Computer Network Project

Enterprise Network Design with Subnet Segmentation and Multi-Routing Protocols in Cisco Packet Tracer

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Course: Computer Networks

Objective :

The objective of this project is to design and implement an **enterprise network** using **Cisco Packet Tracer**, with a focus on the following:

- **Subnet Segmentation**: Dividing the 192.168.1.0/24 network into multiple subnets to efficiently allocate IP addresses for various departments such as HR, Sales, IT, Marketing, Finance, and R&D.
- **Routing Protocols**: Configuring a combination of **RIP**, **OSPF**, and **EIGRP** routing protocols to enable inter-department communication.
- **NAT Configuration**: Setting up **Network Address Translation (NAT)** to provide internet access to devices in the network.
- **DHCP**: Implementing **Dynamic Host Configuration Protocol (DHCP)** to assign IP addresses dynamically to devices within each subnet.
- **Wireless Connectivity**: Integrating **Access Points (APs)** to provide wireless access to devices.
- **All server services implemented**.

Technologies Used:

Tools

- **Cisco Packet Tracer**: A network simulation tool used to design and configure network devices, including routers, switches, and end devices.
- **Routing Protocols**:
    - **RIP** (Routing Information Protocol)
    - **OSPF** (Open Shortest Path First)
    - **EIGRP** (Enhanced Interior Gateway Routing Protocol)
- **DHCP**: Used to automatically assign IP addresses to devices in the network.
- **NAT**: Configured to allow devices within the network to access the internet using a single public IP.
- **Wireless Connectivity**: Integrating **Access Points (APs)** to provide wireless access to devices.

Implementation Details:

Design and Approach

The project was divided into several key components:

1. **Subnetting**: The given 192.168.1.0/24 network was divided into **/27 subnets** for departmental segmentation. A **/30** subnet was used for the **router-to-router point-to-point connections**.
2. **Routing Protocols**:
    - **RIP** was applied on Router 1 (HR) to advertise routes within the **HR, Sales, and IT** subnets.
    - **OSPF** was configured on Routers 2 and 4 (Sales and Marketing) to allow routing between their respective subnets and the central network.
    - **EIGRP** was used on Router 3 (IT) to handle routing between the IT, Finance, and R&D subnets.
3. **Network Configuration**: Each router interface was assigned a static IP from the subnet range. **DHCP** was configured on each router to assign IPs dynamically to devices in the subnets. **NAT** was configured on Router 3 (IT) to provide internet access to the entire network.
4. **Wireless Access Points**: A wireless AP was set up in each department, connected to the respective subnet's switch to provide wireless access.

Results and Testing:

Functionality

The network was successfully configured with the following results:

- **Subnet Segmentation**: Each department was assigned a unique subnet, ensuring efficient IP management.
- **Routing Protocols**: The routers were able to communicate and route traffic between departments using RIP, OSPF, and EIGRP.
- **DHCP**: IP addresses were automatically assigned to devices in each department.
- **NAT**: Devices were able to access the internet via NAT configuration on Router 3.
- **Wireless Connectivity**: End devices connected to the wireless APs were able to access the network.

Testing and Results

- **Ping Test**: Successful pings between PCs in different subnets.
- **Internet Access**: Devices were able to access the internet via NAT.
- **DHCP**: Devices received IP addresses dynamically from the DHCP server on the routers.

Challenges and Learnings:

Challenges

1. **Subnetting**: Initially, the calculation and assignment of IP addresses for subnetting caused confusion, especially when handling multiple departments and router-to-router links.
2. **Routing Protocol Configuration**: Ensuring that the different routing protocols (RIP, OSPF, EIGRP) worked in harmony was tricky. There were issues with routing advertisements that needed troubleshooting.
3. **NAT Configuration**: Setting up NAT properly was a challenge, especially in ensuring that the internal network could access the internet without issues.

Learnings

- **Subnetting**: Gaining a deeper understanding of subnet masks, CIDR notation, and how subnetting is essential for network efficiency.
- **Routing Protocols**: Learning how to configure and troubleshoot different routing protocols (RIP, OSPF, EIGRP) and their role in interconnecting departments.
- **NAT and DHCP**: Understanding the role of NAT in managing internet access and how DHCP automates IP assignment.

Conclusion

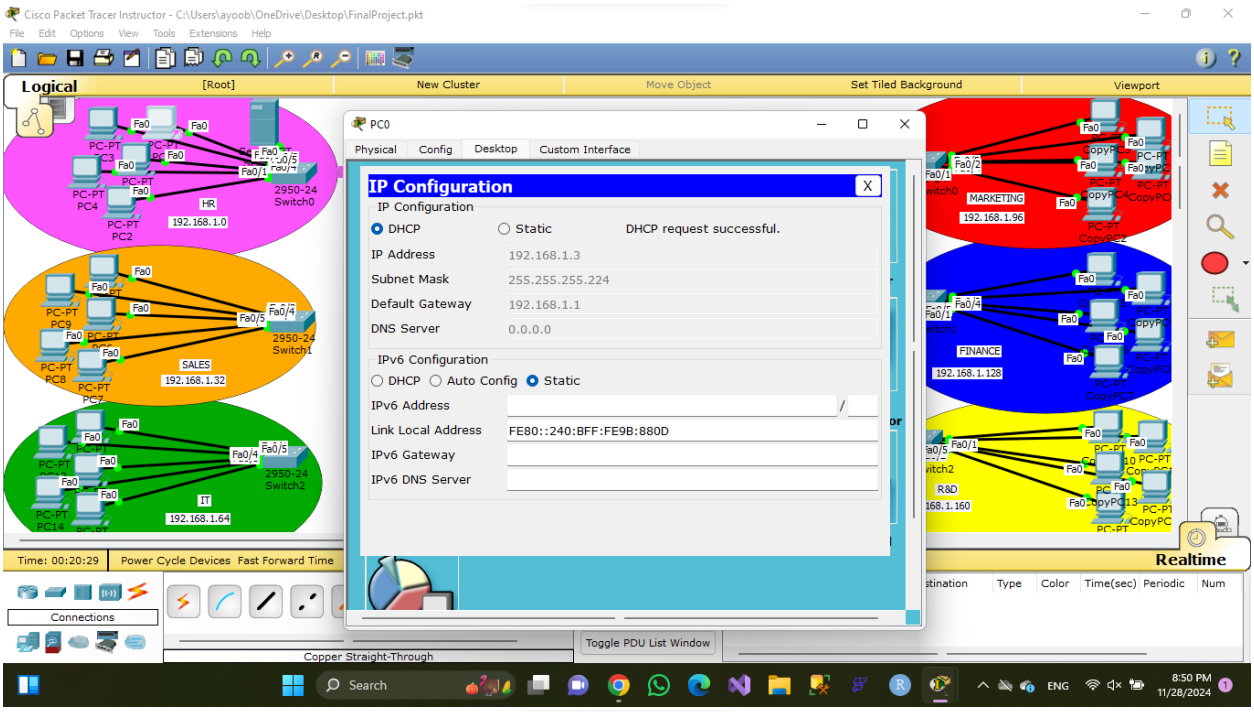
This project successfully demonstrated how to design and implement a network for an enterprise with subnet segmentation, multi-routing protocols, and NAT configuration. The key outcomes are:

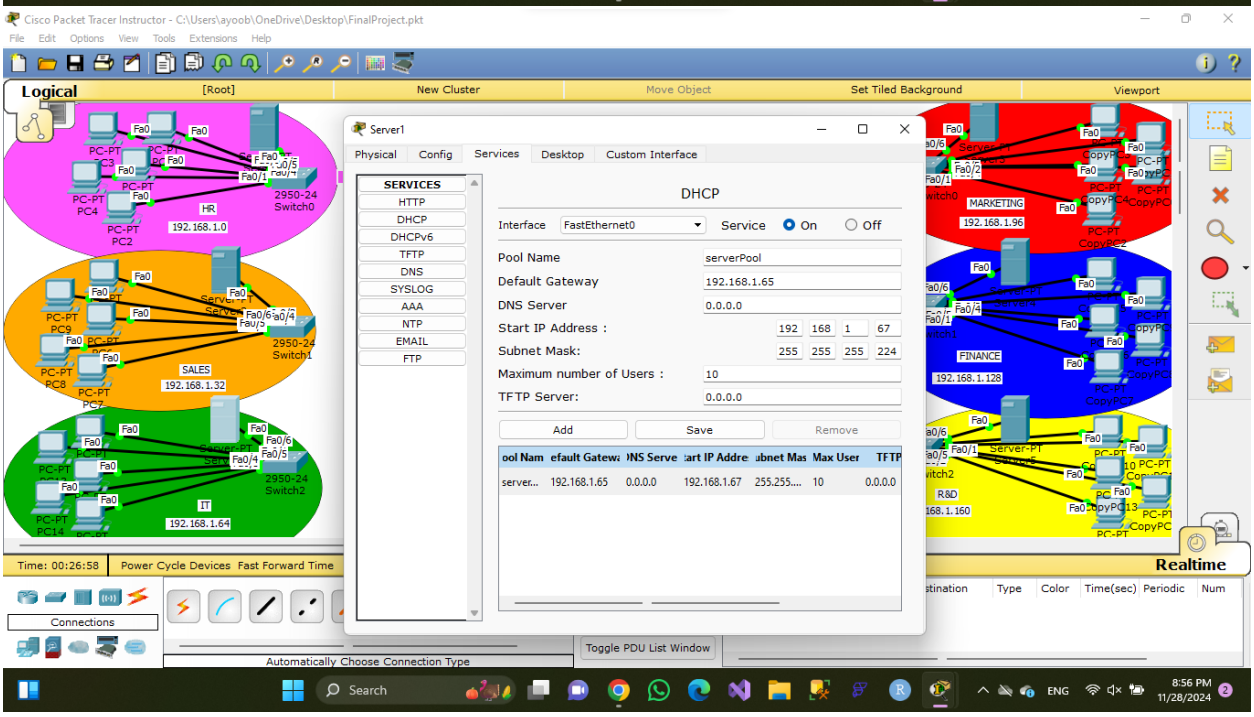
- **Efficient IP Management**: Through subnetting and DHCP.
- **Robust Routing**: With RIP, OSPF, and EIGRP ensuring connectivity between departments.
- **Internet Access**: Through NAT on Router 3.

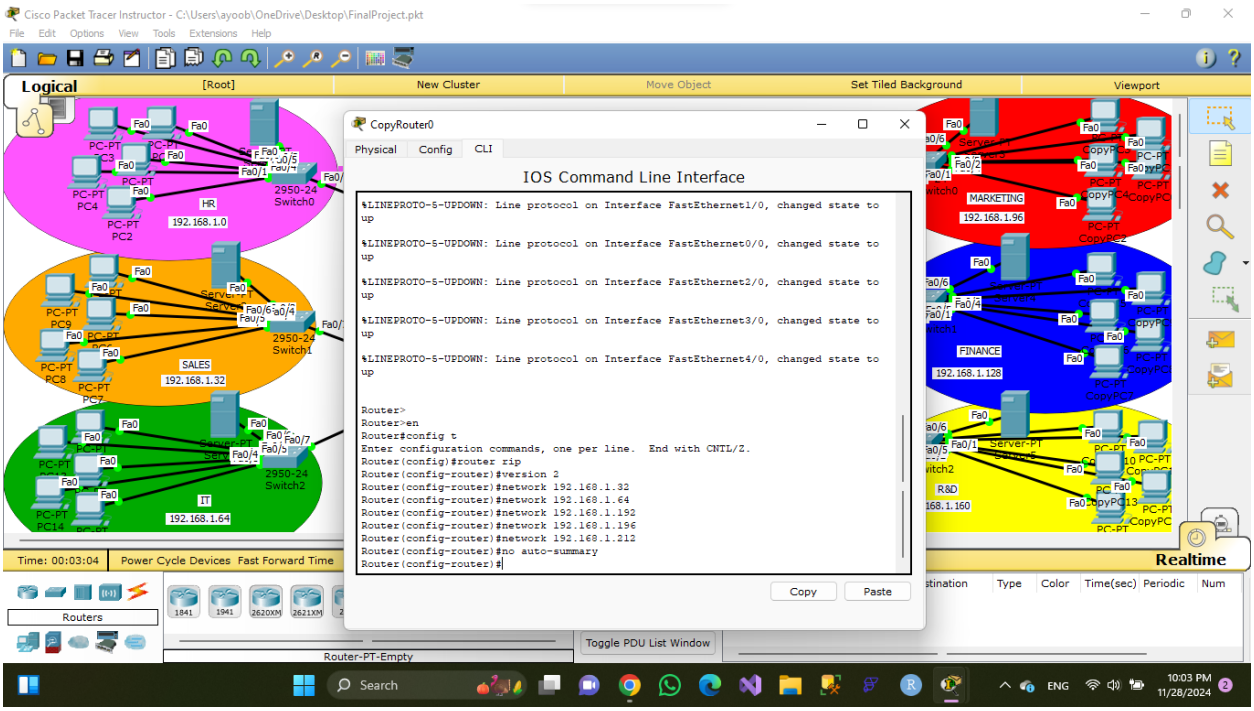
Future Recommendations

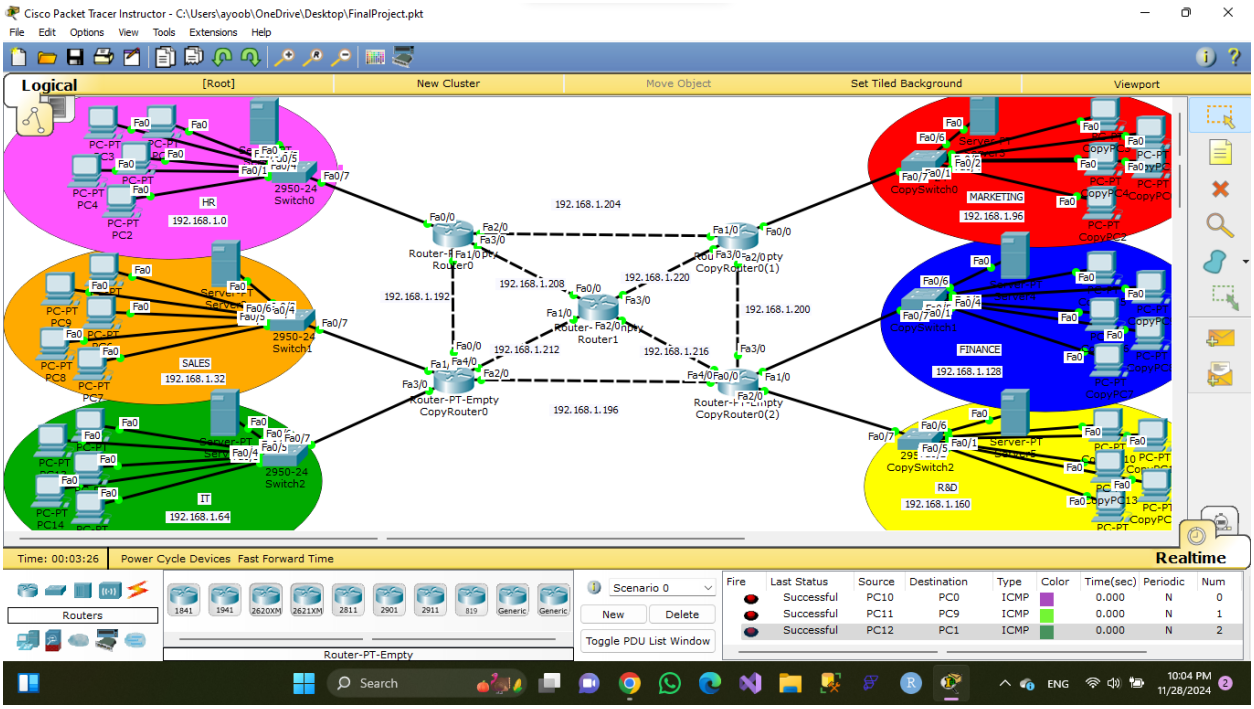
- **Network Security**: Implement security measures such as firewalls and ACLs to protect internal networks.
- **Scalability**: Consider using **VLSM** (Variable Length Subnet Masking) for more efficient IP address usage in larger networks.
- **Network Monitoring**: Integrate monitoring tools to observe network performance and troubleshoot potential issues.

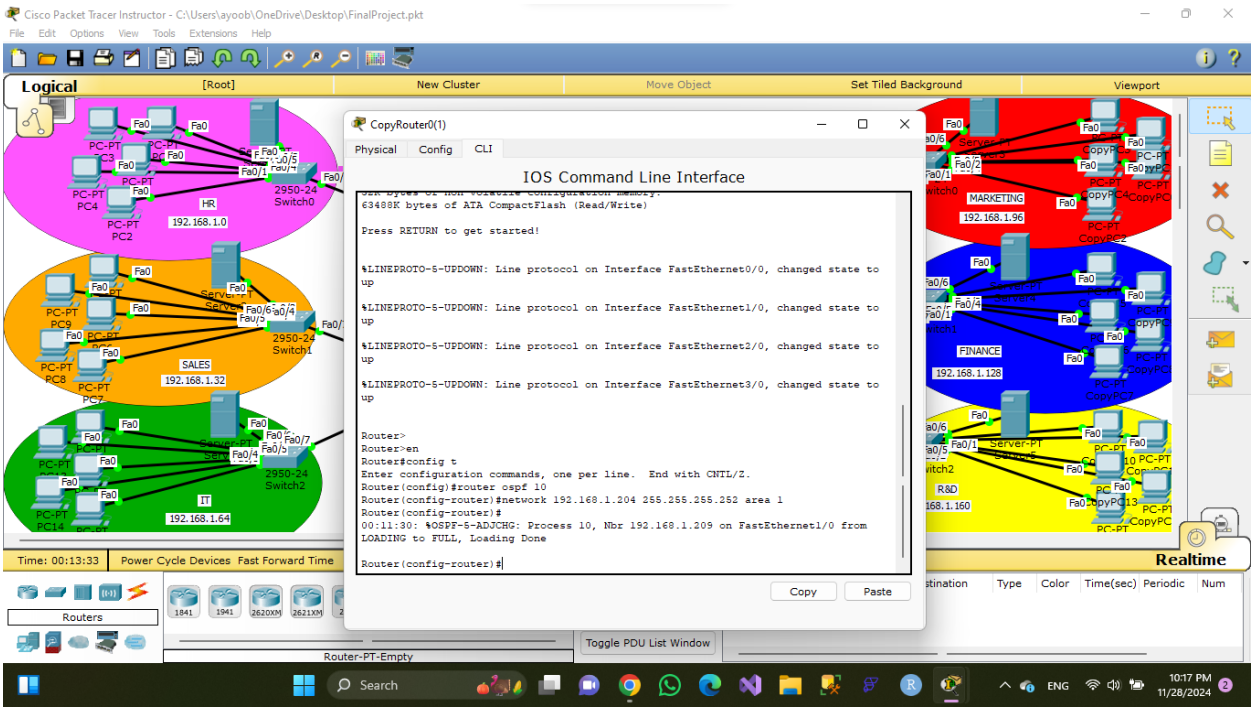
Screenshots and evidence:

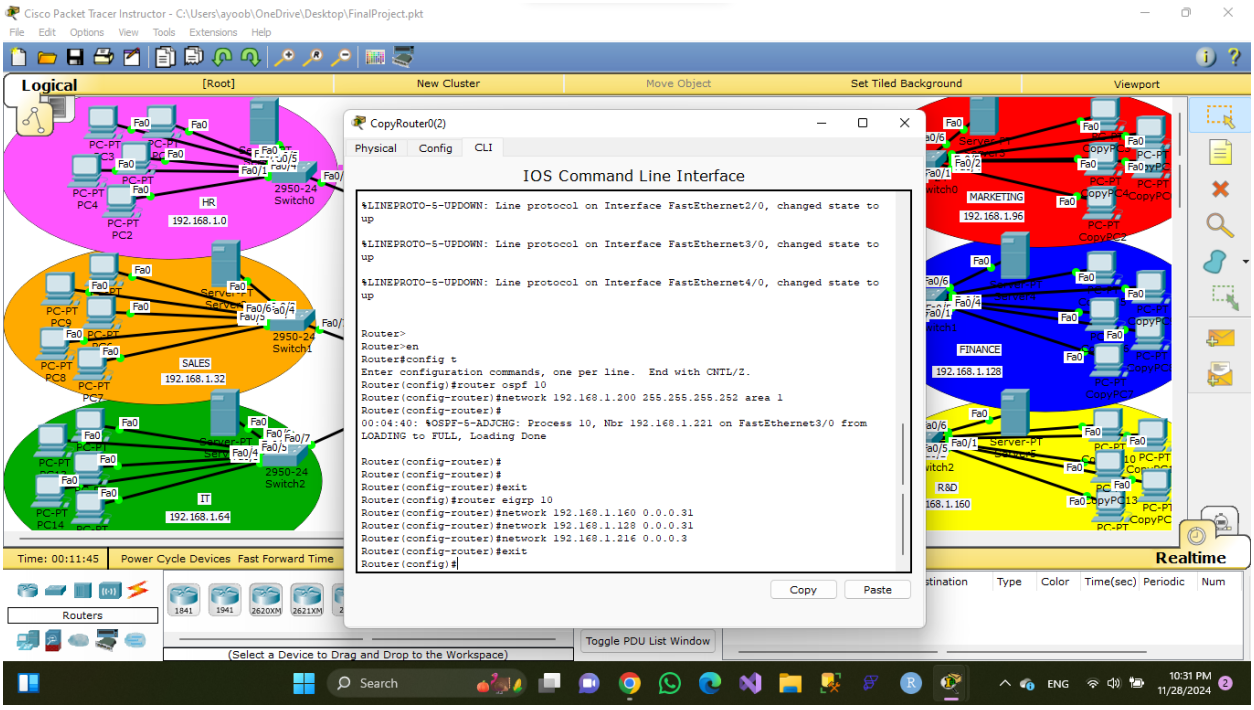


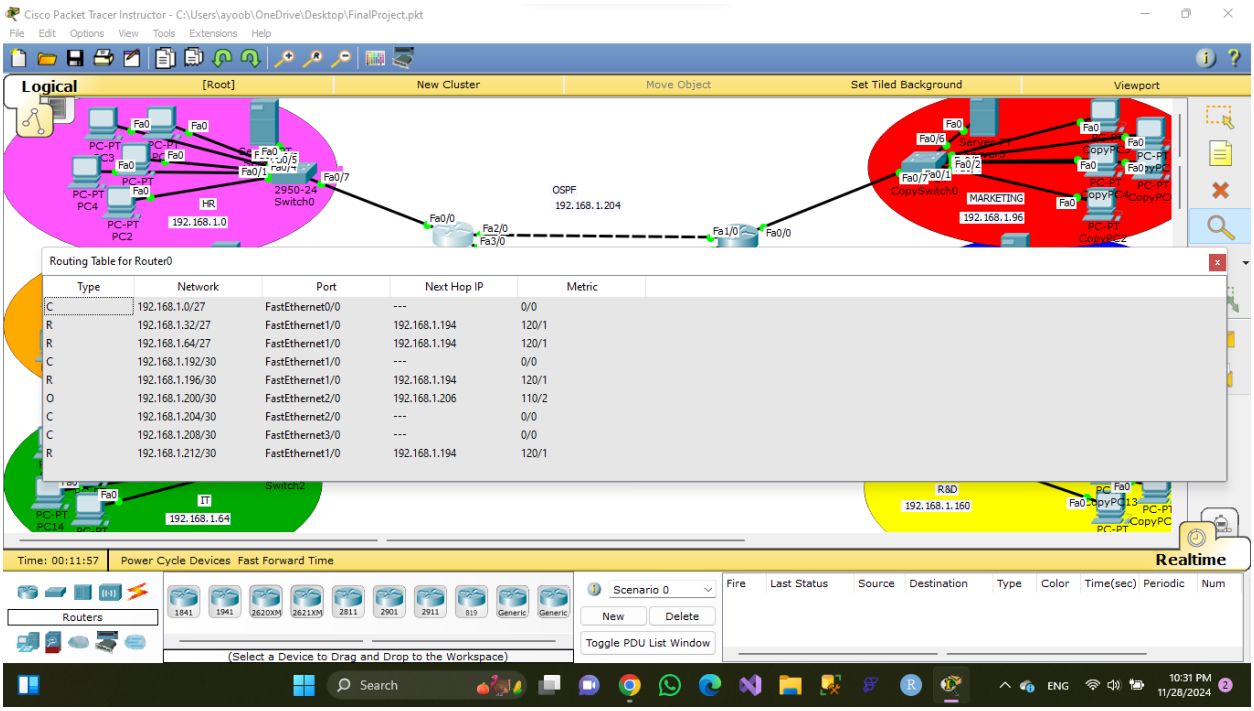


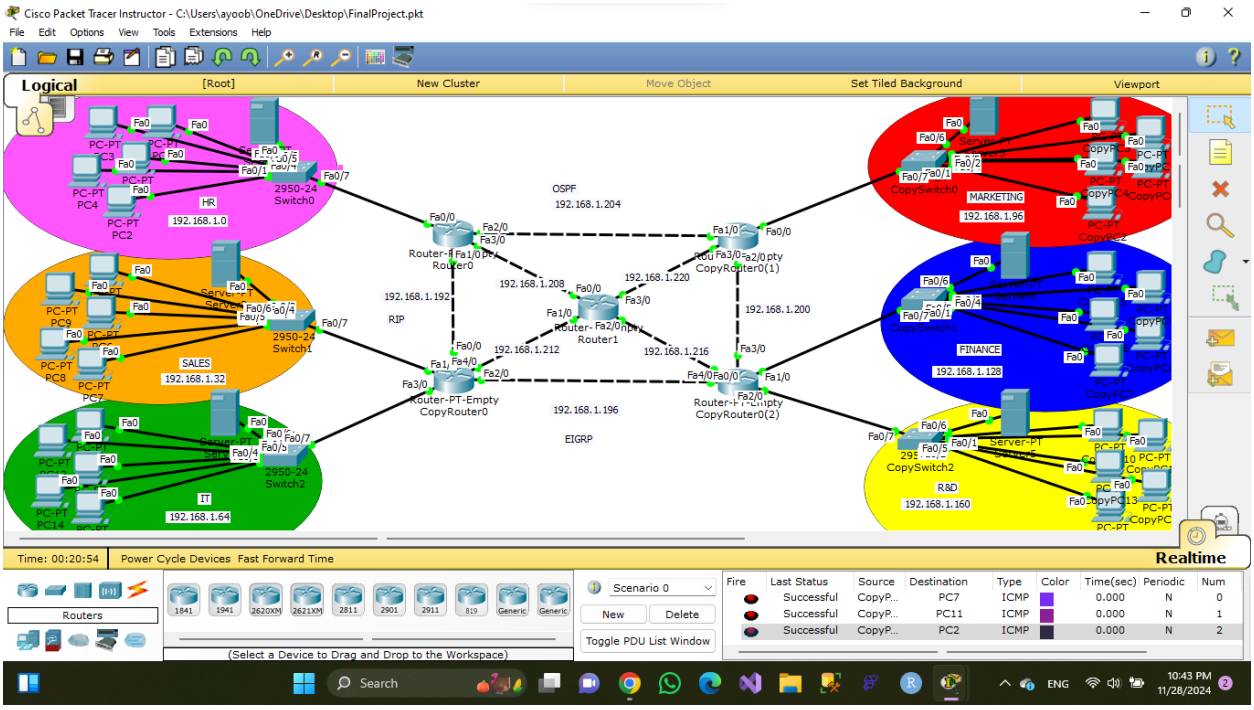

Cisco Packet Tracer Instructor - C:\Users\ayoob\OneDrive\Desktop\FinalProject.pkt
File Edit Options View Tools Extensions Help
Logical
[Root]
New Cluster
Move Object
Set Tiled Background
Viewport
CopyRouter0
Physical
Config
CLI
IOS Command Line Interface
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet2/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet3/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet4/0, changed state to up
Router>
Router>en
Router#config t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#router rip
Router(config-router)#version 2
Router(config-router)#network 192.168.1.32
Router(config-router)#network 192.168.1.64
Router(config-router)#network 192.168.1.192
Router(config-router)#network 192.168.1.196
Router(config-router)#network 192.168.1.212
Router(config-router)#no auto-summary
Router(config-router)#
Copy
Paste
HR
192.168.1.0
SALES
192.168.1.32
IT
192.168.1.64
MARKETING
192.168.1.96
FINANCE
192.168.1.128
R&D
192.168.1.160
Time: 00:03:04
Power Cycle Devices Fast Forward Time
Realtime
Routers
Toggle PDU List Window
Router-PT-Empty
Search
ENG
10:03 PM
11/28/2024

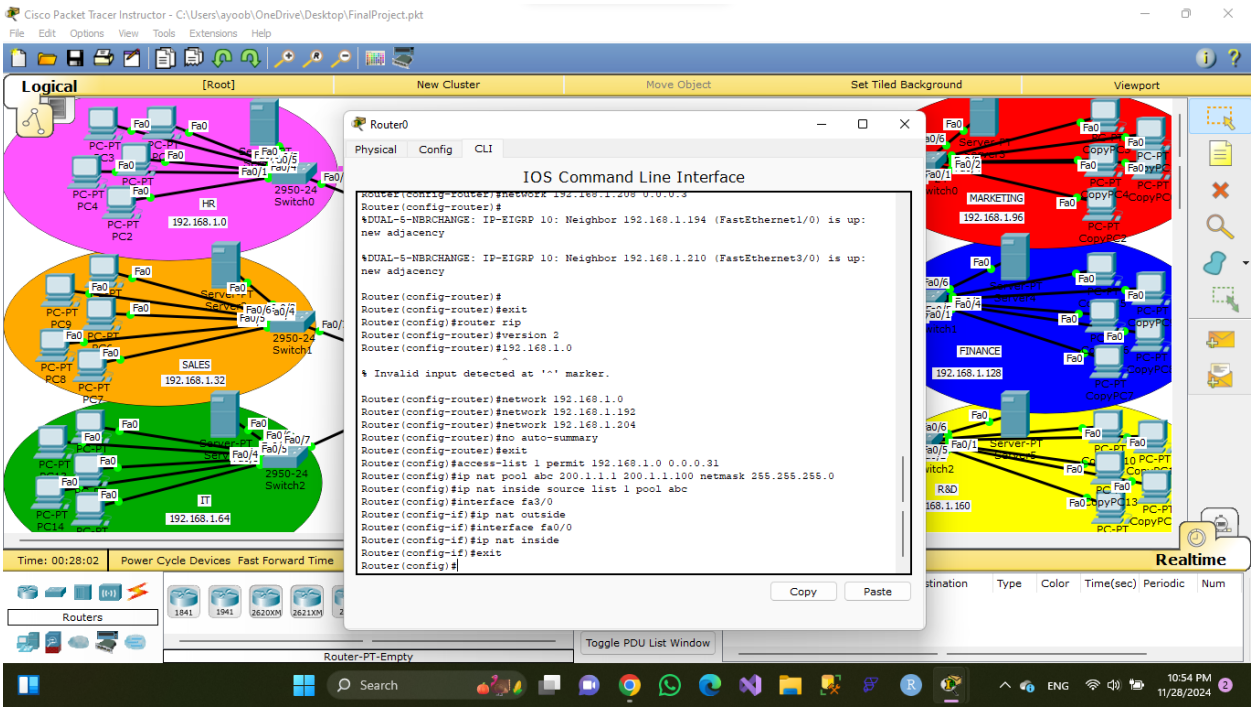

Cisco Packet Tracer Instructor - C:\Users\ayoob\OneDrive\Desktop\FinalProject.pkt
File Edit Options View Tools Extensions Help
Logical
[Root]
New Cluster
Move Object
Set Tiled Background
Viewport
192.168.1.204
192.168.1.208
192.168.1.220
192.168.1.192
192.168.1.200
192.168.1.212
192.168.1.216
192.168.1.196
Router0
Router1
CopyRouter0
CopyRouter0(1)
CopyRouter0(2)
HR
192.168.1.0
SALES
192.168.1.32
IT
192.168.1.64
MARKETING
192.168.1.96
FINANCE
192.168.1.128
R&D
192.168.1.160
Time: 00:03:26
Power Cycle Devices Fast Forward Time
Realtime
Routers
Scenario 0
New
Delete
Toggle PDU List Window
Router-PT-Empty
Fire
Last Status
Source
Destination
Type
Color
Time(sec)
Periodic
Num
Successful PC10 PC0 ICMP 0.000 N 0
Successful PC11 PC9 ICMP 0.000 N 1
Successful PC12 PC1 ICMP 0.000 N 2
Search
ENG
10:04 PM
11/28/2024

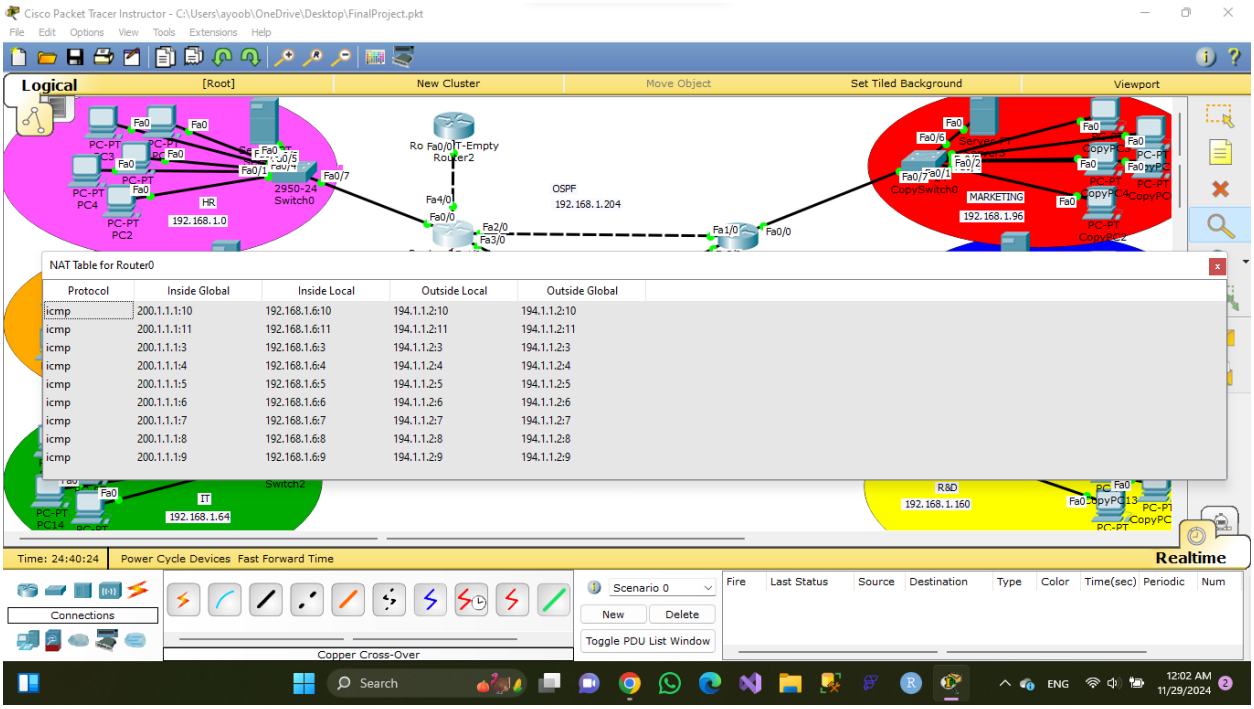

Cisco Packet Tracer Instructor - C:\Users\ayoob\OneDrive\Desktop\FinalProject.pkt
File Edit Options View Tools Extensions Help
Logical
[Root]
New Cluster
Move Object
Set Tiled Background
Viewport
CopyRouter0(1)
Physical
Config
CLI
IOS Command Line Interface
63488K bytes of ATA CompactFlash (Read/Write)
Press RETURN to get started!
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet2/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet3/0, changed state to up
Router>
Router>en
Router#config t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#router ospf 10
Router(config-router)#network 192.168.1.204 255.255.255.252 area 1
Router(config-router)#
00:11:30: %OSPF-5-ADJCHG: Process 10, Nbr 192.168.1.209 on FastEthernet1/0 from LOADING to FULL, Loading Done
Router(config-router)#
Copy
Paste
HR
192.168.1.0
SALES
192.168.1.32
IT
192.168.1.64
MARKETING
192.168.1.96
FINANCE
192.168.1.128
R&D
192.168.1.160
2950-24 Switch0
2950-24 Switch1
2950-24 Switch2
Time: 00:13:33
Power Cycle Devices Fast Forward Time
Realtime
Routers
Toggle PDU List Window
Router-PT-Empty
Search
ENG
10:17 PM
11/28/2024


Cisco Packet Tracer Instructor - C:\Users\ayoob\OneDrive\Desktop\FinalProject.pkt
File Edit Options View Tools Extensions Help
Logical
[Root]
New Cluster
Move Object
Set Tiled Background
Viewport
CopyRouter0(2)
Physical
Config
CLI
IOS Command Line Interface
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet2/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet3/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet4/0, changed state to up
Router>
Router>en
Router#config t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#router ospf 10
Router(config-router)#network 192.168.1.200 255.255.255.252 area 1
Router(config-router)#
00:04:40: %OSPF-5-ADJCHG: Process 10, Nbr 192.168.1.221 on FastEthernet3/0 from LOADING to FULL, Loading Done
Router(config-router)#
Router(config-router)#
Router(config-router)#exit
Router(config)#router eigrp 10
Router(config-router)#network 192.168.1.160 0.0.0.31
Router(config-router)#network 192.168.1.128 0.0.0.31
Router(config-router)#network 192.168.1.216 0.0.0.3
Router(config-router)#exit
Router(config)#
Copy
Paste
HR
192.168.1.0
SALES
192.168.1.32
IT
192.168.1.64
MARKETING
192.168.1.96
FINANCE
192.168.1.128
R&D
192.168.1.160
2950-24 Switch0
2950-24 Switch1
2950-24 Switch2
Time: 00:11:45
Power Cycle Devices Fast Forward Time
Realtime
Routers
Toggle PDU List Window
(Select a Device to Drag and Drop to the Workspace)
Search
ENG
10:31 PM
11/28/2024

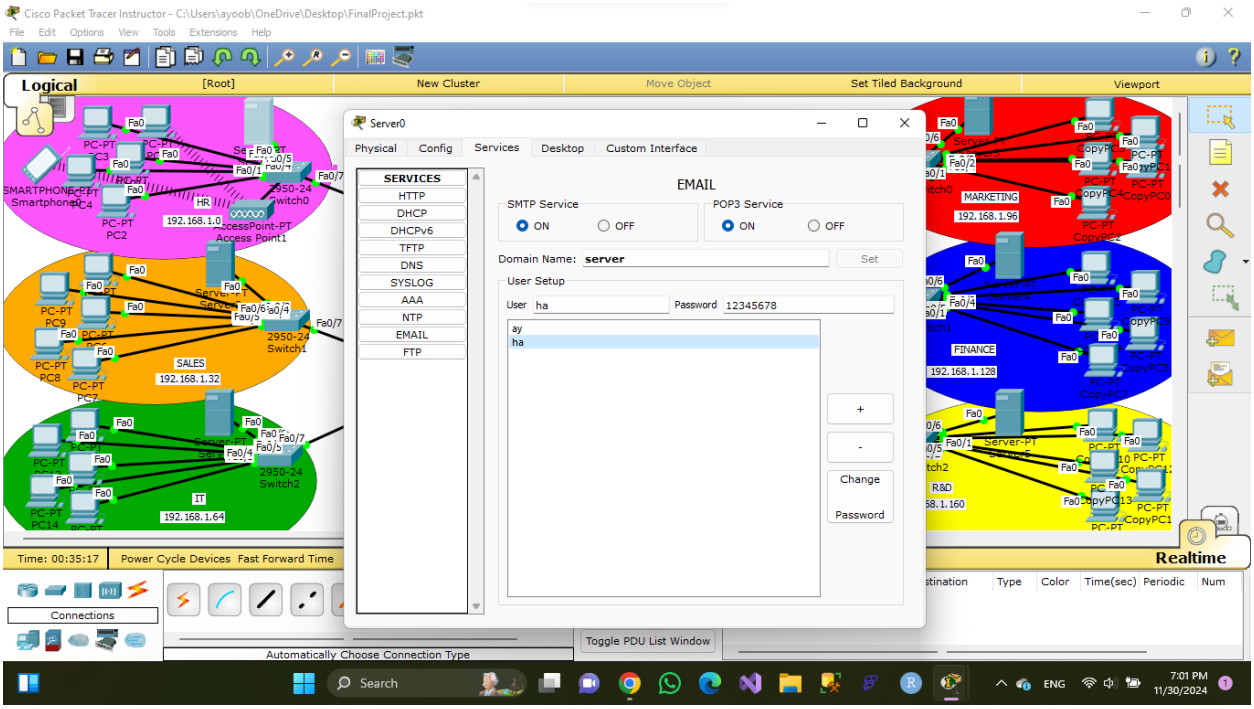

Cisco Packet Tracer Instructor - C:\Users\ayoob\OneDrive\Desktop\FinalProject.pkt
File Edit Options View Tools Extensions Help
Logical
[Root]
New Cluster
Move Object
Set Tiled Background
Viewport
OSPF
192.168.1.204
HR
192.168.1.0
IT
192.168.1.64
MARKETING
192.168.1.96
R&D
192.168.1.160
Routing Table for Router0
Type Network Port Next Hop IP Metric
C 192.168.1.0/27 FastEthernet0/0 --- 0/0
R 192.168.1.32/27 FastEthernet1/0 192.168.1.194 120/1
R 192.168.1.64/27 FastEthernet1/0 192.168.1.194 120/1
C 192.168.1.192/30 FastEthernet1/0 --- 0/0
R 192.168.1.196/30 FastEthernet1/0 192.168.1.194 120/1
O 192.168.1.200/30 FastEthernet2/0 192.168.1.206 110/2
C 192.168.1.204/30 FastEthernet2/0 --- 0/0
C 192.168.1.208/30 FastEthernet3/0 --- 0/0
R 192.168.1.212/30 FastEthernet1/0 192.168.1.194 120/1
Time: 00:11:57
Power Cycle Devices Fast Forward Time
Realtime
Routers
(Select a Device to Drag and Drop to the Workspace)
Scenario 0
New
Delete
Toggle PDU List Window
Fire Last Status Source Destination Type Color Time(sec) Periodic Num
10:31 PM
11/28/2024

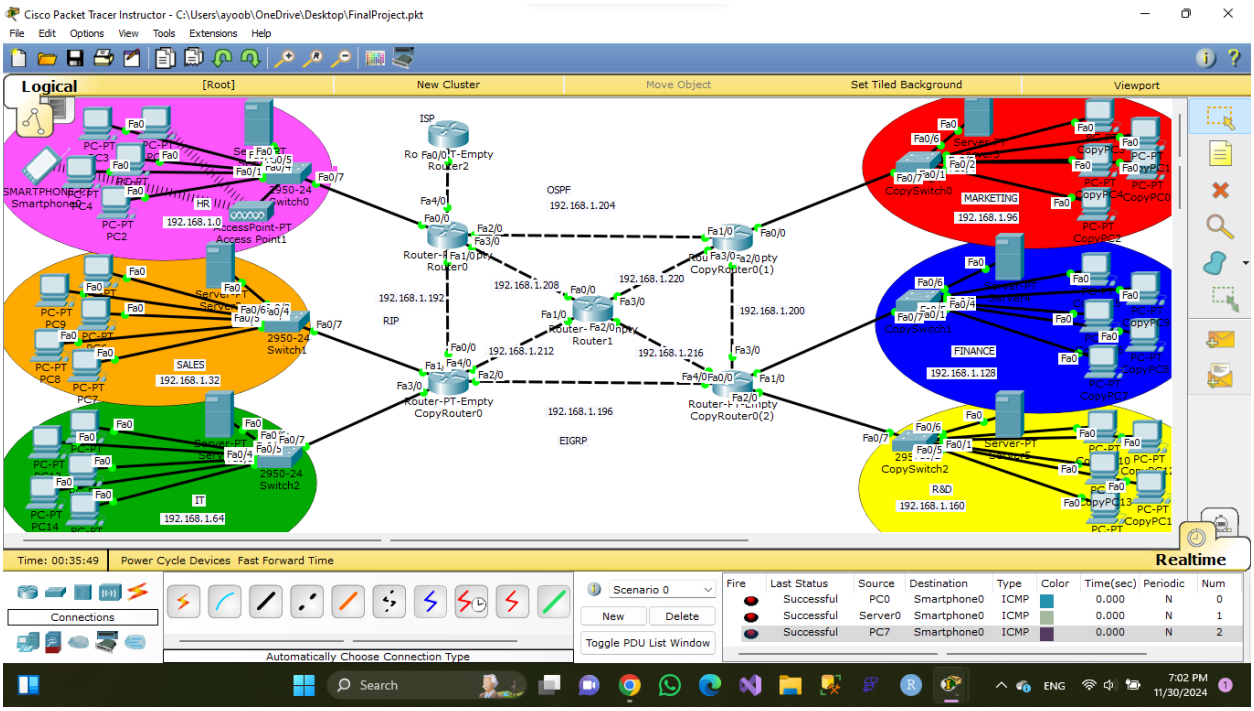

Cisco Packet Tracer Instructor - C:\Users\ayoob\OneDrive\Desktop\FinalProject.pkt
File Edit Options View Tools Extensions Help
Logical
[Root]
New Cluster
Move Object
Set Tiled Background
Viewport
OSPF
192.168.1.204
RIP
EIGRP
HR
192.168.1.0
SALES
192.168.1.32
IT
192.168.1.64
FINANCE
192.168.1.128
MARKETING
192.168.1.96
R&D
192.168.1.160
192.168.1.192
192.168.1.208
192.168.1.220
192.168.1.200
192.168.1.212
192.168.1.216
192.168.1.196
Time: 00:20:54
Power Cycle Devices Fast Forward Time
Realtime
Routers
(Select a Device to Drag and Drop to the Workspace)
Scenario 0
New
Delete
Toggle PDU List Window
Fire Last Status Source Destination Type Color Time(sec) Periodic Num
Successful CopyP... PC7 ICMP 0.000 N 0
Successful CopyP... PC11 ICMP 0.000 N 1
Successful CopyP... PC2 ICMP 0.000 N 2
10:43 PM
11/28/2024

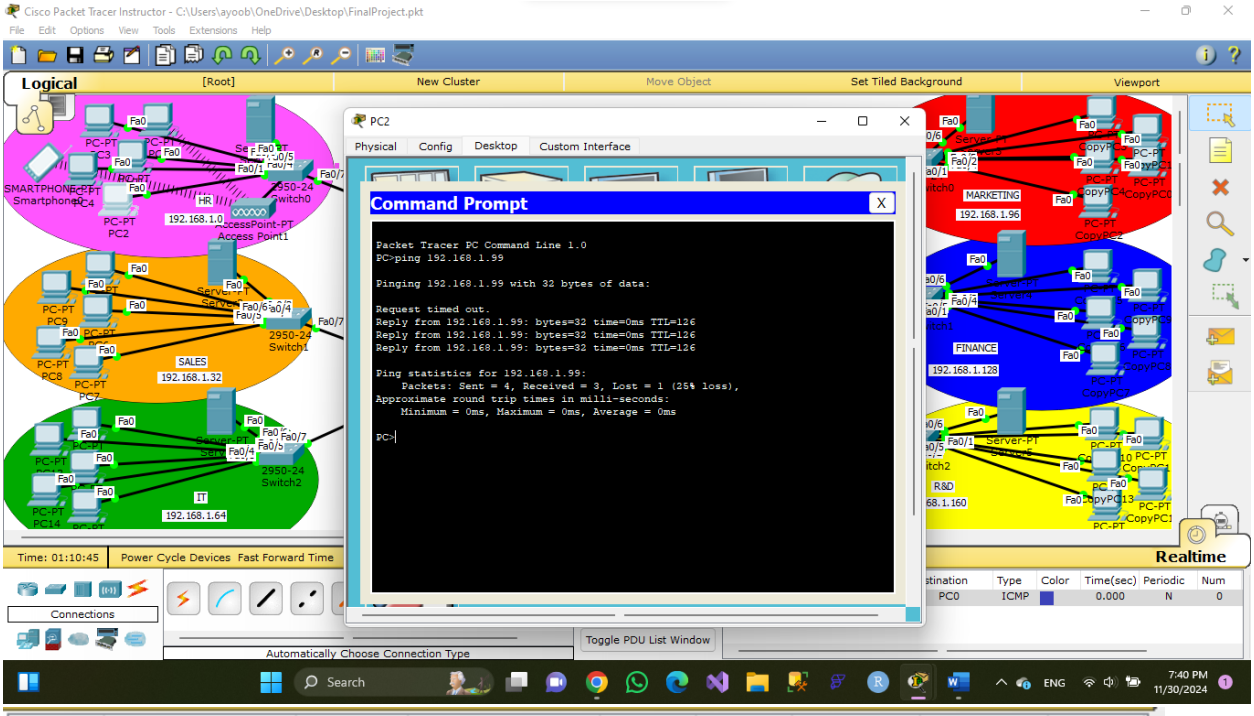

Cisco Packet Tracer Instructor - C:\Users\ayoob\OneDrive\Desktop\FinalProject.pkt
Logical
[Root]
New Cluster
Move Object
Set Tiled Background
Viewport
Router0
Physical
Config
CLI
IOS Command Line Interface
%DUAL-5-NBRCHANGE: IP-EIGRP 10: Neighbor 192.168.1.194 (FastEthernet1/0) is up: new adjacency
%DUAL-5-NBRCHANGE: IP-EIGRP 10: Neighbor 192.168.1.210 (FastEthernet3/0) is up: new adjacency
Router(config-router)#
Router(config-router)#exit
Router(config)#router rip
Router(config-router)#version 2
Router(config-router)#192.168.1.0
% Invalid input detected at '^' marker.
Router(config-router)#network 192.168.1.0
Router(config-router)#network 192.168.1.192
Router(config-router)#network 192.168.1.204
Router(config-router)#no auto-summary
Router(config-router)#exit
Router(config)#access-list 1 permit 192.168.1.0 0.0.0.31
Router(config)#ip nat pool abc 200.1.1.1 200.1.1.100 netmask 255.255.255.0
Router(config)#ip nat inside source list 1 pool abc
Router(config)#interface fa3/0
Router(config-if)#ip nat outside
Router(config-if)#interface fa0/0
Router(config-if)#ip nat inside
Router(config-if)#exit
Router(config)#
Copy
Paste
HR
192.168.1.0
SALES
192.168.1.32
IT
192.168.1.64
MARKETING
192.168.1.96
FINANCE
192.168.1.128
R&D
192.168.1.160
Time: 00:28:02
Power Cycle Devices
Fast Forward Time
Realtime
Routers
Router-PT-Empty
Toggle PDU List Window
Type
Color
Time(sec)
Periodic
Num
Search
ENG
10:54 PM
11/28/2024


Cisco Packet Tracer Instructor - C:\Users\ayoob\OneDrive\Desktop\FinalProject.pkt
Logical
[Root]
New Cluster
Move Object
Set Tiled Background
Viewport
Router2
OSPF
192.168.1.204
NAT Table for Router0
Protocol
Inside Global
Inside Local
Outside Local
Outside Global
icmp 200.1.1.1:10 192.168.1.6:10 194.1.1.2:10 194.1.1.2:10
icmp 200.1.1.1:11 192.168.1.6:11 194.1.1.2:11 194.1.1.2:11
icmp 200.1.1.1:3 192.168.1.6:3 194.1.1.2:3 194.1.1.2:3
icmp 200.1.1.1:4 192.168.1.6:4 194.1.1.2:4 194.1.1.2:4
icmp 200.1.1.1:5 192.168.1.6:5 194.1.1.2:5 194.1.1.2:5
icmp 200.1.1.1:6 192.168.1.6:6 194.1.1.2:6 194.1.1.2:6
icmp 200.1.1.1:7 192.168.1.6:7 194.1.1.2:7 194.1.1.2:7
icmp 200.1.1.1:8 192.168.1.6:8 194.1.1.2:8 194.1.1.2:8
icmp 200.1.1.1:9 192.168.1.6:9 194.1.1.2:9 194.1.1.2:9
HR
192.168.1.0
IT
192.168.1.64
MARKETING
192.168.1.96
R&D
192.168.1.160
Time: 24:40:24
Power Cycle Devices
Fast Forward Time
Realtime
Connections
Copper Cross-Over
Scenario 0
New
Delete
Toggle PDU List Window
Fire
Last Status
Source
Destination
Type
Color
Time(sec)
Periodic
Num
Search
ENG
12:02 AM
11/29/2024


Cisco Packet Tracer Instructor - C:\Users\ayoob\OneDrive\Desktop\FinalProject.pkt
Logical
[Root]
New Cluster
Move Object
Set Tiled Background
Viewport
PC0
Physical
Config
Desktop
Custom Interface
Link Information
Connect
Profiles
More Information
Infrastructure Mode
2.4GHz
You have successfully connected to the access point
Signal Strength
Link Quality
Adapter is Active
Wireless-N Notebook Adapter
Wireless Network Monitor v1.0
WPC300N
192.168.1.0
192.168.1.32
192.168.1.64
192.168.1.96
192.168.1.128
Time: 00:30:13
Power Cycle Devices
Fast Forward Time
Realtime
Connections
Automatically Choose Connection Type
Toggle PDU List Window
Search
ENG
6:54 PM
11/30/2024


Cisco Packet Tracer Instructor - C:\Users\ayoob\OneDrive\Desktop\FinalProject.pkt
Logical
[Root]
New Cluster
Move Object
Set Tiled Background
Viewport
Server0
Physical
Config
Services
Desktop
Custom Interface
SERVICES
HTTP
DHCP
DHCPv6
TFTP
DNS
SYSLOG
AAA
NTP
EMAIL
FTP
EMAIL
SMTP Service
ON
OFF
POP3 Service
ON
OFF
Domain Name: server
Set
User Setup
User ha
Password 12345678
ay
ha
+
-
Change
Password
192.168.1.0
192.168.1.32
192.168.1.64
192.168.1.96
192.168.1.128
Time: 00:35:17
Power Cycle Devices
Fast Forward Time
Realtime
Connections
Automatically Choose Connection Type
Toggle PDU List Window
Search
ENG
7:01 PM
11/30/2024





Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num
	Successful	CopyP...	PC0	ICMP		0.000	N	0
	Successful	CopyP...	PC11	ICMP		0.000	N	1
	Successful	CopyP...	PC6	ICMP		0.000	N	2