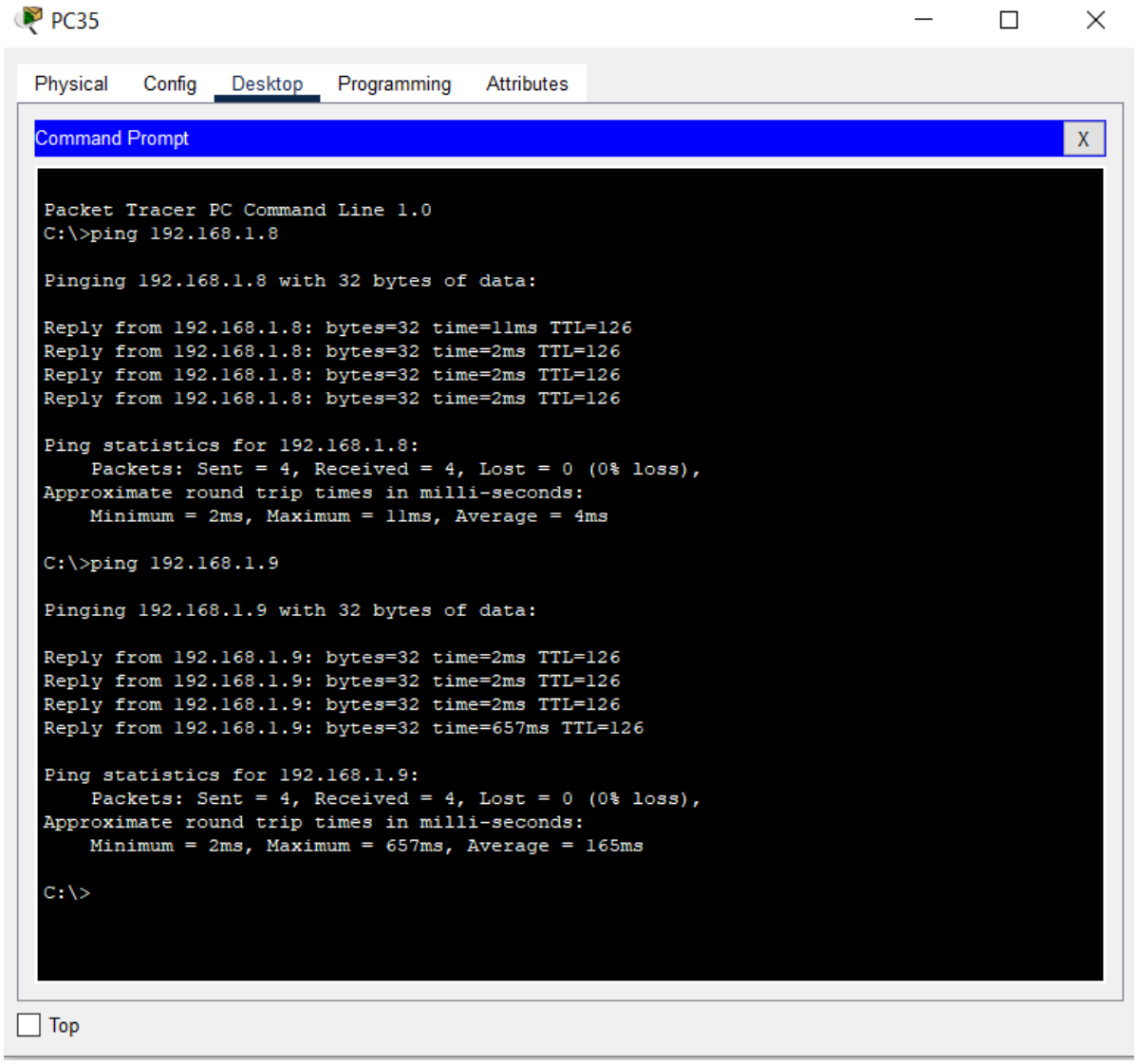

Figure 10.1: Ping DHCP and DNS servers.

CONCLUSION

The simulation of the Metropolitan Area Network System is completed with every demanded checkpoints. With the project, network systems and connection flaw is comprehended quite well, and the importance of simulation in terms of implementing a project to real life is processed. Main impediments that were encountered; router connections and interrelations, IP address distribution, and selecting the correct device models to operate correctly. Although all components and systems work completely fine, some simulations have not yielded a PDU list due to a full buffer error, even if the event list is empty. This error does not interrupt the operation in any manner, but only fails to present a PDU list as mentioned. Those simulation results that do not include a PDU list is affected by this error.

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