



**Faculty of Engineering and Technology**

**Electrical and Computer Engineering Department**

**Computer Networks**

**ENCS 3320**

**Comprehensive Network Design and Implementation**

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# Table of contents

Table of contents.....	2
List of figures .....	6
List of tables.....	10
Theory .....	11
A. Subnetting :.....	11
B. Dynamic Host Configuration Protocol (DHCP) : .....	11
C. Domain Name System (DNS) :.....	12
D. Email Protocols (SMTP and POP3) :.....	12
➤ SMTP :.....	12
➤ POP3 : .....	12
E. Network Address Translation (NAT) : .....	13
F. Routing Protocols : .....	13
➤ Open Shortest Path First (OSPF) : .....	13
➤ Border Gateway Protocol (BGP) : .....	14
G. Wireless LAN : .....	14
Procedure .....	15
Results and Discussions :.....	16
Network Topology:.....	16
➤ Google Network (AS-300) :.....	17
1. Router Port IP Configuration:.....	18
● R1_Google & gmail.com:.....	18
● R1_Google & R0_Google:.....	19
● R0_Google & dns.google.com:.....	20
2. Setting Up DNS Server with Resource Records:.....	21
● Configured the server to enable only the DNS service.....	21
● Set up a static IP configuration .....	21
● Included the following resource records (RRs): .....	22
3. Email Server Setup (gmail.com):.....	22
● SMTP & POP3 Enabled:.....	22
● Configured static IP: .....	23

● Domain set to gmail.com .....	23
● Added two user accounts.....	24
Operation and Functionality of the Google Network (AS-300):.....	25
➤ Faculty of Engineering and Technology Network (AS-100).....	26
1. IP Allocation and Subnet Distribution: .....	26
2. Subnet Requirements Defined: .....	28
● Servers Subnet: .....	28
a. Web Server (www.it.birzeit.edu): .....	28
b. Mail Server (mail.it.birzeit.edu):.....	39
c. DNS Server (dns.it.birzeit.edu):.....	41
d. DHCP Server (dhcp.it.birzeit.edu): .....	43
● ECE Subnet:.....	46
● CS Subnet: .....	49
● Backbone Subnet: .....	52
➤ Home-ISP Network (AS-200):.....	53
1. Wireless network configured by setting up the access point: .....	53
2. Connections established for wireless and wired devices: .....	54
3. Static IP configured on R_Home router as home subnet gateway:.....	54
4. DHCP server functionality enabled on the R_Home router:.....	55
5. End devices configured to receive dynamic IP addresses:.....	55
6. Dynamic NAT with PAT implemented on the R_Home router: .....	56
❖ R_Home and R_ISP router interfaces assigned static public IPs:.....	56
❖ Default route configured from the R_Home router to the R_ISP router.....	56
❖ Standard ACL enabled for home IPs. ....	56
❖ NAT pool set with one unused IP from 209.165.49.224/29. ....	56
❖ Router configured with NAT functionality.....	56
❖ Inside and outside NAT interfaces configured.....	56
7. Two devices set up with Gmail accounts on the email client: .....	57
8. Two devices set up with Birzeit email accounts: .....	57
➤ Configure Router Interfaces and Label Topology in .pkt File: .....	59
1. R_ISP & R0_Google:.....	59
2. R_ISP & R0_IT:.....	60

3. R0_Google & R0_IT:.....	61
4. R1_IT & R0_IT:.....	61
5. Annotate Topology in .pkt File with Descriptive Labels:.....	63
Routing Configuration : .....	64
➤ OSPF Areas Enabled: .....	64
The setup of OSPF, including the three areas, is now complete.....	64
➤ Setting up BGP on a router: .....	65
Inter-domain routing between autonomous systems is active with BGP.....	65
➤ OSPF and BGP Redistribution Configuration: .....	66
Testing Faculty network devices: .....	67
➤ Ping between Faculty network devices:.....	67
1. PC_ECE & laptop_ECE.....	67
2. Printer_ECE & laptop_ECE.....	68
3. Printer_CS & laptop_ECE .....	69
4. PC_CS & laptop_CS.....	69
5. PC_ECE & laptop_CS .....	70
6. PC_ECE & PC_CS .....	71
7. PC_CS & www.it.birzeit.....	73
8. PC_CS & mail.it.birzeit.edu .....	74
9. PC_CS & dns.it.birzeit.edu .....	75
10. PC_CS & dhcp.it.birzeit.edu.....	76
➤ Access to the website www.it.birzeit.edu: .....	77
Testing Home-ISP network devices:.....	78
➤ Ping between Home network devices: .....	78
1. PC_Home & Laptop_Home.....	78
2. Smartphone_Home & Tablet_Home.....	80
Simulation Mode:.....	81
➤ Sending Emails: .....	81
➤ Send packet from Laptop0_Home to www.it.birzeit.edu: .....	84
➤ Send packet from www.it.birzeit.edu to Laptop0_Home: .....	87
Alternative Solutions, Issues, and Limitations: .....	92
A. Failure to send emails : .....	92

B. Failure to send packet from www.it.birzeit.edu to Laptop0_Home :.....	94
Teamwork .....	95
Task Chart.....	95
Task 1: Google AS.....	95
Task 2: Faculty of Engineering and Technology AS .....	95
Task 3: Home-ISP AS.....	96
Report Sections .....	96
Toqa's Responsibilities: .....	96
Mohammad's Responsibilities: .....	97
Omar's Responsibilities:.....	97
References:.....	98

# List of figures

Figure 1: Network Topology .....	17
Figure 2: Google Network .....	17
Figure 3: R1_Google IP.....	18
Figure 4: R1_Google & R0_Google IPs .....	19
Figure 5: R0_Google IP .....	20
Figure 6: DNS Configuration .....	21
Figure 7:Server IP Configuration.....	21
Figure 8:SRRs Configured.....	22
Figure 9: Email Protocols Setup .....	22
Figure 10: Email Server Configuration.....	23
Figure 11: Hostname Setup.....	23
Figure 11: Team Accounts Setup.....	24
Figure 12: Faculty of Engineering and Technology Network.....	26
Figure 13 : HTTP Configuration.....	28
Figure 14 : HTTP Server IP Configuration.....	29
Figure 15 : Index Page -1.....	30
Figure 15 : Index Page -2.....	30
Figure 15 : Index Page -3.....	31
Figure 15 : Index Page -4.....	31
Figure 16 : Edit the Index.html Page .....	37
Figure 17 : Index Page For Web Server.....	38
Figure 18 : Set Up Email Communication Protocols .....	39
Figure 19 : Configure Static IP For Mail Server .....	39
Table 5: Team Accounts Setup.....	40
Figure 20 : Create Team User Accounts in Mail Server .....	40
Figure 20 : Turn On DNS Service.....	41
Figure 21 : List of Resource Records (RRs) .....	42
Figure 22 : DHCP Configuration .....	43
Figure 23 : DHCP Server IP Configuration .....	43
Figure 24 : Configured Pools for ECE and CS Subnets.....	44
Figure 25 : IP Helper Configuration for ECE and CS Networks.....	45

Figure :R1_IT Static IP Configuration in ECE Subnet.....	46
Figure 26 :Printer Static IP Configuration in ECE Subnet .....	46
Figure 27 :PC and Laptop Dynamic IP Configuration in ECE Subnet .....	47
Figure 28: Setting Up First Gmail Account on Email Client.....	47
Figure 29: Setting Up First Birzeit Account on Email Client.....	48
Figure :R1_IT Static IP Configuration in CS Subnet .....	49
Figure 30 :Printer Static IP Configuration in CS Subnet .....	49
Figure 31 :PC and Laptop Dynamic IP Configuration in CS Subnet.....	50
Figure 32: Setting Up Second Gmail Account on Email Client.....	50
Figure 33: Setting Up Second Birzeit Account on Email Client .....	51
Figure : R0_IT and an R1_IT IPs in Backbone Subnet .....	52
Figure 34: Home-ISP Network.....	53
Figure 35: Setting Up Wireless Network via Access Point .....	53
Figure 36: ENCS3320Home Network Device Connections.....	54
Figure 37: R_Home Router Gateway Configuration.....	54
Figure 38: R_Home Router as DHCP Server Setup.....	55
Figure 39: End Devices with Dynamic IP configuration .....	55
Figure 40: R_Home and R_ISP Router Interface Configuration.....	56
Figure 41: R_Home Router Setup and NAT Configuration .....	57
Figure 42: Gmail and Birzeit Email Accounts on Devices.....	58
Figure 44: Successful Ping Tests Between Home Network Devices .....	58
Figure 45: R_ISP & R0_Google IPs.....	59
Figure 46: R_ISP & R0_IT IPs.....	60
Figure 47: R0_Google & R0_IT IPs.....	61
Figure 48: R1_IT & R0_IT IPs.....	62
Figure 49: Labeled Network in .pkt File .....	63
Figure 50: OSPF Three-Area Network Design .....	64
Figure 51: BGP Configuration Between Autonomous Systems .....	65
Figure 52: Route Redistribution Between OSPF and BGP .....	66
Figure 53: Ping Test from PC_ECE to laptop_ECE .....	67
Figure 54: Ping Test from laptop_ECE to PC_ECE .....	68
Figure 55: Ping Test from laptop_ECE to Printer_ECE .....	68
Figure 56: Ping Test from laptop_ECE to Printer_CS.....	69

Figure 57: Ping Test from PC_CS to laptop_ECE .....	69
Figure 58: Ping Test from laptop_ECE to PC_CS .....	70
Figure 59: Ping Test from PC_ECE to laptop_CS .....	70
Figure 60: Ping Test from laptop_CS to PC_ECE .....	71
Figure 61: Ping Test from PC_ECE to PC_CS .....	71
Figure 62: Ping Test from PC_CS to PC_ECE .....	72
Figure 63: Ping Test from <b>www.it.birzeit</b> to PC_CS .....	73
Figure 64: Ping Test from PC_CS to <b>www.it.birzeit</b> .....	73
Figure 65: Ping Test from PC_CS to mail.it.birzeit.edu .....	74
Figure 66: Ping Test from mail.it.birzeit.edu to PC_CS .....	74
Figure 67: Ping Test from PC_CS to dns.it.birzeit.edu .....	75
Figure 68: Ping Test from dns.it.birzeit.edu to PC_CS .....	75
Figure 69: Ping Test from PC_CS to dhcp.it.birzeit.edu .....	76
Figure 70: Ping Test from dhcp.it.birzeit.edu to PC_CS .....	76
Figure 71: Access to the website www.it.birzeit.edu .....	77
Figure 72: Ping Test from Laptop_Home to PC_Home .....	78
Figure 73: Ping Test from PC_Home to Laptop_Home .....	79
Figure 74: Ping Test from Tablet_Home to Smartphone_Home .....	80
Figure 75: Ping Test from Smartphone_Home to Tablet_Home .....	80
Figure 76: Simulation Mode for Sending Emails -1 .....	81
Figure 77: Simulation Mode for Sending Emails -2 .....	82
Figure 78: Simulation Mode for Sending Emails -3 .....	83
Figure 79 Simulation Mode for Sending packet from Laptop0_Home to www.it.birzeit.edu -1 .....	84
Figure 80: Simulation Mode for Sending packet from Laptop0_Home to www.it.birzeit.edu - 2.....	85
Figure 81 Simulation Mode for Sending packet from Laptop0_Home to www.it.birzeit.edu - 3.....	85
Figure 82: Simulation Mode for Sending packet from Laptop0_Home to www.it.birzeit.edu - 4.....	86
Figure 83: Simulation Mode: PDU Information at Device:www.it.birzeit.edu .....	86
Figure 84: Simulation Mode for Sending packet from www.it.birzeit.edu to Laptop0_Home - 1.....	87
Figure 85: Simulation Mode for Sending packet from www.it.birzeit.edu to Laptop0_Home - 2.....	88
Figure 86: Simulation Mode for Sending packet from www.it.birzeit.edu to Laptop0_Home - 3.....	88
Figure 87: Simulation Mode for Sending packet from www.it.birzeit.edu to Laptop0_Home - 4.....	89
Figure 88: Simulation Mode for Sending packet from www.it.birzeit.edu to Laptop0_Home - 5.....	89
Figure 89: Simulation Mode for Sending packet from www.it.birzeit.edu to Laptop0_Home - 6.....	90

Figure 90: Simulation Mode: PDU Information at Device: Laptop0_Home -1.....	90
Figure 91: Simulation Mode: PDU Information at Device: Laptop0_Home -2.....	91
Figure 92: Contribution Distribution Among Team Members .....	97

## List of tables

Table 1: The difference between SMTP and POP3 .....	13
Table 2: List of Resource Records (RRs) .....	22
Table 3: Team Accounts Setup .....	24
Table 4: IP Address Distribution .....	27
Table 5: Team Accounts Setup .....	40
Table 6: List of Resource Records (RRs) .....	41
Table 7: ECE_Pool and CS_Pool Details .....	44
Table 8: Gmail Account Setup on End Devices.....	57
Table 9: Birzeit Account Setup on End Devices.....	57
Table 10: R_ISP & R0_Google IPs .....	59
Figure 45: R_ISP & R0_Google IPs .....	59
Table 11: R_ISP & R0_IT IPs .....	60
Table 12: R0_Google & R0_IT IPs .....	61
Table 13:R1_IT & R0_IT IPs .....	61

# Theory

In modern networking, creating efficient and secure network layouts is essential to allow devices and systems to communicate and share resources smoothly.

This project involved the use of Cisco Packet Tracer to simulate the creation of a network. Key concepts explored included static and dynamic routing protocols, the design of a wireless network architecture, and the implementation of fundamental network services (Web, Email, DNS, and DHCP) through dedicated servers.

Below, we discuss the theoretical foundation of the project's core components:

## A. Subnetting :

It is the process of dividing the network into several smaller logical networks known as subnetworks, which enhances the organization and security of the network, as each subnetwork can be monitored and controlled.

## B. Dynamic Host Configuration Protocol (DHCP) :

Dynamic Host Configuration Protocol is a network protocol used to automate the process of assigning IP addresses and other network configuration parameters to devices (such as computers, smartphones, and printers) on a network. Instead of manually configuring each device with an IP address, DHCP allows devices to connect to a network and receive all necessary network information, like IP address, subnet mask, default gateway, and DNS server addresses, automatically from a DHCP server.<sup>[1]</sup>

## **C. Domain Name System (DNS) :**

Domain Name System, it provides the following services:

- hostname to IP address translation.
- host aliasing
  - canonical, alias names.
- mail server aliasing.
- load distribution
  - replicated Web servers: many IP addresses correspond to one name. [2]

## **D. Email Protocols (SMTP and POP3) :**

### **➤ SMTP :**

SMTP (Simple Mail Transfer Protocol) is the standard protocol for sending emails between mail servers. It defines the rules and commands used to transmit email messages, including the sender's address, recipient's address, subject, and message body. SMTP ensures reliable and efficient delivery of emails across the internet.

### **➤ POP3 :**

POP3 (Post Office Protocol version 3) is an application-layer internet standard protocol used to retrieve emails from a mail server. It allows email clients to download messages from the server and store them locally on the user's device. POP3 typically deletes messages from the server after they are downloaded, making them inaccessible from other devices.

Table 1: The difference between SMTP and POP3

<b>Feature</b>	<b>SMTP</b>	<b>POP3</b>
<b>Purpose</b>	Sending emails	Retrieving emails
<b>Direction</b>	Client to server	Server to client
<b>Server interaction</b>	Transmits messages to the server	Downloads messages from the server
<b>Message storage</b>	Messages remain on the server	Messages typically deleted from server after download
<b>Access from multiple devices</b>	Yes	Limited
<b>Offline access</b>	No	Yes

## **E. Network Address Translation (NAT) :**

Network address translation (NAT) is a method of mapping an IP address space into another by modifying network address information in the IP header of packets while they are in transit across a traffic routing device.[3]

## **F. Routing Protocols :**

### **➤ Open Shortest Path First (OSPF) :**

Open Shortest Path First (OSPF) is a routing protocol for Internet Protocol (IP) networks. It uses a link state routing (LSR) algorithm.

➤ **Border Gateway Protocol (BGP) :**

Border Gateway Protocol (BGP) refers to a gateway protocol that enables the internet to exchange routing information between autonomous systems (AS). As networks interact with each other, they need a way to communicate. This is accomplished through peering.<sup>[4]</sup>

**G. Wireless LAN :**

A wireless local-area network (WLAN) enables devices to communicate within a limited area using radio waves instead of physical cables.

## **Procedure**

To implement this project, we start by designing the network topology in Cisco Packet Tracer, dividing it into three autonomous systems (AS): Google Network (AS-300), Faculty Network (AS-100), and Home-ISP Network (AS-200). Subnetting is performed to allocate IP addresses efficiently, integrating the team leader's SID to customize the addressing scheme. Static IP addresses are assigned to key devices like routers, printers, and servers, while dynamic IP assignment is enabled using DHCP for PCs and laptops. Various services are configured: DNS servers for domain name resolution, Email servers for communication using SMTP and POP3, Web servers for hosting custom pages, and DHCP servers to automate IP address distribution. Routing protocols are implemented, with OSPF handling intra-AS routing and BGP managing inter-AS communication. Wireless connectivity is set up with WPA2 encryption for security. NAT with PAT is configured on the home router to translate private IPs for internet access. The network is tested for functionality by performing ping tests, verifying service accessibility, and simulating DNS and email workflows. Finally, all configurations and results are documented in the project report, including screenshots, analysis, and a breakdown of team contributions, before submission.

## **Results and Discussions :**

### **Network Topology:**

We have constructed the topology shown in Figure 1, use the following devices :

1. Routers (Router-PT)
2. Switches (Switch-PT)
3. Access Point (AccessPoint-PT)
4. PCs/Laptops (PC-PT/Laptop-PT)
5. Smartphone (SMARTPHONE-PT)
6. Servers (Server-PT)
7. Printers (Printer-PT)
8. Tablet (TabletPC-PT)

The network topology consists of three Autonomous Systems (ASs):

- **Google Network:**
- **Faculty of Engineering and Technology Network:**
- **Home-ISP Network:**

These ASs are interconnected via three distinct links, as illustrated in Figure 1. The IP addresses for each network are specified in the figure.

### **IP Address Assignment:**

The variable "X" within the network IP addresses is replaced with the last two digits of the team leader's Student ID (SID). Since the team leader's SID is 12220549, X is substituted with 49.

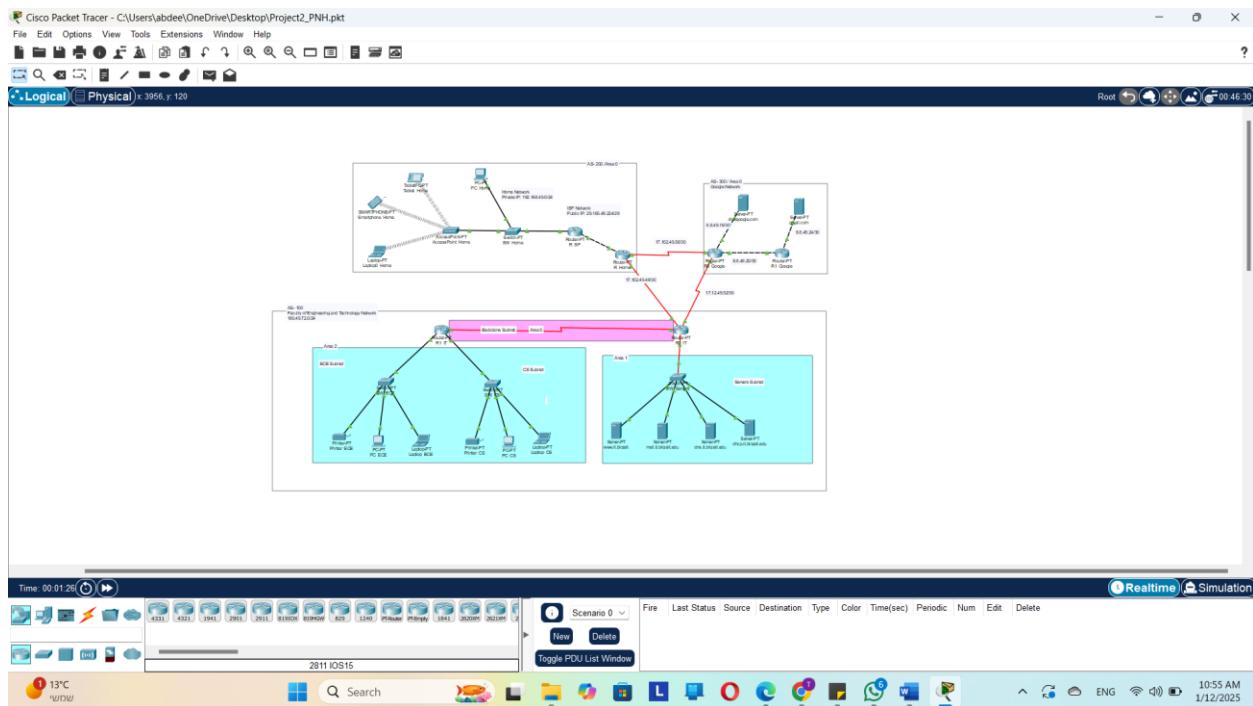


Figure 1: Network Topology

## ➤ Google Network (AS-300) :

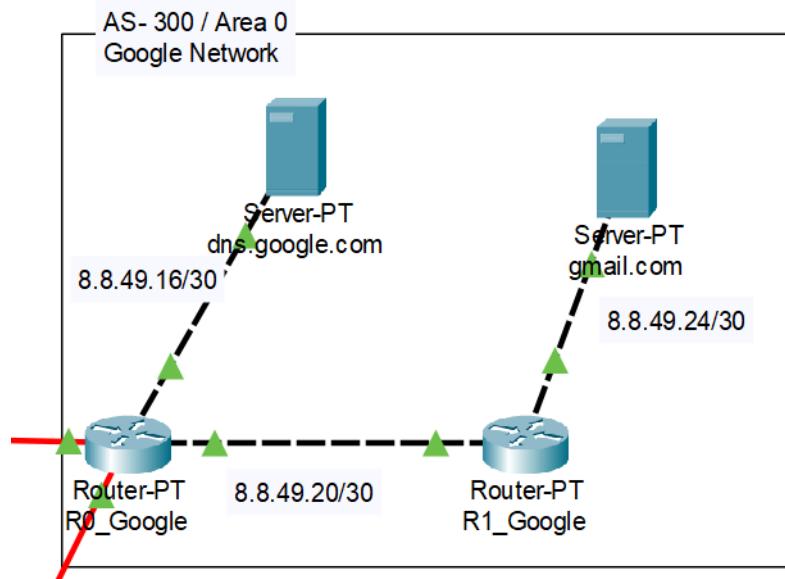


Figure 2: Google Network

We created this network in sequential steps as follows:

## 1. Router Port IP Configuration:

Static IP configurations have been successfully applied to all router ports.

- **R1\_Google & gmail.com:**

The IP address that connects them is: **8.8.49.24/30**, This means that the number of possible IPs is 4 IPs, calculated as follows:

$$2^{32-30} = 2^2 = 4$$
, but we can only use 2 IPs, 2 IPs for network IP and broadcast IP.

**8.8.49.25/30:** This IP is used for the interface between the router and the server from the router side.

**8.8.49.26/30:** This IP is used for the interface between the router and the server from the server side.

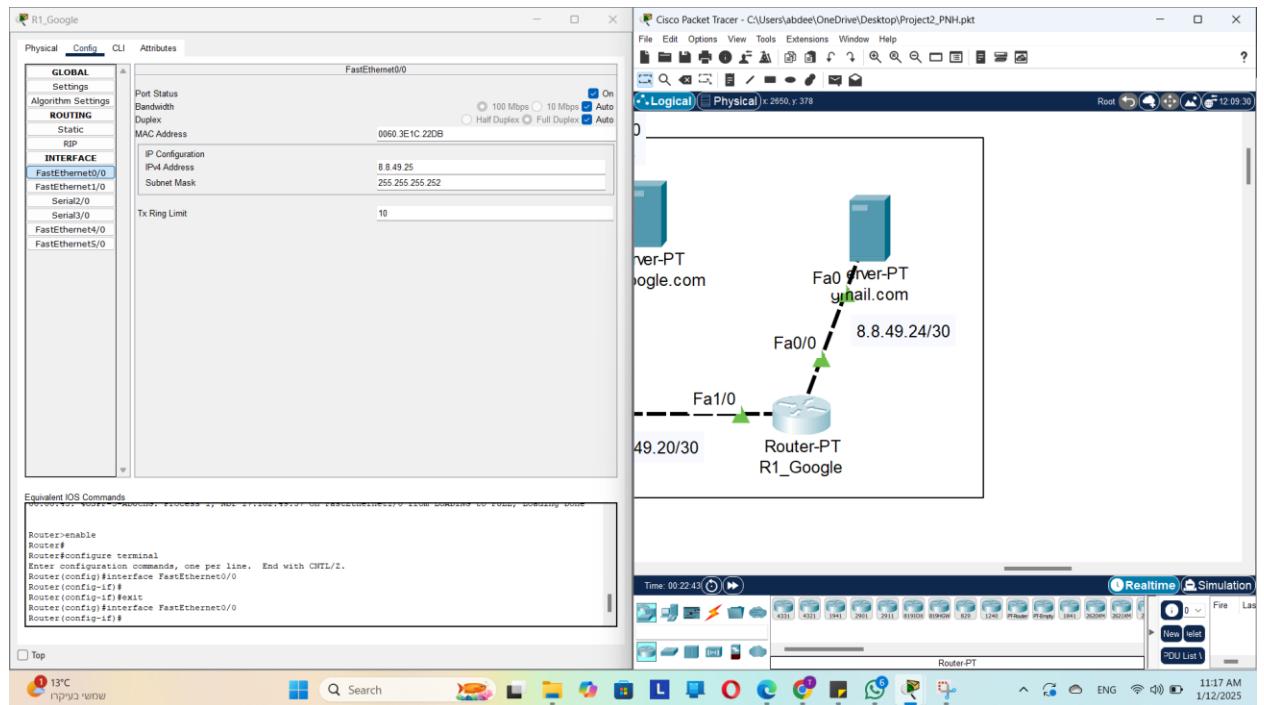


Figure 3: R1\_Google IP

- **R1\_Google & R0\_Google:**

The connecting IP address is **8.8.49.20/30**. This subnet allows for a total of 4 possible IP addresses, determined as follows:

$2^{32-30} = 2^2 = 4$ , However, only 2 IPs can be used, as 1 is reserved for the network address and another for the broadcast address.

**8.8.49.21/30:** This IP is used for the interface between the R1\_Google and R0\_Google from the R1\_Google side.

**8.8.49.22/30:** This IP is used for the interface between R0\_Google and R1\_Google from the R0\_Google side.

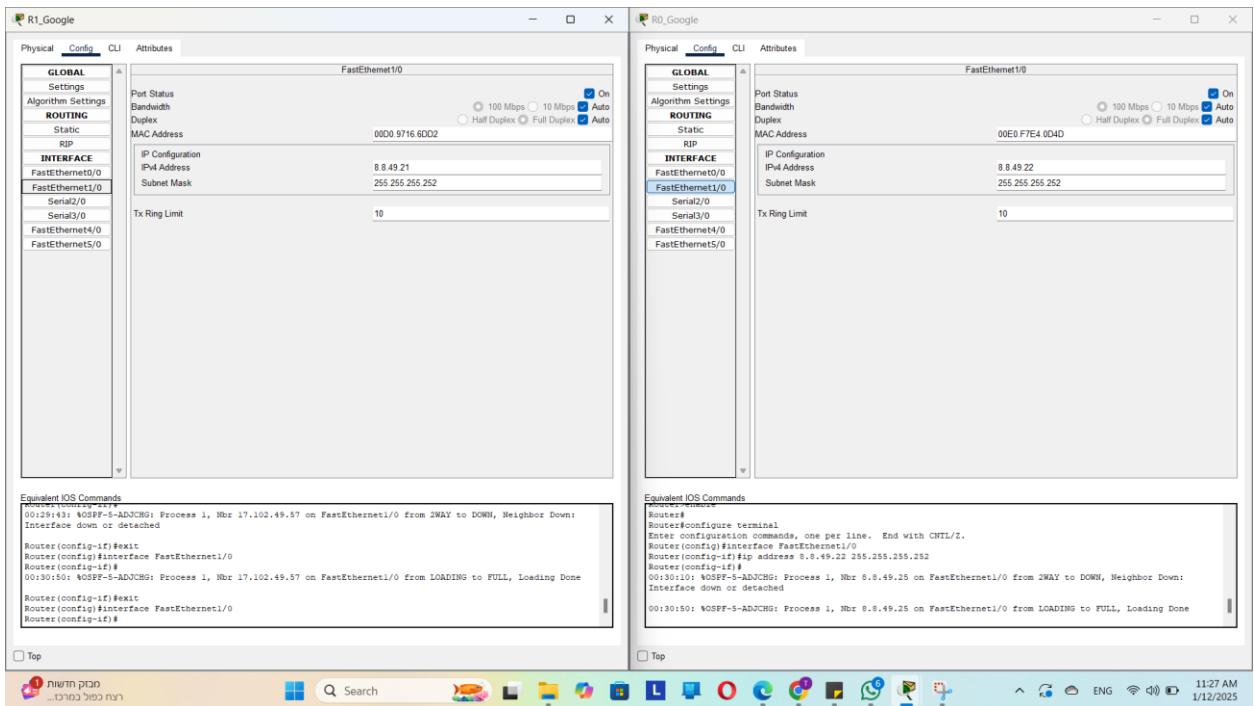


Figure 4: R1\_Google & R0\_Google IPs

- **R0\_Google & dns.google.com:**

With the IP address **8.8.49.16/30**, there are 4 possible IPs, as outlined in the calculation below:

$2^{32-30} = 2^2 = 4$ . Only 2 IPs are usable; the other 2 are reserved for the network and broadcast IPs.

**8.8.49.17:** This IP is used for the interface between the R0\_Google and dns.google.com from the R0\_Google side.

**8.8.49.18:** This IP is used for the interface between the dns.google.com and R0\_Google from the dns.google.com side.

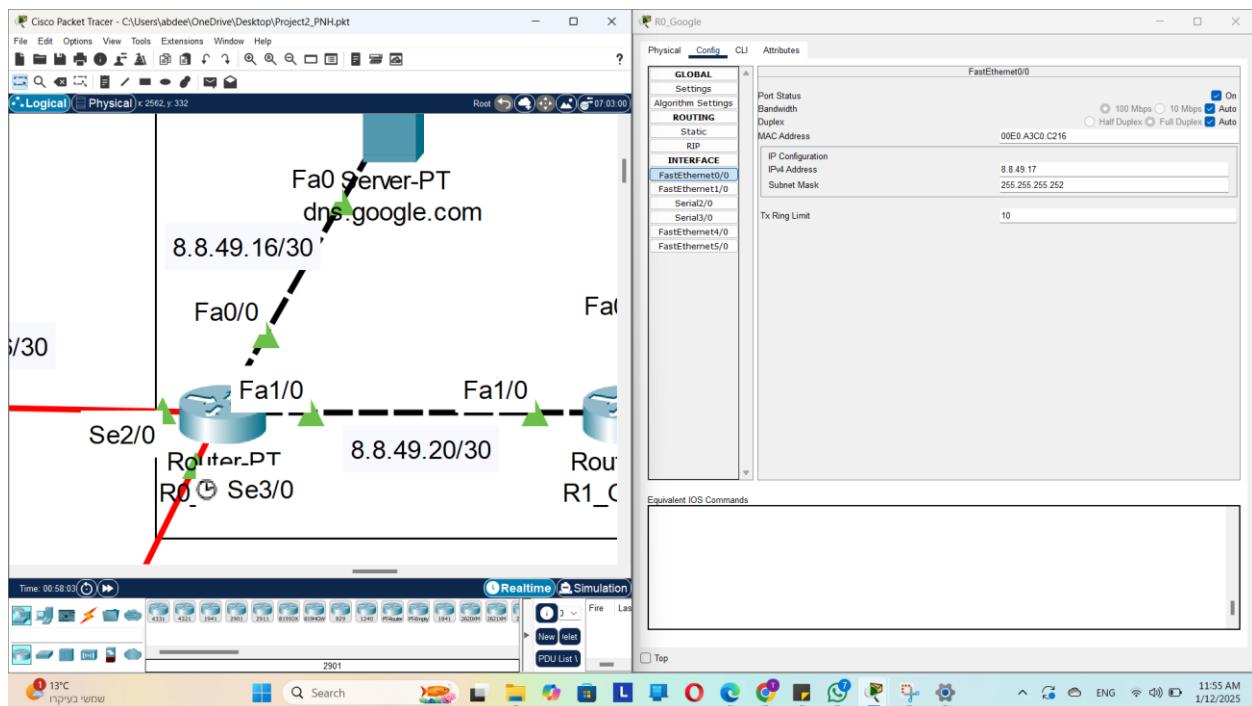


Figure 5: R0\_Google IP

## 2. Setting Up DNS Server with Resource Records:

- Configured the server to enable only the DNS service.

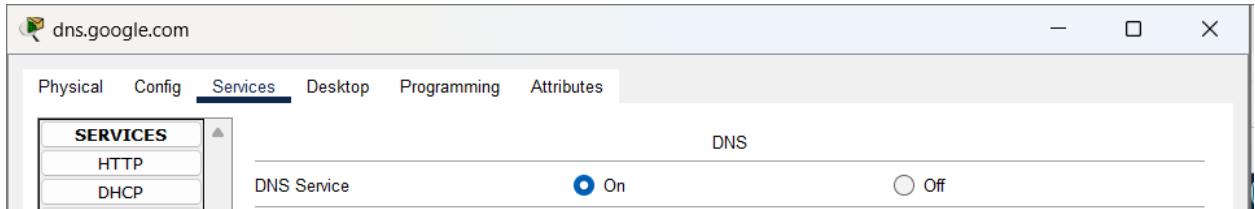


Figure 6: DNS Configuration

- Set up a static IP configuration

The server IP was assigned as outlined earlier.

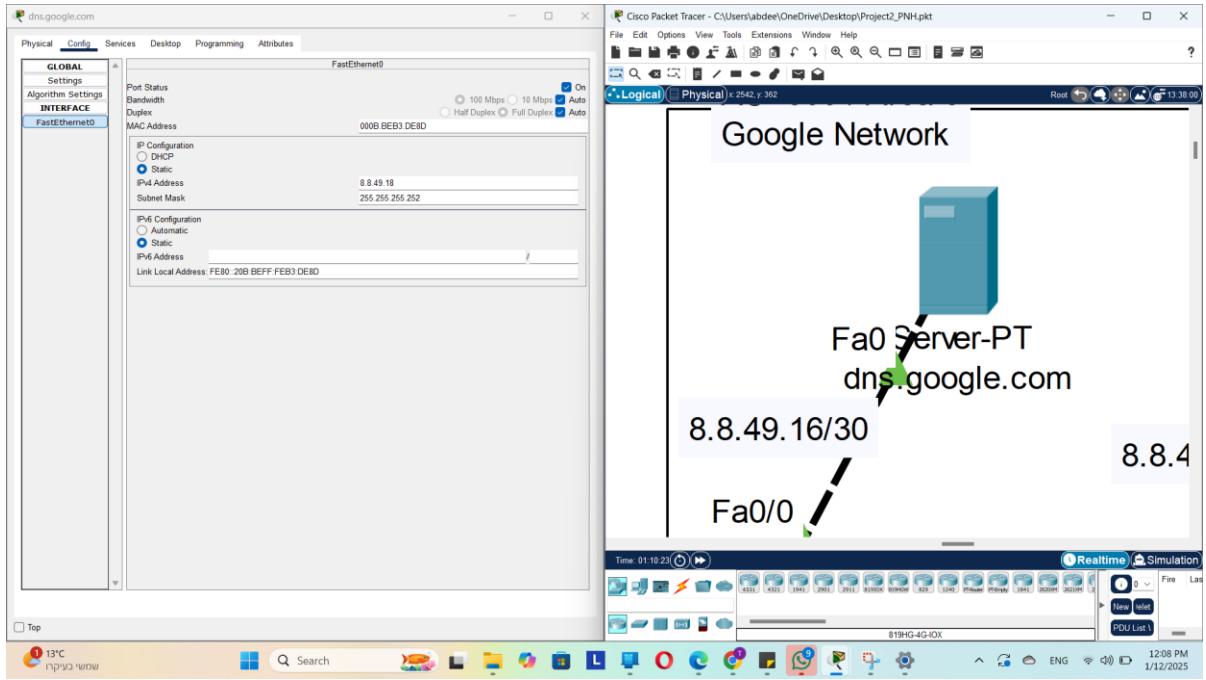


Figure 7:Server IP Configuration

- Included the following resource records (RRs):

Table 2: List of Resource Records (RRs)

Name	Value	Type
dns.google.com	8.8.49.18	A
A it.birzeit.edu	dns.it.birzeit.edu	NS
dns.it.birzeit.edu	180.49.72.36	A

Figure 8:SRRs Configured

### 3. Email Server Setup (gmail.com):

- SMTP & POP3 Enabled:

Set up SMTP (sending) and POP3 (receiving) protocols exclusively.

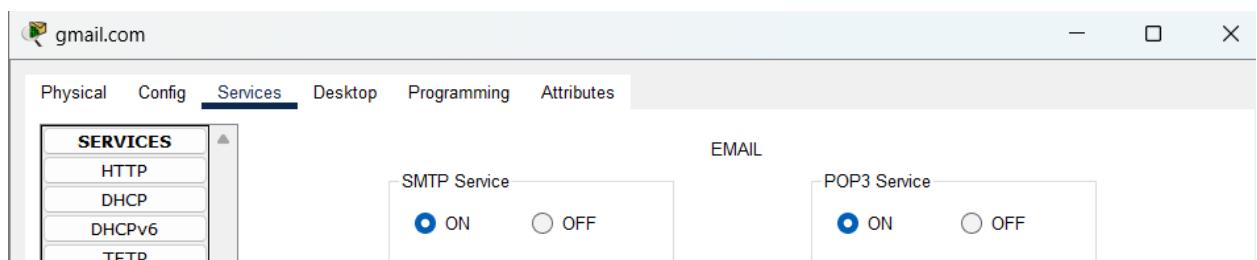


Figure 9: Email Protocols Setup

- **Configured static IP:**

The server IP was implemented as indicated previously.

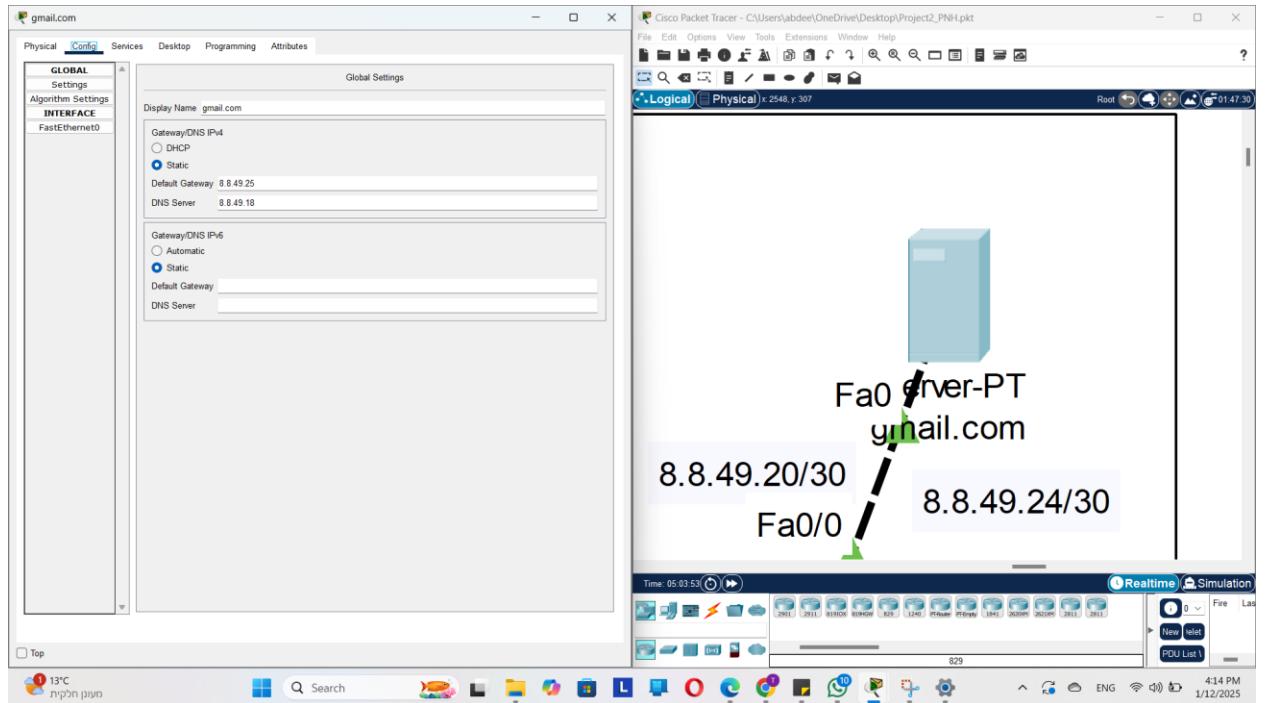


Figure 10: Email Server Configuration

- **Domain set to gmail.com**

Defined the domain name (mail server alias) as gmail.com.

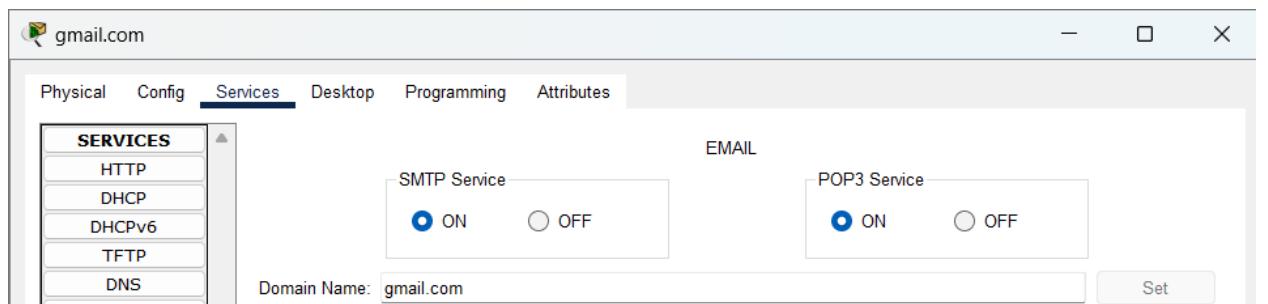


Figure 11: Hostname Setup

- Added two user accounts.

Added two user accounts for team members with the following details:

Table 3: Team Accounts Setup

Username	Password
abdeen_toqa	122049
ammar_mohammad	1212402
diebas_omar	1210243

The

email address will adhere to the structure: [LastName\\_FirstName@gmail.com](mailto:LastName_FirstName@gmail.com).

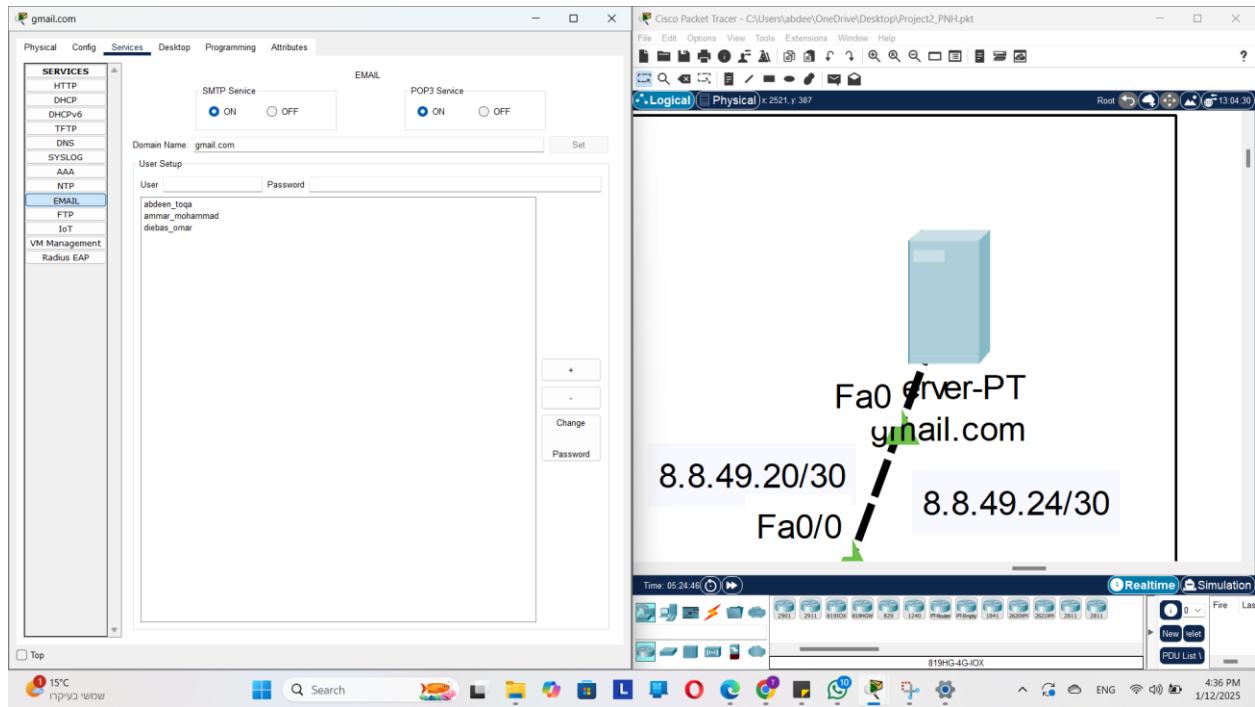


Figure 11: Team Accounts Setup

### **Operation and Functionality of the Google Network (AS-300):**

The Google Network will be an autonomous system, AS-300, which will be used for domain-specific services and efficient data exchange. It resolves domain names to IP addresses, enabling devices to communicate with each other. Routing within the network ensures that packets of data are always forwarded along the most efficient paths, using protocols to maintain the best performance. The network communicates with other networks, such as Faculty and Home-ISP, regarding routing information, while it also accesses services through the links that it is connected to. Requests being processed that might be within AS-300-for example, domain lookups or email exchange-are forwarded effectively to wherever they need to go, whether the task operation involves local communication or interaction with external systems.

## ➤ Faculty of Engineering and Technology Network (AS-100)

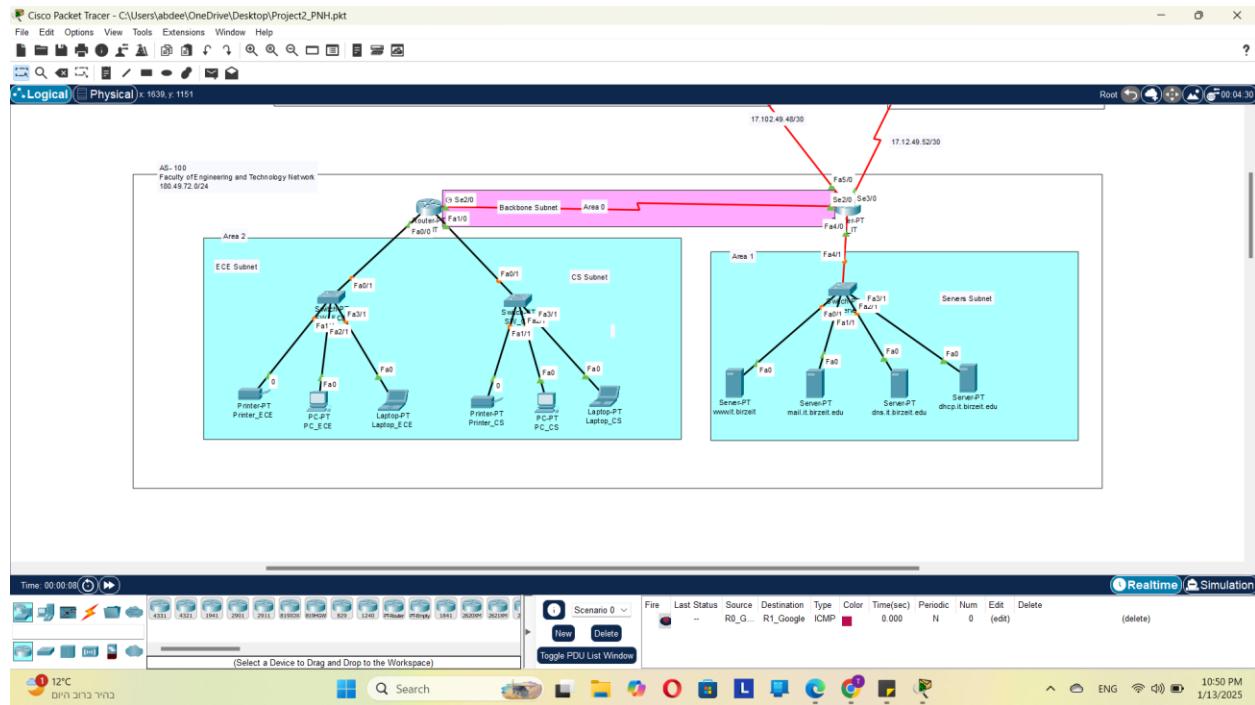


Figure 12: Faculty of Engineering and Technology Network

We developed this network through a series of sequential steps, as outlined below:

### 1. IP Allocation and Subnet Distribution:

The Faculty of Engineering and Technology has been assigned the IP address range 180.49.72.0/24 by the Information Technology Department .

The IP addresses are distributed as follows:

- Electrical and Computer Engineering (ECE) Subnet: Requires 120 IP addresses → Allocates 128 IPs →  $2^7 = /25$
- Computer Science (CS) Subnet: Requires 55 IP addresses → Allocates **64 IPs** →  $2^6 = /26$
- Servers Subnet: Requires 28 IP addresses → Allocates 32 IPs →  $2^5 = /27$
- Backbone Subnet: Requires 4 IP addresses → Allocates 4 IPs →  $2^2 = /30$

Table 4: IP Address Distribution

Subnet	IP address (in CIDR notation)	Subnet Mask	Broadcast IP	First usable host IP address	Last usable host IP address
ECE	180.49.72.128/25	255.255.255.128	180.49.72.255	180.49.72.129	180.49.72.254
CS	180.49.72.64/26	255.255.255.192	180.49.72.127	180.49.72.65	180.49.72.126
Servers Subnet	180.49.72.32/27	255.255.255.224	180.49.72.63	180.49.72.33	180.49.72.62
Backbone Subnet	180.49.72.4/30	255.255.255.252	180.49.72.7	180.49.72.5	180.49.72.6

## 2. Subnet Requirements Defined:

- Servers Subnet:

- a. Web Server ([www.it.birzeit.edu](http://www.it.birzeit.edu)):

- ❖ HTTP/HTTPS Protocols Enabled:

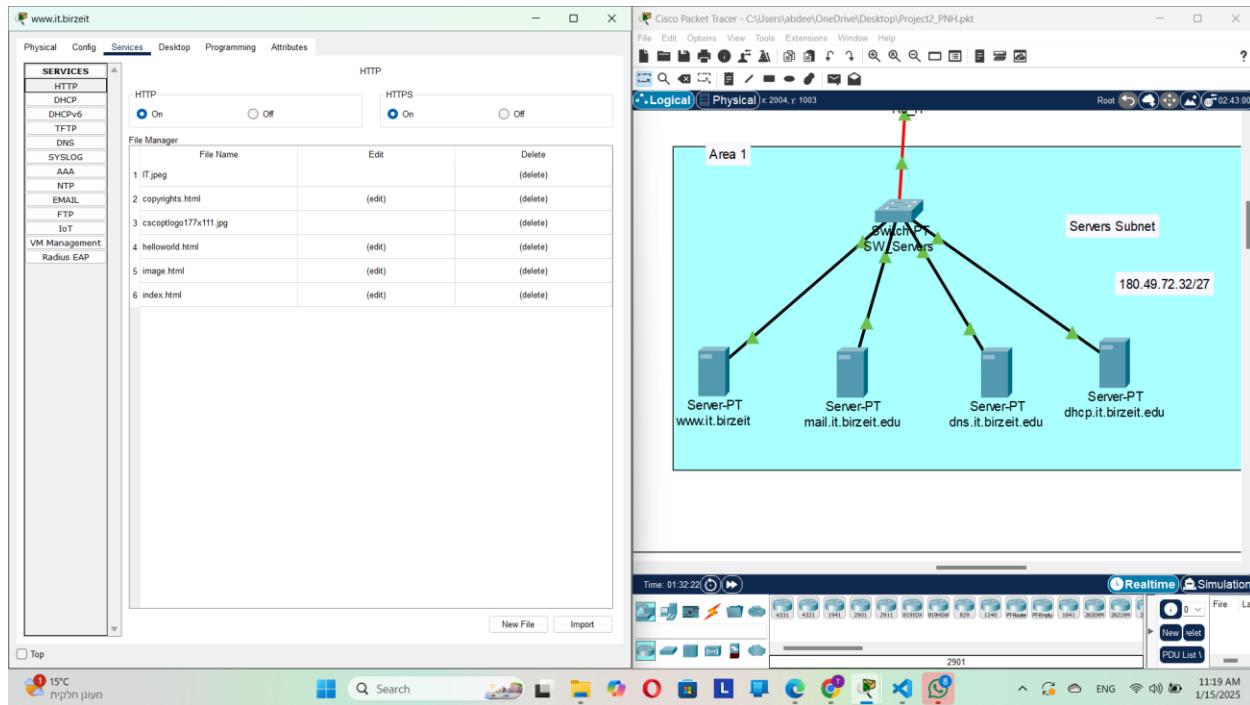


Figure 13 : HTTP Configuration

## ❖ Establish a static IP configuration:

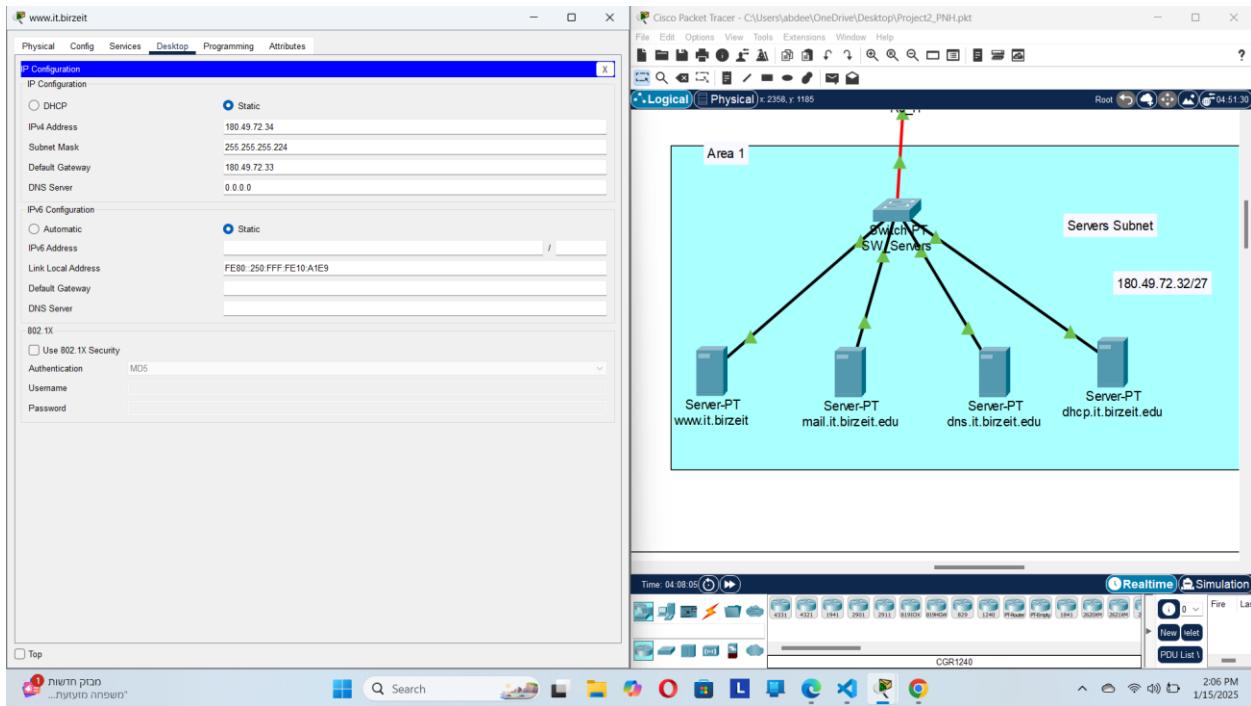


Figure 14 : HTTP Server IP Configuration

❖ Index.html page customized:

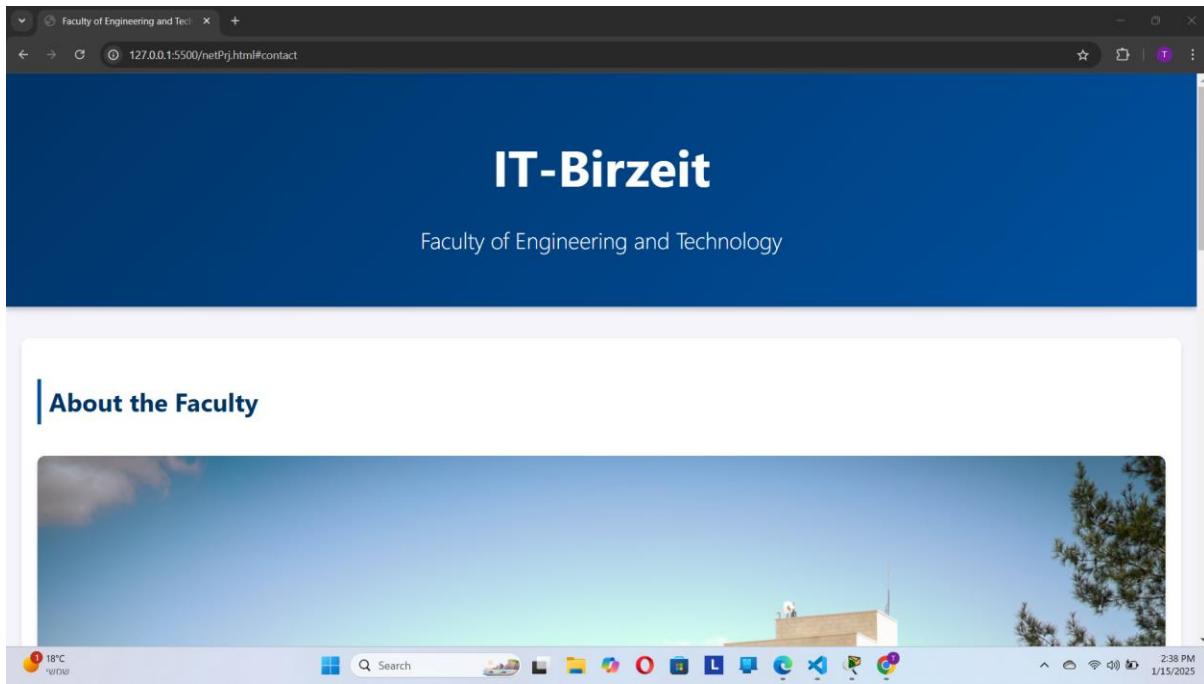


Figure 15 : Index Page -1

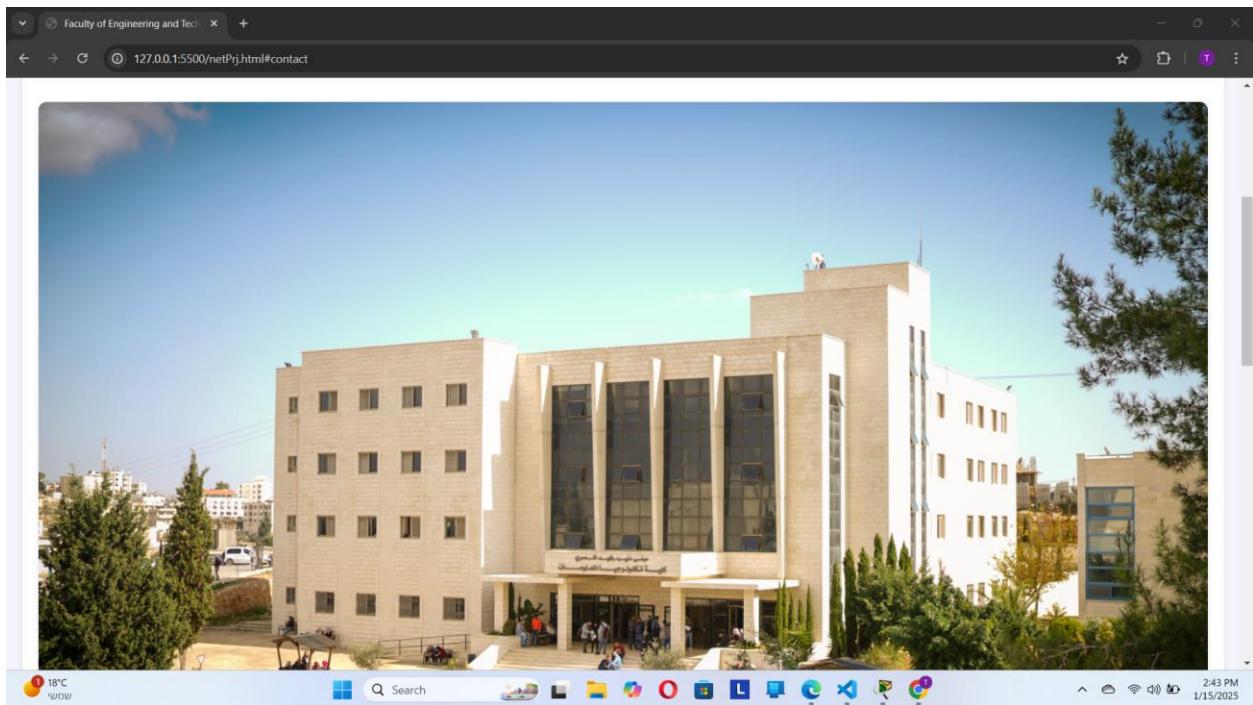


Figure 15 : Index Page -2

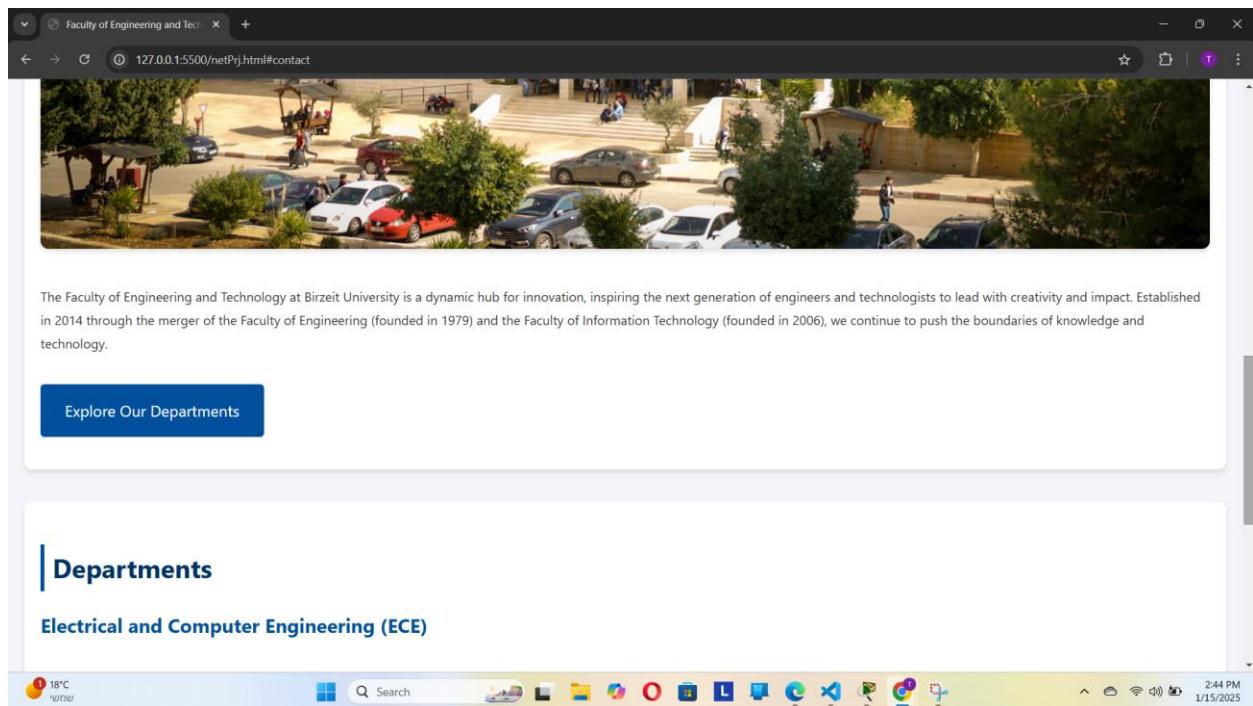


Figure 15 : Index Page -3

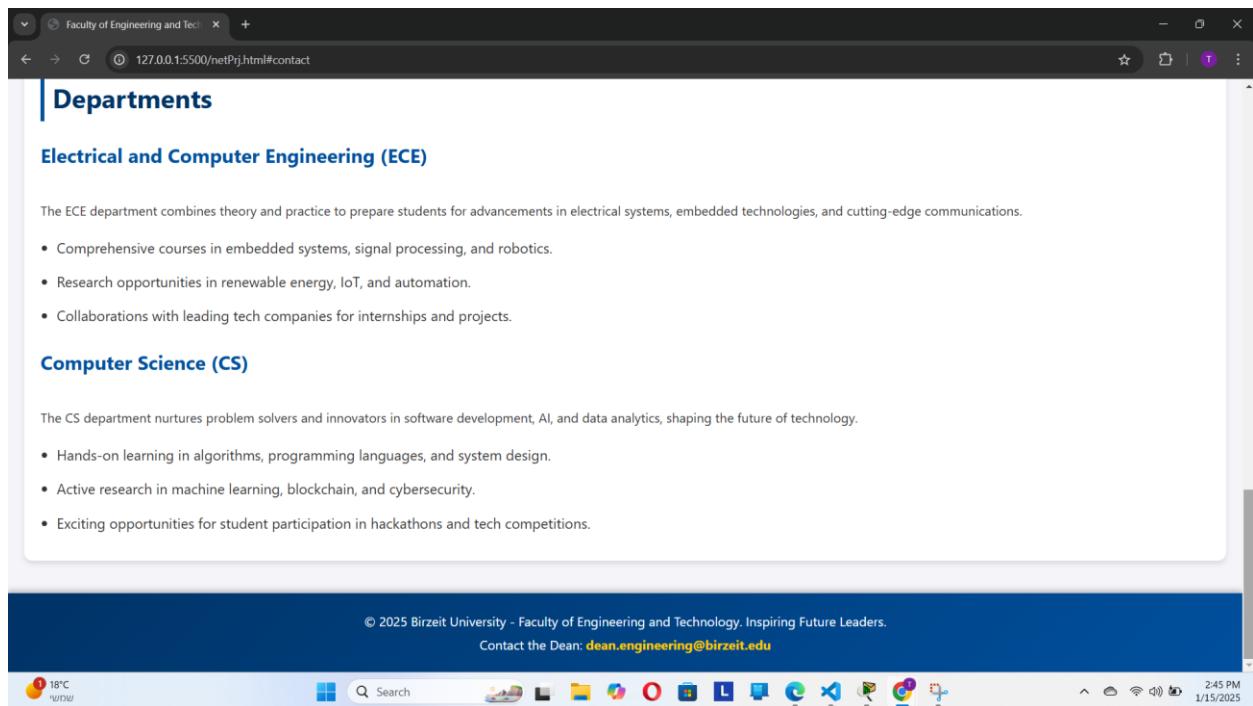


Figure 15 : Index Page -4

## **Index.html code:**

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Faculty of Engineering and Technology</title>
    <style>
      body {
        font-family: "Segoe UI", Tahoma, Geneva, Verdana, sans-serif;
        margin: 0;
        padding: 0;
        background-color: #f4f4f9;
        color: #333;
        line-height: 1.8;
      }
      header {
        background: linear-gradient(135deg, #003366, #00509e);
        color: white;
        padding: 60px 20px;
        text-align: center;
        box-shadow: 0 4px 6px rgba(0, 0, 0, 0.2);
        position: relative;
        overflow: hidden;
      }
      header h1 {
        margin: 0;
        font-size: 4rem;
        font-weight: bold;
        animation: fadeIn 2s ease-in-out;
      }
      header h2 {
        margin: 10px 0 0;
        font-size: 1.8rem;
        font-weight: lighter;
        animation: fadeIn 3s ease-in-out;
      }
      @keyframes fadeIn {
        0% { opacity: 0; }
        100% { opacity: 1; }
      }
    </style>
  </head>
  <body>
    <header>
      <h1>Faculty of Engineering and Technology</h1>
      <h2>About Us</h2>
      <h2>Programmes</h2>
      <h2>Facilities</h2>
      <h2>Contact Us</h2>
    </header>
    <h1>Faculty of Engineering and Technology</h1>
    <p>The Faculty of Engineering and Technology (FET) is a leading institution in providing quality engineering education. We offer a wide range of undergraduate and postgraduate programmes in various fields of engineering. Our faculty consists of highly qualified and experienced professionals who are dedicated to the success of our students. We believe in the motto of "Excellence through Education" and strive to provide an excellent learning environment for our students. We are committed to the development of our students both academically and personally, and we encourage them to pursue their dreams and aspirations. We are always looking for ways to improve our programmes and services, and we welcome suggestions and feedback from our students and stakeholders. We are proud of our achievements and look forward to continuing our tradition of excellence in the years to come.</p>
  </body>
</html>
```

```
from {
    opacity: 0;
}
to {
    opacity: 1;
}
}

section {
    margin: 40px 20px;
    padding: 20px;
    background: white;
    border-radius: 10px;
    box-shadow: 0 4px 6px rgba(0, 0, 0, 0.1);
}

section h3 {
    border-left: 5px solid #00509e;
    padding-left: 10px;
    color: #003366;
    font-size: 2rem;
    margin-bottom: 20px;
}

section h4 {
    color: #00509e;
    font-size: 1.5rem;
    margin-top: 20px;
}

img {
    max-width: 100%;
    height: auto;
    border-radius: 10px;
    margin: 20px 0;
    box-shadow: 0 4px 6px rgba(0, 0, 0, 0.1);
    transition: transform 0.3s ease;
}

img:hover {
    transform: scale(1.05);
}

ul {
    margin: 10px 0;
    padding-left: 20px;
```

```
list-style-type: disc;
}
ul li {
    margin: 10px 0;
    font-size: 1.1rem;
}
.cta-button {
    display: inline-block;
    margin: 20px 0;
    padding: 15px 30px;
    background: #00509e;
    color: white;
    text-decoration: none;
    border-radius: 5px;
    font-size: 1.2rem;
    transition: background 0.3s ease;
}
.cta-button:hover {
    background: #003366;
}
footer {
    background: linear-gradient(135deg, #003366, #00509e);
    color: white;
    text-align: center;
    padding: 20px;
    margin-top: 40px;
    box-shadow: 0 -4px 6px rgba(0, 0, 0, 0.2);
}
footer p {
    margin: 0;
    font-size: 1rem;
}
footer a {
    color: #ffcc00;
    text-decoration: none;
    font-weight: bold;
}
footer a:hover {
    text-decoration: underline;
}
```

```

</style>
</head>
<body>
<header>
    <h1>IT-Birzeit</h1>
    <h2>Faculty of Engineering and Technology</h2>
</header>

<section>
    <h3>About the Faculty</h3>
    
    <p>
        The Faculty of Engineering and Technology at Birzeit University is
    a
        dynamic hub for innovation, inspiring the next generation of
    engineers
        and technologists to lead with creativity and impact. Established
    in
        2014 through the merger of the Faculty of Engineering (founded in
    1979)
        and the Faculty of Information Technology (founded in 2006), we
    continue
        to push the boundaries of knowledge and technology.
    </p>
    <a href="#departments" class="cta-button">Explore Our
    Departments</a>
</section>

<section id="departments">
    <h3>Departments</h3>

    <h4>Electrical and Computer Engineering (ECE)</h4>
    <p>
        The ECE department combines theory and practice to prepare
    students for
        advancements in electrical systems, embedded technologies, and
        cutting-edge communications.
    </p>
    <ul>
        <li>

```

Comprehensive courses in embedded systems, signal processing, and robotics.

</li>

<li>

Research opportunities in renewable energy, IoT, and automation.

</li>

<li>

Collaborations with leading tech companies for internships and projects.

</li>

</ul>

<h4>Computer Science (CS)</h4>

<p>

The CS department nurtures problem solvers and innovators in software development, AI, and data analytics, shaping the future of technology.

</p>

<ul>

<li>

Hands-on learning in algorithms, programming languages, and system design.

</li>

<li>

Active research in machine learning, blockchain, and cybersecurity.

</li>

<li>

Exciting opportunities for student participation in hackathons and tech competitions.

</li>

</ul>

</section>

<footer id="contact">

<p>

&copy; 2025 Birzeit University - Faculty of Engineering and Technology.

Inspiring Future Leaders.

</p>

<p>

Contact the Dean:

<a href="mailto:dean.engineering@birzeit.edu"

>dean.engineering@birzeit.edu</a

>

</p>

</footer>

</body>

</html>

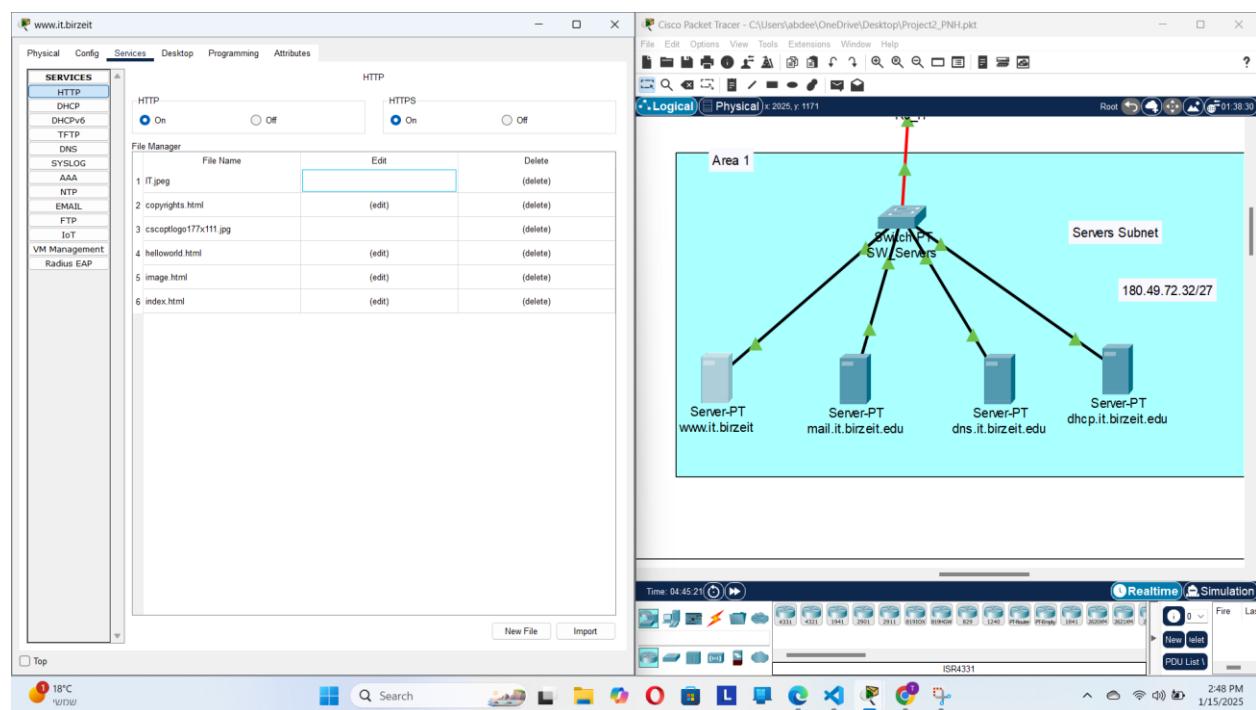


Figure 16 : Edit the Index.html Page

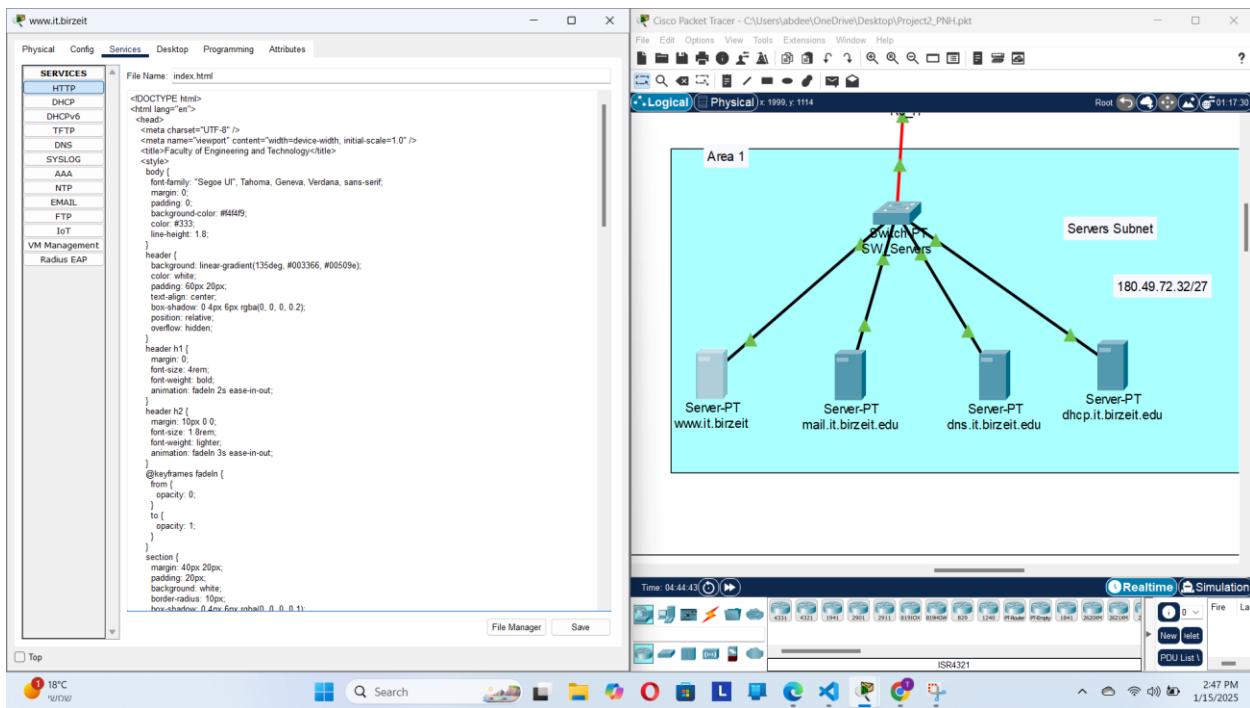


Figure 17 : Index Page For Web Server

## b. Mail Server (mail.it.birzeit.edu):

### ❖ SMTP (send) and POP3 (receive) activated:

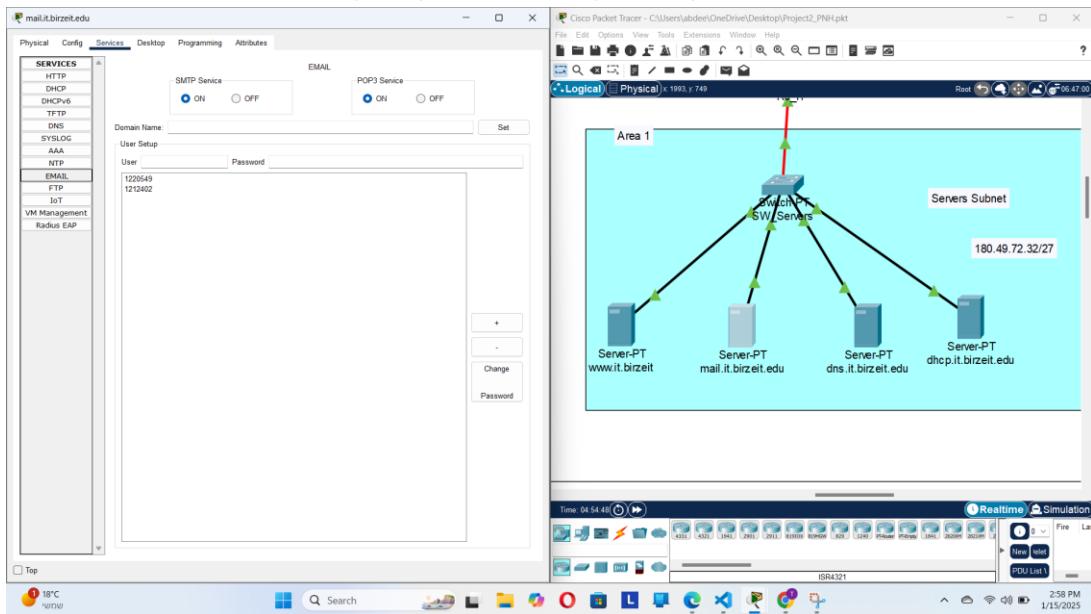


Figure 18 : Set Up Email Communication Protocols

### ❖ Set up a fixed IP address configuration:

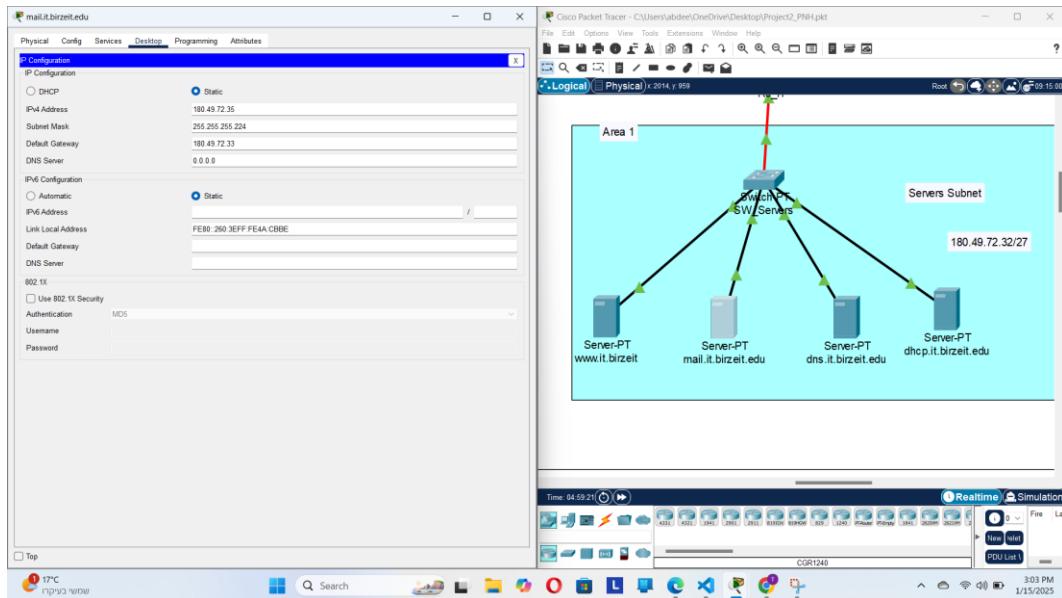


Figure 19 : Configure Static IP For Mail Server

- ❖ Assign the domain name to **it.birzeit.edu**.
- ❖ Set up two user accounts for team members as detailed below:

Table 5: Team Accounts Setup

Username	Password
1220549	1220549
1212402	1212402

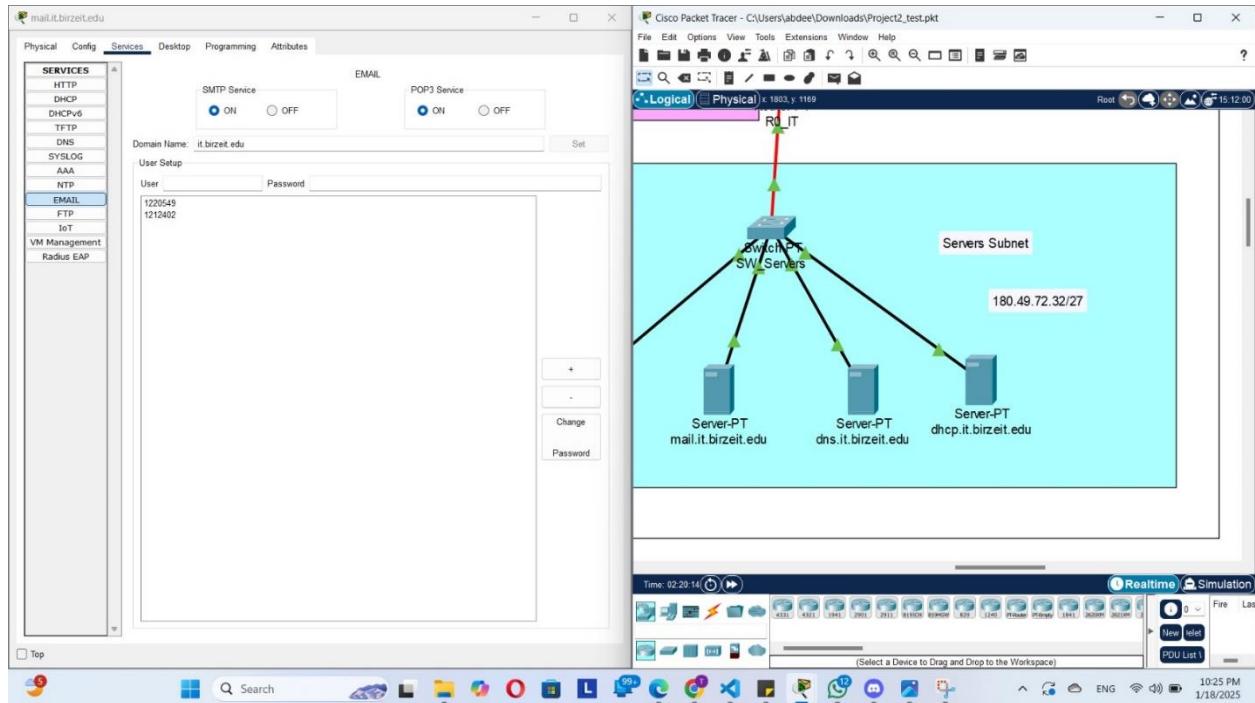


Figure 20 : Create Team User Accounts in Mail Server

**c. DNS Server (dns.it.birzeit.edu):**

**❖ DNS service set up and running**

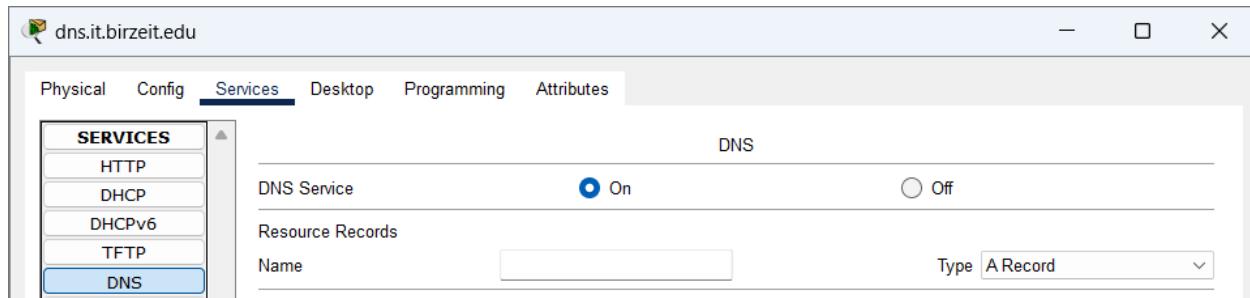


Figure 20 : Turn On DNS Service

**❖ Add Required Resource Records (RRs)**

Table 6: List of Resource Records (RRs)

Name	Value	Type
www.it.birzeit.edu	180.49.72.34	A
mail.it.birzeit.edu	180.49.72.35	A
dns.google.com	8.8.49.18	A
gmail.com	dns.google.com	NS
it.birzeit.edu	mail.it.birzeit.edu	CNAME

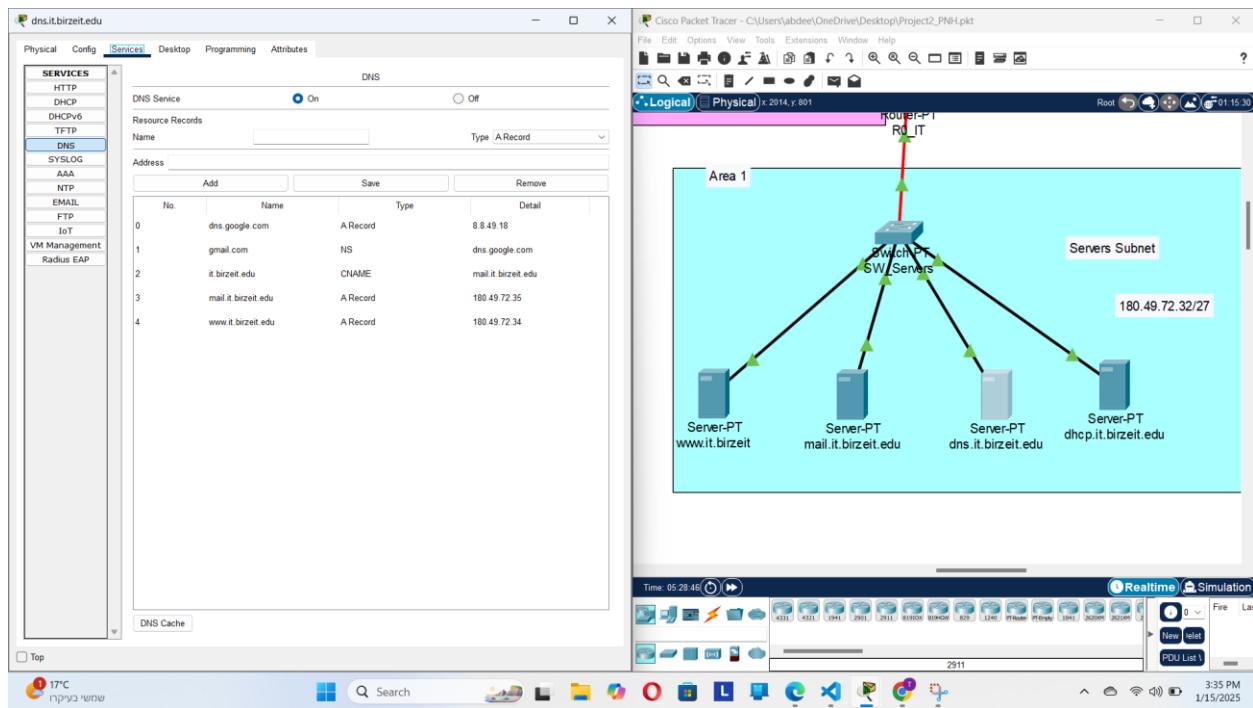


Figure 21 : List of Resource Records (RRs)

#### d. DHCP Server (dhcp.it.birzeit.edu):

##### ❖ DHCP services Enabled:

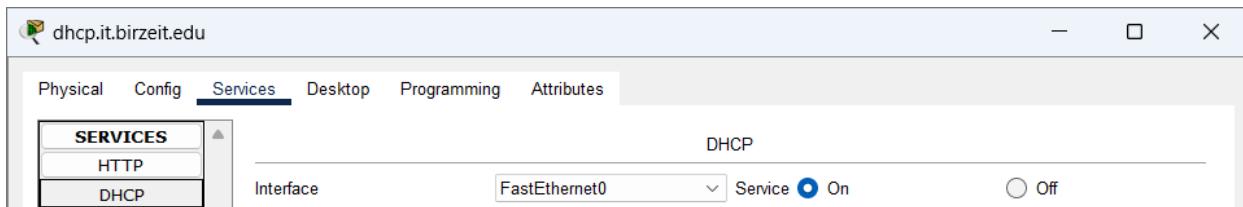


Figure 22 : DHCP Configuration

##### ❖ Establish a static IP configuration:

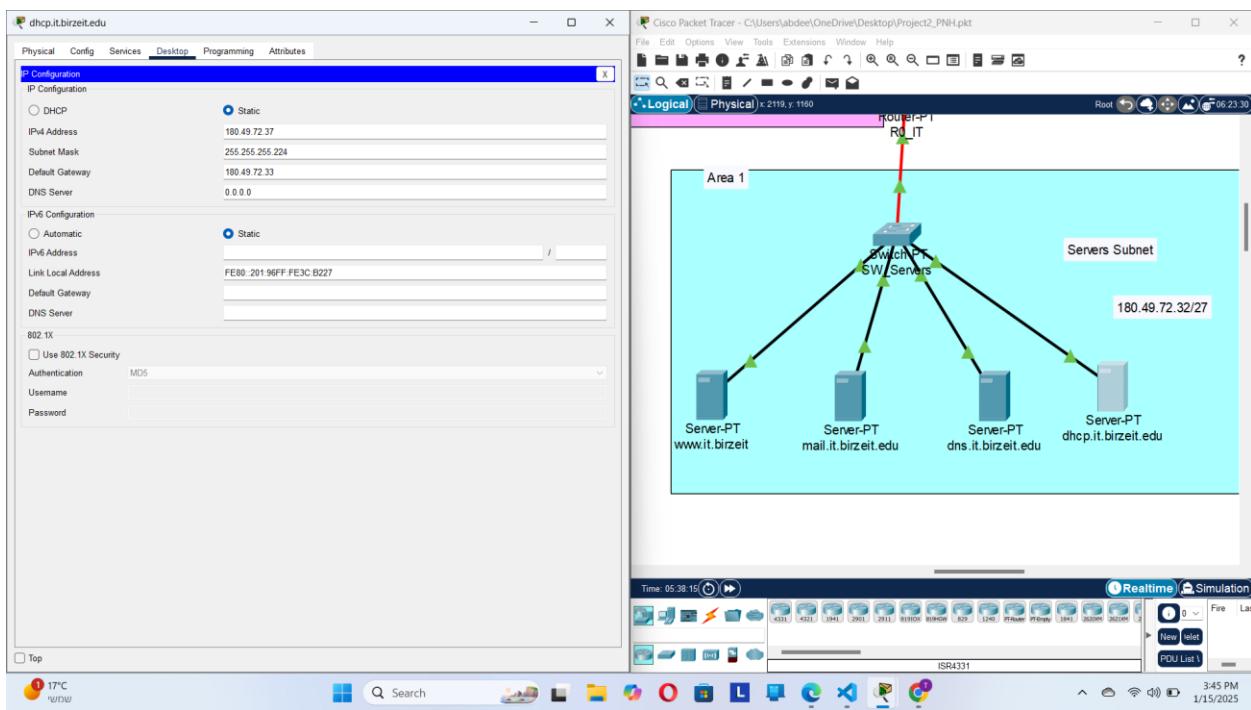


Figure 23 : DHCP Server IP Configuration

- ❖ Dedicated pools for ECE and CS subnets set up as follow:

Table 7: ECE\_Pool and CS\_Pool Details

Pool	Default Gateway	DNS Server	Start IP Address	Subnet Mask	Maximum Number of Users
ECE_Pool	180.49.72.129	180.49.72.36	180.49.72.139	255.255.255.128	116
CS_Pool	180.49.72.65	180.49.72.36	180.49.72.75	255.255.255.192	52

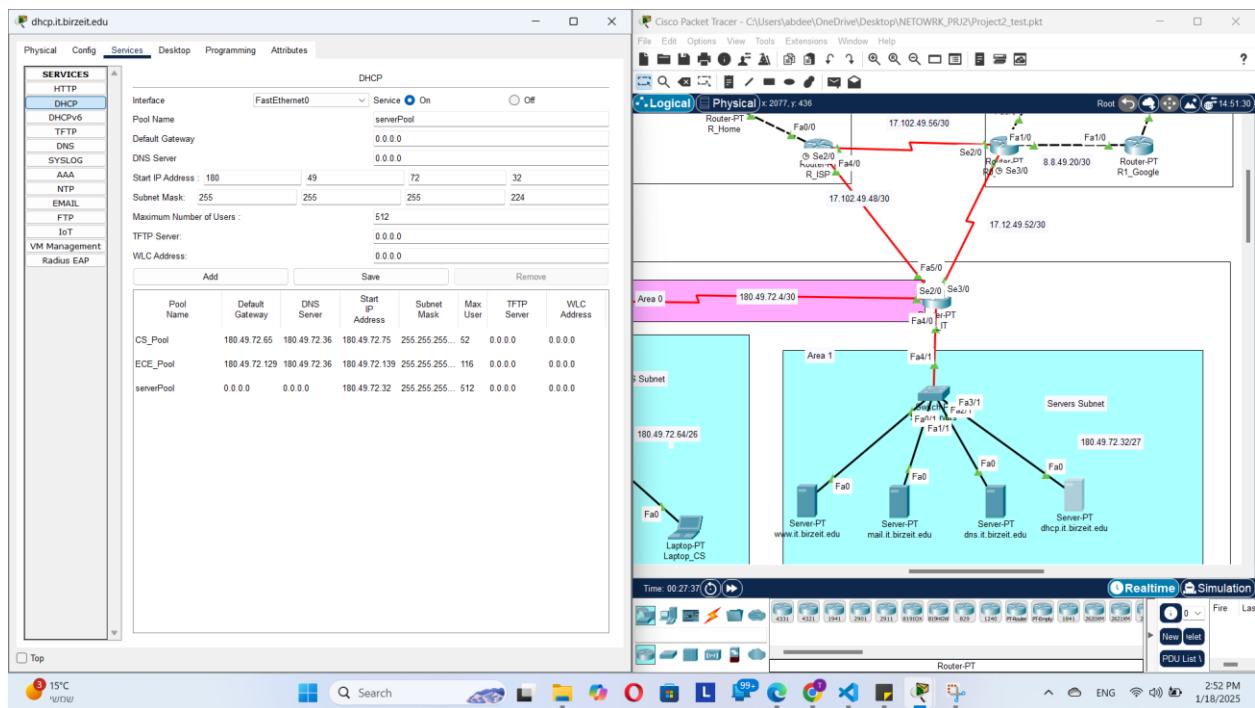


Figure 24 : Configured Pools for ECE and CS Subnets

❖ R1\_IT Router Configured for DHCP Broadcast Forwarding:

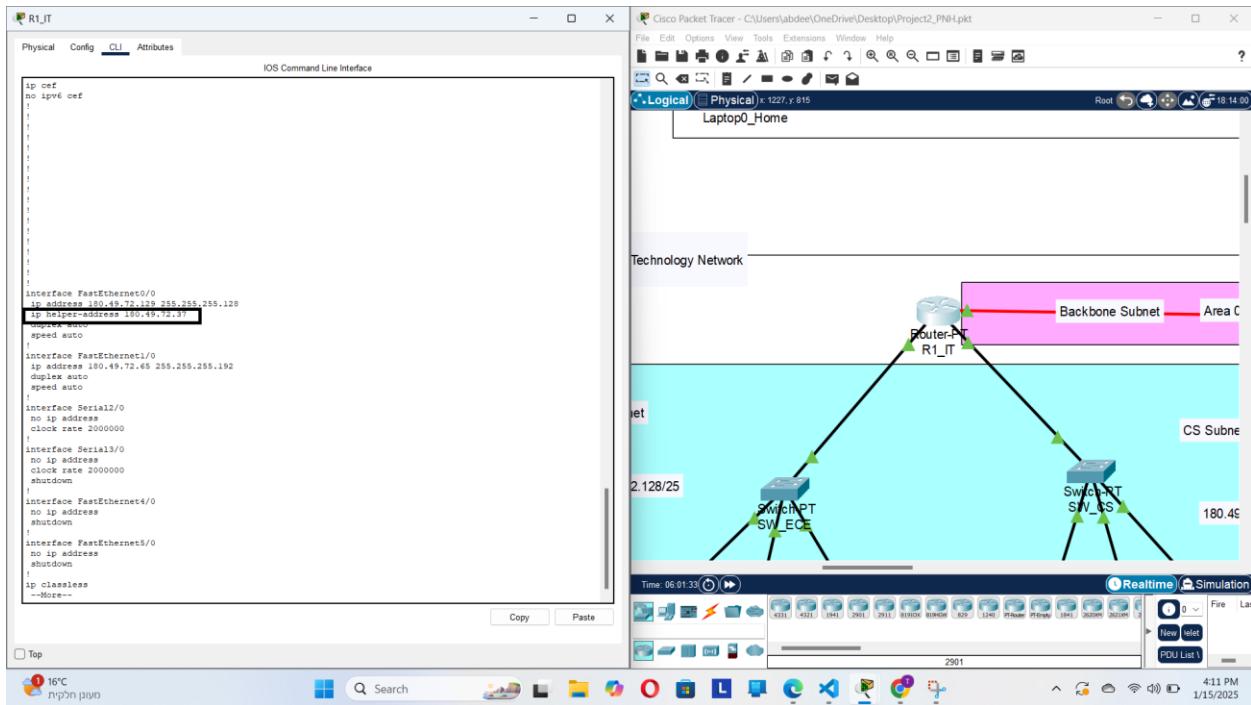


Figure 25 : IP Helper Configuration for ECE and CS Networks

- ECE Subnet:
- ❖ R1\_IT configured with a static IP address:

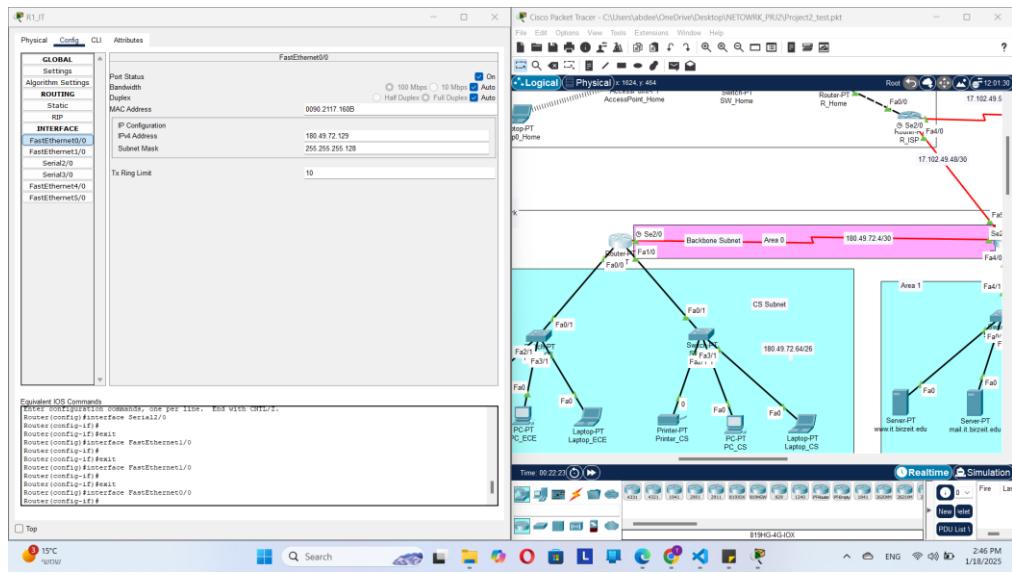


Figure 25 :R1\_IT Static IP Configuration in ECE Subnet

- ❖ Printer configured with a static IP address:

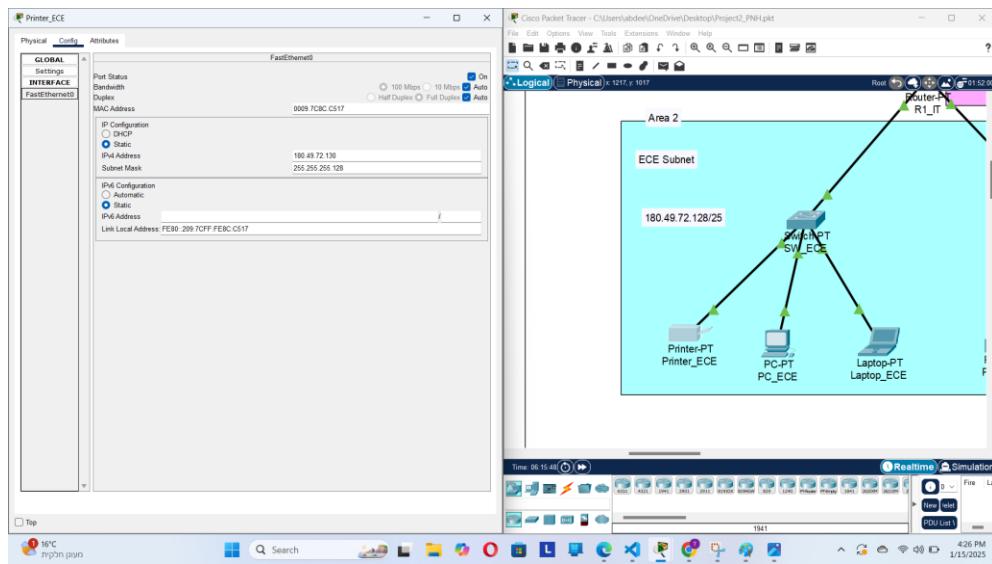


Figure 26 :Printer Static IP Configuration in ECE Subnet

❖ PC and laptop configured with a dynamic IP address:

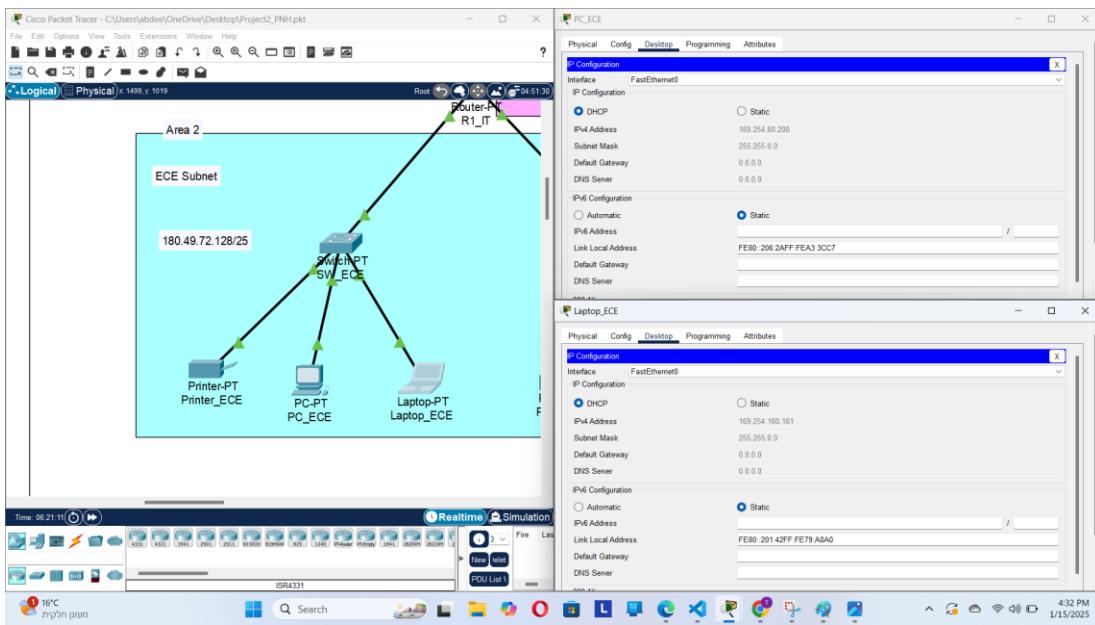


Figure 27 :PC and Laptop Dynamic IP Configuration in ECE Subnet

❖ Set Up First Gmail Account on the PC's Email Client

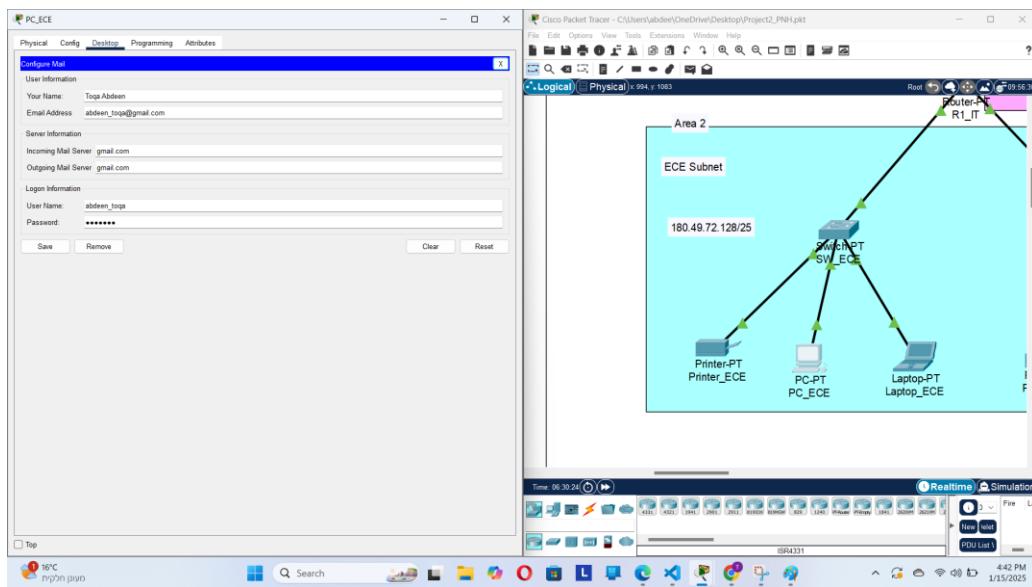


Figure 28: Setting Up First Gmail Account on Email Client

## ❖ Set Up First Birzeit Email on the Laptop's Email Client

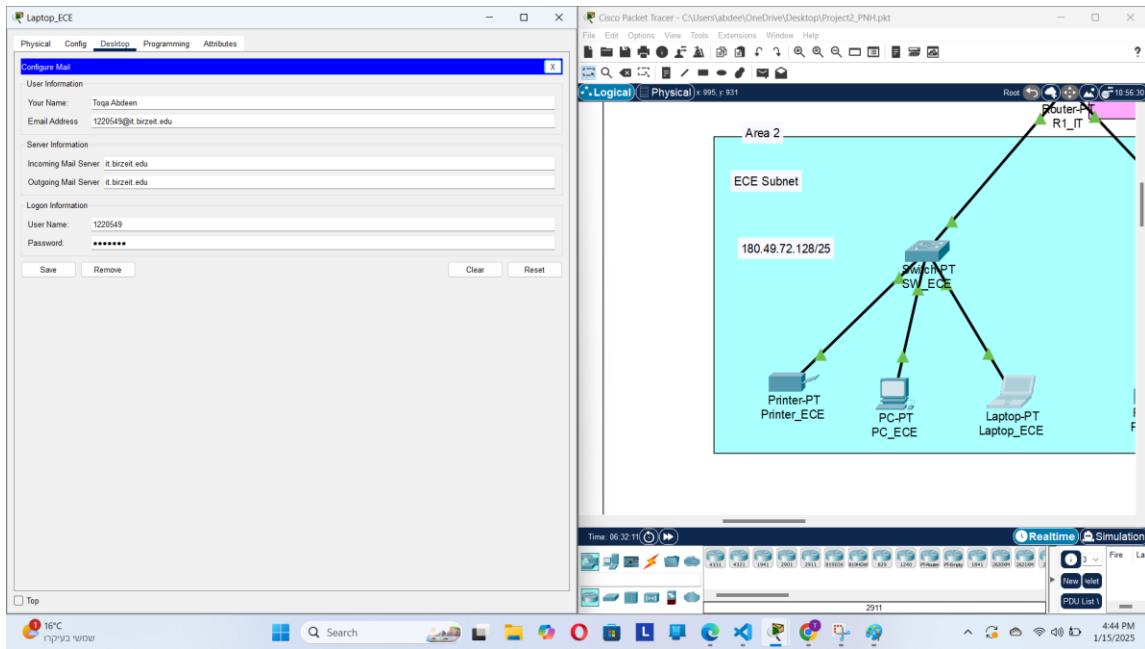


Figure 29: Setting Up First Birzeit Account on Email Client

- CS Subnet:
  - ❖ R1\_IT configured with a static IP address:

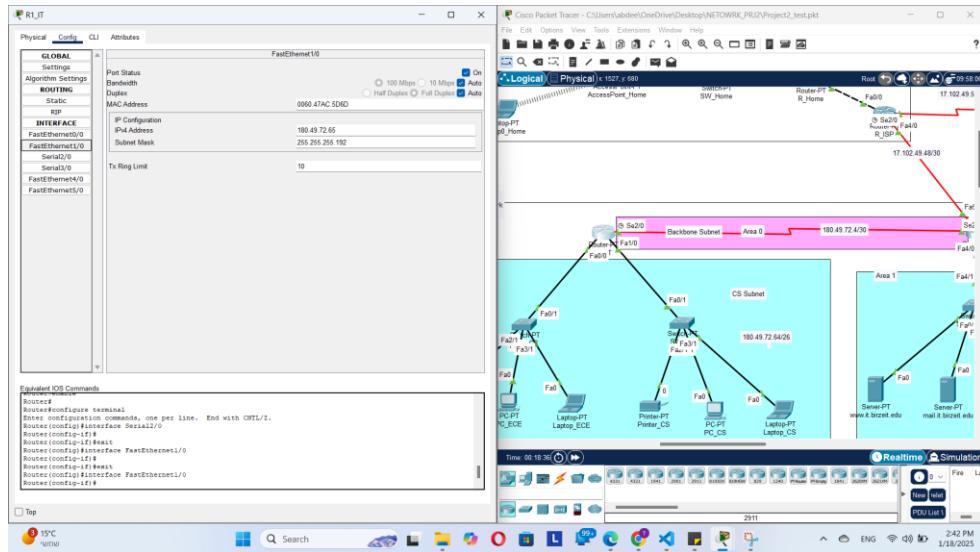


Figure 29 :R1\_IT Static IP Configuration in CS Subnet

- ❖ Printer configured with a static IP address:

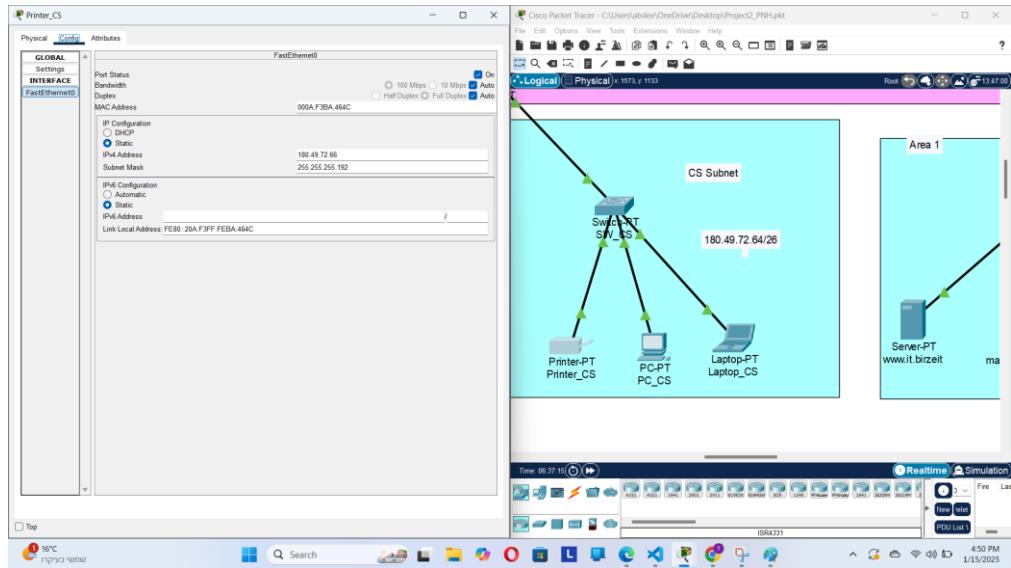


Figure 30 :Printer Static IP Configuration in CS Subnet

❖ PC and laptop configured with a dynamic IP address:

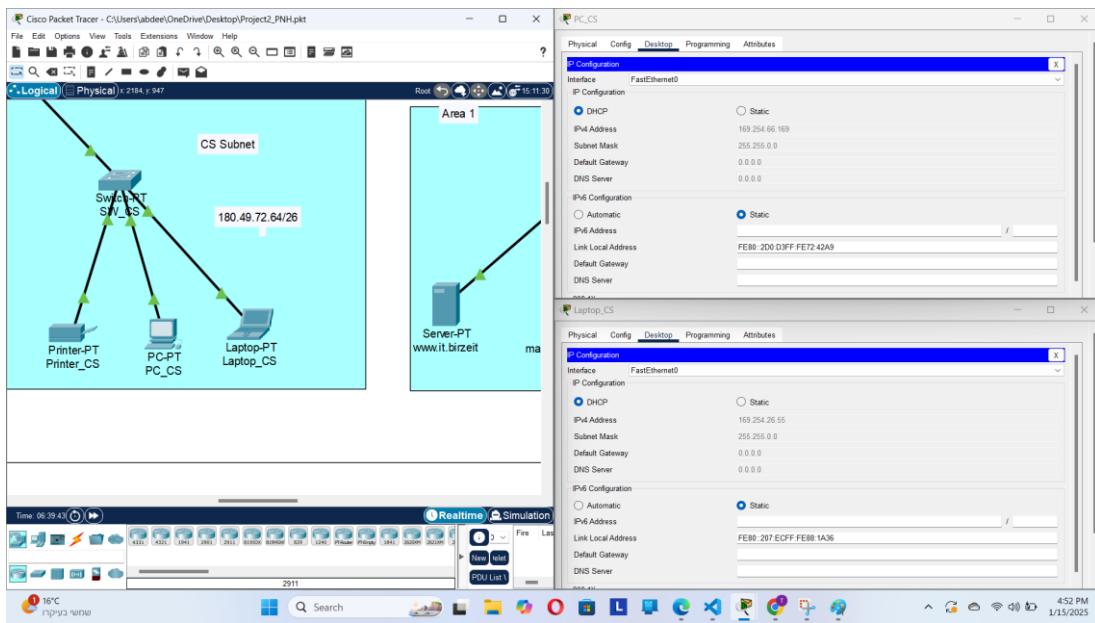


Figure 31 :PC and Laptop Dynamic IP Configuration in CS Subnet

❖ Set Up Second Gmail Account on the PC's Email Client

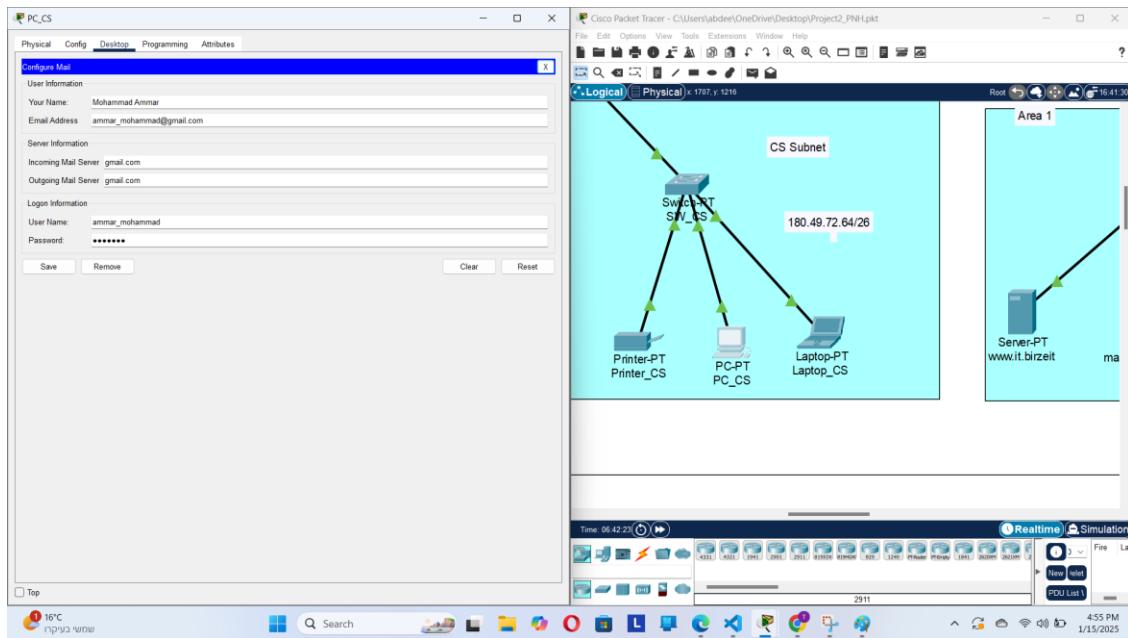


Figure 32: Setting Up Second Gmail Account on Email Client

❖ Set Up Second Birzeit Email on the Laptop's Email Client:

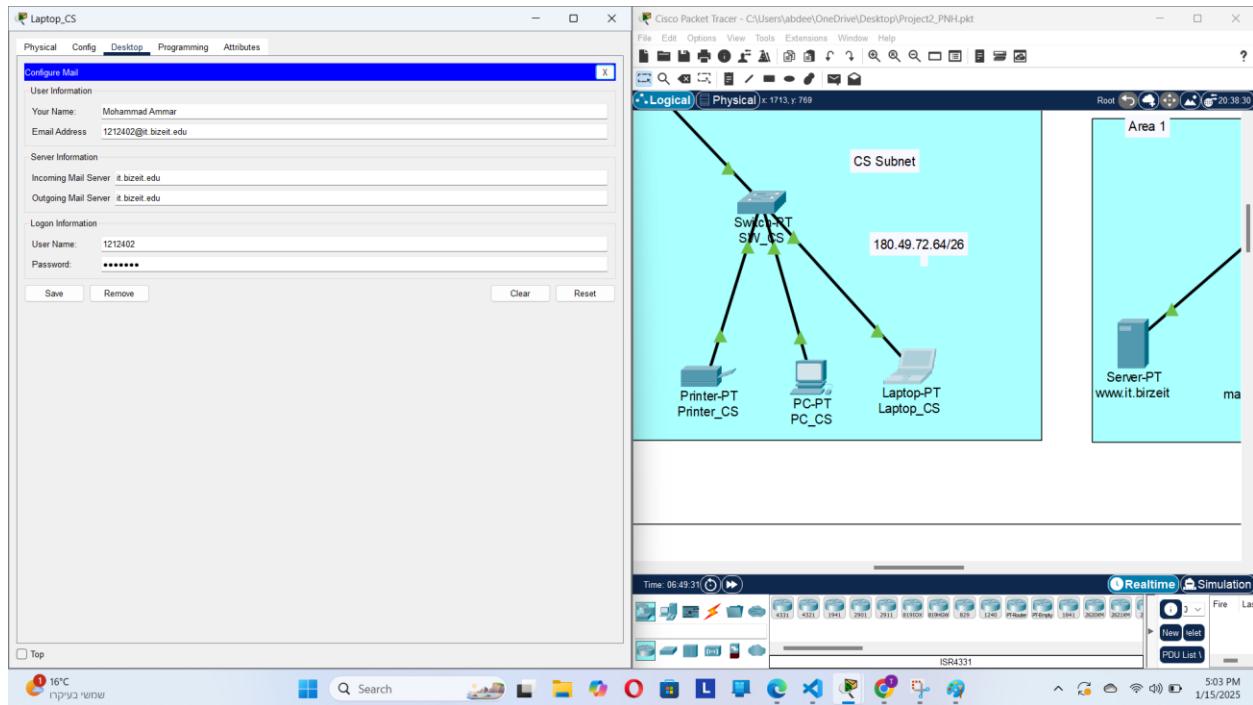


Figure 33: Setting Up Second Birzeit Account on Email Client

- **Backbone Subnet:**

**R0\_IT router port and an R1\_IT router port:**

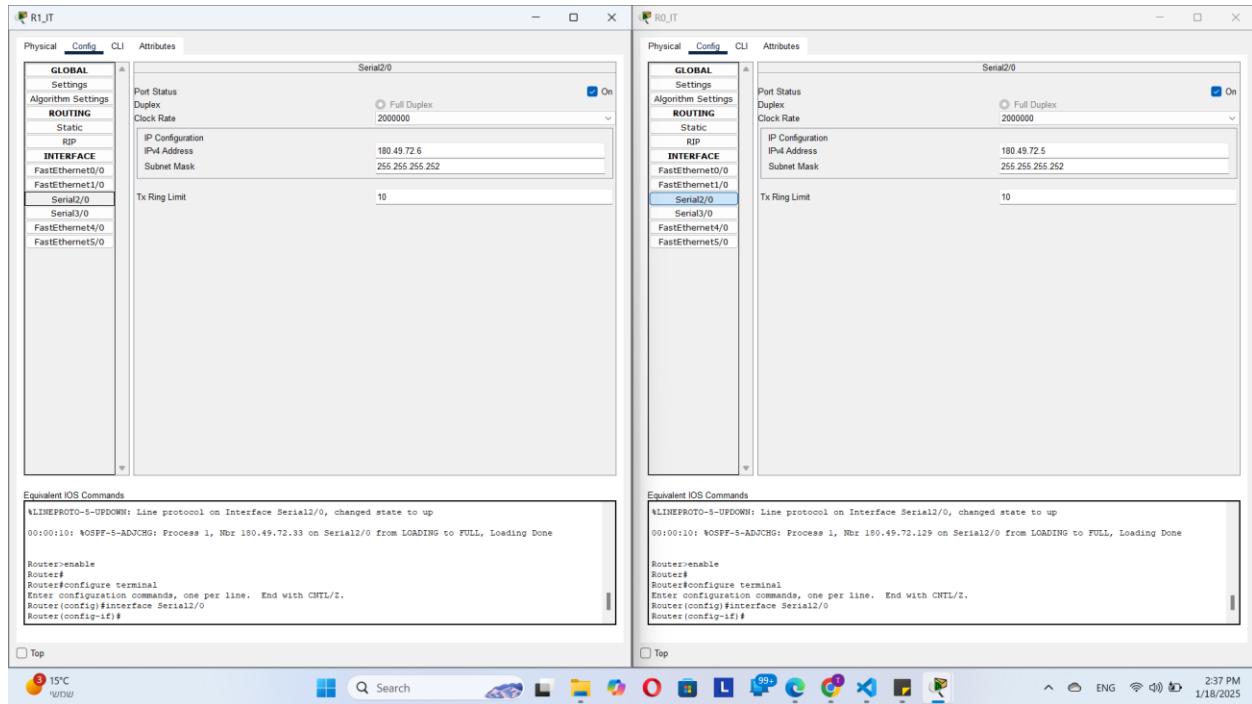


Figure : R0\_IT and an R1\_IT IPs in Backbone Subnet

## ➤ Home-ISP Network (AS-200):

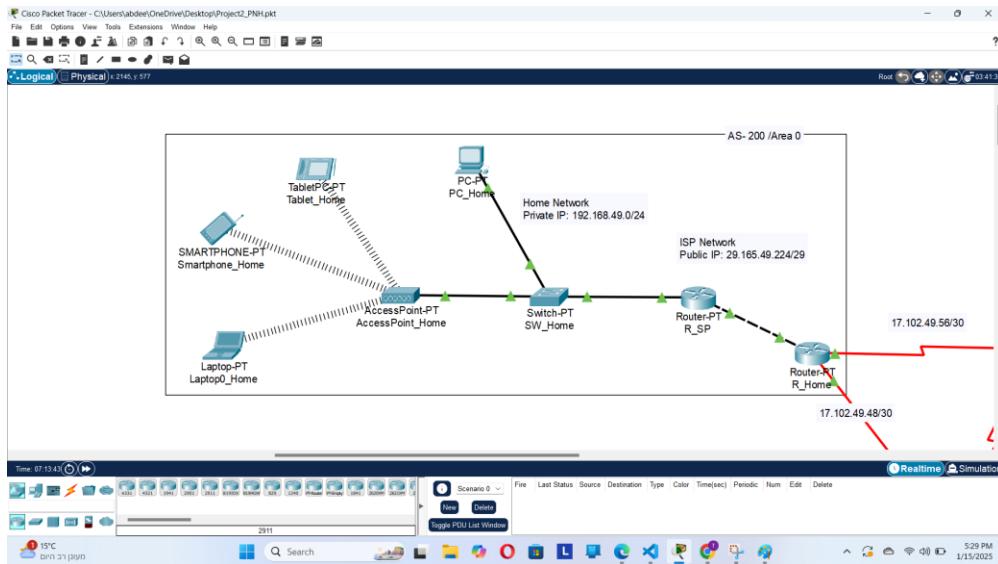


Figure 34: Home-ISP Network

We built this network step by step in the following sequence:

### 1. Wireless network configured by setting up the access point:

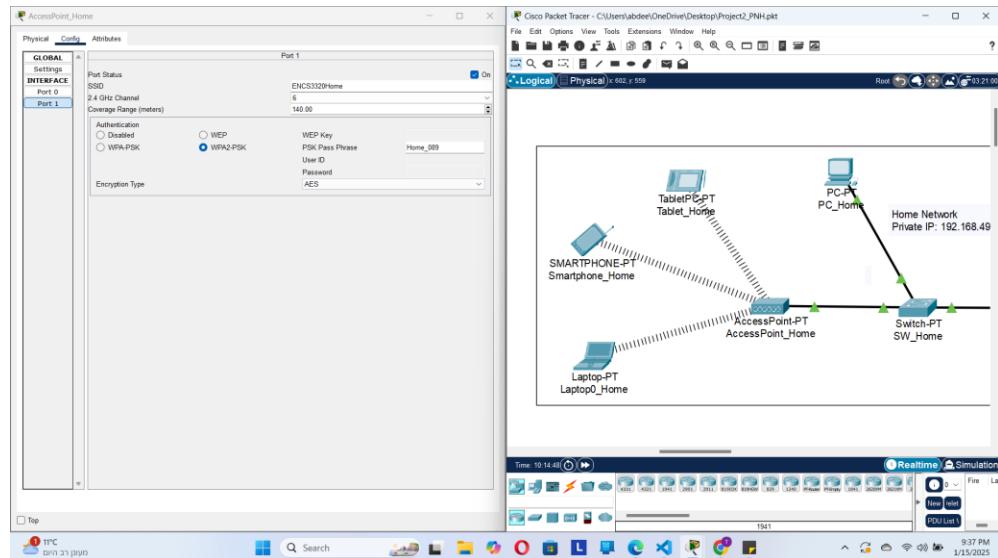


Figure 35: Setting Up Wireless Network via Access Point

## 2. Connections established for wireless and wired devices:

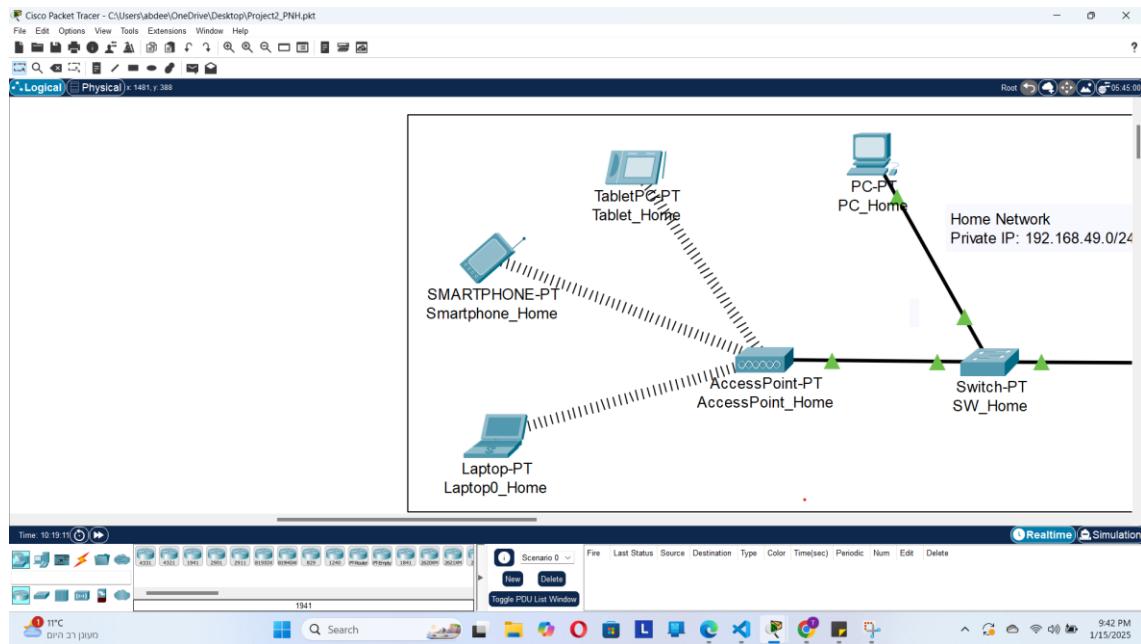


Figure 36: ENCS3320Home Network Device Connections

## 3. Static IP configured on R\_Home router as home subnet gateway:

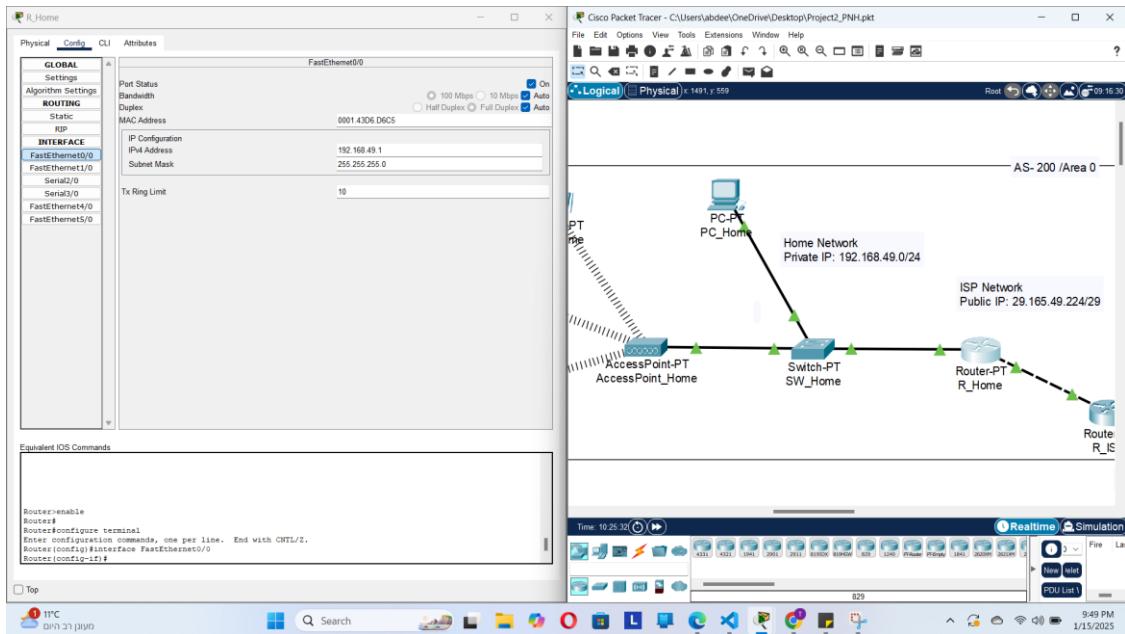


Figure 37: R\_Home Router Gateway Configuration

#### 4. DHCP server functionality enabled on the R\_Home router:

- DHCP-Pool-Name: T089

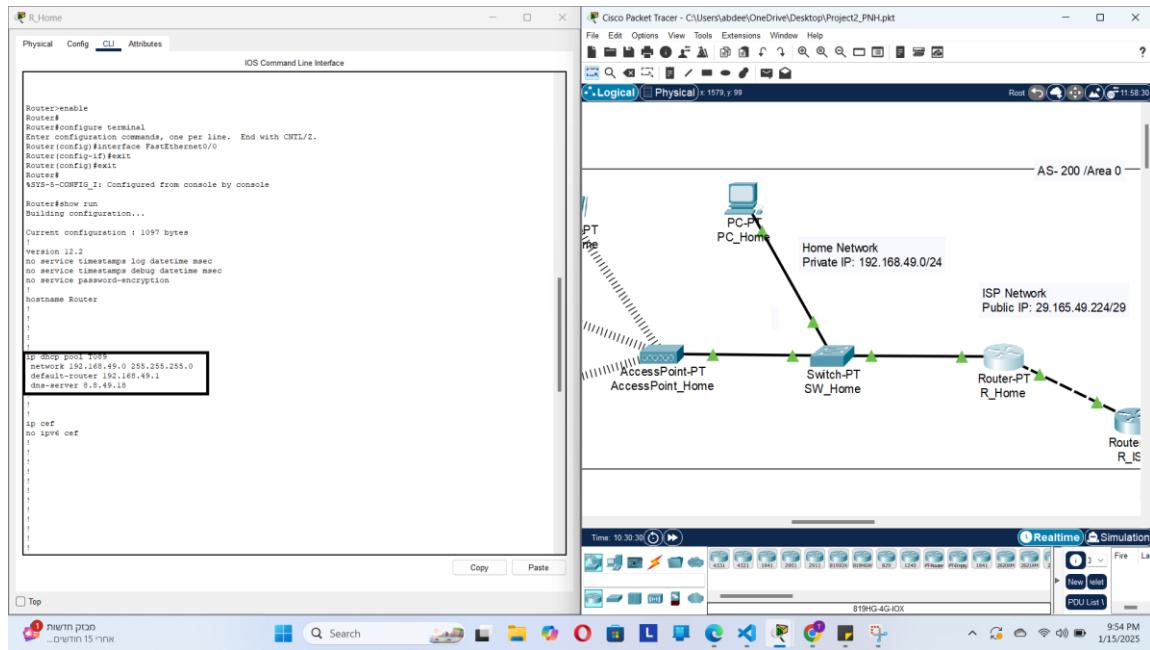


Figure 38: R\_Home Router as DHCP Server Setup

#### 5. End devices configured to receive dynamic IP addresses:

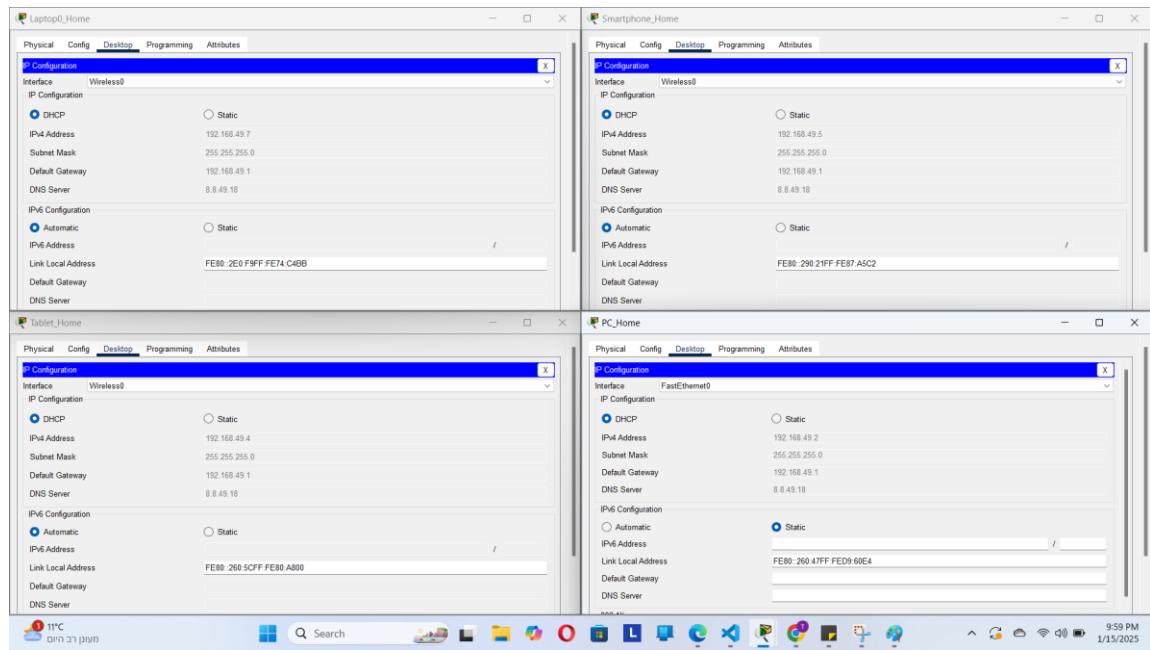


Figure 39: End Devices with Dynamic IP configuration

## 6. Dynamic NAT with PAT implemented on the R\_Home router:

- ❖ R\_Home and R\_ISP router interfaces assigned static public IPs:

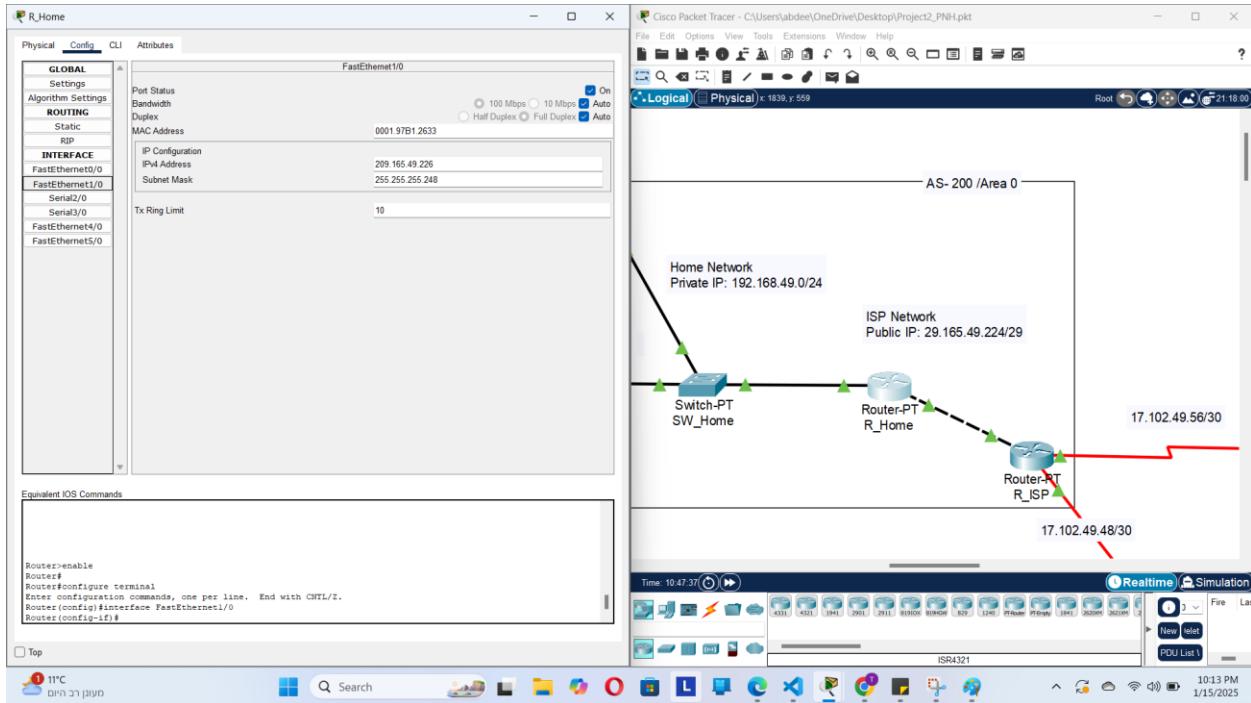


Figure 40: R\_Home and R\_ISP Router Interface Configuration

- ❖ Default route configured from the R\_Home router to the R\_ISP router.
- ❖ Standard ACL enabled for home IPs.
- ❖ NAT pool set with one unused IP from 209.165.49.224/29.
- ❖ Router configured with NAT functionality.
- ❖ Inside and outside NAT interfaces configured.

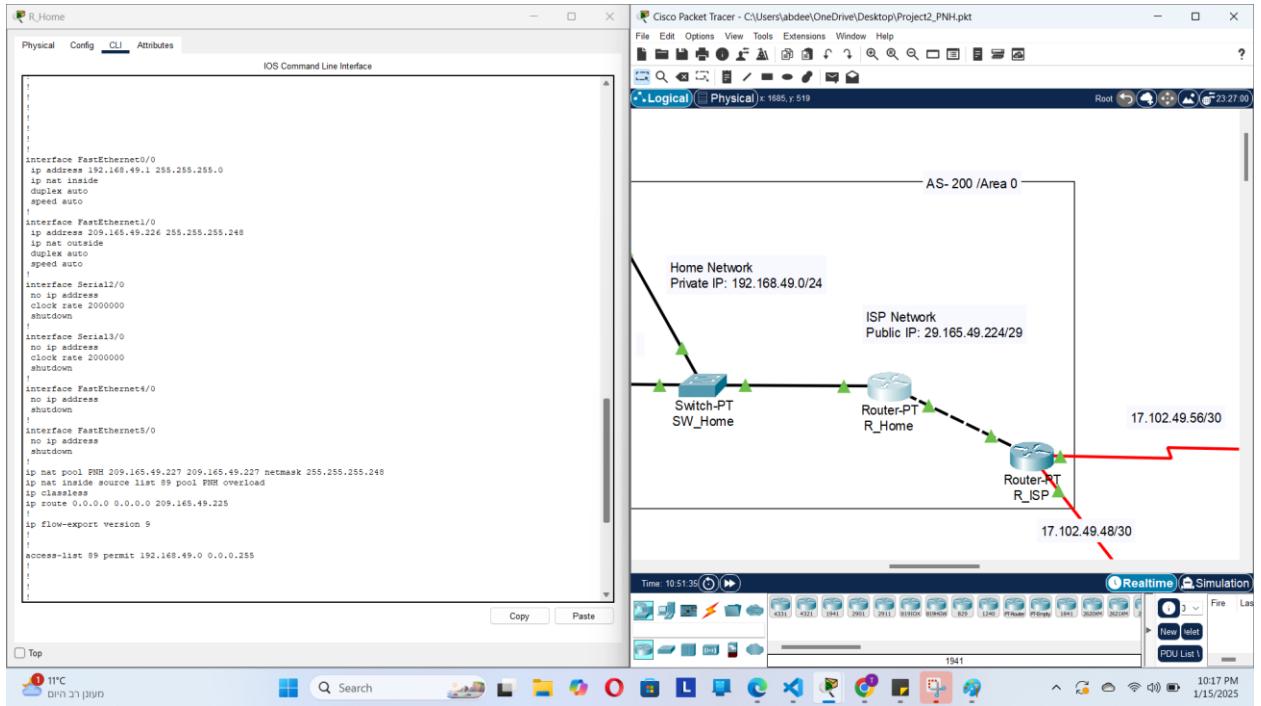


Figure 41: R\_Home Router Setup and NAT Configuration

## 7. Two devices set up with Gmail accounts on the email client:

Table 8: Gmail Account Setup on End Devices

Device	Account	Account Type
PC_Home	Toqa Abdeen	gmail
Smartphone_Home	Mohammad Ammar	gmail

## 8. Two devices set up with Birzeit email accounts:

Table 9: Birzeit Account Setup on End Devices

Device	Account	Account Type
Tablet_Home	Toqa Abdeen	it.birzeit
Laptop0_Home	Mohammad Ammar	it.birzeit

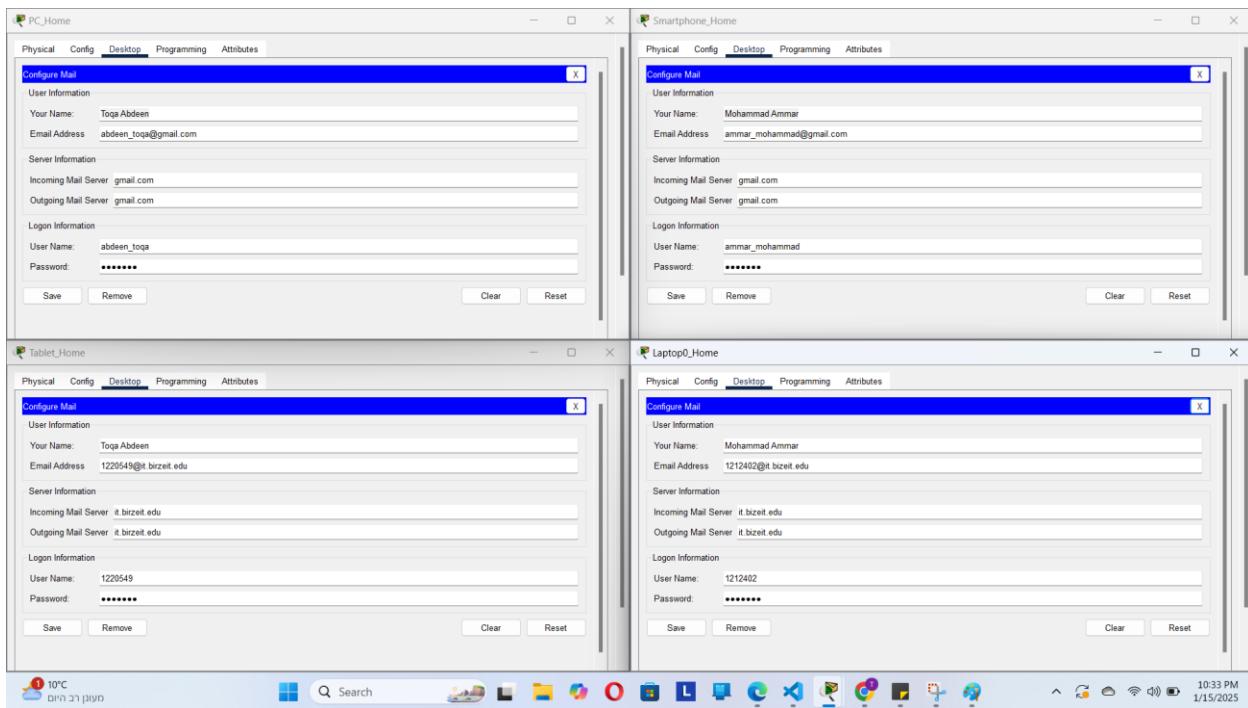


Figure 42: Gmail and Birzeit Email Accounts on Devices

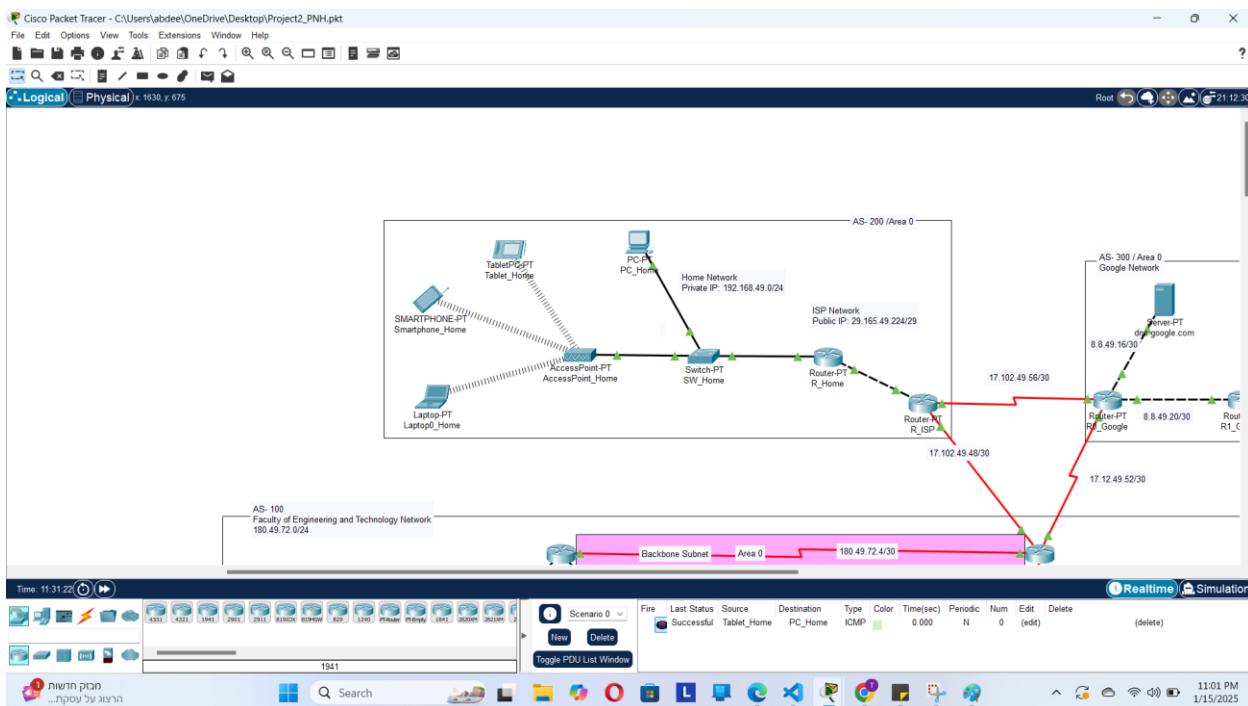


Figure 44: Successful Ping Tests Between Home Network Devices

➤ Configure Router Interfaces and Label Topology in .pkt File:

1. R\_ISP & R0\_Google:

Table 10: R\_ISP & R0\_Google IPs

	Interface Name	IP	Subnet Mask
R0_Google	Se2/0	17.102.49.57	255.255.255.252
R_ISP	Se2/0	17.102.49.58	255.255.255.252

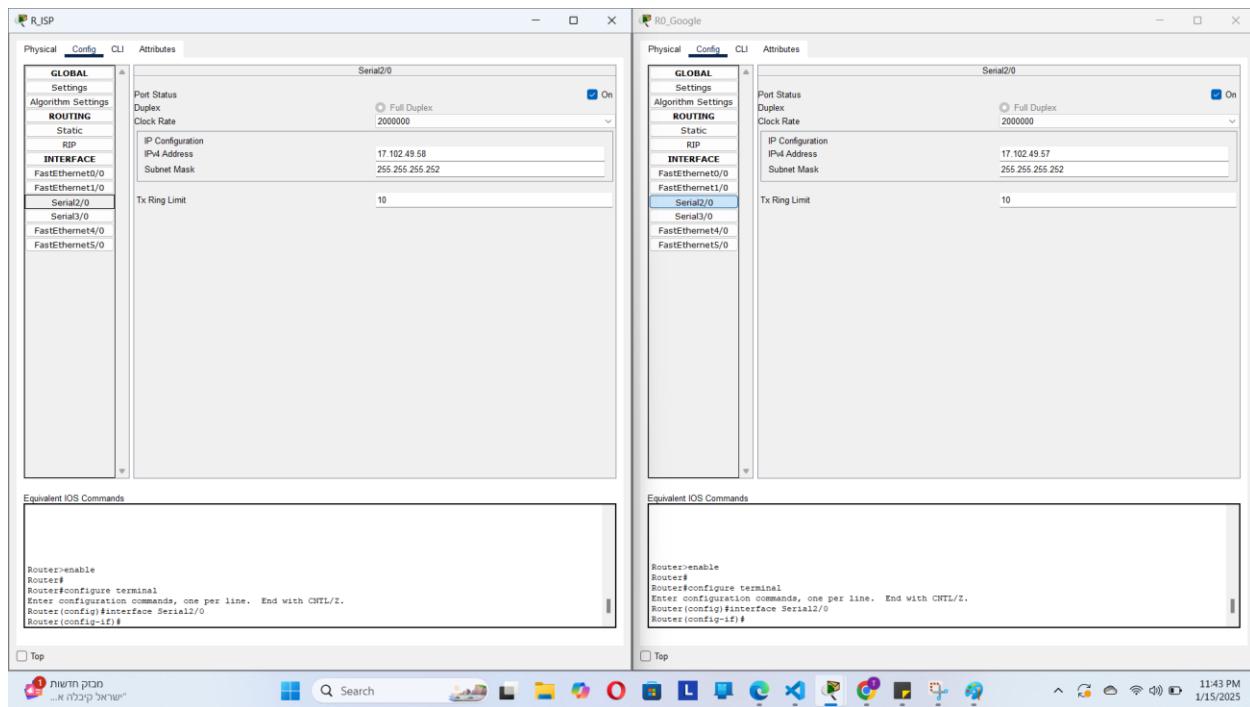


Figure 45: R\_ISP & R0\_Google IPs

## 2. R\_ISP & R0\_IT:

Table 11: R\_ISP & R0\_IT IPs

	Interface Name	IP	Subnet Mask
R_ISP	Fa4/0	17.102.49.49	255.255.255.252
R0_IT	Fa5/0	17.102.49.50	255.255.255.252

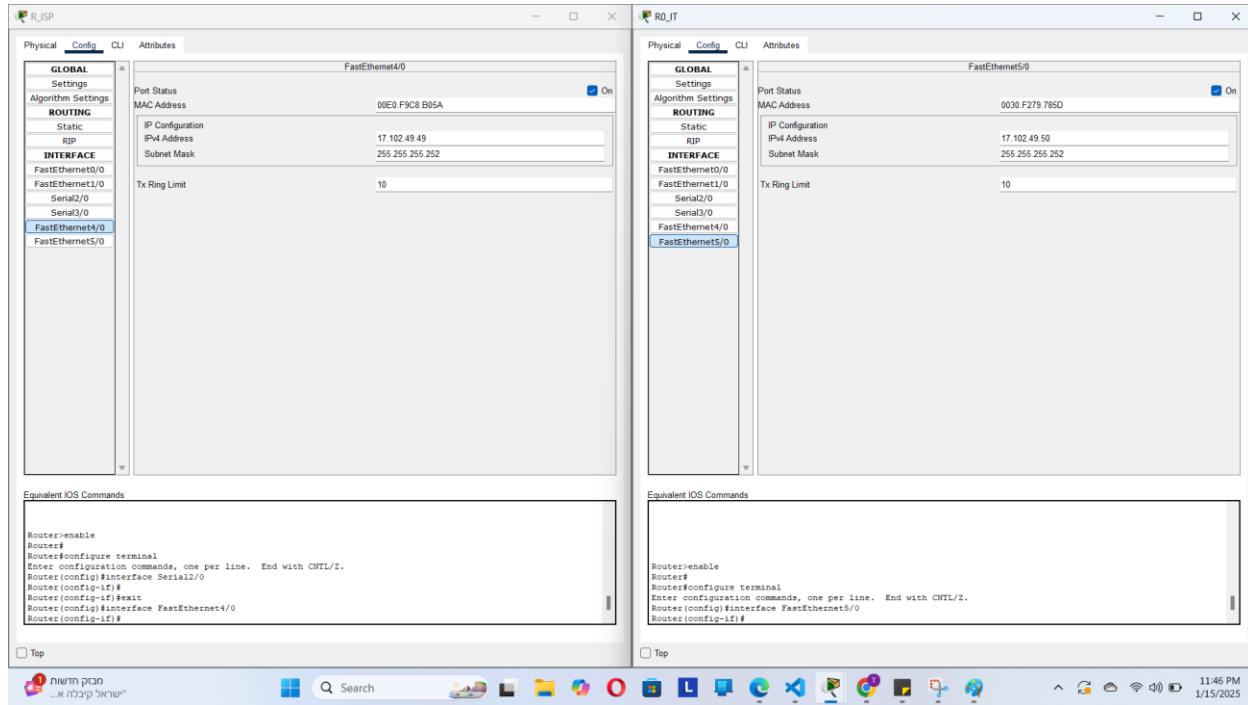


Figure 46: R\_ISP & R0\_IT IPs

### 3. R0\_Google & R0\_IT:

Table 12: R0\_Google & R0\_IT IPs

	Interface Name	IP	Subnet Mask
R0_Google	Se3/0	17.102.49.53	255.255.255.252
R0_IT	Se3/0	17.102.49.54	255.255.255.252

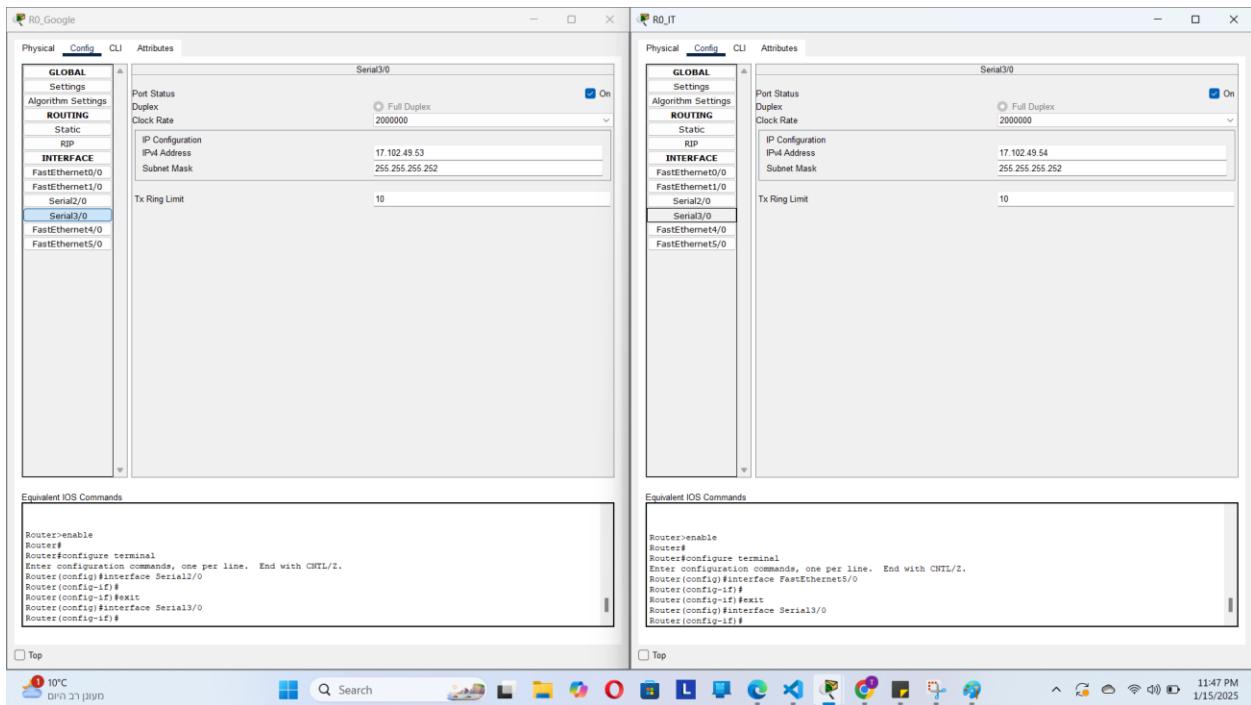


Figure 47: R0\_Google & R0\_IT IPs

### 4. R1\_IT & R0\_IT:

Table 13: R1\_IT & R0\_IT IPs

	Interface Name	IP	Subnet Mask
R0_IT	Se2/0	180.49.72.5	255.255.255.252
R1_IT	Se2/0	180.49.72.6	255.255.255.252

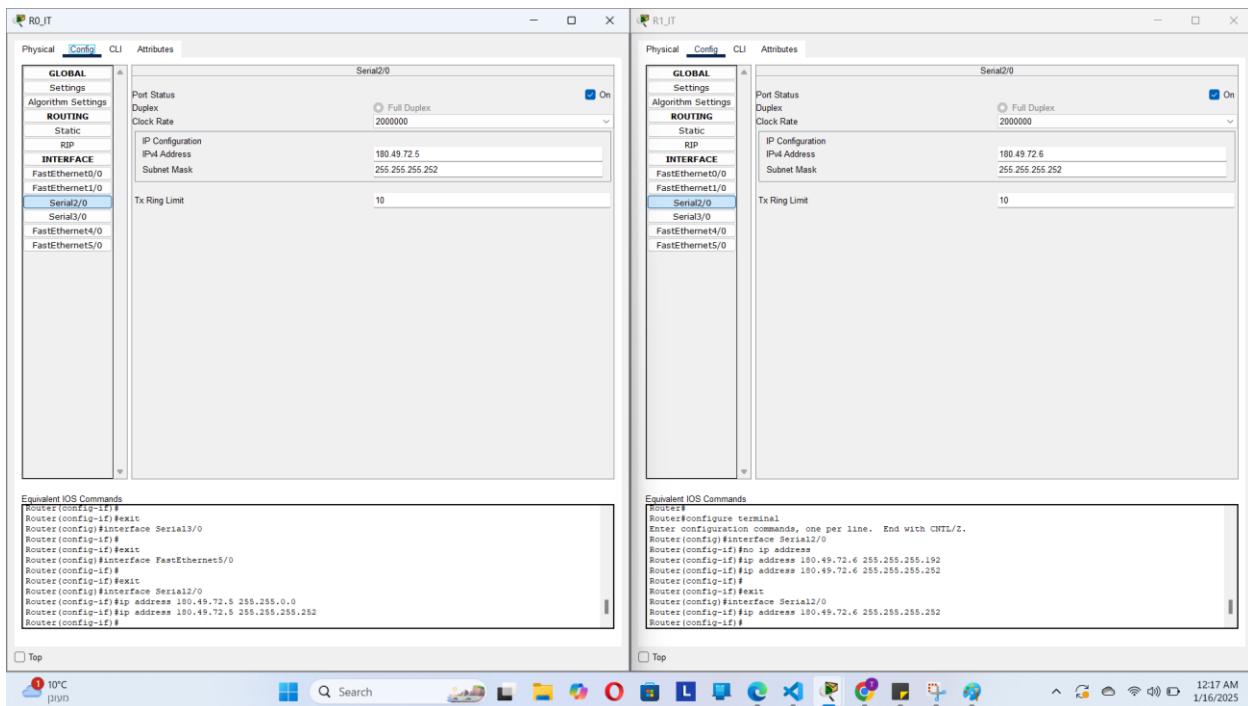


Figure 48: R1\_IT & R0\_IT IPs

## 5. Annotate Topology in .pkt File with Descriptive Labels:

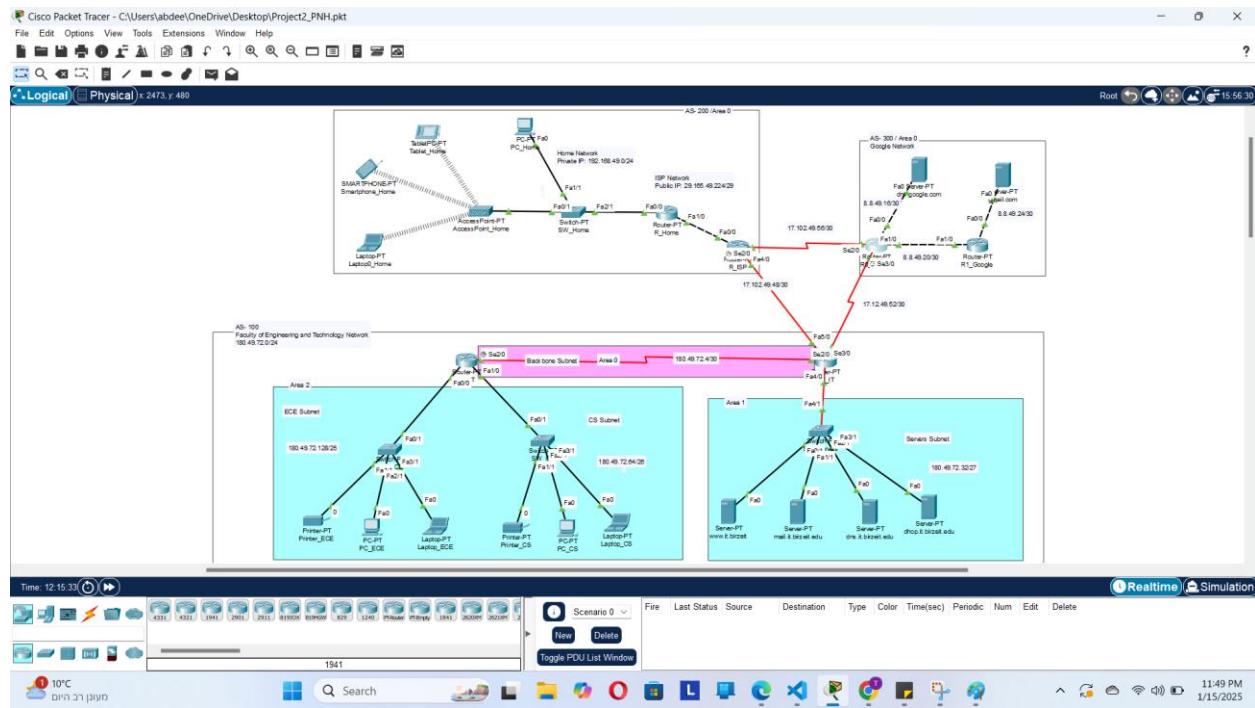


Figure 49: Labeled Network in .pkt File

## Routing Configuration :

### ➤ OSPF Areas Enabled:

The setup of OSPF, including the three areas, is now complete.

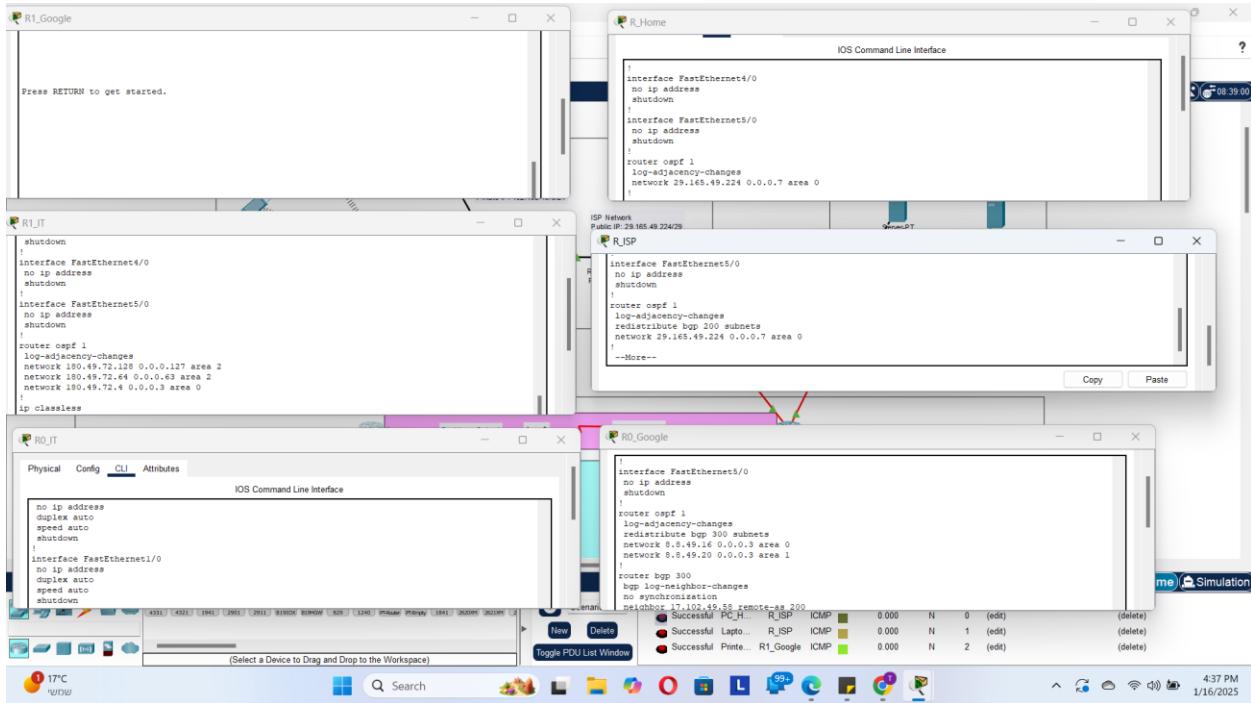


Figure 50: OSPF Three-Area Network Design

## ➤ Setting up BGP on a router:

Inter-domain routing between autonomous systems is active with BGP.

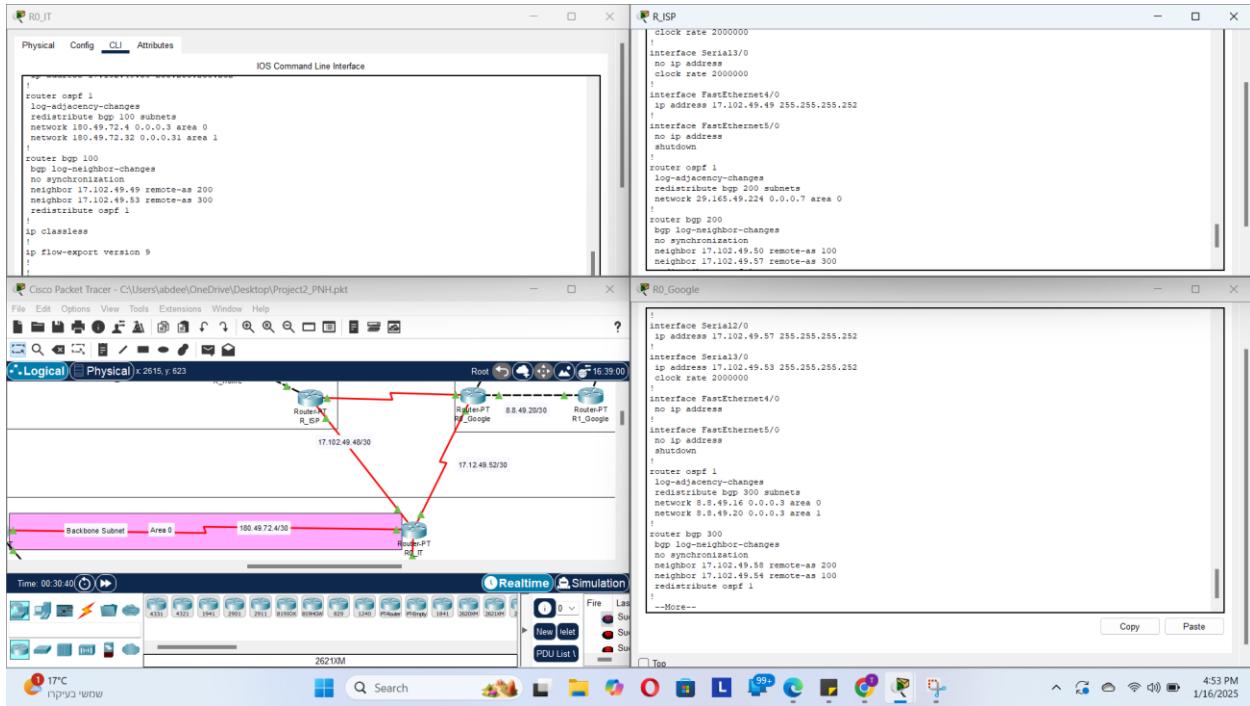


Figure 51: BGP Configuration Between Autonomous Systems

## > OSPF and BGP Redistribution Configuration:

Redistribution between OSPF and BGP has been successfully deployed, ensuring seamless connectivity across the topology.

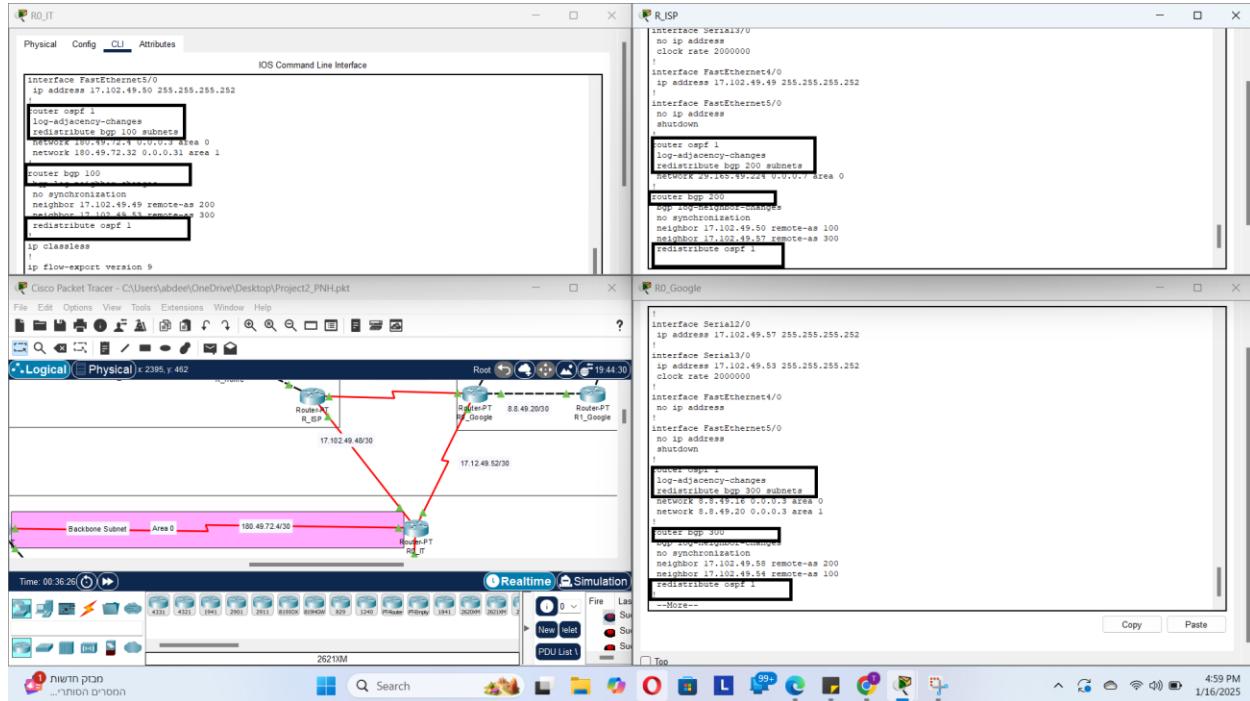


Figure 52: Route Redistribution Between OSPF and BGP

## Testing Faculty network devices:

### ➤ Ping between Faculty network devices:

Due to the large number of devices in the network, conducting a ping operation for every single device is not feasible. Instead, we will perform the ping test on a selected subset of devices to ensure network performance and reliability while maintaining efficiency.

#### 1. PC\_ECE & laptop\_ECE

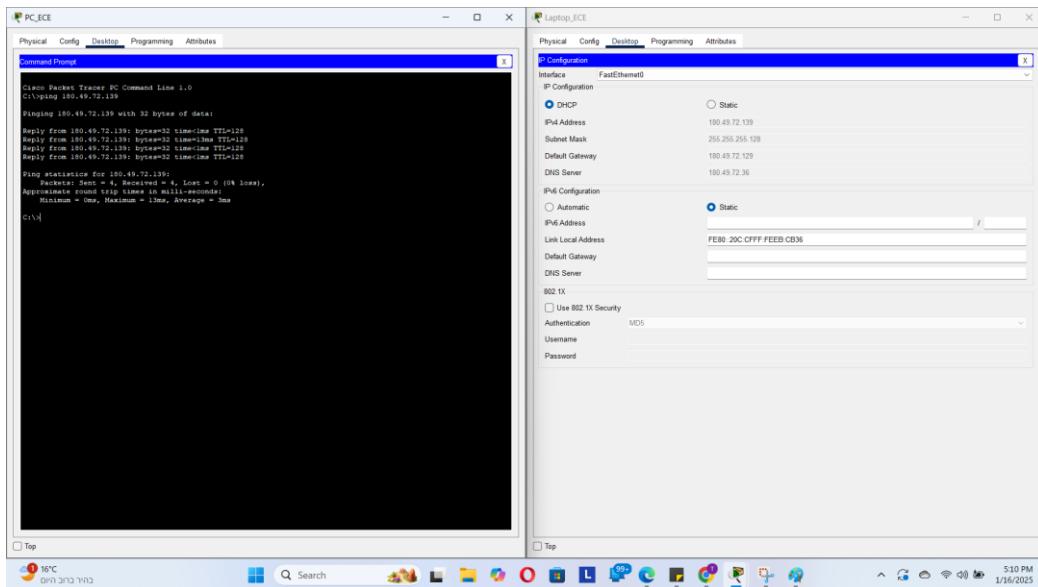


Figure 53: Ping Test from PC\_ECE to laptop\_ECE

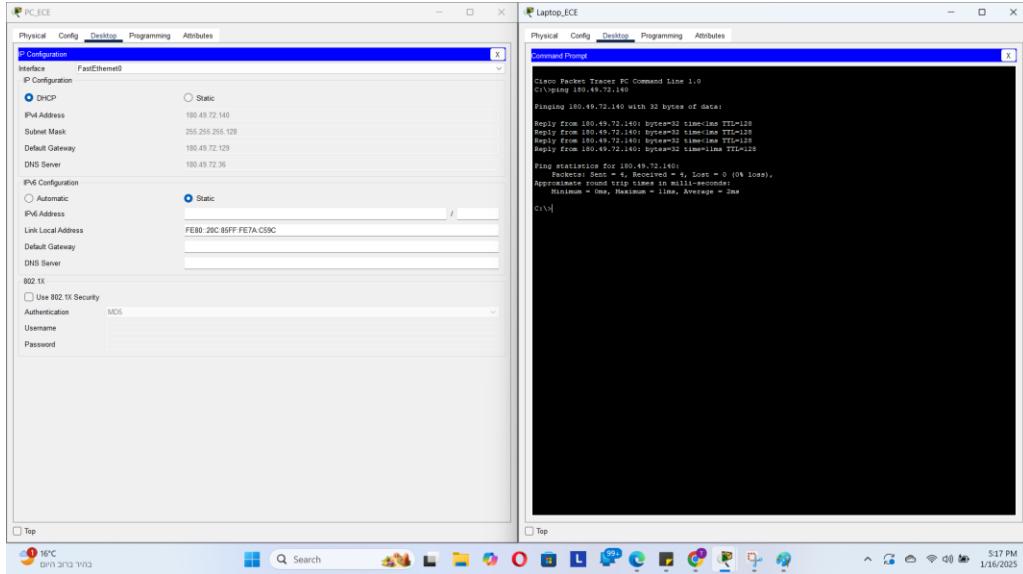


Figure 54: Ping Test from laptop\_ECE to PC\_ECE

## 1. Printer\_ECE & laptop\_ECE

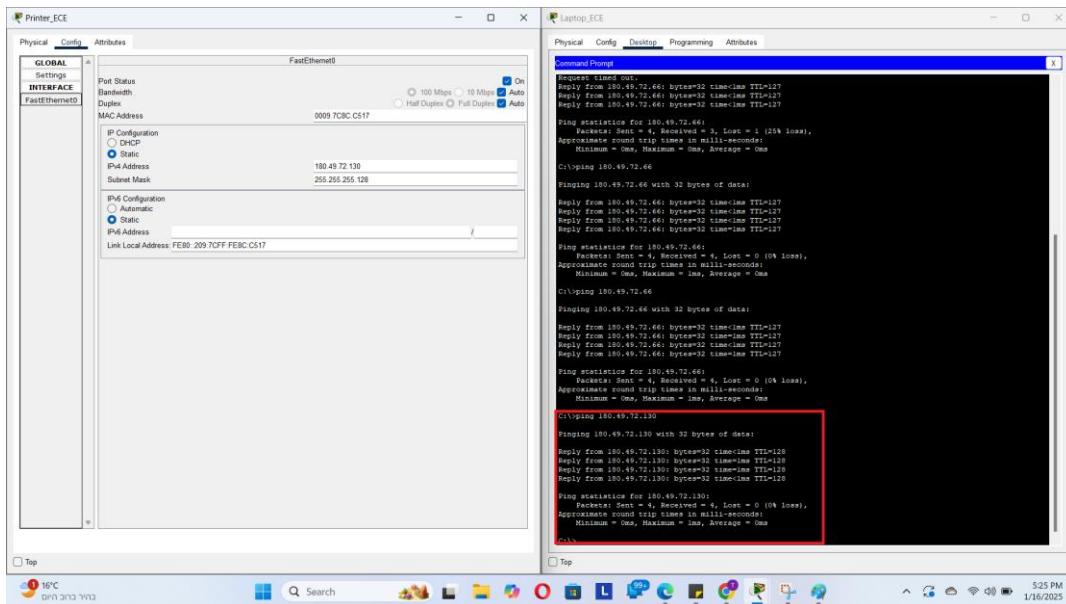


Figure 55: Ping Test from laptop\_ECE to Printer\_ECE

## Printer\_CS & laptop\_ECE

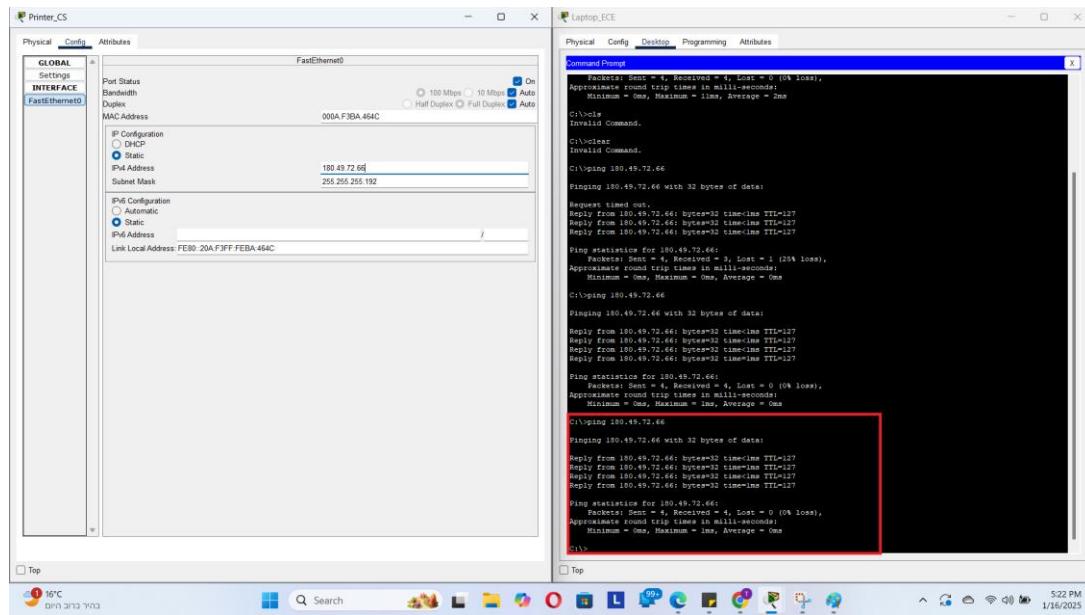


Figure 56: Ping Test from laptop\_ECE to Printer\_CS

## 2. PC\_CS & laptop\_CS

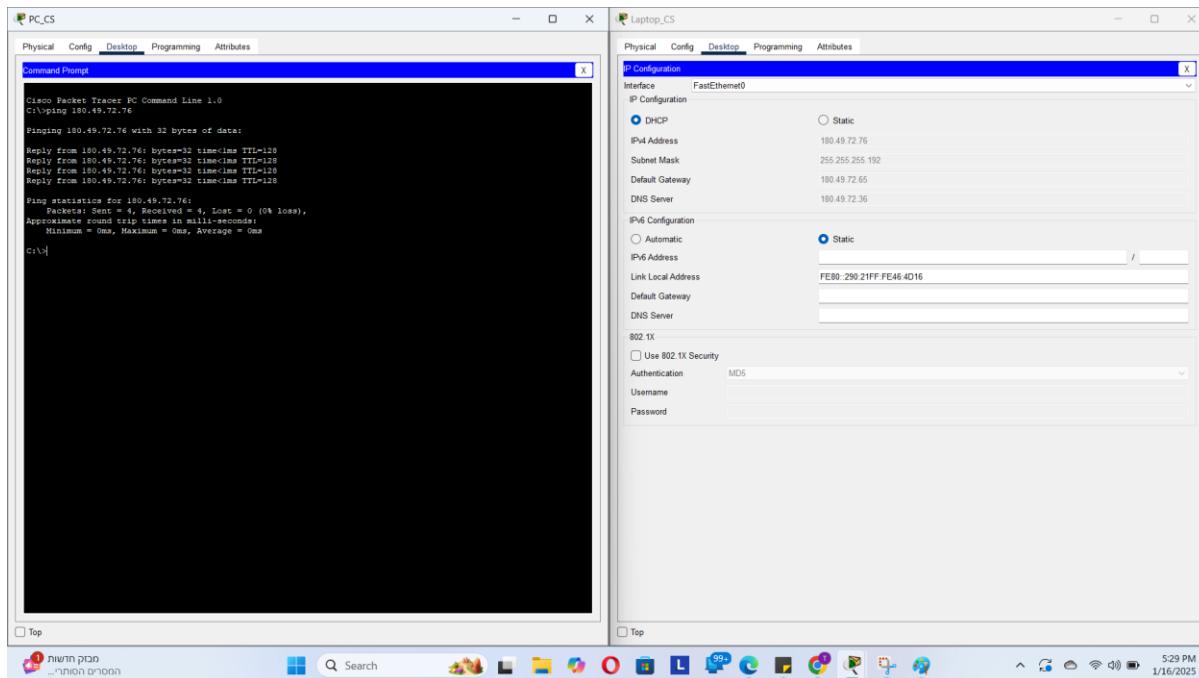


Figure 57: Ping Test from PC\_CS to laptop\_ECE

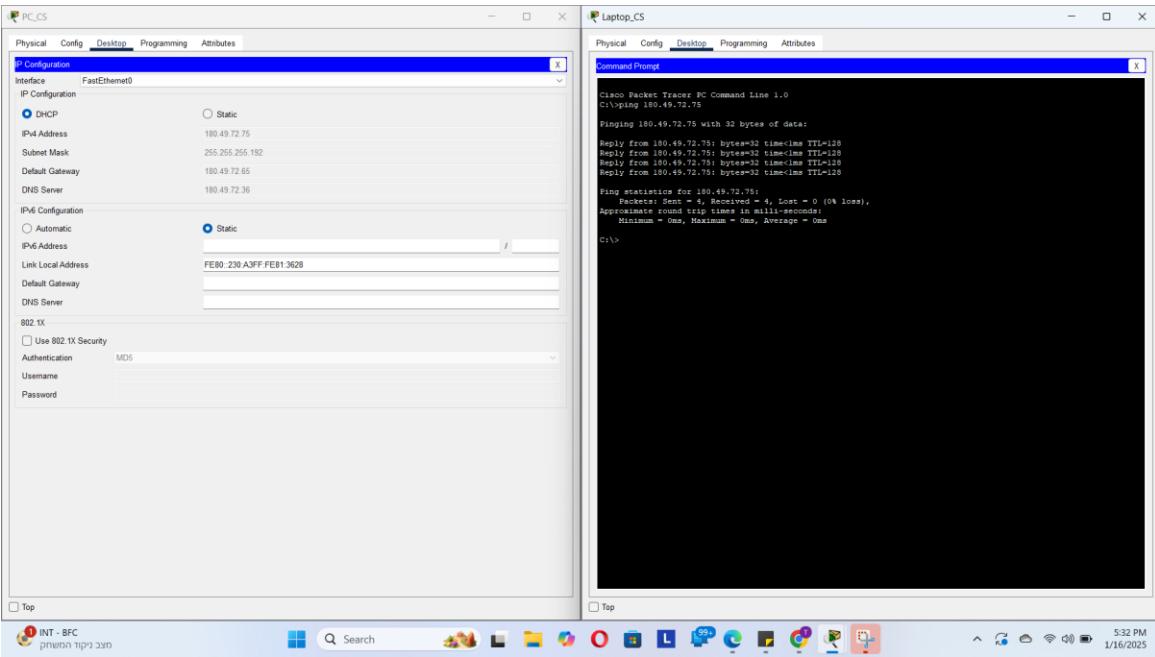


Figure 58: Ping Test from laptop\_ECE to PC\_CS

### 3. PC\_ECE & laptop\_CS

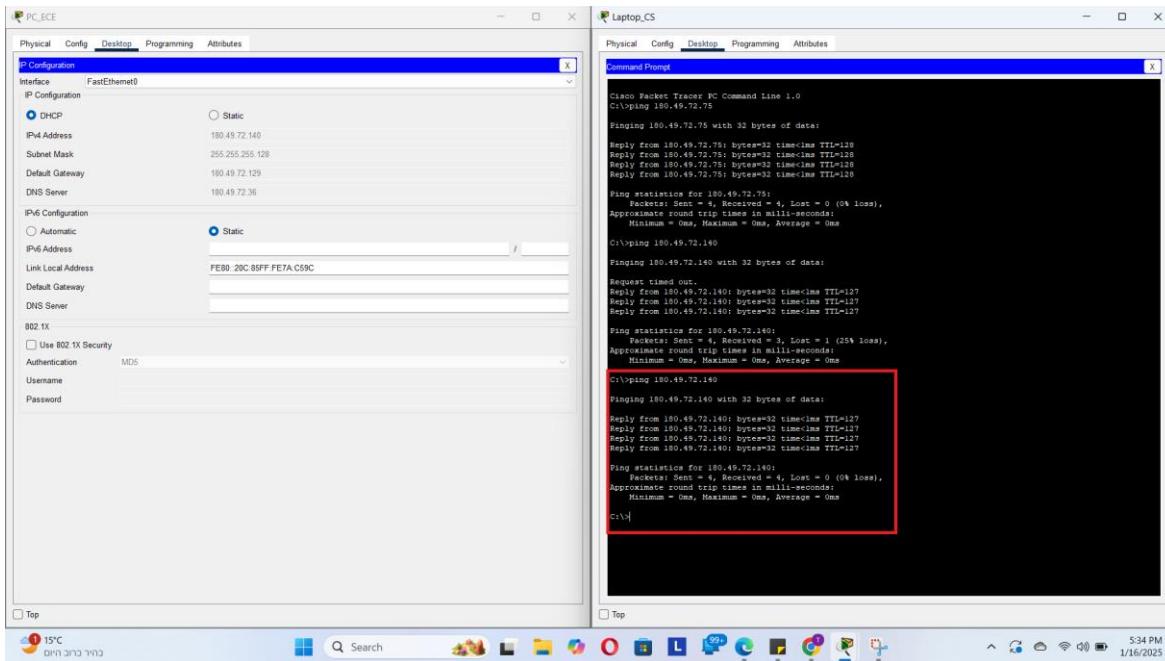


Figure 59: Ping Test from PC\_ECE to laptop\_CS

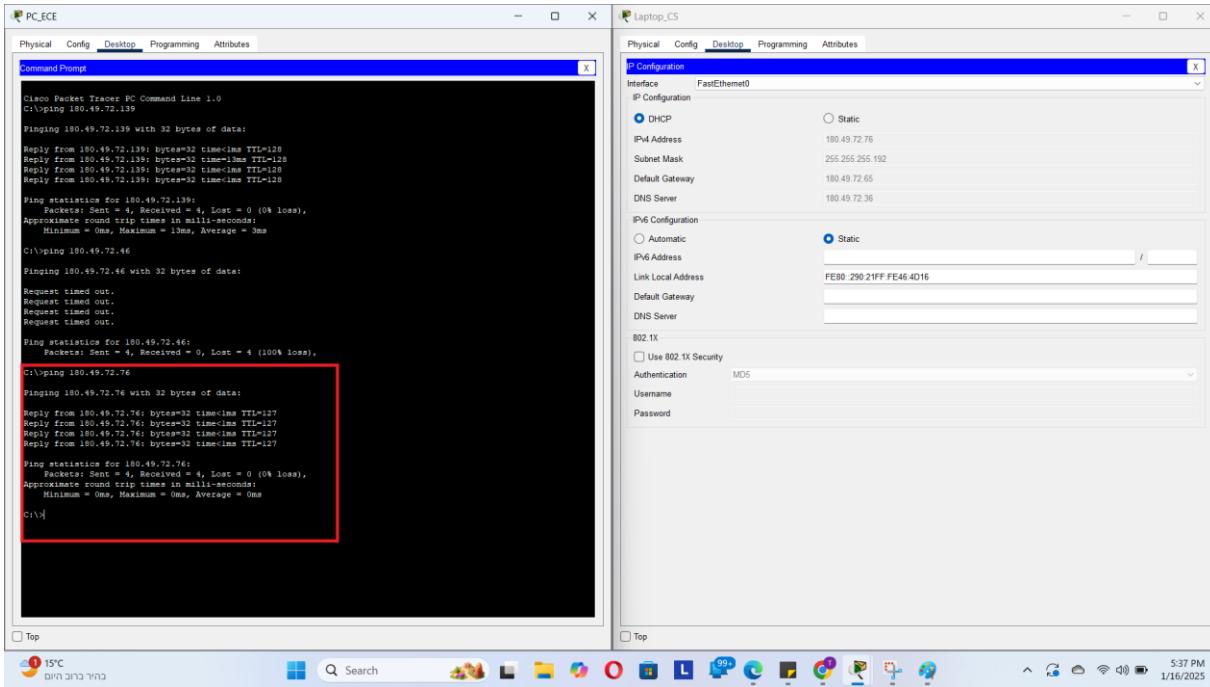


Figure 60: Ping Test from laptop\_CS to PC\_ECE

#### 4. PC\_ECE & PC\_CS

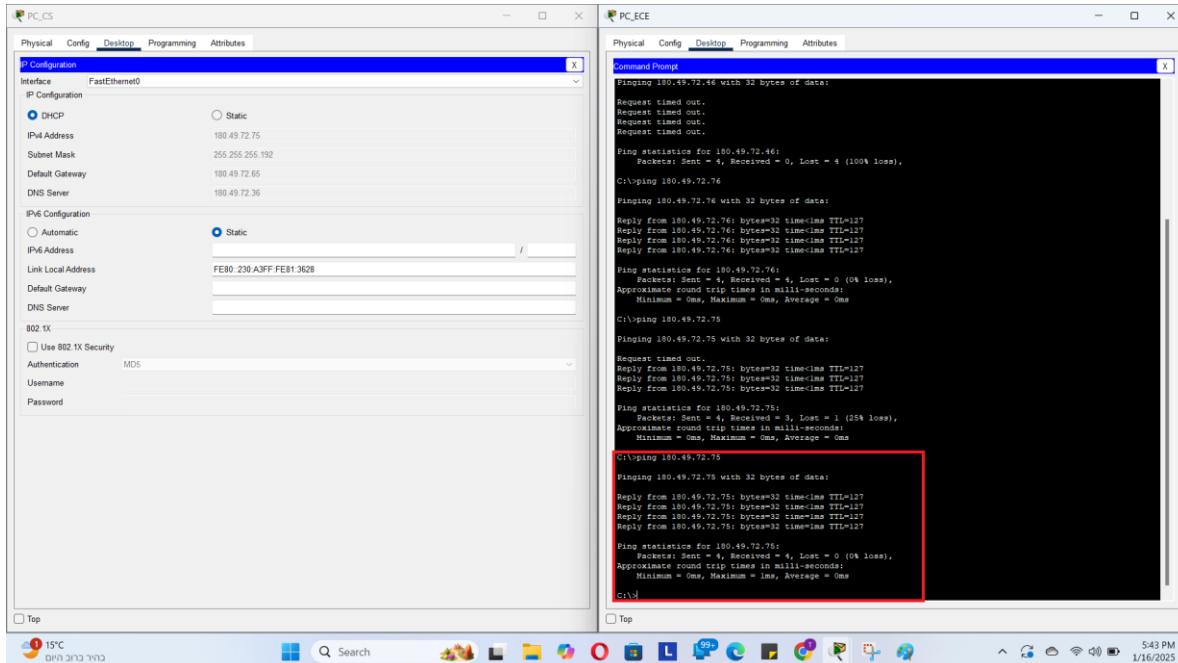


Figure 61: Ping Test from PC\_ECE to PC\_CS

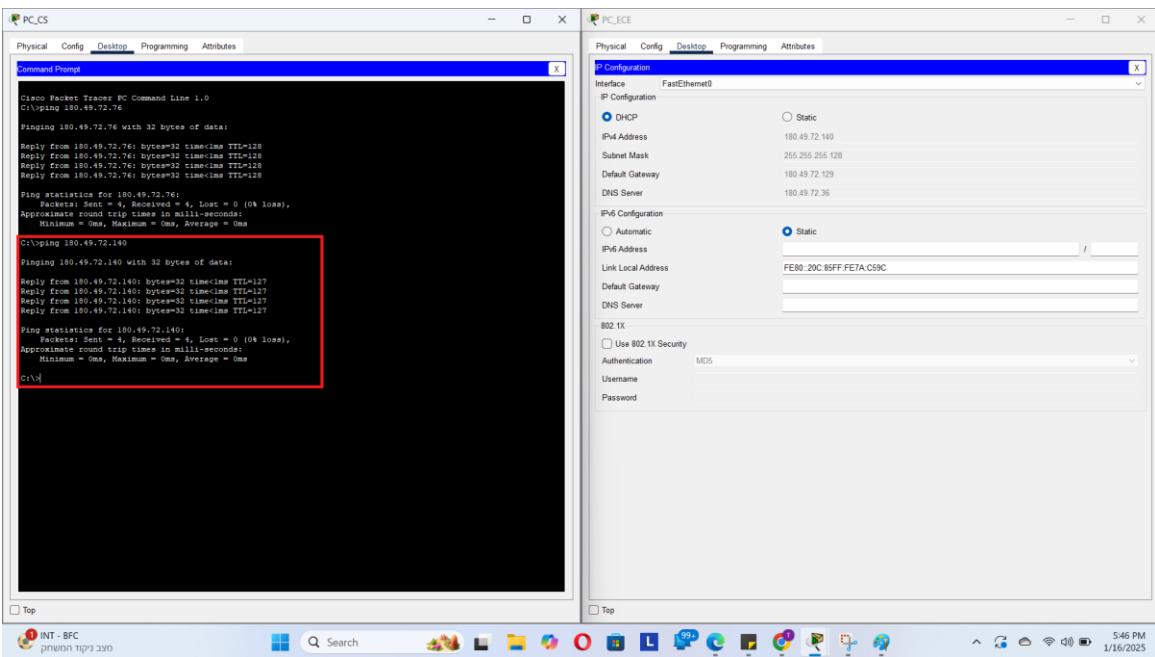


Figure 62: Ping Test from PC\_CS to PC\_ECE

## 5. PC\_CS & [www.it.birzeit](http://www.it.birzeit)

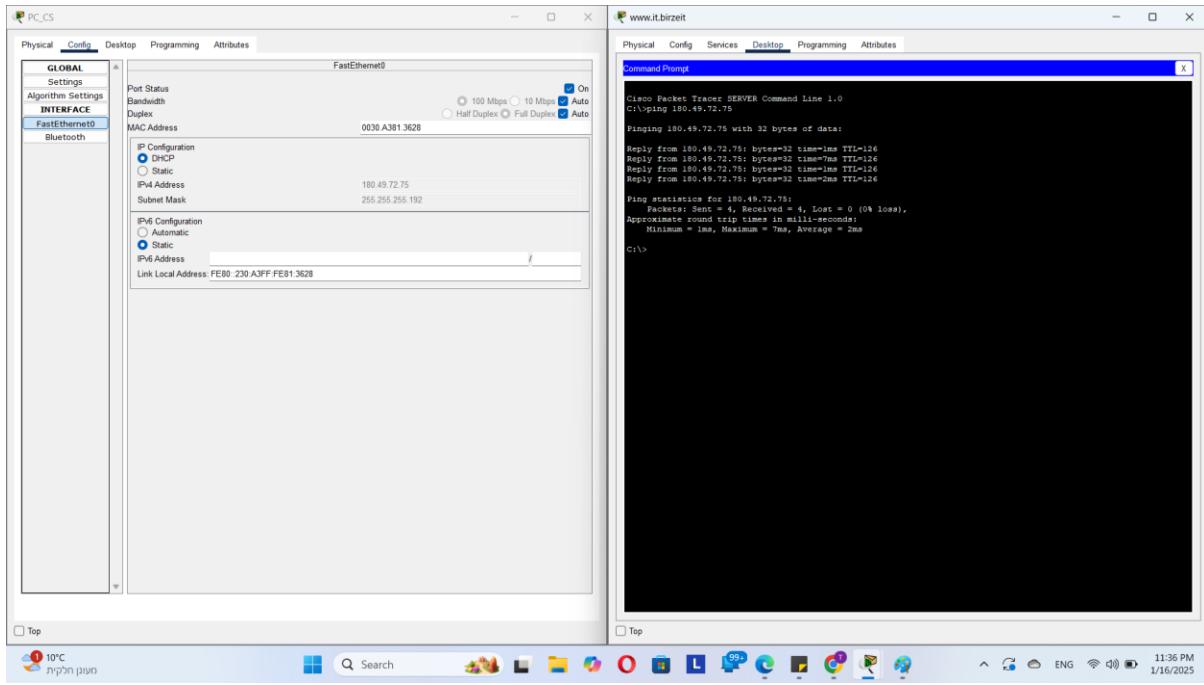


Figure 63: Ping Test from [www.it.birzeit](http://www.it.birzeit) to PC\_CS

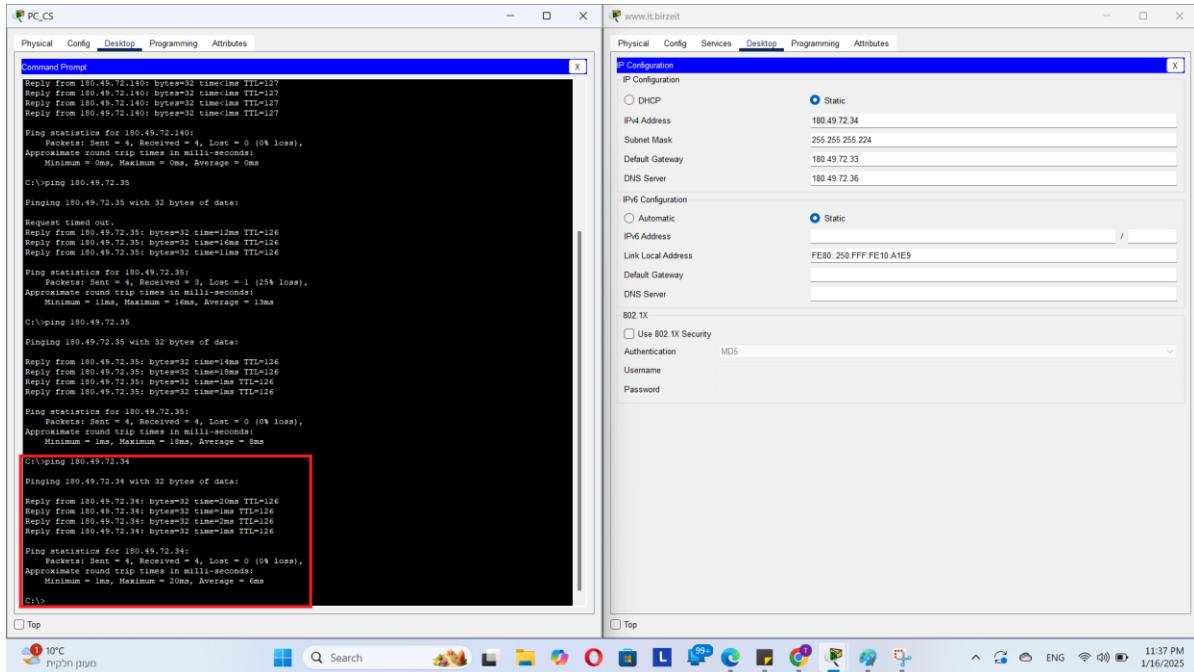


Figure 64: Ping Test from PC\_CS to [www.it.birzeit](http://www.it.birzeit)

## 6. PC\_CS & mail.it.birzeit.edu

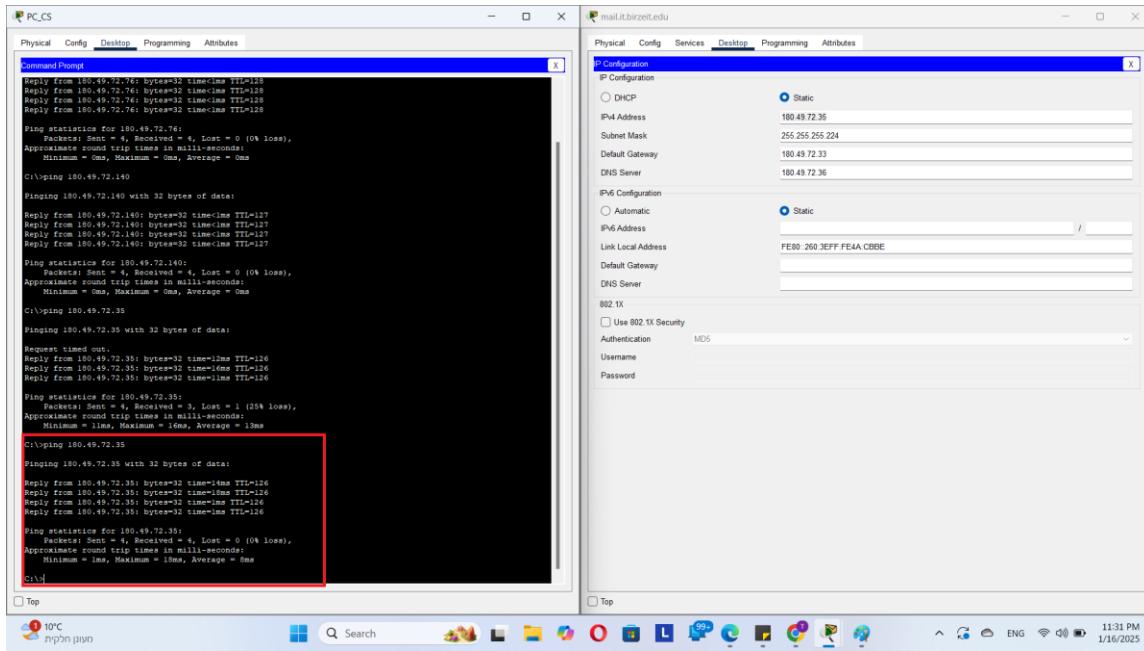


Figure 65: Ping Test from PC\_CS to mail.it.birzeit.edu

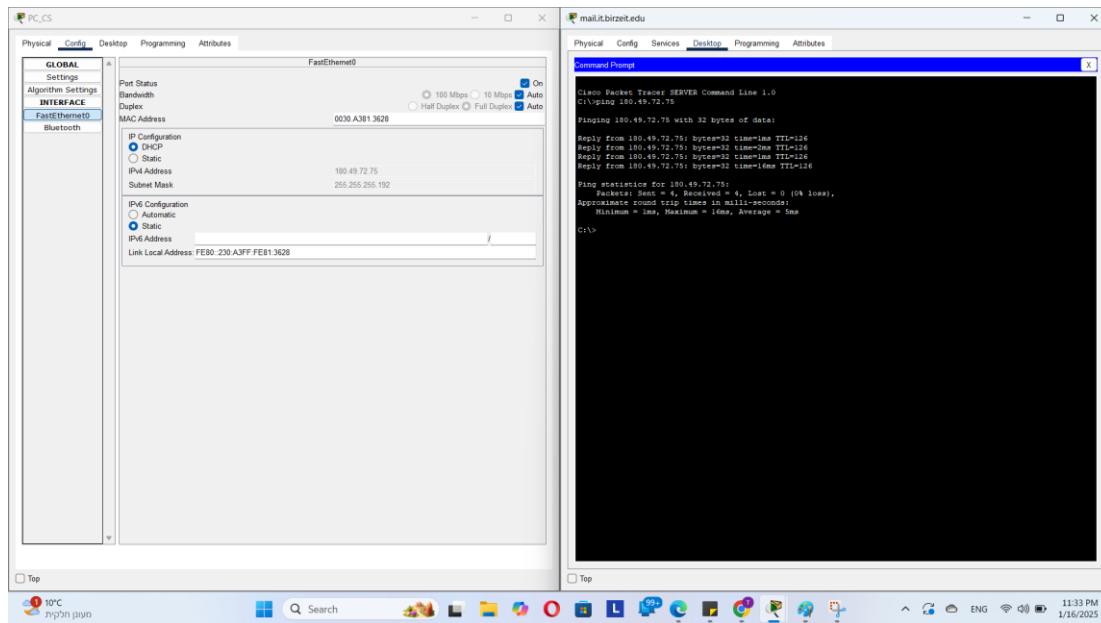


Figure 66: Ping Test from mail.it.birzeit.edu to PC\_CS

## 7. PC\_CS & dns.it.birzeit.edu

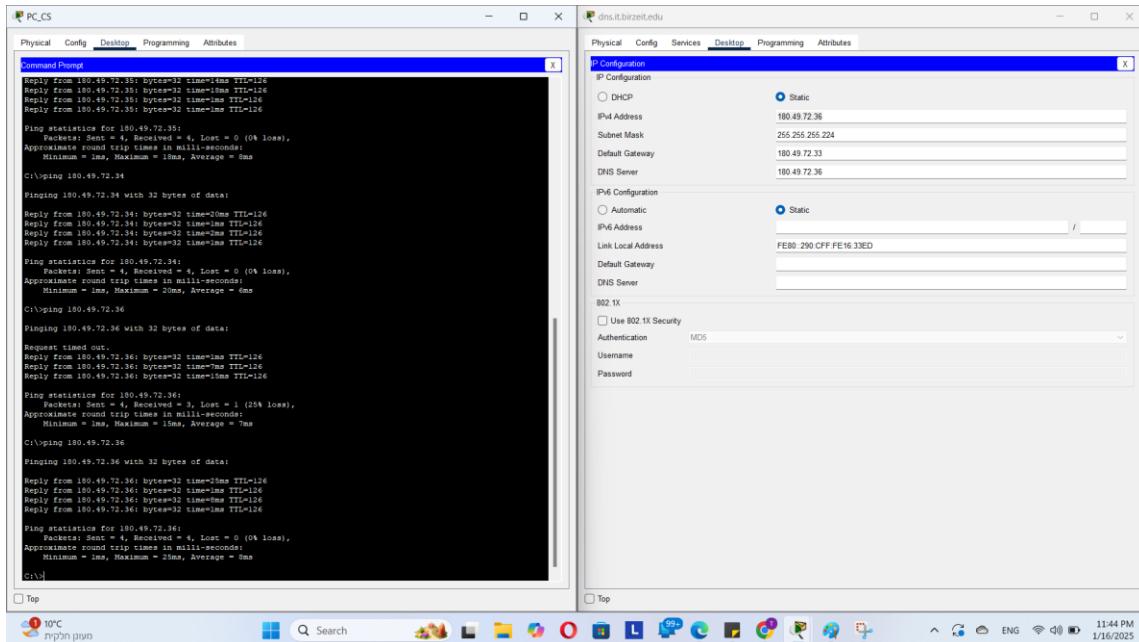


Figure 67: Ping Test from PC\_CS to dns.it.birzeit.edu

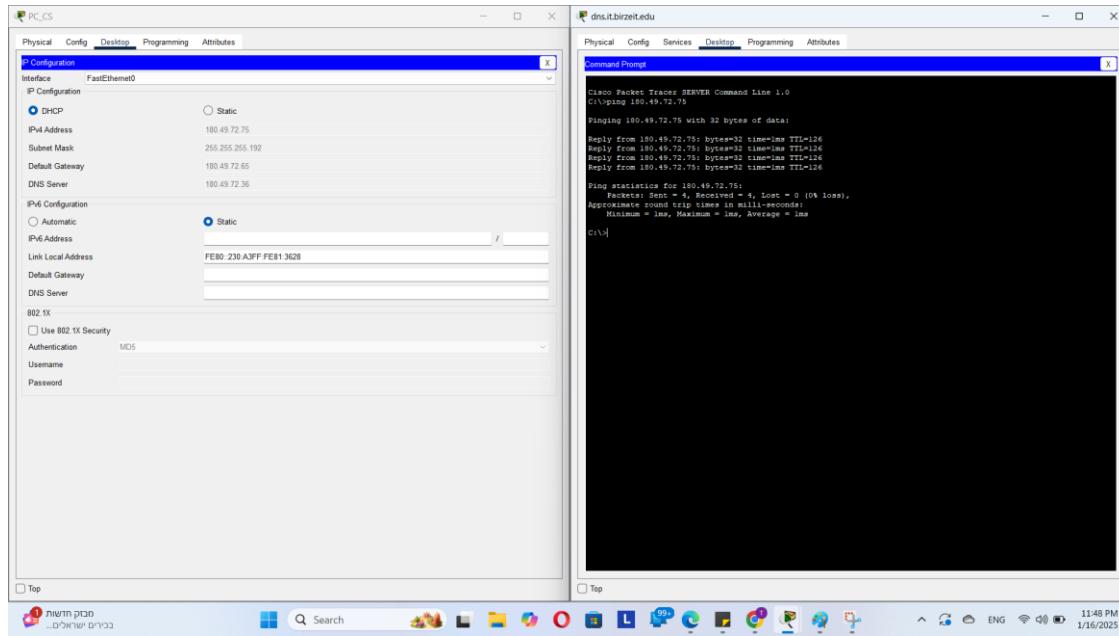


Figure 68: Ping Test from dns.it.birzeit.edu to PC\_CS

## 8. PC\_CS & dhcp.it.birzeit.edu

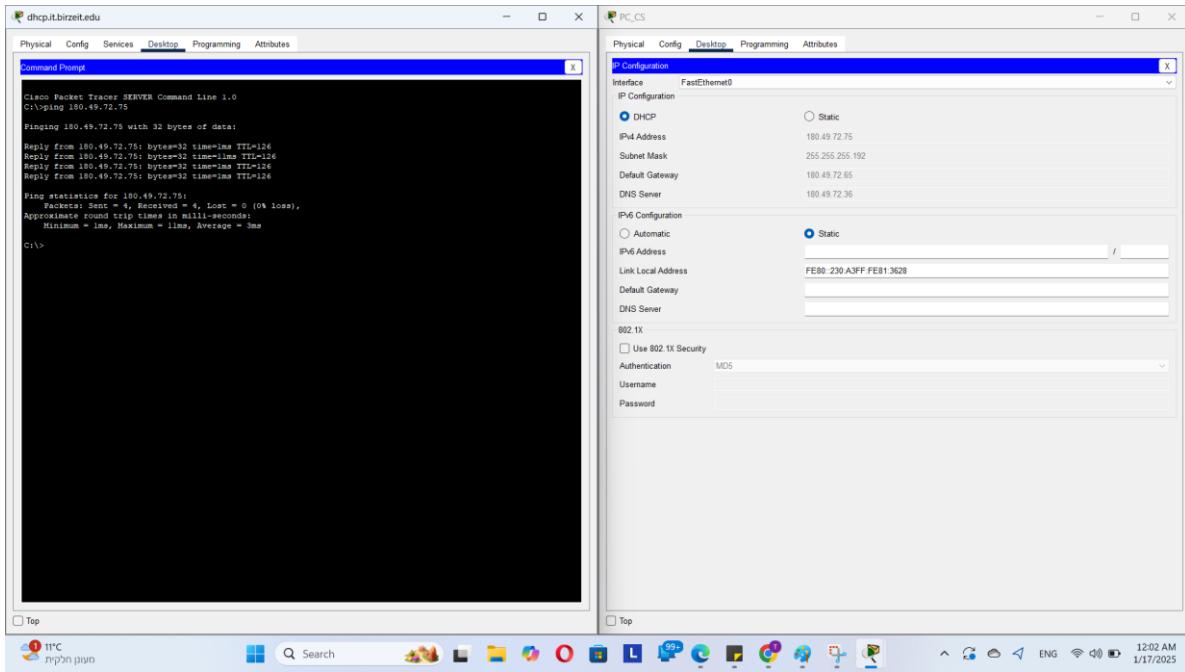


Figure 69: Ping Test from PC\_CS to dhcp.it.birzeit.edu

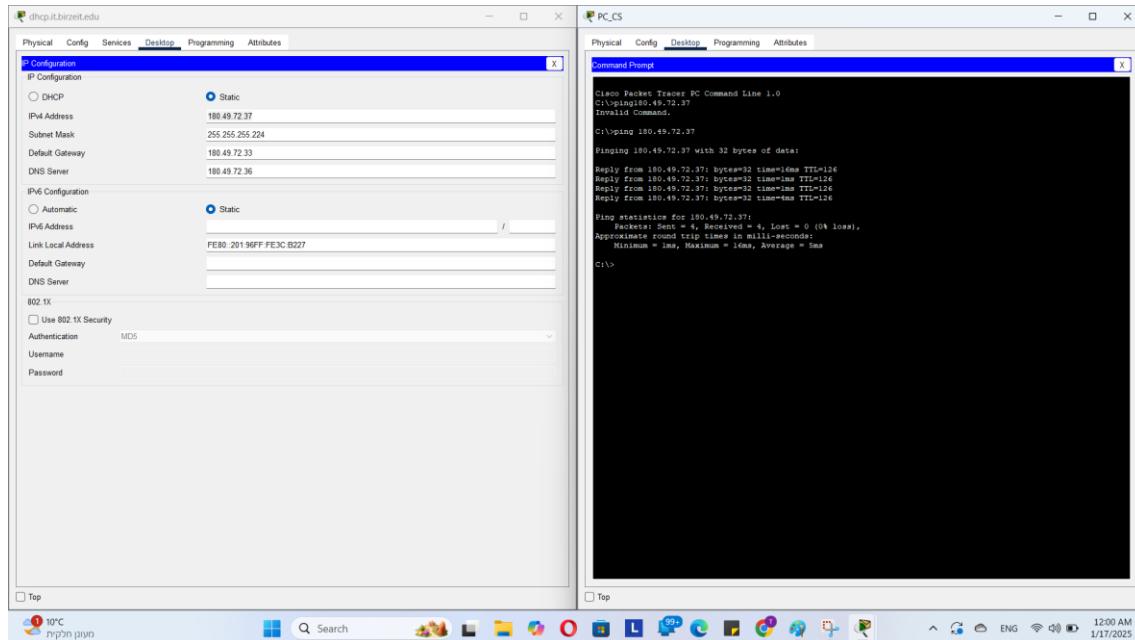


Figure 70: Ping Test from dhcp.it.birzeit.edu to PC\_CS

➤ Access to the website [www.it.birzeit.edu](http://www.it.birzeit.edu):

Access to the website www.it.birzeit.edu has been successfully verified for the following devices: PC\_ECE and Laptop\_CS. Both devices are able to connect to the site without any issues.

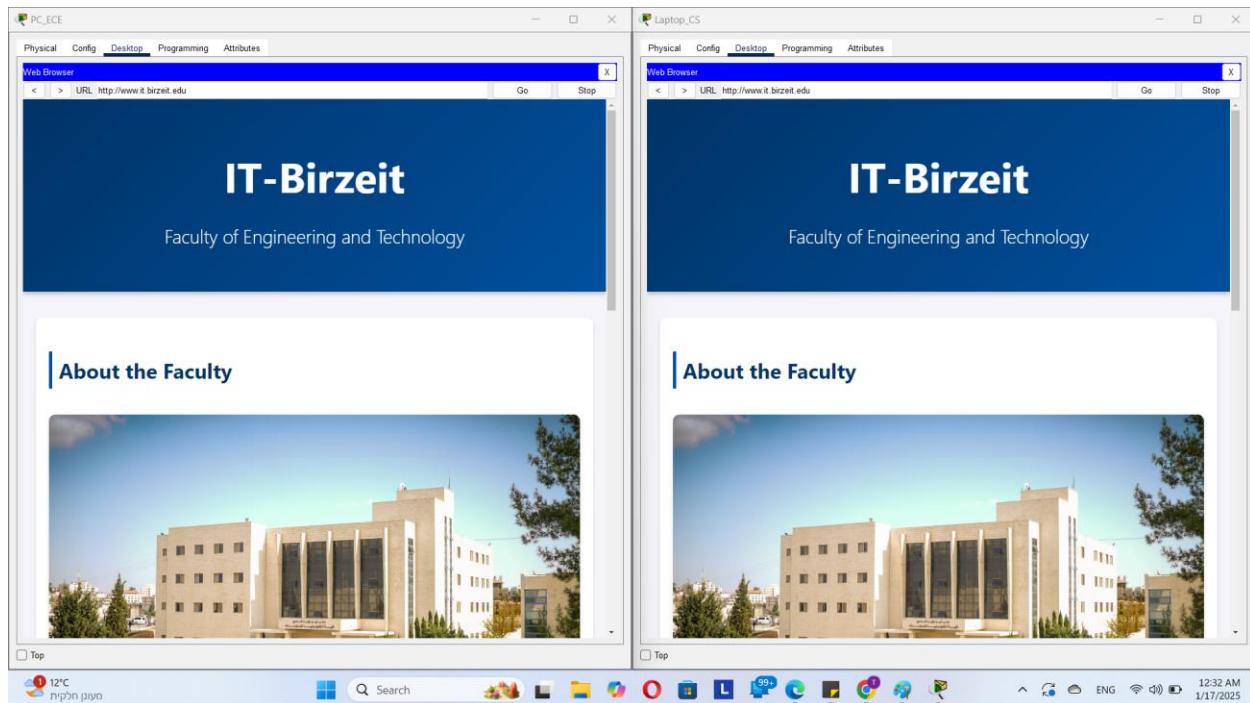


Figure 71: Access to the website [www.it.birzeit.edu](http://www.it.birzeit.edu)

## Testing Home-ISP network devices:

- Ping between Home network devices:

### 1. PC\_Home & Laptop\_Home

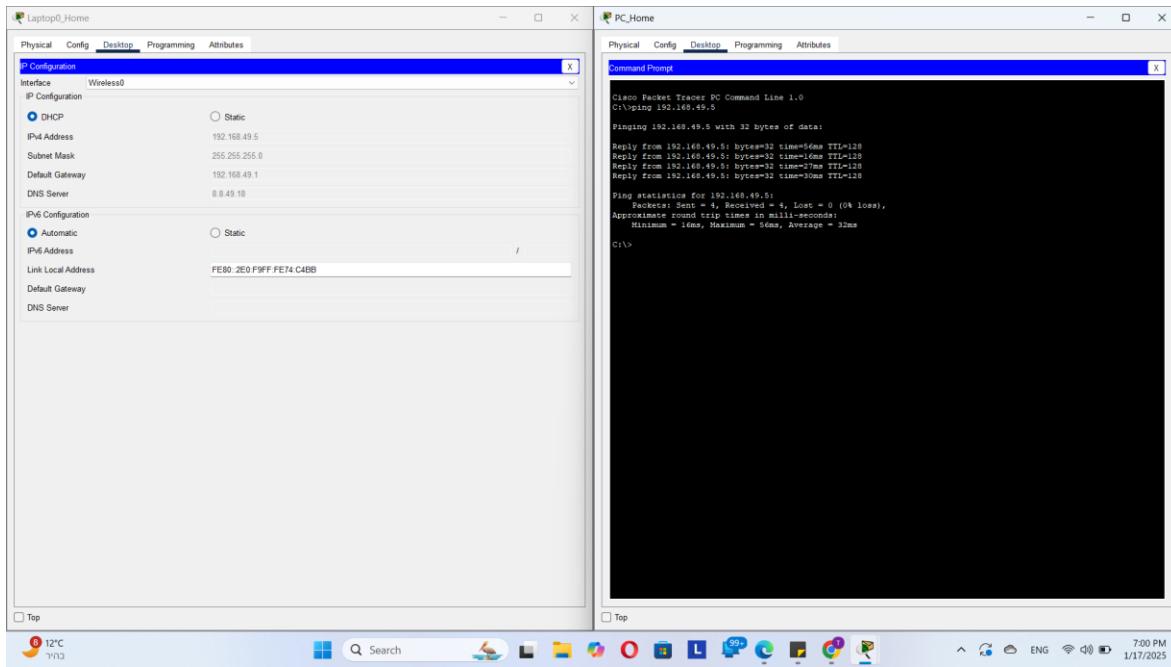


Figure 72: Ping Test from Laptop\_Home to PC\_Home

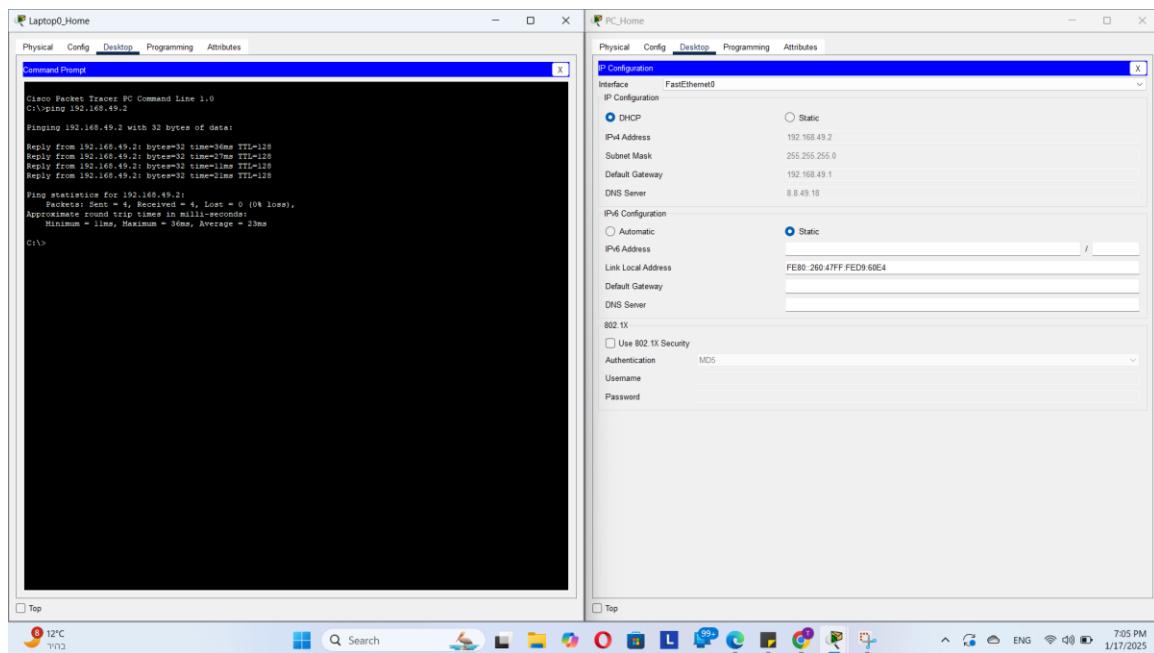


Figure 73: Ping Test from PC\_Home to Laptop\_Home

## 2. Smartphone\_Home & Tablet\_Home

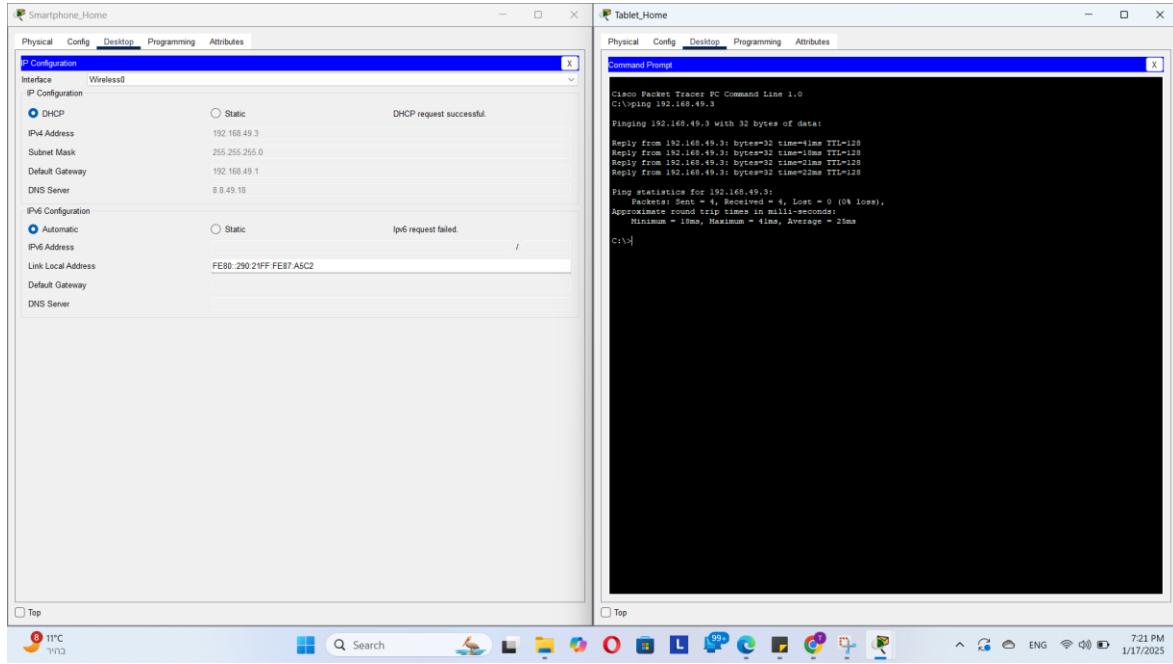


Figure 74: Ping Test from Tablet\_Home to Smartphone\_Home

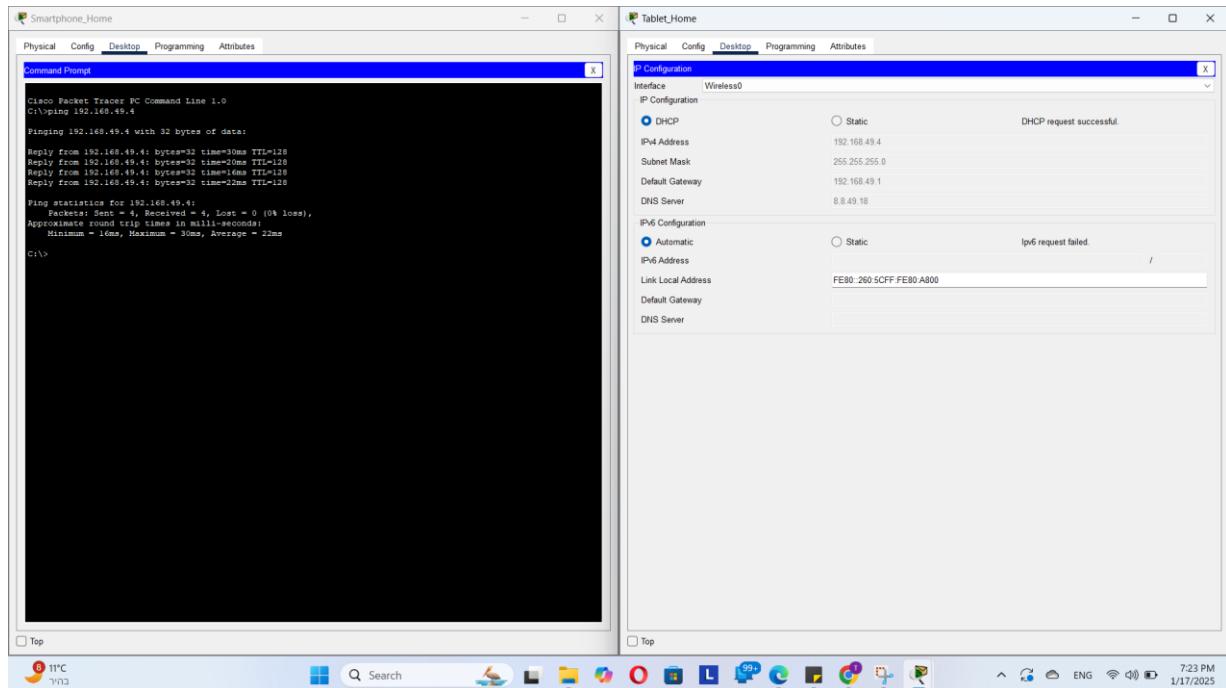


Figure 75: Ping Test from Smartphone\_Home to Tablet\_Home

## Simulation Mode:

### ➤ Sending Emails:

The email sending process fails due to an error during transmission. I will discuss the problem in the **Alternative Solutions, Issues, and Limitations** of the report, rather than detailing it under the Simulation Mode analysis.

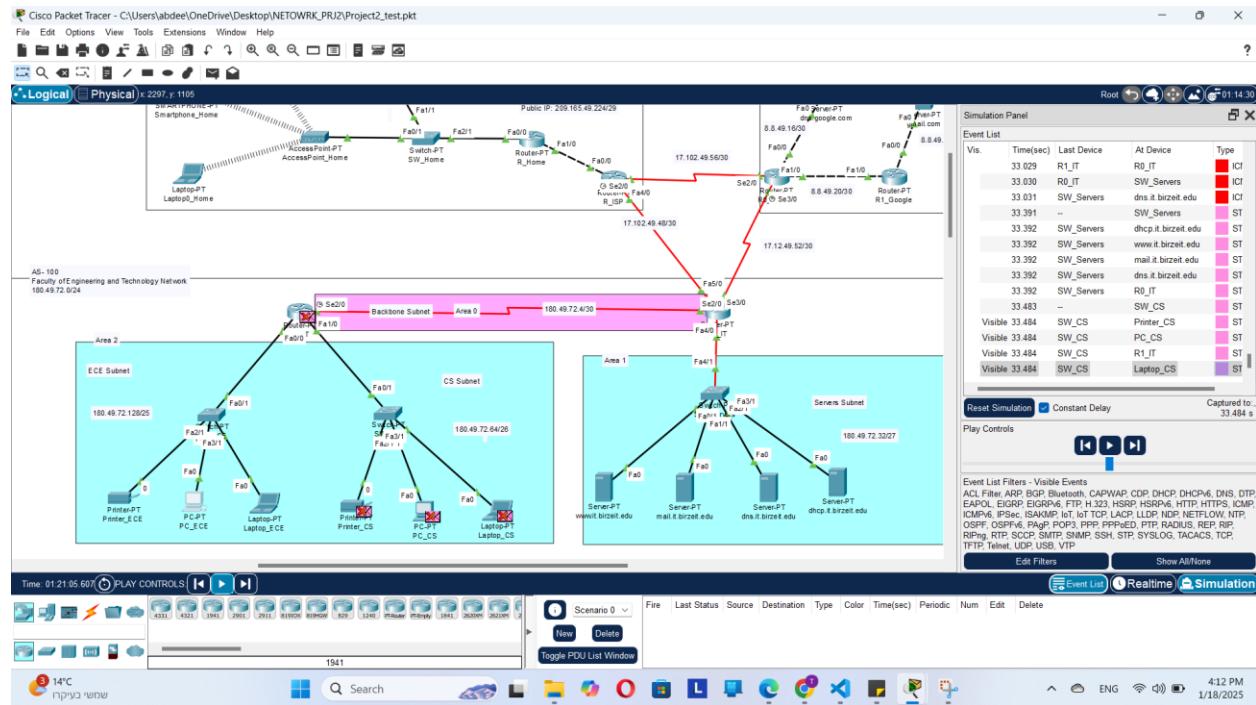


Figure 76: Simulation Mode for Sending Emails - 1

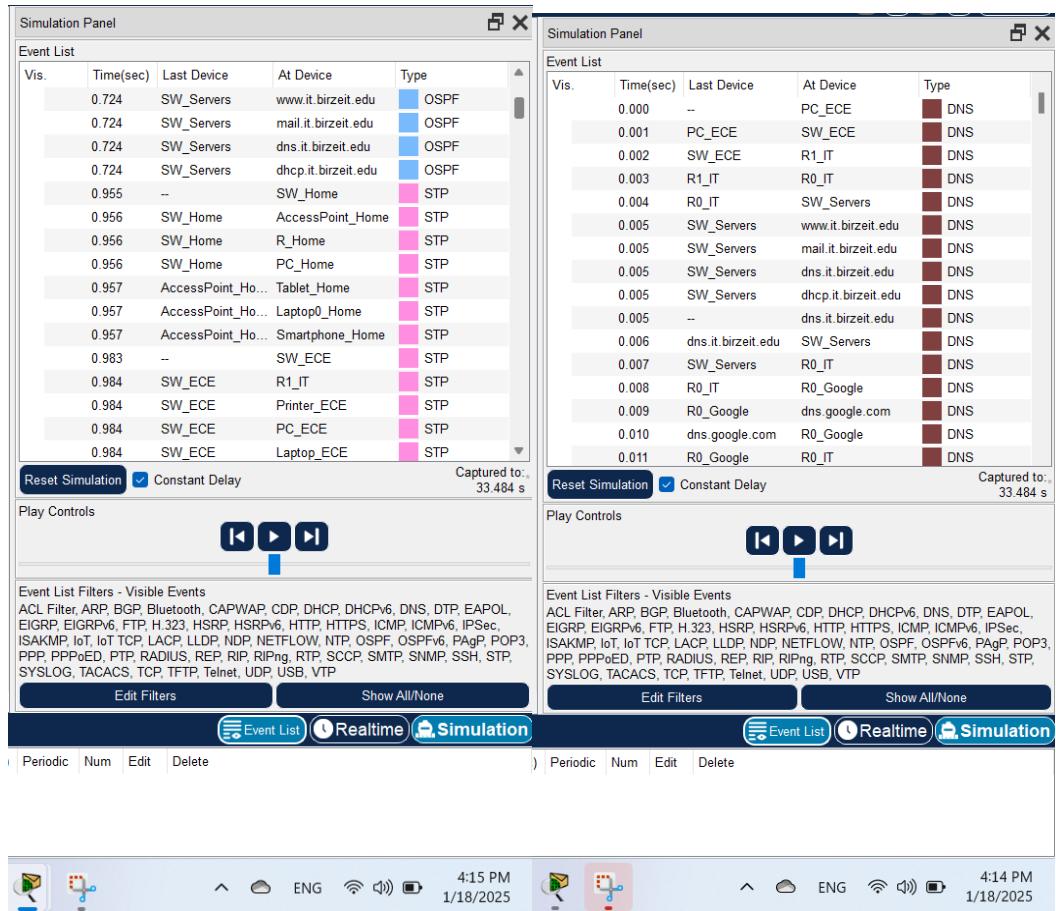


Figure 77: Simulation Mode for Sending Emails -2

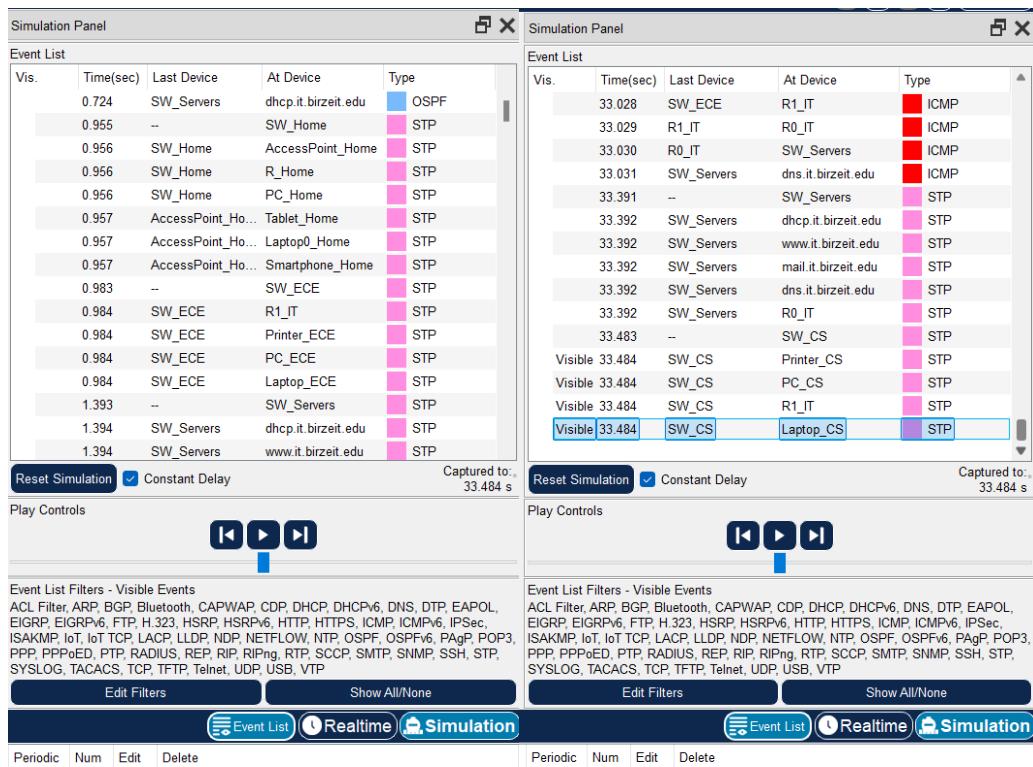


Figure 78: Simulation Mode for Sending Emails -3

➤ Send packet from Laptop0\_Home to [www.it.birzeit.edu](http://www.it.birzeit.edu):

The packet from Laptop0\_Home to www.it.birzeit.edu is successfully transmitted because the devices are on different networks with proper IP addressing and routing configuration. The router forwards the packet to the correct network based on its routing table. DNS resolution ensures the hostname is converted to the appropriate IP address for communication.

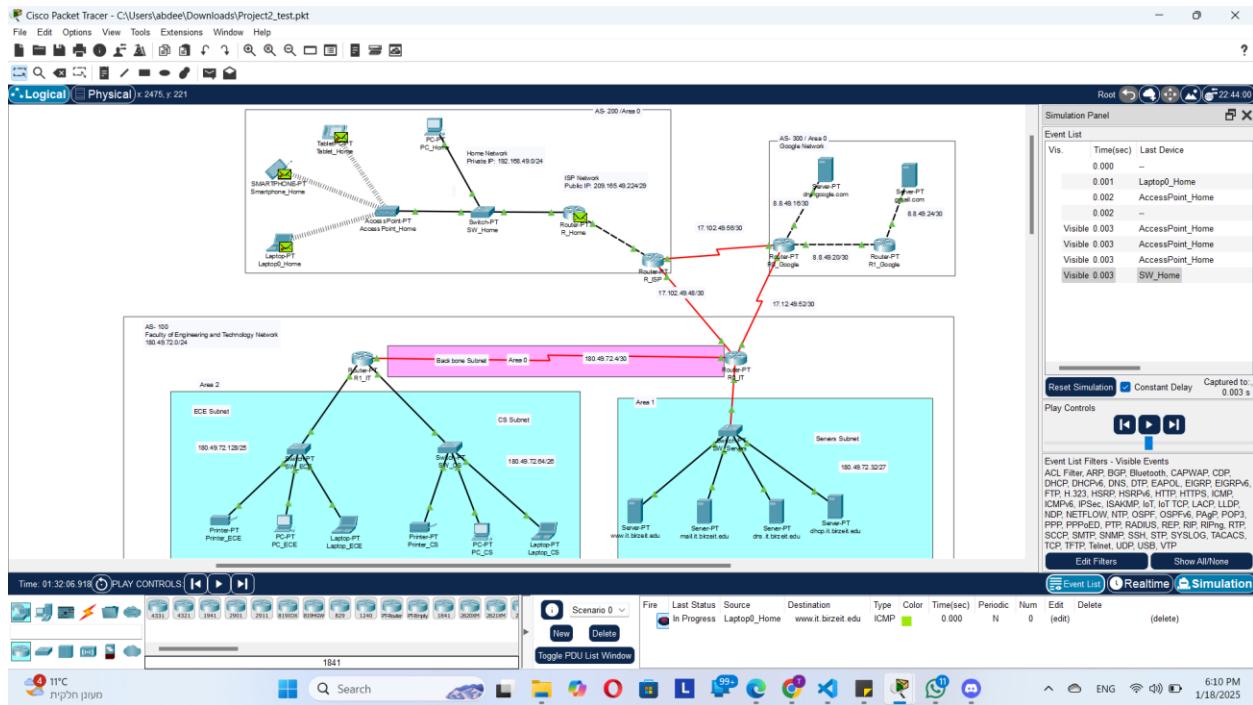


Figure 79 Simulation Mode for Sending packet from Laptop0\_Home to [www.it.birzeit.edu](http://www.it.birzeit.edu) -1

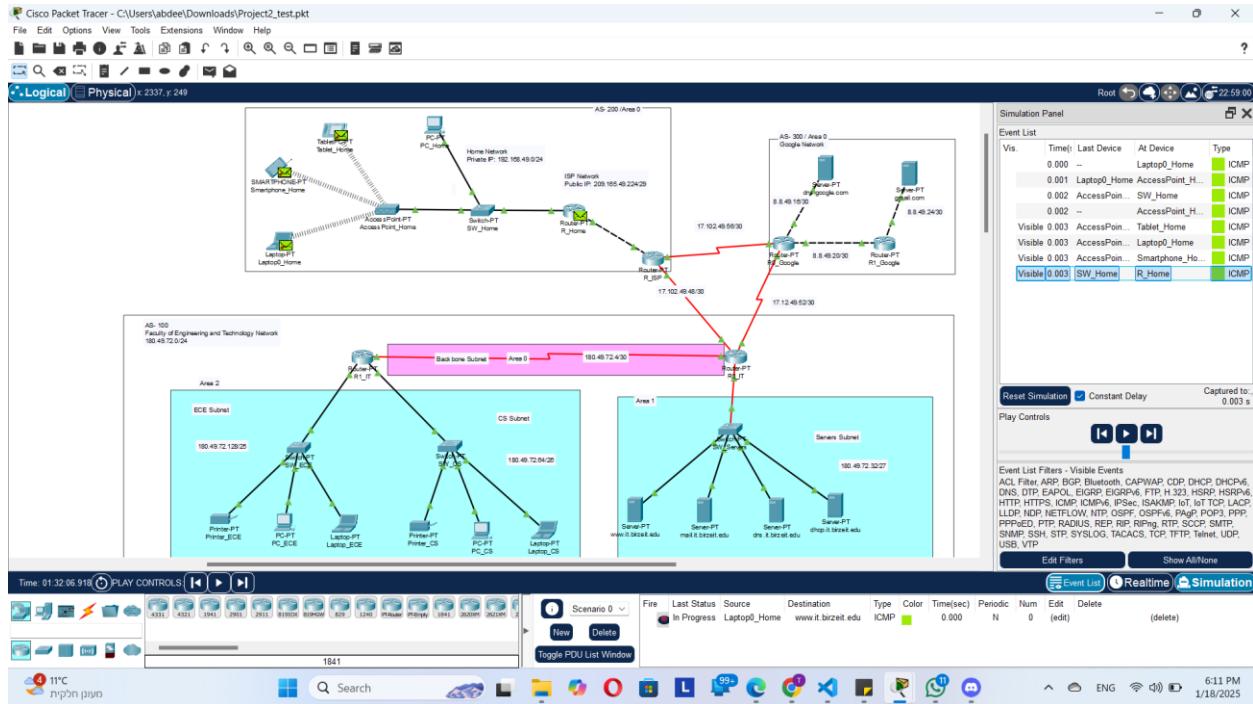


Figure 80: Simulation Mode for Sending packet from Laptop0\_Home to [www.it.birzeit.edu](http://www.it.birzeit.edu) - 2

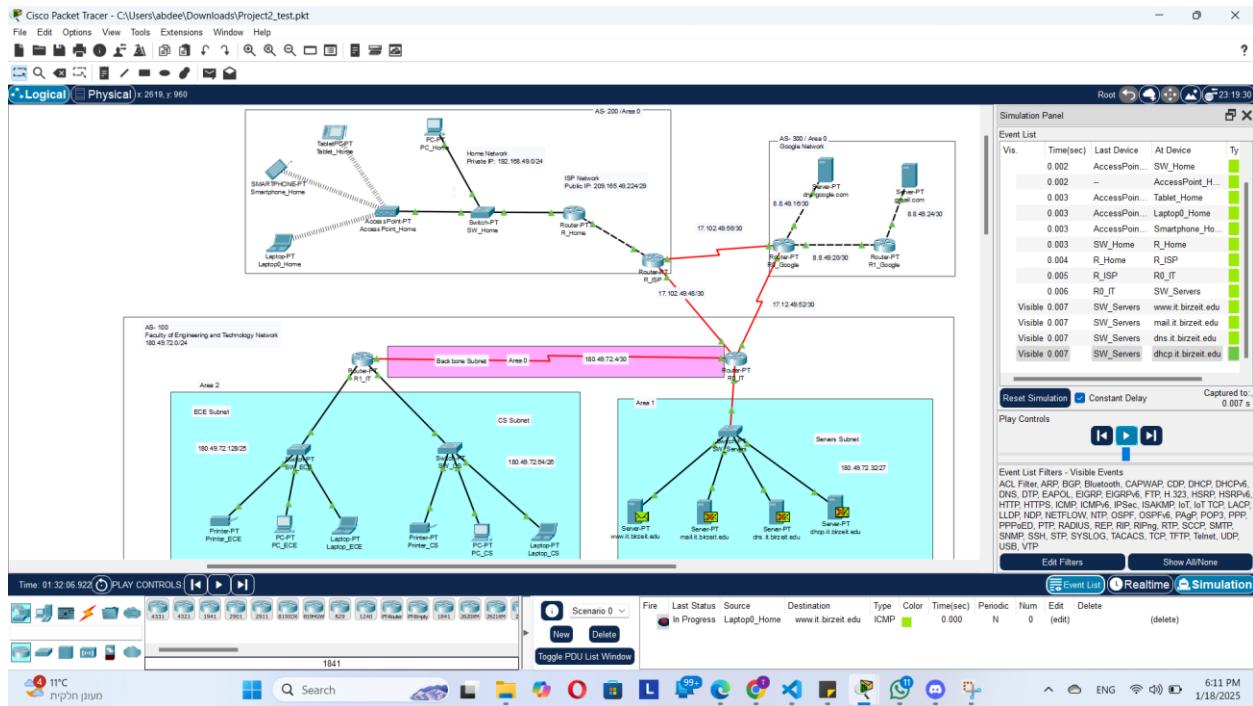


Figure 81 Simulation Mode for Sending packet from Laptop0\_Home to [www.it.birzeit.edu](http://www.it.birzeit.edu) - 3

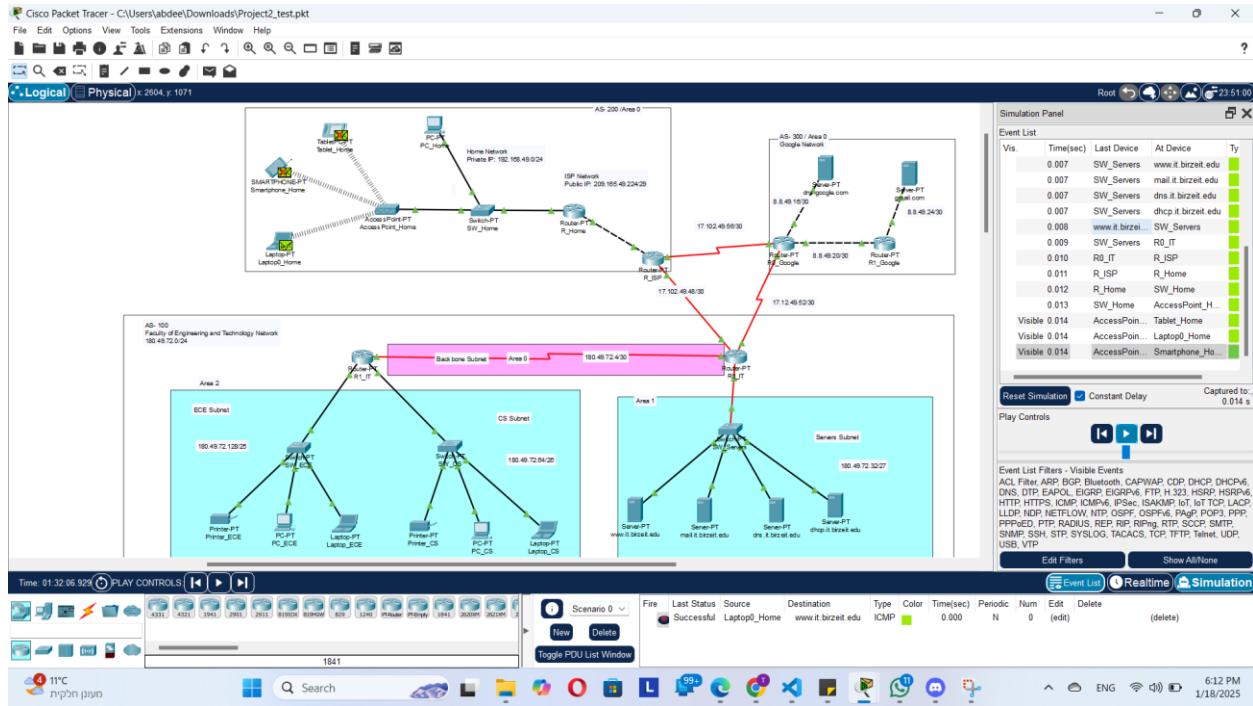


Figure 82: Simulation Mode for Sending packet from Laptop0\_Home to [www.it.birzeit.edu](http://www.it.birzeit.edu) - 4

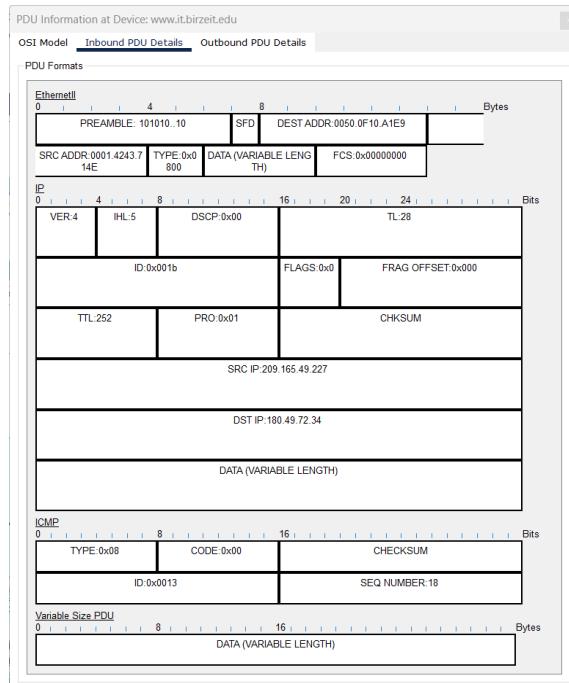


Figure 83: Simulation Mode: PDU Information at Device:[www.it.birzeit.edu](http://www.it.birzeit.edu)

➤ Send packet from [www.it.birzeit.edu](http://www.it.birzeit.edu) to Laptop0\_Home:

The packet from www.it.birzeit.edu to Laptop0\_Home failed despite correct configurations of the return path.

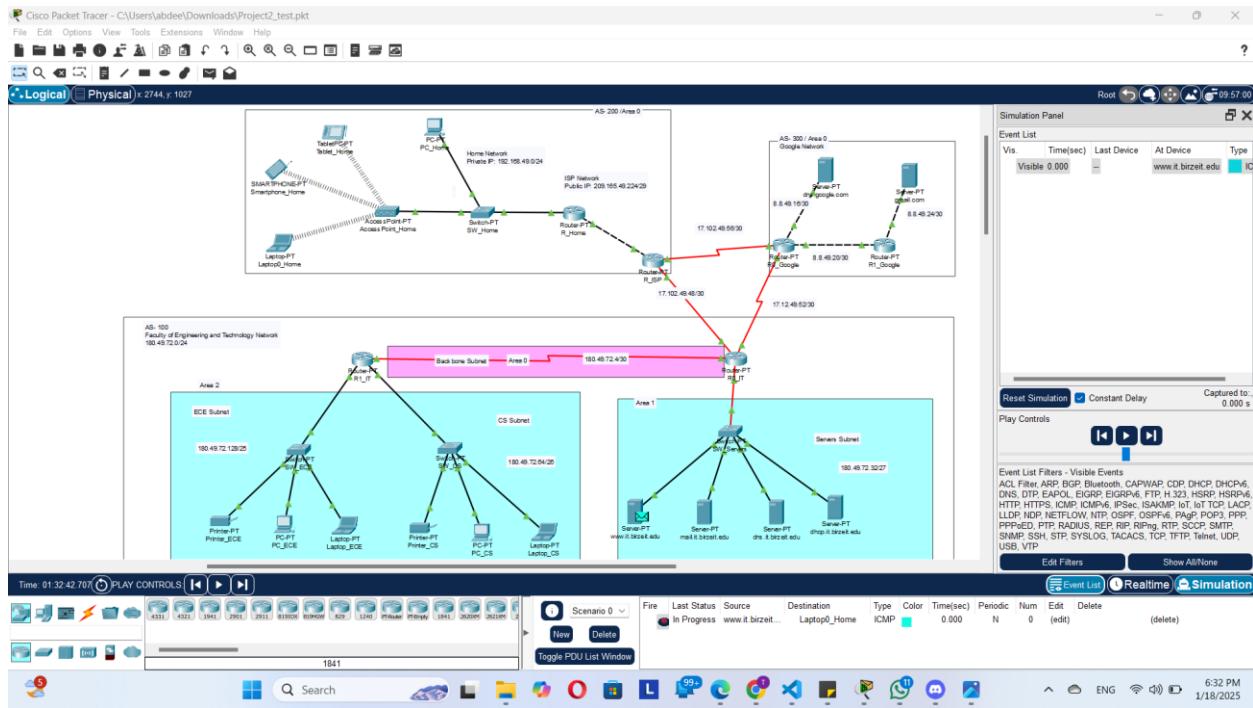


Figure 84: Simulation Mode for Sending packet from [www.it.birzeit.edu](http://www.it.birzeit.edu) to Laptop0\_Home - 1

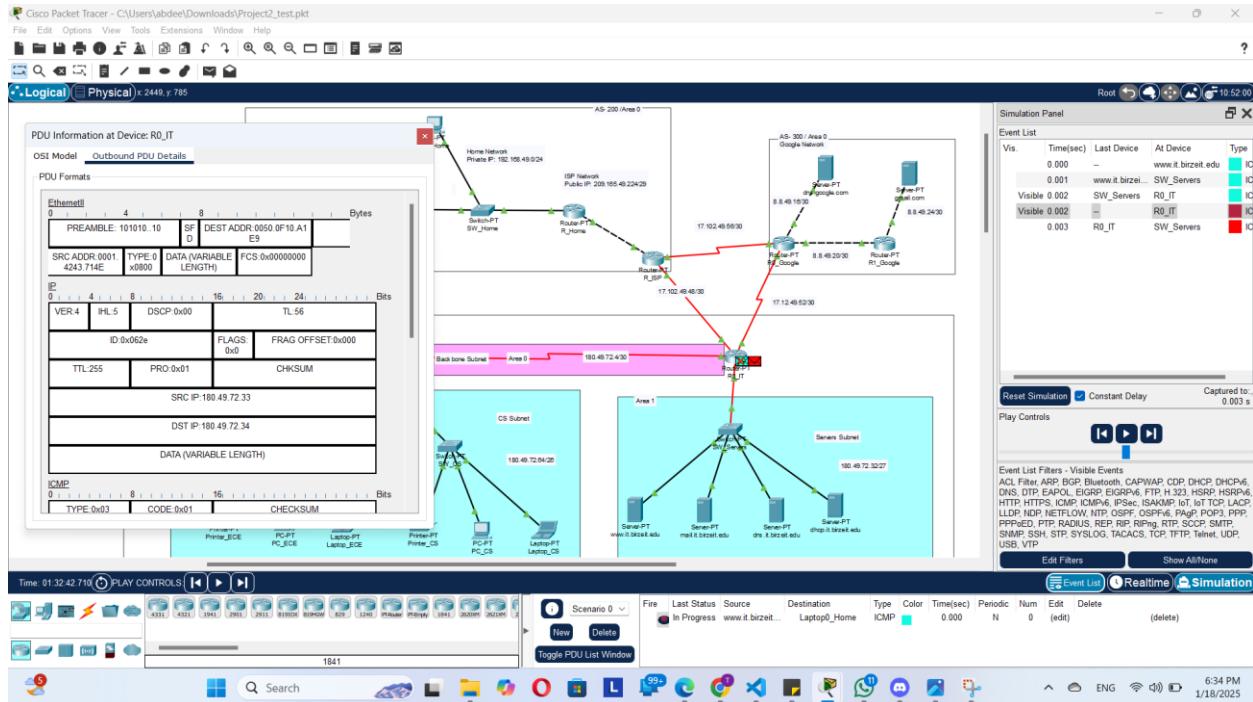


Figure 85: Simulation Mode for Sending packet from [www.it.birzeit.edu](http://www.it.birzeit.edu) to Laptop0\_Home - 2

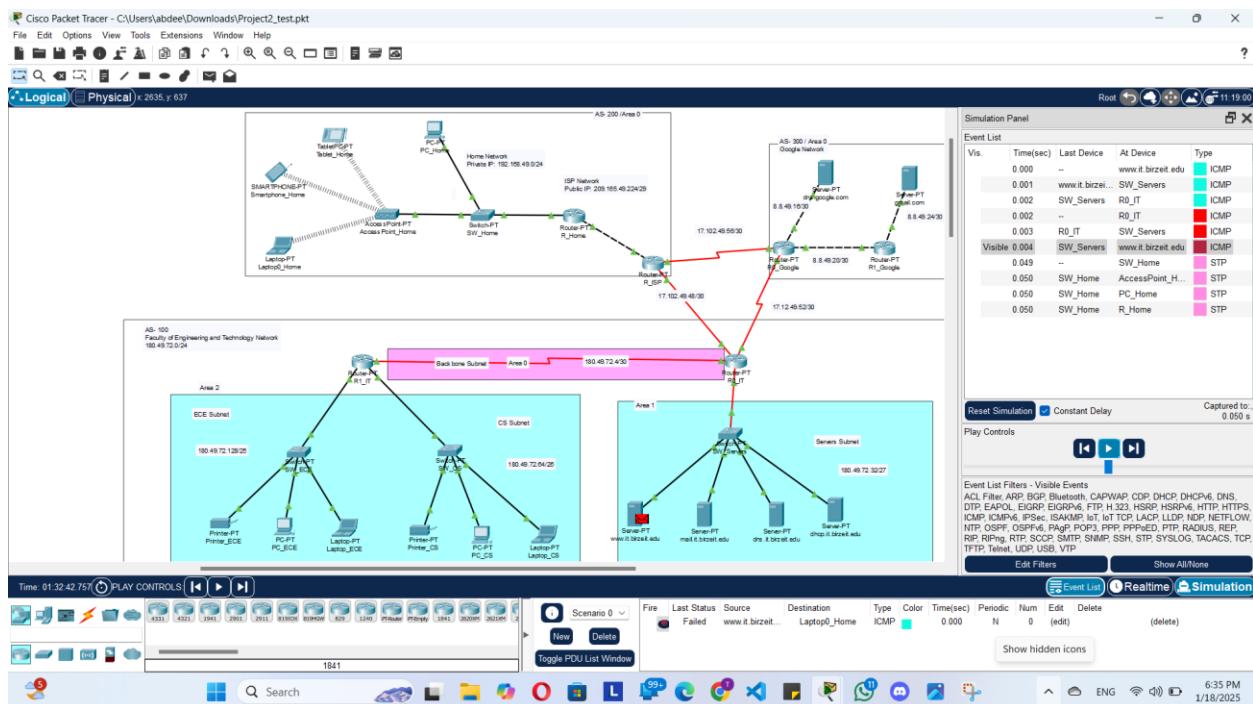


Figure 86: Simulation Mode for Sending packet from [www.it.birzeit.edu](http://www.it.birzeit.edu) to Laptop0\_Home - 3

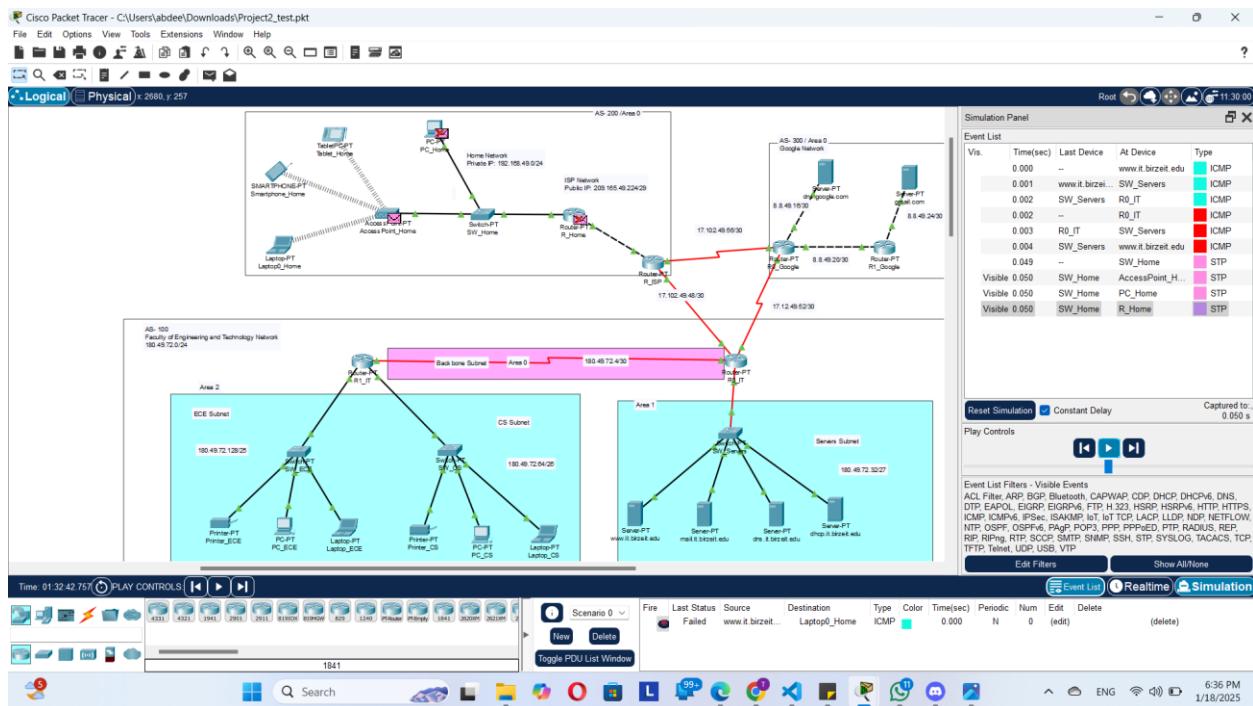


Figure 87: Simulation Mode for Sending packet from [www.it.birzeit.edu](http://www.it.birzeit.edu) to Laptop0\_Home - 4

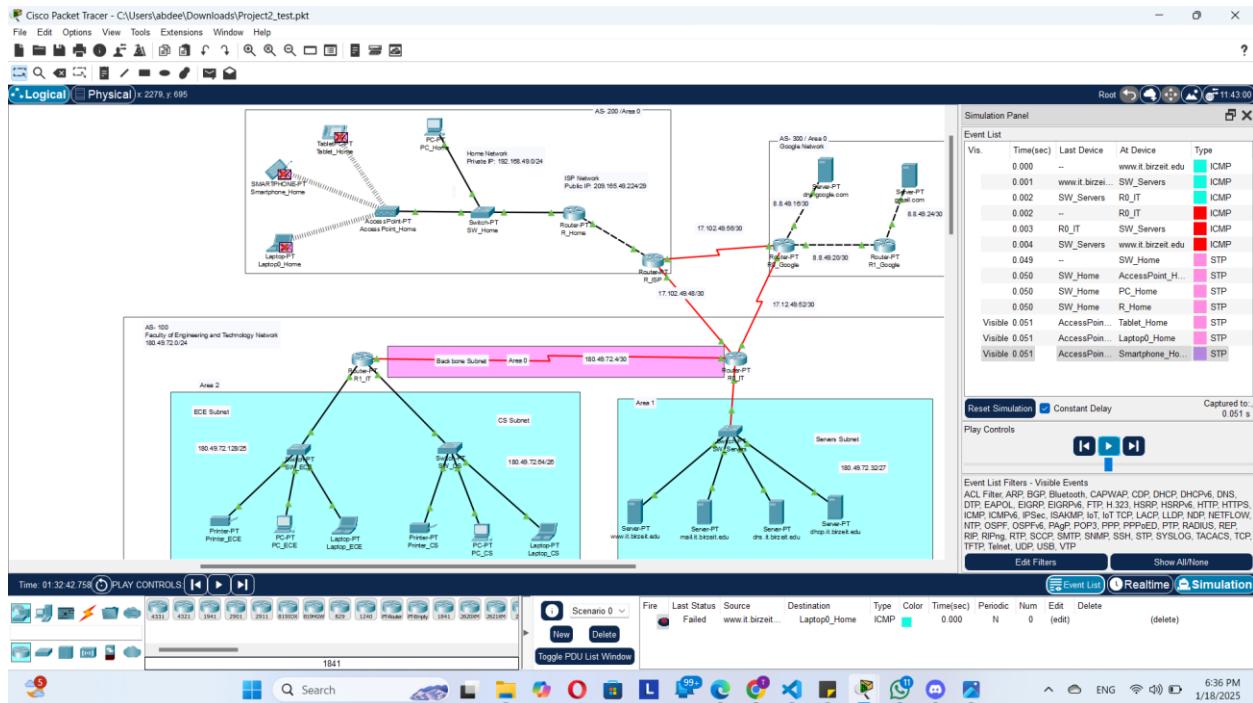


Figure 88: Simulation Mode for Sending packet from [www.it.birzeit.edu](http://www.it.birzeit.edu) to Laptop0\_Home - 5

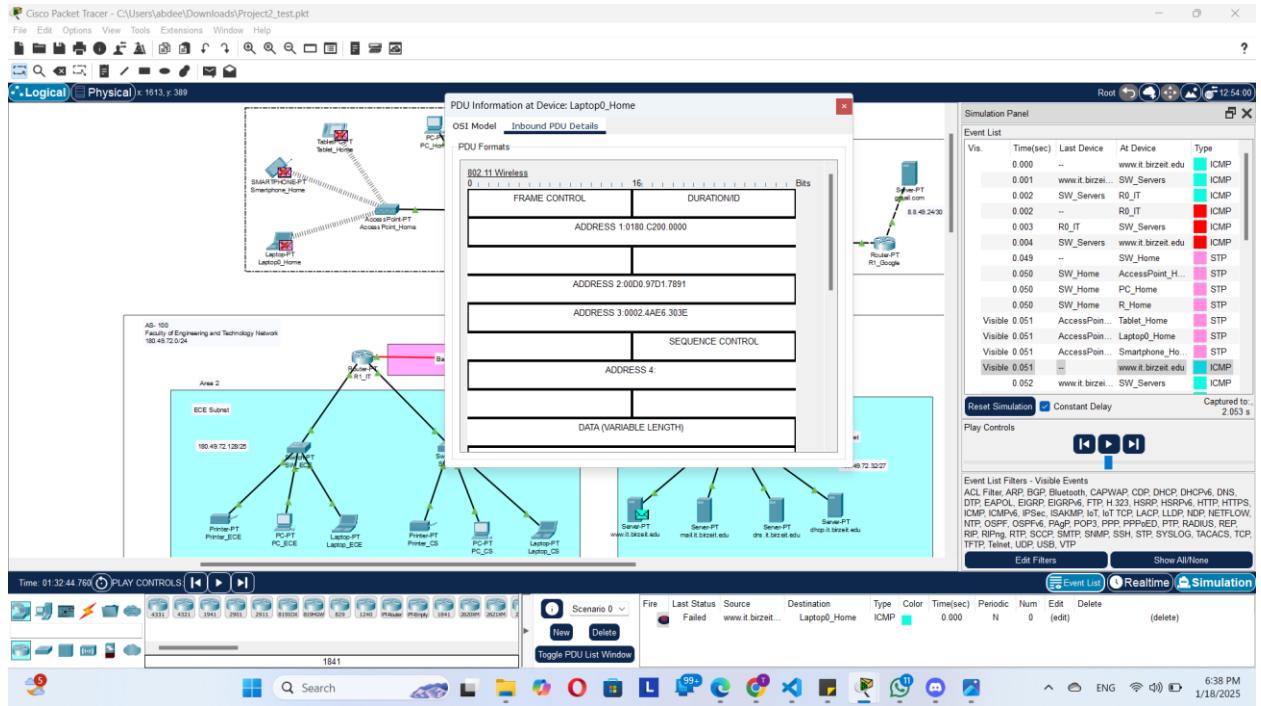


Figure 89: Simulation Mode for Sending packet from [www.it.birzeit.edu](http://www.it.birzeit.edu) to Laptop0\_Home - 6

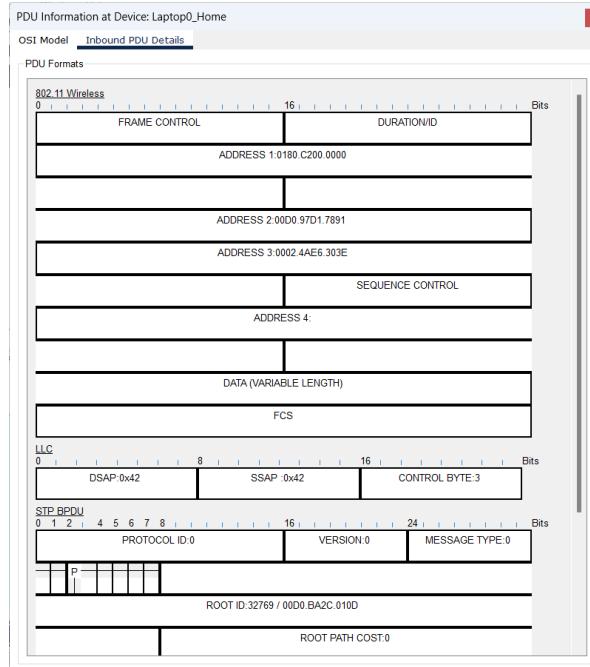


Figure 90: Simulation Mode: PDU Information at Device: Laptop0\_Home - 1

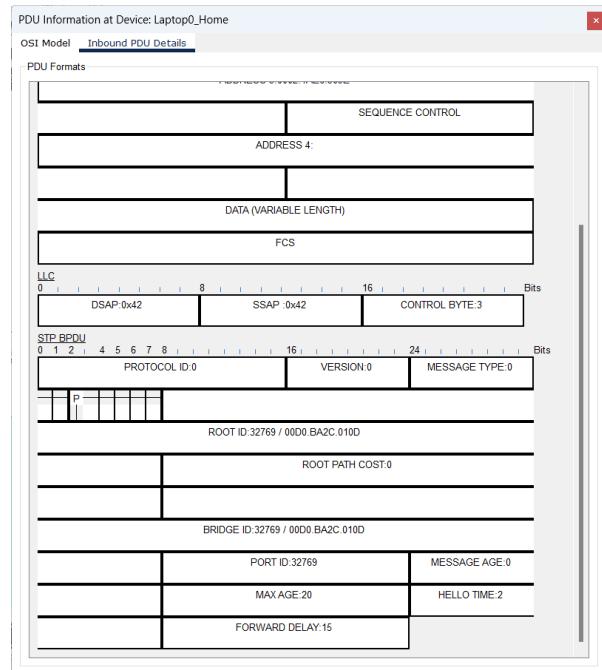


Figure 91: Simulation Mode: PDU Information at Device: Laptop0\_Home -2

## **Alternative Solutions, Issues, and Limitations:**

### **A. Failure to send emails :**

#### **Possible Causes for the Email Failure**

When trying to send an email from a gmail.com account to an it.birzeit.edu account in Packet Tracer, the error "Connection received a reset from server" is displayed. This error means that the email server has refused the connection request, which could be due to the following causes:

- Email Server Configuration:

The email server for it.birzeit.edu may not be configured properly or enabled to the SMTP service, which can decline emails originating from external domains like gmail.com. Here, the server may not well be configured with identifying gmail.com as a well-known sender of your domain.

c) Domain Name Resolution DNS:

For instance, if the email client or server is using a domain name-for example, gmail.com or it.birzeit.edu-the DNS server may not be configured to resolve these domain names into their corresponding IP addresses. The DNS entry could be missing or misconfigured and may be the cause of the failure in the connection.

- Authentication and Permissions:

Most mail servers are configured to authenticate, for example through a username/password, before accepting emails from any other host. If it does not see appropriate credentials from the client it may reset the connection.

The server for it.birzeit.edu might be configured to reject emails coming from unknown domains such as gmail.com as a part of anti-spam configuration settings.

## **Steps Taken to Overcome the Problem**

A range of troubleshooting steps were taken in attempting to overcome the problem. The error would persist. These included:

- Reconfiguration of the Email Server:

The SMTP and POP3 services were enabled on it.birzeit.edu.

Checked the server settings to allow it to connect from external domains such as gmail.com.

- Email Client Re-configuration

Doubled-checked the configuration in the email client on the PC and made sure to correctly identify the SMTP server, domain, and port numbers.

Added the proper authentication credentials via username and password into the client settings.

- Network Connectivity Test

Used the ping command to verify the connectivity between PC and email server.

Ensured the devices were on the same subnet and that routing was set up properly.

- Simulation of the Connection

Activated Simulation Mode in order to view the process of delivering emails. It appeared from the simulation that the server was resetting the connection during the handshake, which usually is a configuration or compatibility issue.

- Log Analysis

Checked server logs for any errors or restrictions that might prevent the delivery of emails. No specific misconfiguration was found.

After trying all the above, the problem still persisted.

## **B. Failure to send packet from [www.it.birzeit.edu](http://www.it.birzeit.edu) to Laptop0\_Home :**

Even after rechecking and verifying all the critical configurations for the R1 router, such as IP address configuration, default gateway configuration, routing configuration, and interface statuses, the problem persists. We have configured routing tables properly and made sure that no ACLs are blocking our traffic. Furthermore, we checked the status of all interfaces in order to find out whether they were all enabled and up. The message did not reach the router as expected although no problems were depicted on NAT. We ran a number of tests like pinging over different addresses on the network. None of these measures succeeded. We have tried our best, have gone through every possible cause, yet the problem still persists, and we could not get the expected result of this project.

# **Teamwork**

## **Task Chart**

### **Task 1: Google AS**

- **Assigned to Toqa:**
  - Subtasks:
    - Connect devices.
    - Configure static IPs.
    - Configure DNS servers (IP, service, and RRs).
    - Configure the email server (IP, service, domain, and accounts).
    - Set up OSPF and BGP routing.

### **Task 2: Faculty of Engineering and Technology AS**

- **Assigned to Toqa:**
  - Subtasks:
    - Connect devices.
    - Perform subnetting.
- **Assigned to Mohammad:**
  - Subtasks:
    - Configure static and dynamic IPs.
    - Set up the web server.
    - Configure the mail server (IP, service, domain, and accounts).
    - Configure the DNS server (IP, service, and RRs).
    - Set up the DHCP server (IP, service, pools, and IP helper command).
    - Configure the email client.
    - Implement OSPF and BGP routing.
    - Conduct testing.
    -

### **Task 3: Home-ISP AS**

- **Assigned to Omar:**

- Subtasks:

- Configure the wireless network.
    - Set up static and dynamic IPs.
    - Configure the DHCP server.
    - Set up dynamic NAT.
    - Configure the email client.
    - Implement OSPF and BGP routing.
    - Conduct testing.

- **Assigned to Toqa:**

- Subtasks:

- Connect devices.

## **Report Sections**

### **Toqa's Responsibilities:**

- Sections to write:
  - Cover page.
  - Theory and Procedure.
  - Results and Discussions (for Google AS).
  - Alternative Solutions.
  - Issues and Limitations.
  - Teamwork.
  - References.
  - Table of contents.
  - List of figures.
  - List of tables.

### **Mohammad's Responsibilities:**

- Sections to write:
  - Results and Discussions (for Faculty of Engineering and Technology AS).

### **Omar's Responsibilities:**

- Sections to write:
  - Results and Discussions (for Home-ISP AS).

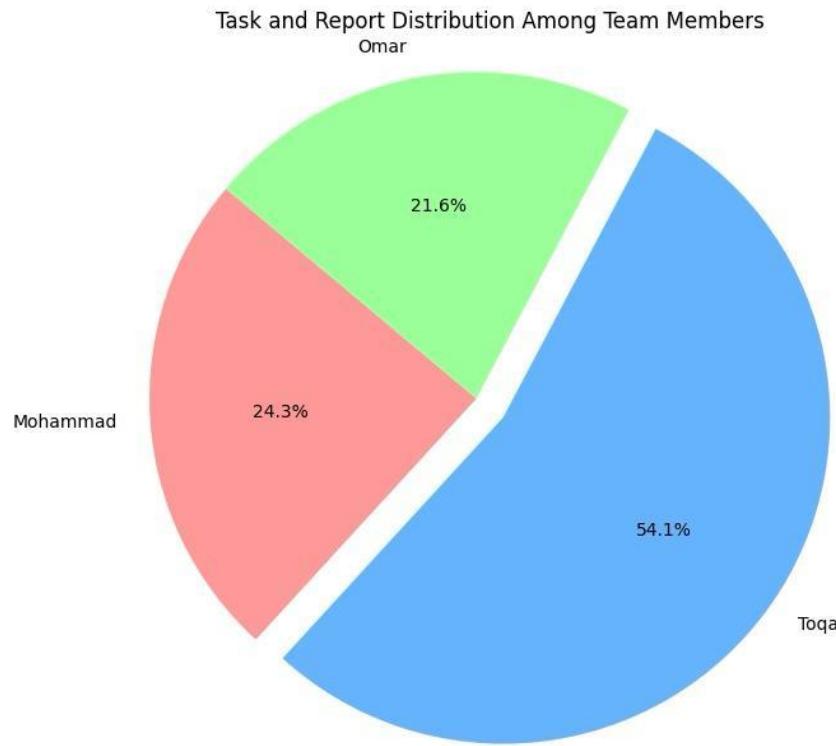


Figure 92: Contribution Distribution Among Team Members

## **References:**

- [1]: <https://www.geeksforgeeks.org/dynamic-host-configuration-protocol-dhcp/>
- [2]: [https://ritaj.birzeit.edu/bzu-msgs/attach/2681408/Chapter\\_2\\_v8.0V1.pdf](https://ritaj.birzeit.edu/bzu-msgs/attach/2681408/Chapter_2_v8.0V1.pdf)
- [3]: [https://en.wikipedia.org/wiki/Network\\_address\\_translation](https://en.wikipedia.org/wiki/Network_address_translation)
- [4]: [https://www.fortinet.com/resources/cyberglossary/bgp-border-gateway-protocol#:~:text=Border%20Gateway%20Protocol%20\(BGP\)%20refers,This%20is%20accomplished%20through%20peering.](https://www.fortinet.com/resources/cyberglossary/bgp-border-gateway-protocol#:~:text=Border%20Gateway%20Protocol%20(BGP)%20refers,This%20is%20accomplished%20through%20peering.)