Project Report
Project Title: Cisco Packet Tracer Simulation with VLSM, Routing, NAT, ACL, and Services

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Course: Computer Networks (CNET)
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1. Introduction

This report outlines the implementation of a complex enterprise-level network in Cisco Packet Tracer based on the topology and configurations outlined in the provided scenario. The design incorporates multiple routing protocols (OSPF, EIGRP, RIP), advanced IP subnetting (VLSM), inter-protocol redistribution, DHCP, NAT/PAT, access control (ACL), and critical services such as Web, FTP, and Mail servers.

2. Network Overview

The network consists of several interconnected blocks labeled with alphabets (A to K), each configured with different routing protocols. The major components of the design are:

- **OSPF**: Area 0 (Backbone), Area 1, and Area 2.
- **EIGRP**: Blocks B and F.
- **RIP**: Legacy network routing used in specific segments.
- **Redistribution**: Between routers that connect two different routing domains.
- **DHCP**: Centralized configuration from Block D.
- **NAT/PAT**: Implemented in Router21 (Net K) and Router10 (Net F).
- **ACL**: To restrict specific host access to the web server.
- **Mail Server & FTP Server Access Control**.

3. IP Addressing Plan

- **VLSM (Variable Length Subnet Masking)** was used to conserve IP space.
- Each network and point-to-point link between routers uses appropriate subnet sizes.
- The IP plan adheres strictly to the host requirements provided in the Google Sheet.

The network 10.0.0.0/24 has 254 hosts.
Your subnets need 410032 hosts.

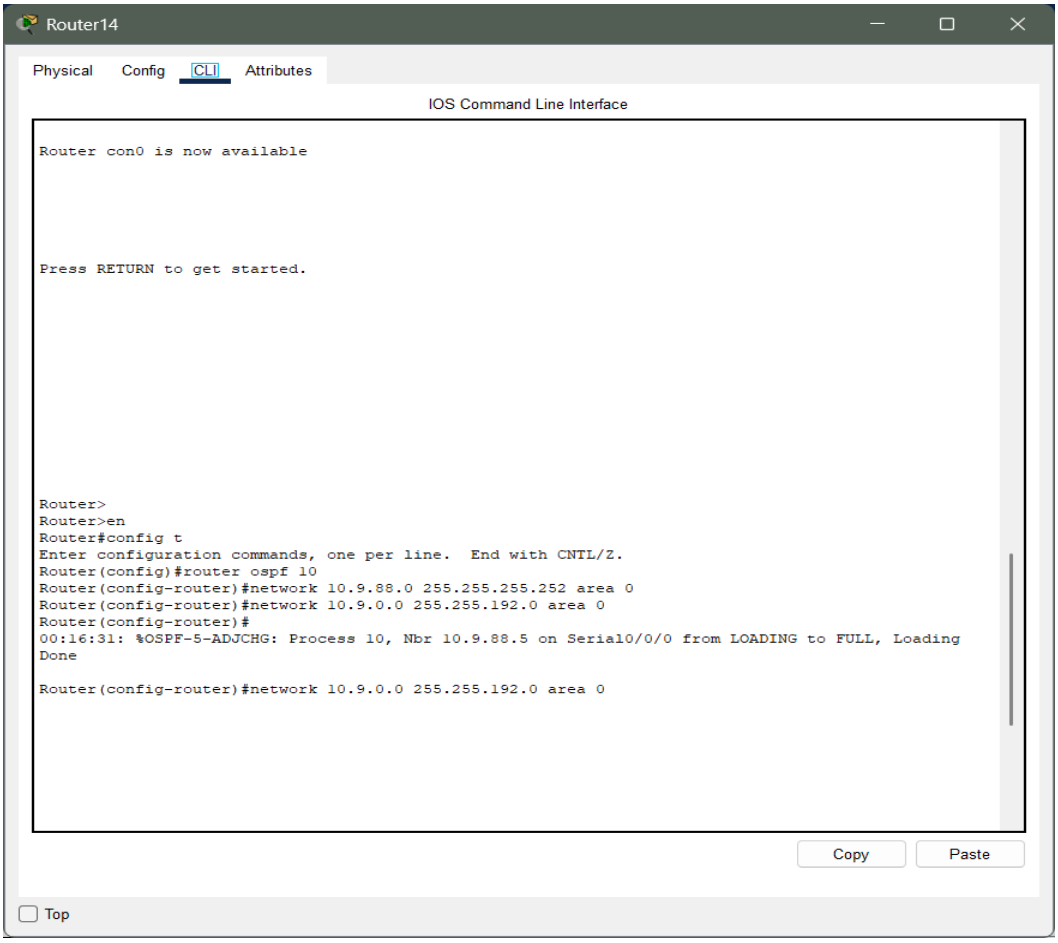
NAME	HOSTS NEEDED	HOSTS AVAILABLE	UNUSED HOSTS	NETWORK ADDRESS	SLASH	MASK	USABLE RANGE	BROADCAST
E	93467	131070	37603	10.0.0.0	/15	255.254.0.0	10.0.0.1 - 10.1.255.254	10.1.255.255
F	67890	131070	63180	10.2.0.0	/15	255.254.0.0	10.2.0.1 - 10.3.255.254	10.3.255.255
K	60438	65534	5096	10.4.0.0	/16	255.255.0.0	10.4.0.1 - 10.4.255.254	10.4.255.255
J	49327	65534	16207	10.5.0.0	/16	255.255.0.0	10.5.0.1 - 10.5.255.254	10.5.255.255
I	38216	65534	27318	10.6.0.0	/16	255.255.0.0	10.6.0.1 - 10.6.255.254	10.6.255.255
N	33626	65534	31908	10.7.0.0	/16	255.255.0.0	10.7.0.1 - 10.7.255.254	10.7.255.255
H	27105	32766	5661	10.8.0.0	/17	255.255.128.0	10.8.0.1 - 10.8.127.254	10.8.127.255
G	16094	16382	288	10.8.128.0	/18	255.255.192.0	10.8.128.1 - 10.8.191.254	10.8.191.255
C	9876	16382	6506	10.8.192.0	/18	255.255.192.0	10.8.192.1 - 10.8.255.254	10.8.255.255
L	9772	16382	6610	10.9.0.0	/18	255.255.192.0	10.9.0.1 - 10.9.63.254	10.9.63.255
M	2543	4094	1551	10.9.64.0	/20	255.255.240.0	10.9.64.1 - 10.9.79.254	10.9.79.255
A	901	1022	121	10.9.80.0	/22	255.255.252.0	10.9.80.1 - 10.9.83.254	10.9.83.255
D	456	510	54	10.9.84.0	/23	255.255.254.0	10.9.84.1 - 10.9.85.254	10.9.85.255
B	321	510	189	10.9.86.0	/23	255.255.254.0	10.9.86.1 - 10.9.87.254	10.9.87.255

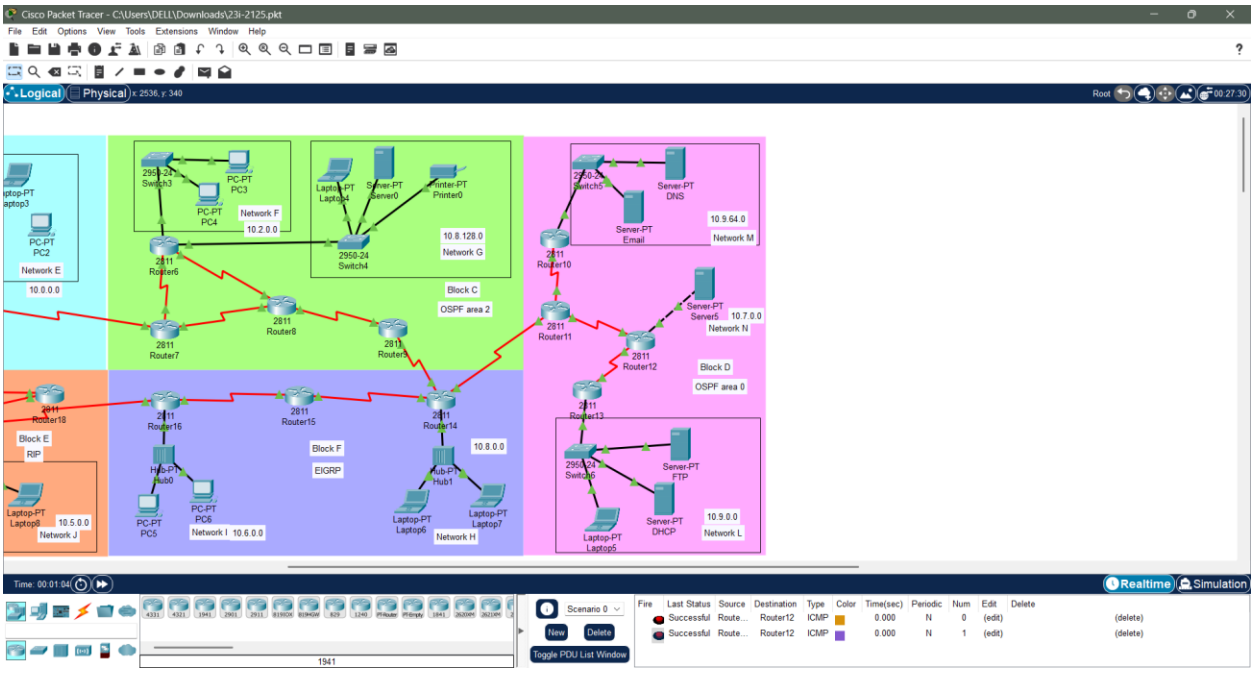
Each router's interfaces were assigned IPs according to their connected network blocks. For inter-router links, /30 or /31 masks were used based on compatibility and requirement of exactly 2 usable Ips from 10.9.88.0-10.9.88. 94.

4. Routing Configuration

OSPF Areas

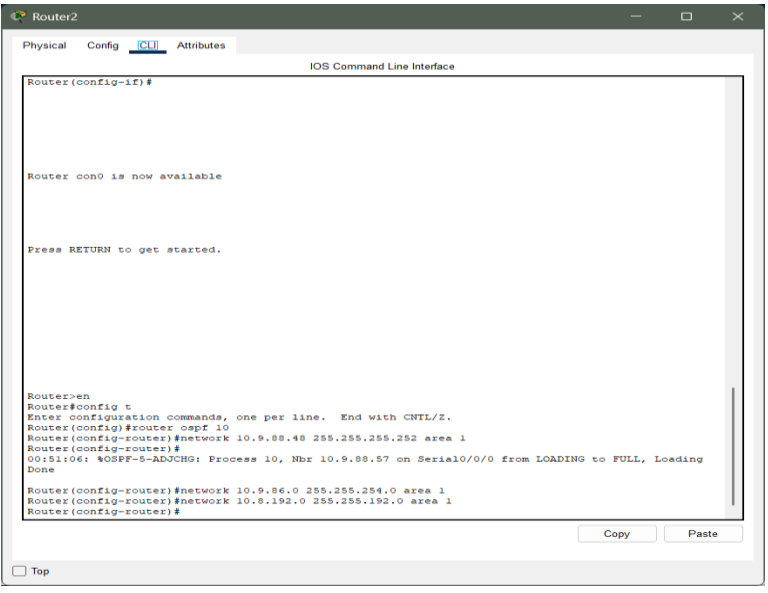
- **Area 0**: Backbone, connected to redistribution routers.



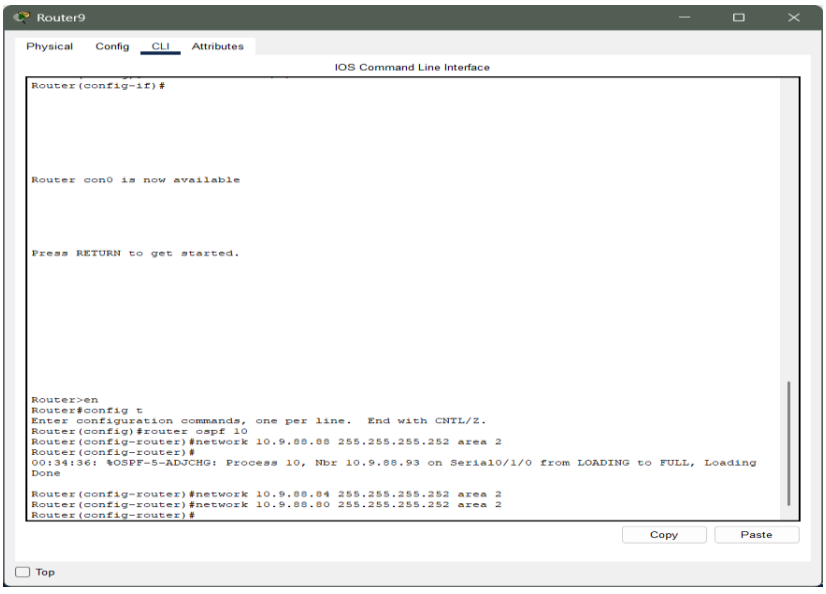


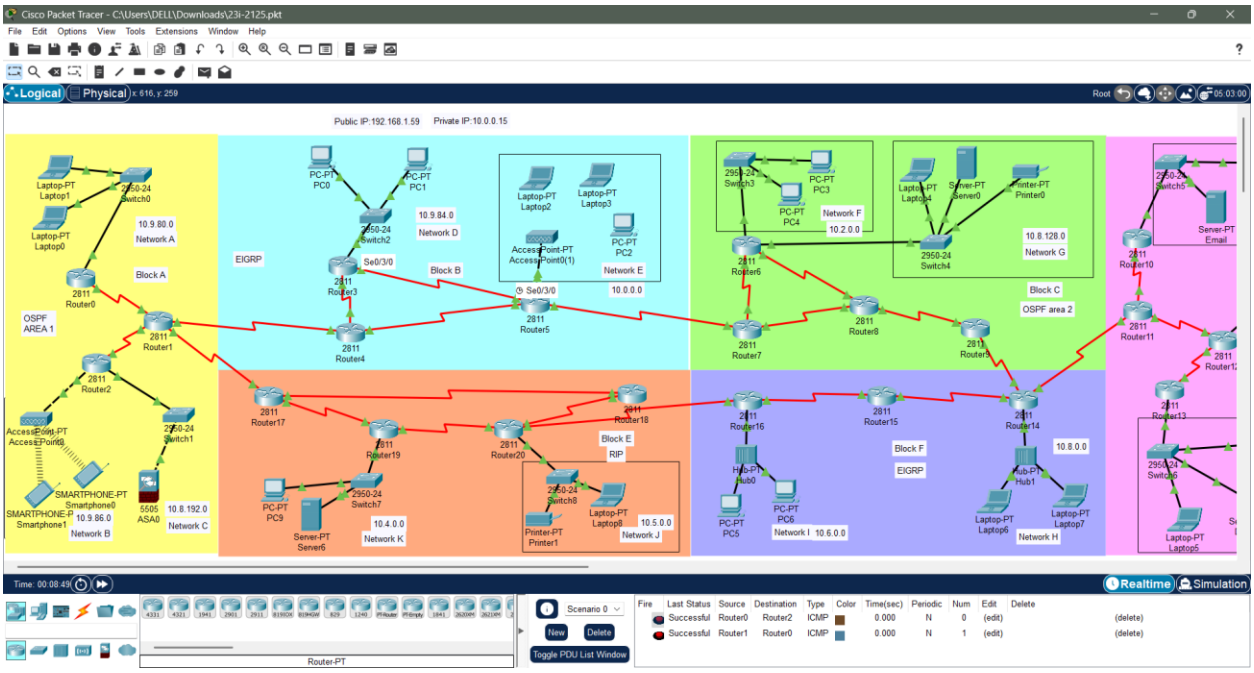
- **Area 1 & Area 2**: Contain multiple networks and hosts, each configured with network statements matching assigned ranges.

AREA 1:



AREA 2:

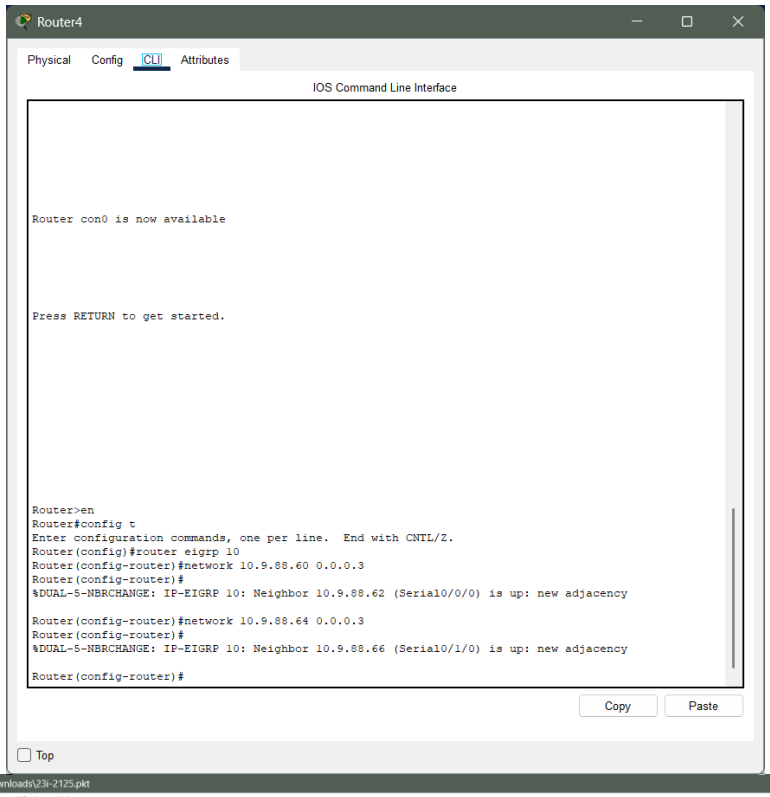


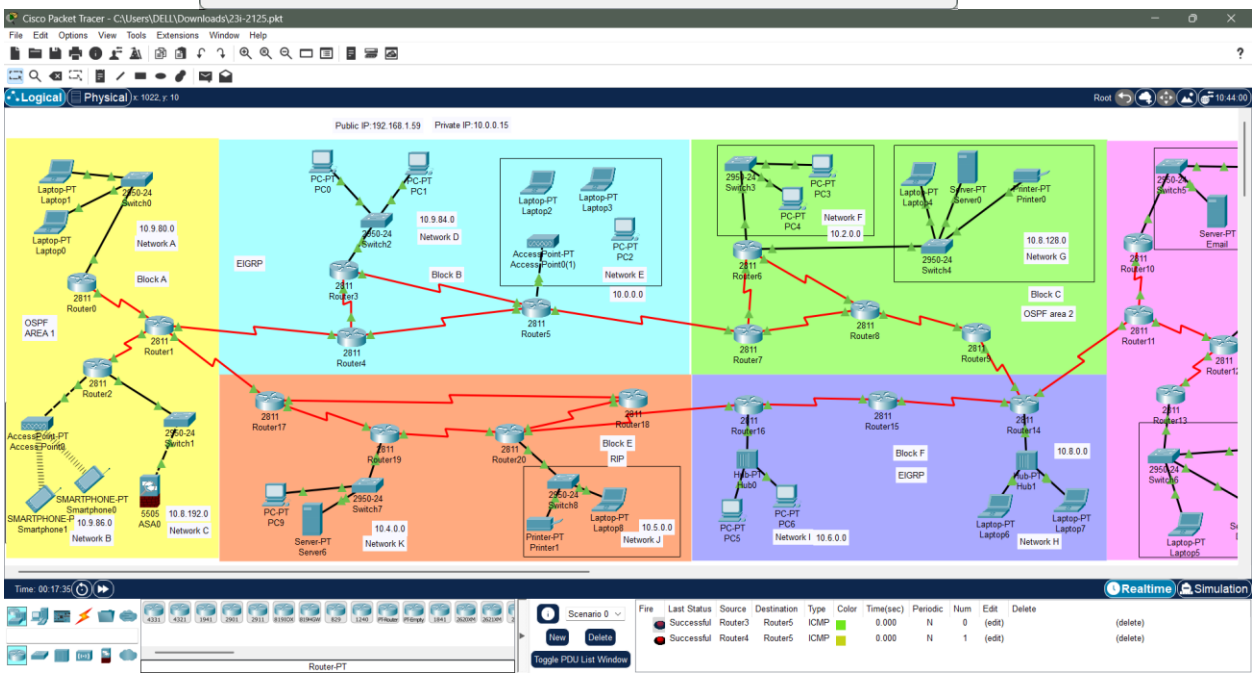


- All OSPF routers used router-id for unique identification and seamless adjacency.

EIGRP Configuration

- **Autonomous System 10** used.
- Included passive interfaces for unnecessary links.
- no auto-summary used for precise routing.



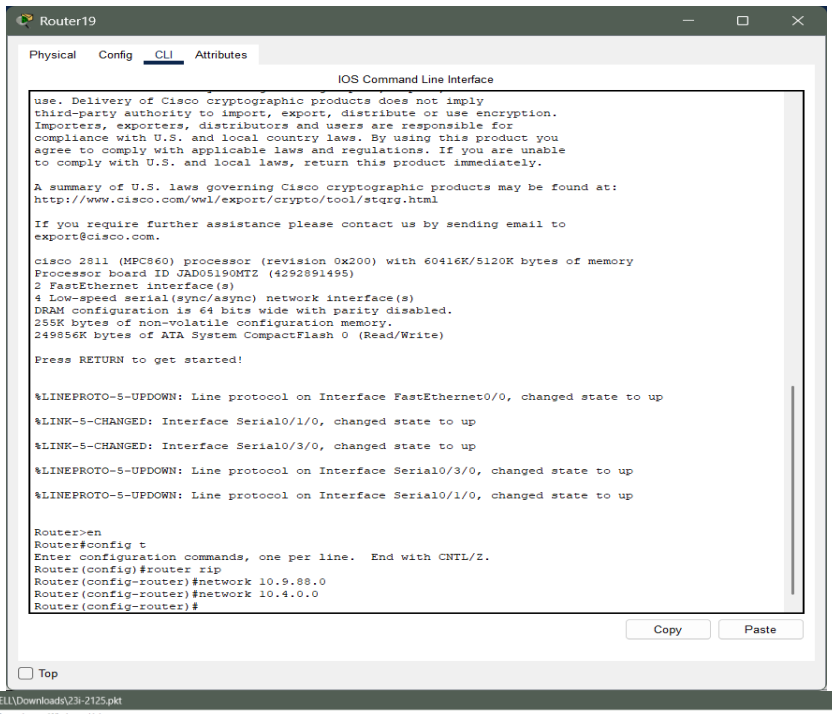


RIP

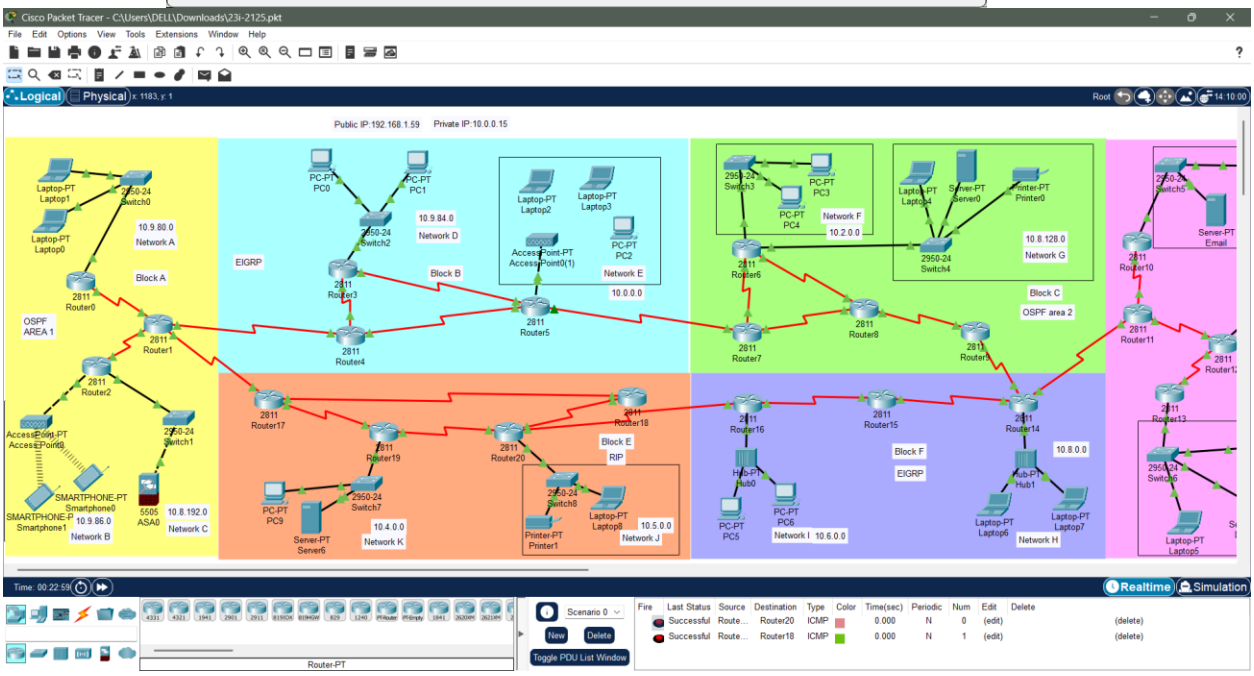
- Implemented RIP v2 using:

version 2

no auto-summary



- Specific networks advertised according to project topology.



5. Redistribution

Redistribution was configured on routers that connected different routes. For example:

- Between **OSPF and EIGRP**
- Between **OSPF and RIP**

Each redistribution point included appropriate route-maps and metric values to avoid routing loops and ensure proper convergence.

Commands used:

router ospf 10

redistribute eigrp 10 metric 100 subnets

redistribute rip metric 200 subnets

router eigrp 10

redistribute ospf 10 metric 1000 10 255 1 1500

redistribute rip metric 1000 10 255 1 1500

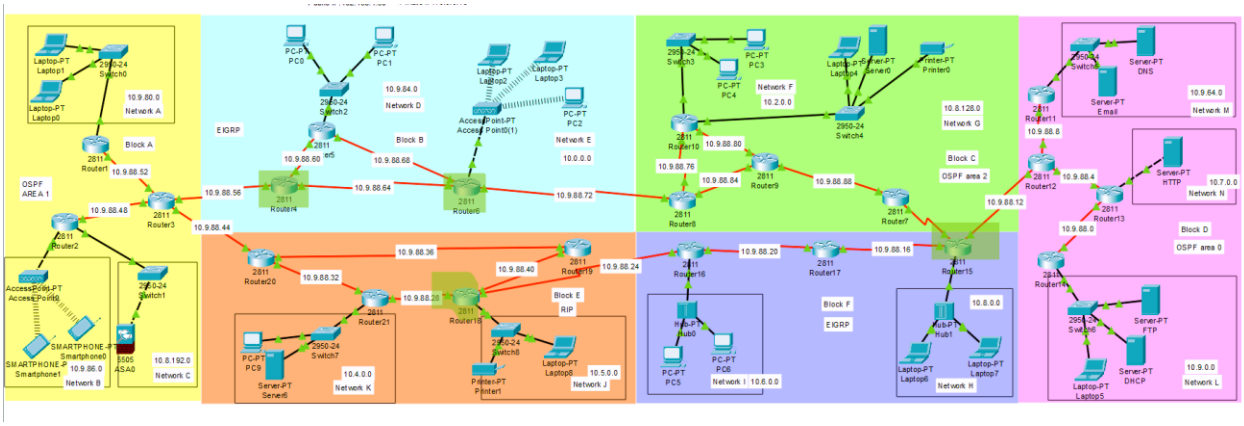
router rip

version 2

redistribute ospf 10 metric 1

redistribute eigrp 10 metric 1

COMMANDS WERE USED ACCORDING TO THE ROUTER CONFIGURATION



The picture highlighted the routers on which redistribution is done.

```
Router>en
Router#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#router ospf 10
Router(config-router)#network 10.9.88.56 255.255.255.252 area 1
Router(config-router)#
00:29:09: %OSPF-5-ADJCHG: Process 10, Nbr 10.9.88.65 on Serial0/2/0 from LOADING to FULL, Loading Done

Router(config-router)#router ospf 10
Router(config-router)#network 10.9.88.44 255.255.255.252 area 1
Router(config-router)#
00:31:15: %OSPF-5-ADJCHG: Process 10, Nbr 10.9.88.45 on Serial0/3/0 from LOADING to FULL, Loading Done
```

Result:

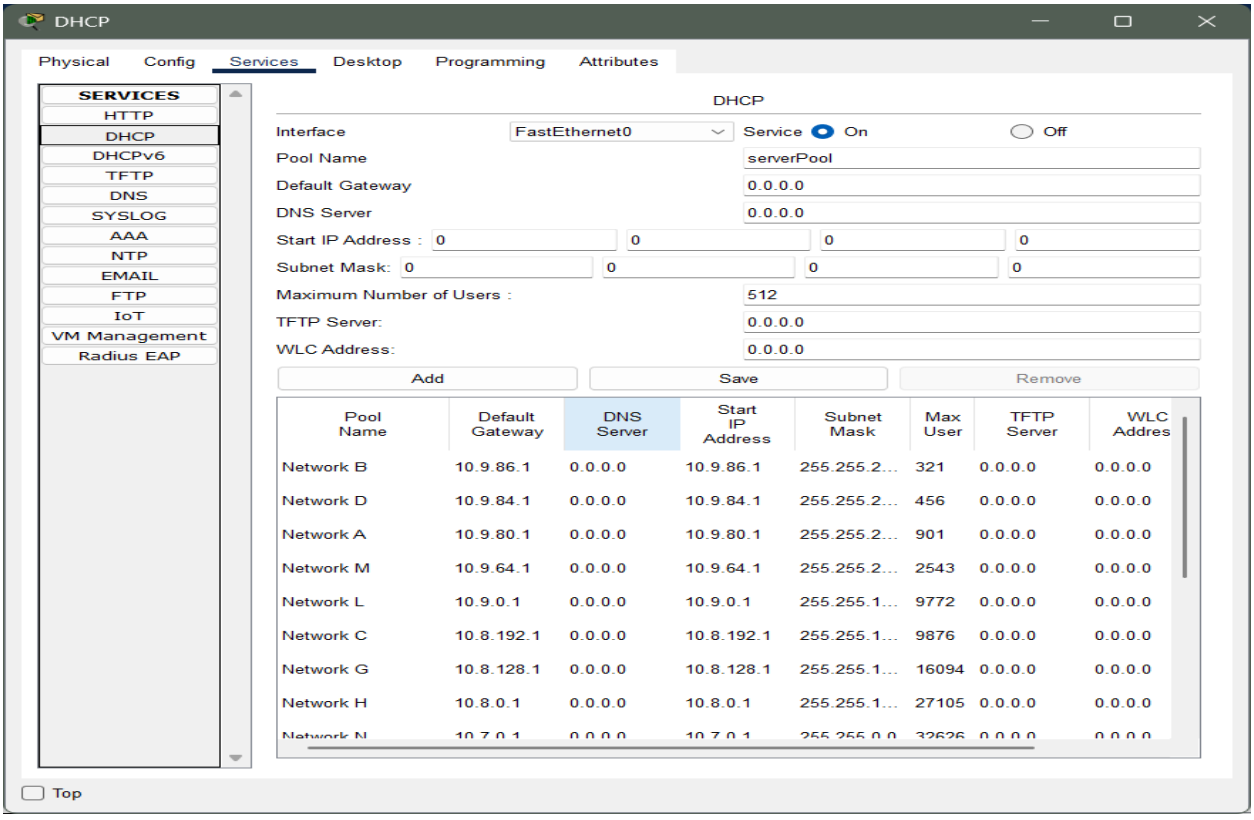
```
     10.0.0.0/8 is variably subnetted, 42 subnets, 9 masks
O E2     10.0.0.0/15 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.2.0.0/15 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.4.0.0/16 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.5.0.0/16 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.6.0.0/16 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.7.0.0/16 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.8.0.0/17 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.8.128.0/18 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O        10.8.192.0/18 [110/65] via 10.9.88.50, 00:32:17, Serial0/0/0
O E2     10.9.0.0/18 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.9.64.0/20 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O        10.9.80.0/22 [110/65] via 10.9.88.54, 00:32:17, Serial0/1/0
O E2     10.9.84.0/23 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O        10.9.86.0/23 [110/65] via 10.9.88.50, 00:32:17, Serial0/0/0
O E2     10.9.88.0/30 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.9.88.4/30 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.9.88.8/30 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.9.88.12/30 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.9.88.16/30 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.9.88.20/30 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.9.88.24/30 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.9.88.28/30 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.9.88.32/30 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.9.88.36/30 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.9.88.40/30 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
C        10.9.88.44/30 is directly connected, Serial0/3/0
L        10.9.88.46/32 is directly connected, Serial0/3/0
C        10.9.88.48/30 is directly connected, Serial0/0/0
L        10.9.88.49/32 is directly connected, Serial0/0/0
C        10.9.88.52/30 is directly connected, Serial0/1/0
L        10.9.88.53/32 is directly connected, Serial0/1/0
C        10.9.88.56/30 is directly connected, Serial0/2/0
L        10.9.88.57/32 is directly connected, Serial0/2/0
O E2     10.9.88.60/30 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.9.88.64/30 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.9.88.68/30 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.9.88.72/30 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.9.88.76/30 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.9.88.80/30 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.9.88.84/30 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.9.88.88/30 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
O E2     10.9.88.92/30 [110/100] via 10.9.88.58, 00:02:51, Serial0/2/0
```

6. DHCP Implementation

- A central **DHCP Server in Block D** was configured to handle IP address assignments.
- Routers used ip helper-address to forward DHCP broadcasts to the DHCP server.

Each network's DHCP pool was configured with:

- Default gateway
- DNS server
- Address range and subnet mask
- Lease time



7. NAT & PAT

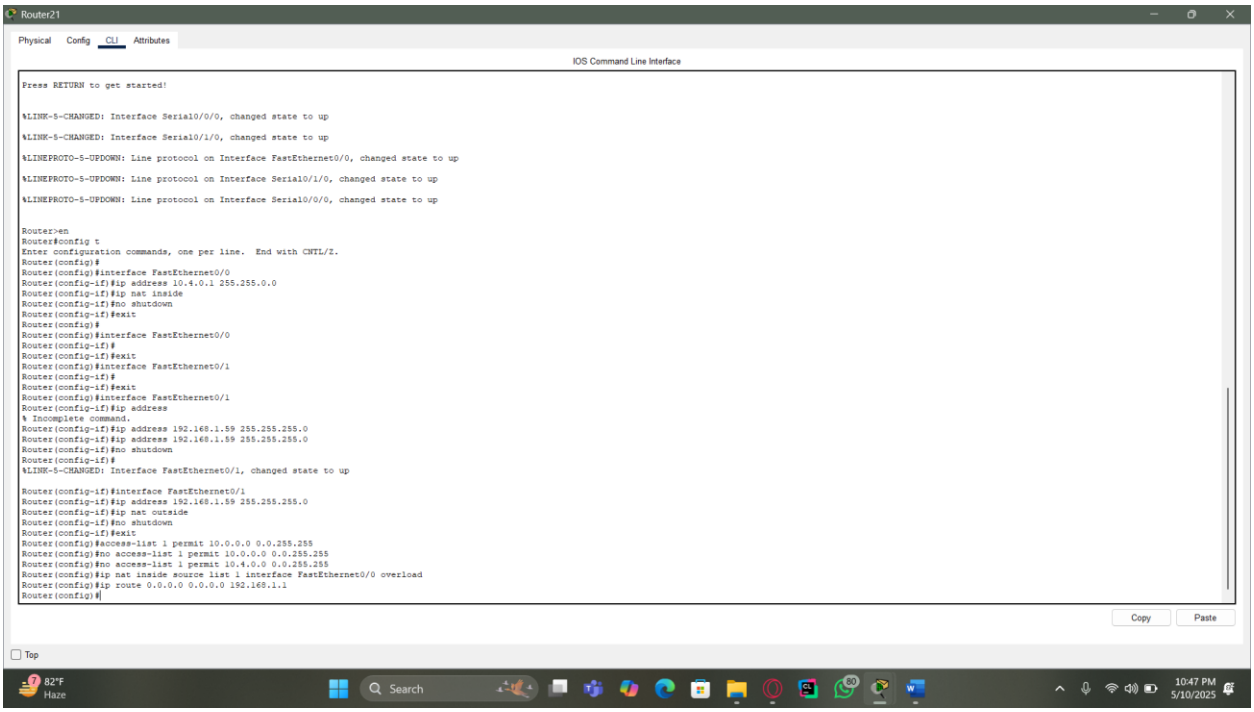
NAT and PAT were implemented on:

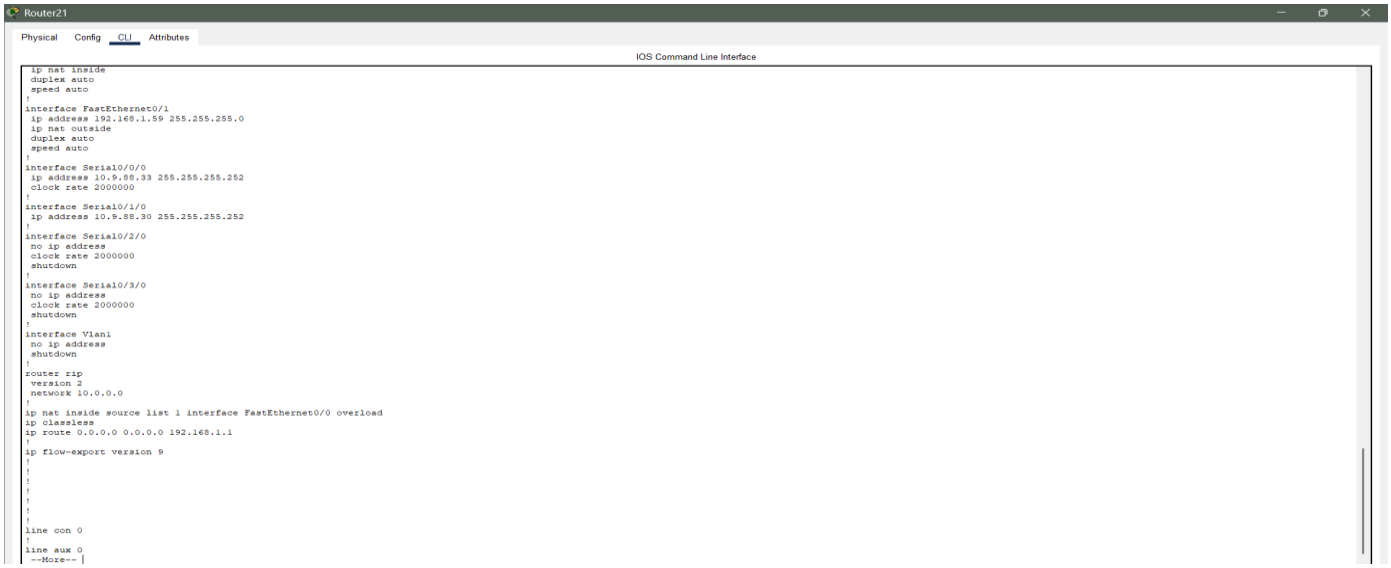
- **Router21 (Network K)**
- **Router10 (Network F)**

Static NAT and overload PAT configuration:

ip nat inside source list 1 interface Serial0/0/1 overload

Public IPs from the Google Sheet were used for NAT translations.





8. ACL Implementation

Access Control Lists were implemented on the router closest to the **Web Server** to enforce the following restrictions:

- **One PC from Network A** denied access.
- **One Laptop from Network E** and **Smartphone from Network B** denied access.
- **All hosts from Network D** denied access.

Example ACL:

access-list 110 deny ip host 10.0.0.5 any

access-list 110 permit ip any any

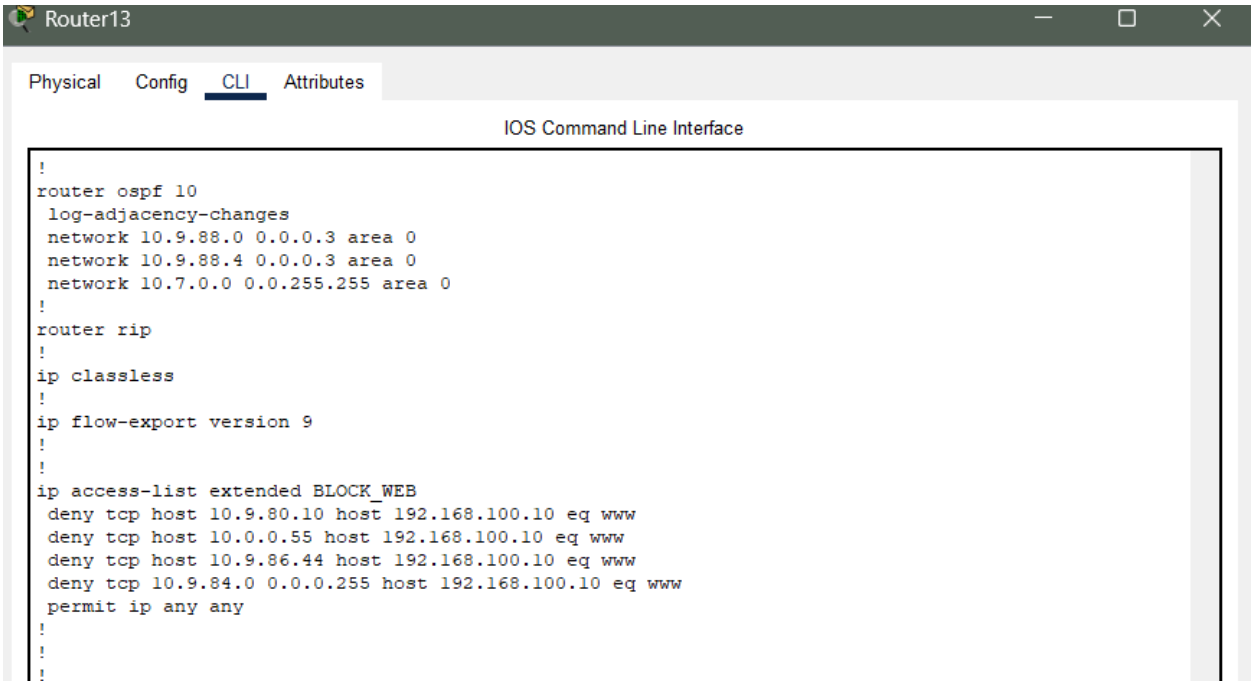
Applied to:

interface FastEthernet0/0

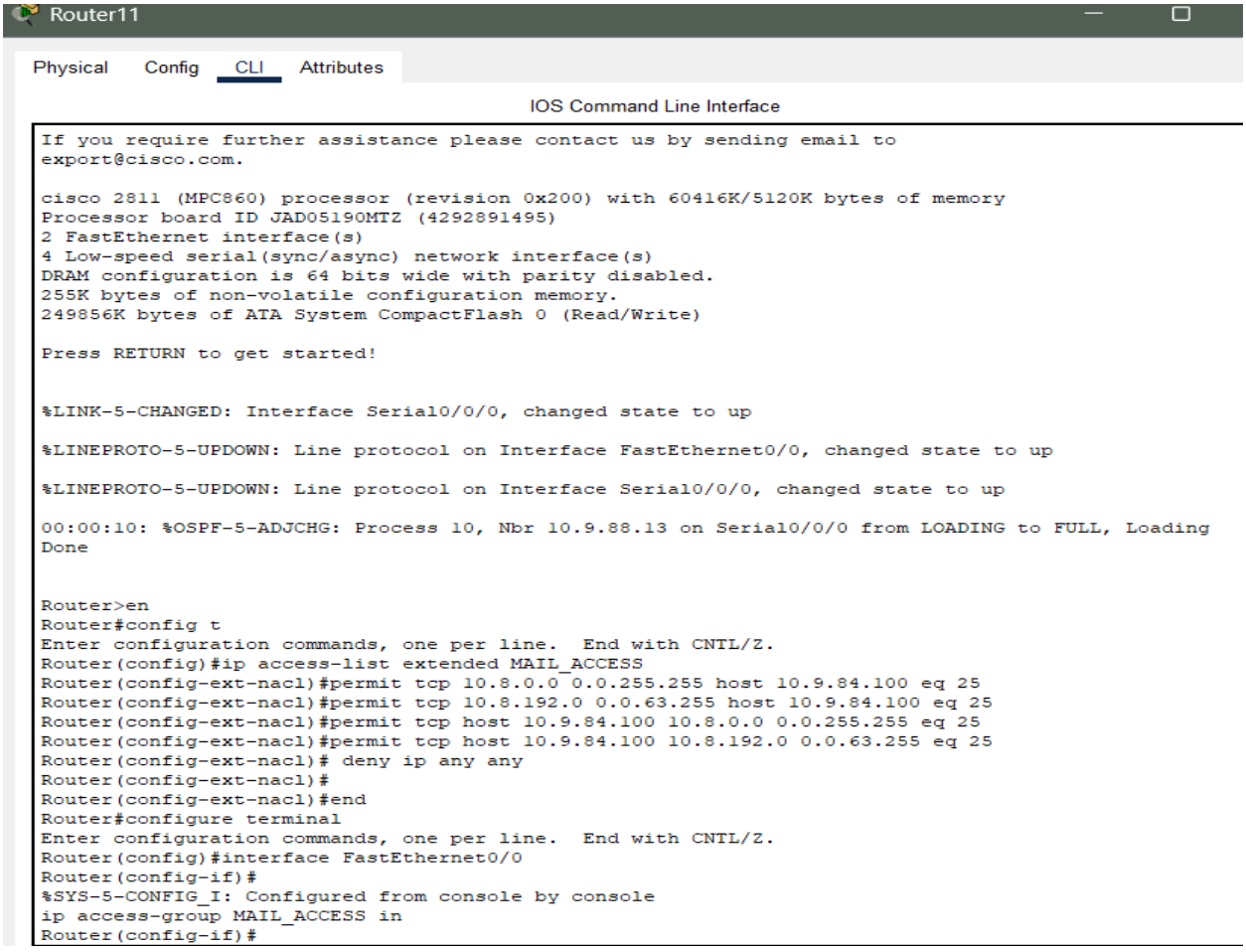
ip access-group 110 in

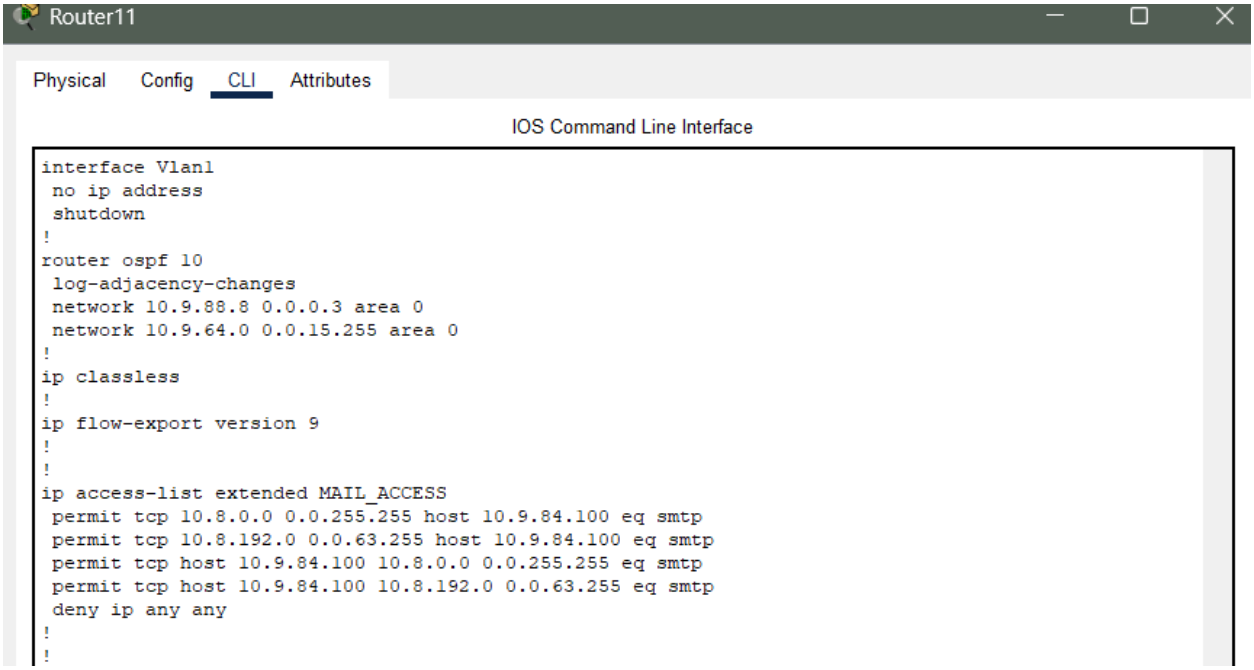
WEB:


Router13
Physical
Config
CLI
Attributes
IOS Command Line Interface
cisco 2811 (MPC860) processor (revision 0x200) with 60416K/5120K bytes of memory
Processor board ID JAD05190MTZ (4292891495)
2 FastEthernet interface(s)
4 Low-speed serial(sync/async) network interface(s)
DRAM configuration is 64 bits wide with parity disabled.
255K bytes of non-volatile configuration memory.
249856K bytes of ATA System CompactFlash 0 (Read/Write)
Press RETURN to get started!
%LINK-5-CHANGED: Interface Serial0/0/0, changed state to up
%LINK-5-CHANGED: Interface Serial0/1/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/0, changed state to up
00:00:10: %OSPF-5-ADJCHG: Process 10, Nbr 10.9.88.13 on Serial0/1/0 from LOADING to FULL,
Done
00:00:10: %OSPF-5-ADJCHG: Process 10, Nbr 10.9.88.1 on Serial0/0/0 from LOADING to FULL,
Done
Router>en
Router#config t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#ip access-list extended BLOCK_WEB
Router(config-ext-nacl)# deny tcp host 10.9.80.10 host 192.168.100.10 eq 80
Router(config-ext-nacl)#deny tcp host 10.0.0.55 host 192.168.100.10 eq 80
Router(config-ext-nacl)#deny tcp host 10.9.86.44 host 192.168.100.10 eq 80
Router(config-ext-nacl)#deny tcp 10.9.84.0 0.0.0.255 host 192.168.100.10 eq 80
Router(config-ext-nacl)#permit ip any any
Router(config-ext-nacl)#exit
Router(config)#
Router(config)#interface FastEthernet0/0
Router(config-if)#ip access-group BLOCK_WEB in
Router(config-if)#
Copy


Router13
Physical
Config
CLI
Attributes
IOS Command Line Interface
!
router ospf 10
 log-adjacency-changes
 network 10.9.88.0 0.0.0.3 area 0
 network 10.9.88.4 0.0.0.3 area 0
 network 10.7.0.0 0.0.255.255 area 0
!
router rip
!
ip classless
!
ip flow-export version 9
!
!
ip access-list extended BLOCK_WEB
 deny tcp host 10.9.80.10 host 192.168.100.10 eq www
 deny tcp host 10.0.0.55 host 192.168.100.10 eq www
 deny tcp host 10.9.86.44 host 192.168.100.10 eq www
 deny tcp 10.9.84.0 0.0.0.255 host 192.168.100.10 eq www
 permit ip any any
!
!
!

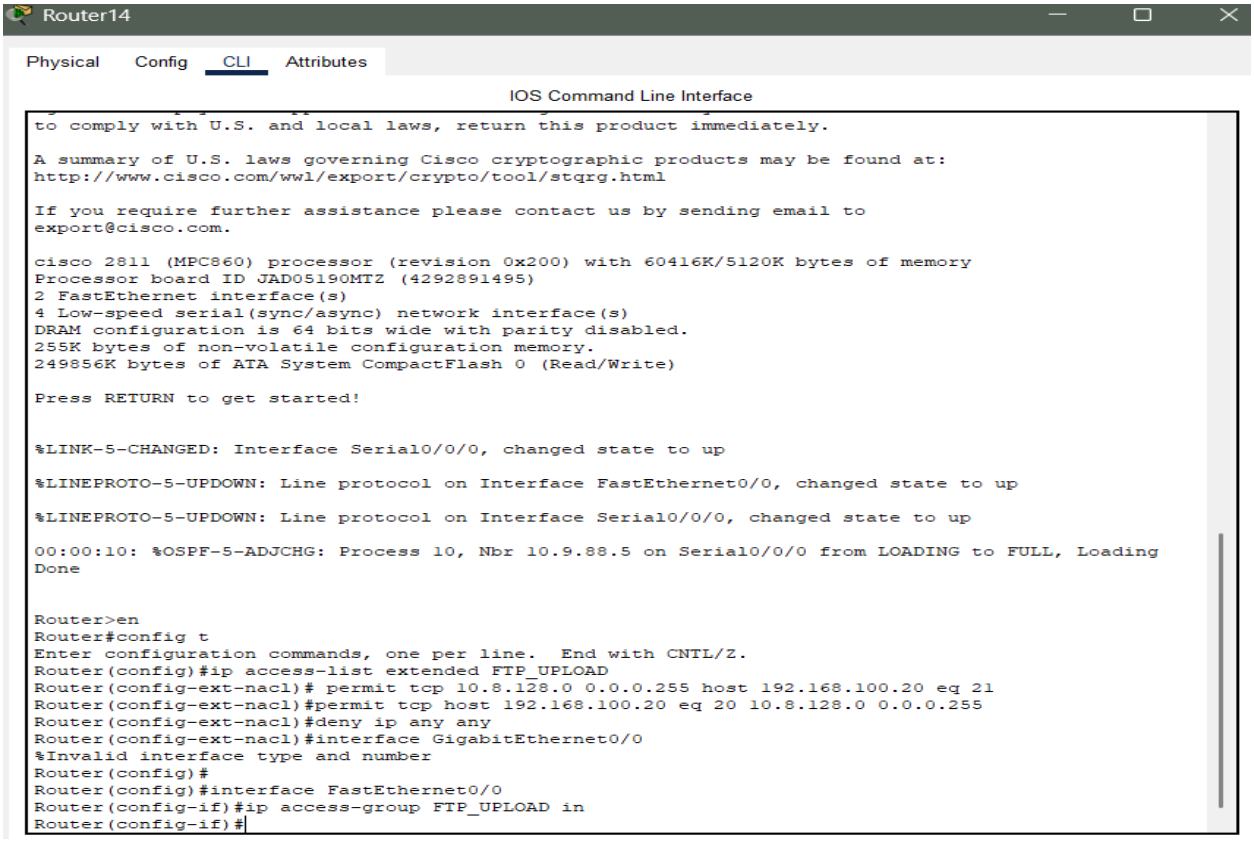
Mail:


Router11
Physical
Config
CLI
Attributes
IOS Command Line Interface
If you require further assistance please contact us by sending email to
export@cisco.com.
cisco 2811 (MPC860) processor (revision 0x200) with 60416K/5120K bytes of memory
Processor board ID JAD05190MTZ (4292891495)
2 FastEthernet interface(s)
4 Low-speed serial(sync/async) network interface(s)
DRAM configuration is 64 bits wide with parity disabled.
255K bytes of non-volatile configuration memory.
249856K bytes of ATA System CompactFlash 0 (Read/Write)
Press RETURN to get started!
%LINK-5-CHANGED: Interface Serial0/0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/0, changed state to up
00:00:10: %OSPF-5-ADJCHG: Process 10, Nbr 10.9.88.13 on Serial0/0/0 from LOADING to FULL, Loading
Done
Router>en
Router#config t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#ip access-list extended MAIL_ACCESS
Router(config-ext-nacl)#permit tcp 10.8.0.0 0.0.255.255 host 10.9.84.100 eq 25
Router(config-ext-nacl)#permit tcp 10.8.192.0 0.0.63.255 host 10.9.84.100 eq 25
Router(config-ext-nacl)#permit tcp host 10.9.84.100 10.8.0.0 0.0.255.255 eq 25
Router(config-ext-nacl)#permit tcp host 10.9.84.100 10.8.192.0 0.0.63.255 eq 25
Router(config-ext-nacl)# deny ip any any
Router(config-ext-nacl)#
Router(config-ext-nacl)#end
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface FastEthernet0/0
Router(config-if)#
%SYS-5-CONFIG_I: Configured from console by console
ip access-group MAIL_ACCESS in
Router(config-if)#


Router11
Physical
Config
CLI
Attributes
IOS Command Line Interface
interface Vlan1
 no ip address
 shutdown
!
router ospf 10
 log-adjacency-changes
 network 10.9.88.8 0.0.0.3 area 0
 network 10.9.64.0 0.0.15.255 area 0
!
ip classless
!
ip flow-export version 9
!
!
ip access-list extended MAIL_ACCESS
 permit tcp 10.8.0.0 0.0.255.255 host 10.9.84.100 eq smtp
 permit tcp 10.8.192.0 0.0.63.255 host 10.9.84.100 eq smtp
 permit tcp host 10.9.84.100 10.8.0.0 0.0.255.255 eq smtp
 permit tcp host 10.9.84.100 10.8.192.0 0.0.63.255 eq smtp
 deny ip any any
!
!

FTP:

‘


Router14
Physical
Config
CLI
Attributes
IOS Command Line Interface
to comply with U.S. and local laws, return this product immediately.
A summary of U.S. laws governing Cisco cryptographic products may be found at:
http://www.cisco.com/wwl/export/crypto/tool/stqrg.html
If you require further assistance please contact us by sending email to
export@cisco.com.
cisco 2811 (MPC860) processor (revision 0x200) with 60416K/5120K bytes of memory
Processor board ID JAD05190MTZ (4292891495)
2 FastEthernet interface(s)
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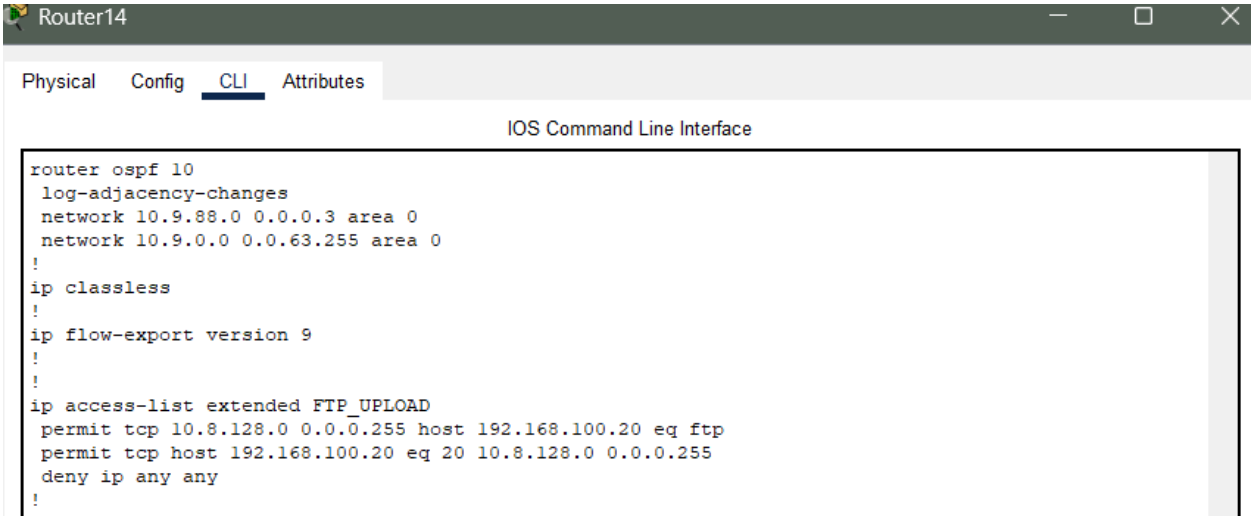
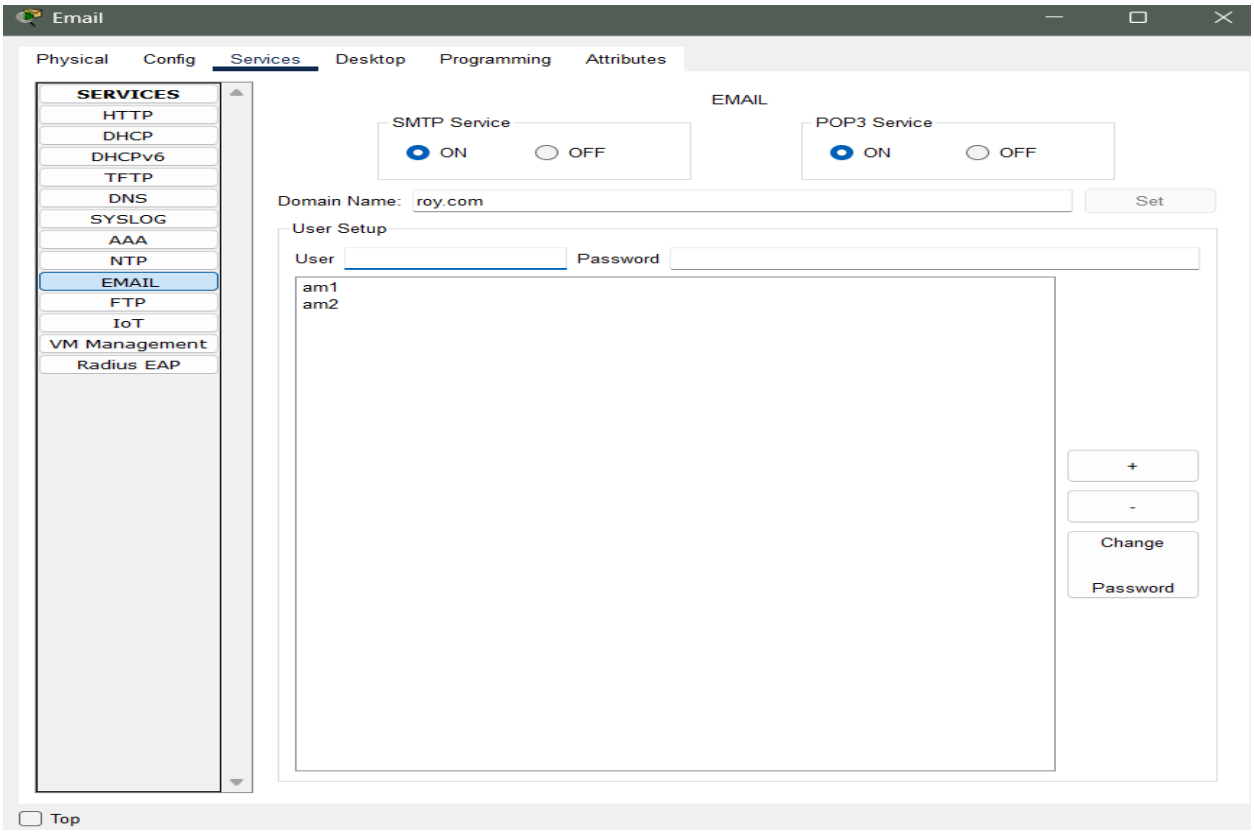
DRAM configuration is 64 bits wide with parity disabled.
255K bytes of non-volatile configuration memory.
249856K bytes of ATA System CompactFlash 0 (Read/Write)
Press RETURN to get started!
%LINK-5-CHANGED: Interface Serial0/0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/0, changed state to up
00:00:10: %OSPF-5-ADJCHG: Process 10, Nbr 10.9.88.5 on Serial0/0/0 from LOADING to FULL, Loading
Done
Router>en
Router#config t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#ip access-list extended FTP_UPLOAD
Router(config-ext-nacl)# permit tcp 10.8.128.0 0.0.0.255 host 192.168.100.20 eq 21
Router(config-ext-nacl)#permit tcp host 192.168.100.20 eq 20 10.8.128.0 0.0.0.255
Router(config-ext-nacl)#deny ip any any
Router(config-ext-nacl)#interface GigabitEthernet0/0
%Invalid interface type and number
Router(config)#
Router(config)#interface FastEthernet0/0
Router(config-if)#ip access-group FTP_UPLOAD in
Router(config-if)#



9. Services Configuration

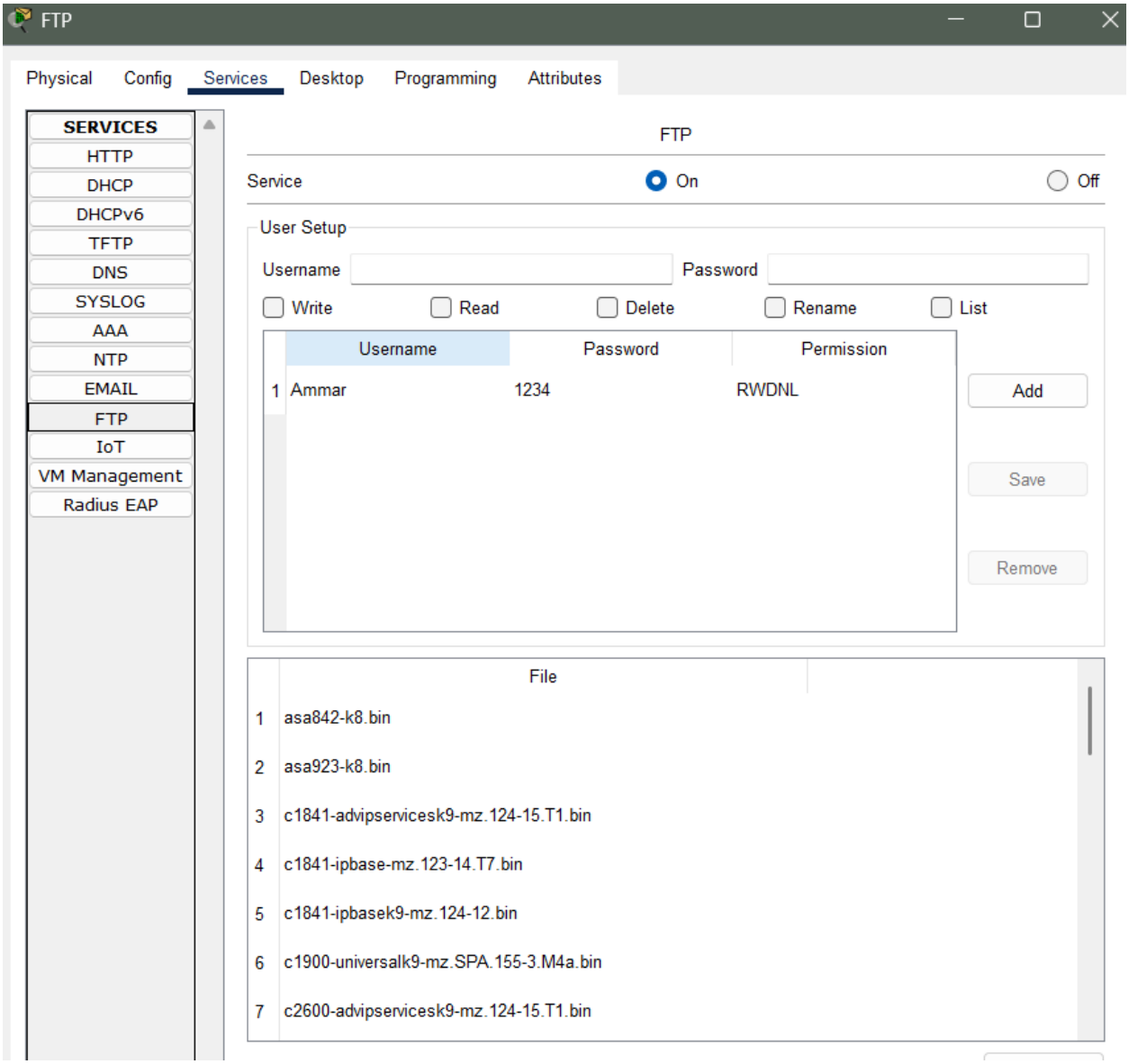
Mail Server (Block D)

- **SMTP and POP3** configured.
- Only **Networks H and I** permitted for email communication.



FTP Server

- Located as per topology.
- Only hosts in **Network G** were permitted to access and upload files.
- Configuration included:
    - FTP usernames and passwords
    - Write permissions
    - ACL to restrict access from other networks



10. Validation & Testing

All services were tested for functionality:

- **Ping tests** across inter-domain routers and to DHCP clients confirmed correct routing and addressing.
- **Web server**:
    - Accessible to all except denied clients (validated via browser simulation).
- **FTP**:
    - Accessed and uploaded by Network G hosts.
- **Mail server**:
    - Email exchange successful between H and I users.
- **DHCP**:
    - Every client auto-assigned correct IP and gateway.
- **NAT**:
    - Verified using show ip nat translations.

11. Challenges & Resolutions

Issue: DHCP clients not receiving IPs in remote networks

Fix: Added ip helper-address on router interfaces.

Issue: ACL blocked unintended traffic

Fix: Carefully structured ACLs with specific deny and permit statements in correct order.

Issue: Redistribution loops

Fix: Used route-map with tag filtering and manual metric tuning.

12. Conclusion

This project successfully demonstrates advanced network design and configuration using Cisco Packet Tracer. It integrates real-world networking scenarios such as routing protocol redistribution, NAT, DHCP centralization, ACL-based access control, and secure service segmentation (Mail, FTP, Web). The entire network is functional, scalable, and secure — showcasing a solid grasp of network engineering principles and Cisco technologies.