

# **ALPHANET ISP NETWORK IMPLEMENTATION**

## **A CASE STUDY REPORT**

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**BONAFIDE CERTIFICATE**

Certified that Computer Network A Case Study Report titled **AlphaNet ISP Network** is the bonafide work of **Lalith Surya G [RA2211032010009]**, **Shabarinathan KRV [RA211032010011]**, **Amal R [RA211032010015]**, who carried out the case study under my supervision. Certified further, that to the best of my knowledge the work reported herein does not form any other work

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# ABSTRACT

This network design presents a robust and scalable network infrastructure for an organization set to integrate multiple ISPs, a cloud provider, and internal networks. Advanced routing protocols such as BGP and OSPF are used in association with network technologies such as VLANs, NAT, and GRE tunnels. The domains are divided in the network: the core AlfaNET network, the customer networks, and the LPnet network. The AlfaNET network is the back-bone part connecting different sites and supplying internet connectivity through ISPs. The LPnet is a separate network for specific purposes and uses RIP internally for routing purposes, while GRE tunnels are used to connect inter-sites. Security is one of the paramount issues addressed through ACLs when controlling traffic flow and protecting sensitive information. This network design is scalable, and this assimilated to grow and expand over time. By combining these technologies and strategies effectively, this promised network would be reliable, efficient, and secure connectivity.

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# **1. Introduction**

## **1.1 Background**

AlfaISP is a local internet service provider located in Belgrade, Serbia. The company expands its network infrastructure to fulfill the growing demand from its residential as well as business customers. The company has four locations, namely, Centar, Zemun, Banovo Brdo, and Kaludjerica, are interconnected by a high-speed ring by using fiber-optic links. The goal of AlfaISP lies mainly in the internet access for individual users by providing ADSL modem connections as well as fiber-optic connections for small and medium-sized enterprises. Besides that, the company provides hosting services both from its own data center and third-party cloud providers, for dedicated and virtual servers.

## **1.2 Objectives**

The main objective is to develop and enhance the network infrastructure of AlfaISP from residential and business customers. This should include the spread of the network, maximizing network performance, detailed security measures, diversification of services, and efficient management of network resources with the least possible operational cost. With the success of these objectives, AlfaISP will be in a better position to sustain its robust positions within the region with superior customer service as well as market growth.

Figure 1: Topology of full network

## **2.2 Components**

The network design for the project incorporates the following devices:

### **1. Routers (16):**

- 2 ISP router for upstream connectivity.
- Positioned at the core layer for redundancy.
- Connect to both ISPs for internet connectivity.
- Configured with static, public IP addresses from ISPs.

### **2. Multilayer Switches (13):**

- Deployed at the core layer to provide redundancy and efficient routing.
- Configured for both switching and routing functionalities.
- Assigned IP addresses to enable inter-VLAN routing.

### **3. End-User Devices (36):**

- Deployed at the access layer.
- Connected to distribution layer switches for departmental access.

### **4. DHCP Servers (18):**

- Dynamically allocate IP addresses to end-user devices.

These devices collectively form a structured and well-organized network architecture, integrating redundancy, efficient routing, and secure communication to meet the specific requirements of the trading floor support center's operations.

## 2.3 IP Addressing Scheme

Provide details about the IP addressing scheme applied to the network.

### Autonomous System 100

10.8.0.0/16 - OSPF routing, NATIVE VLAN ID: 5

Address range for internal business subnets: 10.8.0.0/20

SALES : 512 addresses : 10.8.0.0/23 (VLAN ID: 10)

Centar : 256 addresses : 10.8.0.0/24

Banovo Brdo : 128 addresses : 10.8.1.0/25

Kaludjerica : 64 addresses : 10.8.1.128/26

Zemun : 64 addresses : 10.8.1.192/26

IT : 256 addresses : 10.8.2.0/24 (VLAN ID: 20)

Centar : 64 addresses : 10.8.2.0/26

Banovo Brdo : 64 addresses : 10.8.2.64/26

Kaludjerica : 64 addresses : 10.8.2.128/26

Zemun : 64 addresses : 10.8.2.192/26

MGMT : 128 addresses : 10.8.3.0/25 (VLAN ID: 30)

ADV : 128 addresses : 10.8.3.128/25 (VLAN ID: 40)

**SWCONTROL : 256 addresses : 10.8.4.0/24 (VLAN ID: 50)**

Centar : 64 addresses : 10.8.4.0/26

Banovo Brdo : 64 addresses : 10.8.4.64/26

Kaludjerica : 64 addresses : 10.8.4.128/26

Zemun : 64 addresses : 10.8.4.192/26

**Address range for servers : 10.8.16.0/22 (VLAN ID: 60)**

Internal (AlfaNET internal server) : 10.8.16.2

NWMon (SNMP monitoring server) : 10.8.16.3

**Address range for internal point-to-point subnets: 10.8.96.0/22**

K-BB : 10.8.96.0/30

BB-Z : 10.8.96.4/30

Z-C : 10.8.96.8/30

C-K : 10.8.96.12/30

C-L3SW1 : 10.8.96.16/30

Z-L3SW2 : 10.8.96.20/30

L3SW1-L3SW2 : 10.8.96.24/30 (Tunnel 1)

BB-L3SW3 : 10.8.96.28/30



L3SW1-L3SW3 : 10.8.96.32/30 (Tunnel 2)

L3SW2-L3SW3 : 10.8.96.36/30 (Tunnel 3)

**Internet link: 10.8.100.0/4**

**AlfaNET public range : 100.20.8.0/24**

IT department : 100.20.8.1 - 100.20.8.16

Customers : 100.20.8.17 - 100.20.8.32

Sales, marketing, management : 100.20.8.33 - 100.20.8.40

LPNet customer : 100.20.8.41 - 100.20.8.41

**Public servers: 100.20.8.96/27**

DNS : 100.20.8.100

WEB : 100.20.8.101

MAIL : 100.20.8.102

**AlfaNET customer's private range**

192.168.8.0/26

DHCP: 192.168.8.10 - 192.168.8.30

Default gateway: 192.168.8.30

**AlfaNET customer's internal range (n - customer's ID): 10.8.128.0/17**

10.8.128.n - Centar - OSPF Area 201 totally stubby

10.8.160.n - Zemun - OSPF Area 202 totally stubby

10.8.192.n - Banovo Brdo - OSPF Area 203 totally stubby

10.8.224.n - Kaludjerica - OSPF Area 204 totally stubby

**LPNet private range**

172.8.0.0/16 - RIP routing

Centar: 172.8.0.0/22

Pivnica 1 : 172.8.0.0/26

Pivnica 2 : 172.8.0.64/26

Pivnica 3 : 172.8.0.128/26

Pivnica 4 : 172.8.0.192/26

LP1-LP2 : 172.8.2.0/30

LP1-LP3 : 172.8.2.4/30

LP1-LP4 : 172.8.2.8/30

LP1-L3SW1 : 172.8.2.12/30

Zemun: 172.8.4.0/22

Pivnica 5 : 172.8.4.0/26

Pivnica 6 : 172.8.4.64/26

Pivnica 7 : 172.8.4.128/26

LP5-LP6 : 172.8.6.0/30

LP5-LP7 : 172.8.6.4/30

LP5-L3SW2 : 172.8.6.8/30

Banovo Brdo: 172.8.8.0/24

LPNET-L3SW3 : 172.8.8.0/30

### **Internet Service Provider (ISP) "101"**

Autonomous System 101

101.8.0.0/16

### **Internet Service Provider (ISP) "102"**

Autonomous System 102

102.8.0.0/16

### **# Cloud provider**

Autonomous System 200

200.8.1.0/28

### **# Point-to-point public networks**

GW\_ISP101 - GW\_CP : 103.8.0.0/30

GW\_CP - GW\_ISP102 : 103.8.0.4/30

GW\_ISP102 - GW\_AlfaNET : 103.8.0.8/30

GW\_AlfaNET - GW\_ISP101 : 103.8.0.12/30

## 3. Routing Configuration

### 3.1 Static and Dynamic Routing

Static and dynamic routing strategies are integrated into the network design to achieve a balanced and resilient routing infrastructure. Static routing is employed for specific, predictable routes within the network. For instance, static routes are configured on routers to direct traffic to the dedicated DHCP servers in the server room. This ensures a fixed and predetermined path for critical internal communication. On the other hand, dynamic routing, specifically OSPF, is implemented for adaptive and automated route selection. OSPF dynamically adjusts to changes in the network, making it suitable for scalability and flexibility. This combination of static and dynamic routing provides a robust and versatile routing solution, catering to both predefined and evolving routing needs within the "Company System Network Design" project.

---

```
# Internet Service Provider "101" BGP Gateway configuration
```

```
enable
```

```
configure terminal
```

```
# Interfaces
```

```
interface FastEthernet 0/0
```

```
ip address 101.8.0.1 255.255.0.0
```

```
no shutdown
```

```
interface GigabitEthernet 5/0
```

```
ip address 103.8.0.1 255.255.255.252
```

```
no shutdown
```

```
interface GigabitEthernet 4/0
```

```
ip address 103.8.0.13 255.255.255.252
```

```
no shutdown
```

```
exit
```

```
# DHCP
```

```
service dhcp
```

```
ip dhcp pool LAN101
```

```
network 101.8.0.0 255.255.0.0
default-router 101.8.0.1
exit
ip dhcp excluded-address 101.8.0.1
```

```
# BGP
```

```
router bgp 101
neighbor 103.8.0.2 remote-as 200
neighbor 103.8.0.14 remote-as 100
network 101.8.0.0 mask 255.255.0.0
exit
```

```
# Save config
```

```
CTRL-C
```

```
copy running-config startup-config
```

---

```
# Internet Service Provider "102" BGP Gateway configuration
```

```
enable
```

```
configure terminal
```

```
# Interfaces
```

```
interface FastEthernet 0/0
ip address 102.8.0.1 255.255.0.0
no shutdown
```

```
interface GigabitEthernet 4/0
ip address 103.8.0.6 255.255.255.252
no shutdown
```

```
interface GigabitEthernet 5/0
ip address 103.8.0.9 255.255.255.252
no shutdown
exit
```

```
# DHCP
```

```
service dhcp
```

```
ip dhcp pool LAN102
network 102.8.0.0 255.255.0.0
default-router 102.8.0.1
exit
ip dhcp excluded-address 102.8.0.1
```

```
# BGP
router bgp 102
neighbor 103.8.0.5 remote-as 200
neighbor 103.8.0.10 remote-as 100
network 102.8.0.0 mask 255.255.0.0
exit
```

```
# Save config
CTRL-C
copy running-config startup-config
```

---

```
# Cloud Provider BGP Gateway configuration
```

```
enable
```

```
configure terminal
```

```
# ACLs
ip access-list extended VIRTUAL-DC-ACL
permit tcp any host 200.8.1.2 eq 80
permit tcp any host 200.8.1.2 eq 443
permit tcp any host 200.8.1.3 eq 80
permit tcp any host 200.8.1.3 eq 443
permit tcp 100.20.8.0 0.0.0.15 host 200.8.1.2 eq 22
permit tcp 100.20.8.0 0.0.0.15 host 200.8.1.2 eq 23
permit tcp host 100.20.8.16 host 200.8.1.2 eq 22
permit tcp host 100.20.8.16 host 200.8.1.2 eq 23
deny tcp host 100.20.8.0 host 200.8.1.2
permit icmp any host 200.8.1.2
permit icmp any host 200.8.1.3
exit
```

# Interfaces

```
interface GigabitEthernet 6/0
ip address 200.8.1.1 255.255.255.240
ip access-group ALFA-NET-ACL out
no shutdown
```

```
interface GigabitEthernet 5/0
ip address 103.8.0.2 255.255.255.252
no shutdown
```

```
interface GigabitEthernet 4/0
ip address 103.8.0.5 255.255.255.252
no shutdown
exit
```

# BGP

```
router bgp 200
neighbor 103.8.0.1 remote-as 101
neighbor 103.8.0.6 remote-as 102
network 200.8.1.0 mask 255.255.255.240
exit
```

# Save config

CTRL-C

```
copy running-config startup-config
```

---

---

# AlfaNET BGP Gateway configuration

enable

configure terminal

# Interfaces

```
interface GigabitEthernet 5/0
ip address 103.8.0.10 255.255.255.252
no shutdown
```

```
interface GigabitEthernet 4/0
```

```
ip address 103.8.0.14 255.255.255.252
no shutdown
```

```
interface GigabitEthernet 9/0
ip address 10.8.100.2 255.255.255.252
no shutdown
exit
```

```
# BGP
router bgp 100
neighbor 103.8.0.9 remote-as 102
neighbor 103.8.0.13 remote-as 101
network 100.20.8.0 mask 255.255.255.0
exit
```

```
# Static route to AlfaNET public range
ip route 100.20.8.0 255.255.255.0 10.8.100.1
```

```
# Save config
CTRL-C
copy running-config startup-config
```

---

```
# Zemun (Z) backbone router configuration
```

```
enable
```

```
configure terminal
```

```
# ACLs
ip access-list extended LPNET-ACL
permit tcp host 10.8.96.25 10.8.96.26
permit udp host 10.8.96.25 10.8.96.26
permit icmp host 10.8.96.25 10.8.96.26
permit tcp host 10.8.96.38 10.8.96.37
permit udp host 10.8.96.38 10.8.96.37
permit icmp host 10.8.96.38 10.8.96.37
deny tcp 10.8.0.0 0.0.255.255 172.8.0.0 0.0.255.255
deny udp 10.8.0.0 0.0.255.255 172.8.0.0 0.0.255.255
deny icmp 10.8.0.0 0.0.255.255 172.8.0.0 0.0.255.255
```

```
permit ip any any
permit tcp any any
permit udp any any
permit icmp any any
exit
```

#### # Interfaces

```
interface GigabitEthernet 4/0
ip address 10.8.96.6 255.255.255.252
no shutdown
```

```
interface GigabitEthernet 5/0
ip address 10.8.96.9 255.255.255.252
no shutdown
exit
```

```
interface FastEthernet 0/0
no shutdown
exit
```

```
interface FastEthernet 0/0.1
encapsulation dot1Q 10
ip address 10.8.1.193 255.255.255.192
```

```
interface FastEthernet 0/0.2
encapsulation dot1Q 20
ip address 10.8.2.193 255.255.255.192
```

```
interface FastEthernet 0/0.5
encapsulation dot1Q 50
ip address 10.8.4.193 255.255.255.192
exit
```

```
interface GigabitEthernet 9/0
ip address 10.8.96.21 255.255.255.252
ip access-group LPNET-ACL out
no shutdown
exit
```

#### # DHCP



```
service dhcp
```

```
ip dhcp pool SALES
```

```
network 10.8.1.192 255.255.255.192
```

```
default-router 10.8.1.193
```

```
dns-server 100.20.8.100
```

```
ip dhcp pool IT
```

```
network 10.8.2.192 255.255.255.192
```

```
default-router 10.8.2.193
```

```
dns-server 100.20.8.100
```

```
exit
```

```
ip dhcp excluded-address 10.8.1.193
```

```
ip dhcp excluded-address 10.8.2.193
```

```
# Static route to LP network
```

```
ip route 172.8.4.0 255.255.252.0 10.8.96.22
```

```
# OSPF
```

```
router ospf 1
```

```
network 10.8.96.0 0.0.3.255 area 0
```

```
network 10.8.0.0 0.0.15.255 area 10
```

```
redistribute static subnets
```

```
exit
```

```
# Save config
```

```
CTRL-C
```

```
copy running-config startup-config
```

```
=====
```

```
# Kaludjerica (K) backbone router configuration
```

```
enable
```

```
configure terminal
```

```
# ACLs
```

```
ip access-list extended CX-ACL
```

```
deny tcp any 10.8.0.0 0.0.255.255
deny udp any 10.8.0.0 0.0.255.255
deny icmp any 10.8.0.0 0.0.255.255
deny tcp any 172.8.0.0 0.0.255.255
deny udp any 172.8.0.0 0.0.255.255
deny icmp any 172.8.0.0 0.0.255.255
permit ip any any
permit tcp any any
permit udp any any
permit icmp any any
exit
```

#### # Interfaces

```
interface GigabitEthernet 7/0
ip address 10.8.96.1 255.255.255.252
no shutdown
```

```
interface GigabitEthernet 6/0
ip address 10.8.96.14 255.255.255.252
no shutdown
```

```
interface GigabitEthernet 4/0
ip address 10.8.224.254 255.255.255.0
ip access-group CX-ACL in
no shutdown
exit
```

#### # OSPF

```
router ospf 1
area 204 stub no-summary
network 10.8.96.0 0.0.3.255 area 0
network 10.8.224.0 0.0.0.255 area 204
exit
```

#### # Save config

```
CTRL-C
copy running-config startup-config
```

---

```
# Centar (C) backbone router configuration
```

enable

configure terminal

# ACLs

ip access-list extended LPNET-ACL

permit tcp host 10.8.96.26 10.8.96.25

permit udp host 10.8.96.26 10.8.96.25

permit icmp host 10.8.96.26 10.8.96.25

permit tcp host 10.8.96.34 10.8.96.33

permit udp host 10.8.96.34 10.8.96.33

permit icmp host 10.8.96.34 10.8.96.33

deny tcp 10.8.0.0 0.0.255.255 172.8.0.0 0.0.255.255

deny udp 10.8.0.0 0.0.255.255 172.8.0.0 0.0.255.255

deny icmp 10.8.0.0 0.0.255.255 172.8.0.0 0.0.255.255

permit ip any any

permit tcp any any

permit udp any any

permit icmp any any

exit

deny tcp any 10.8.0.0 0.0.255.255

deny udp any 10.8.0.0 0.0.255.255

deny icmp any 10.8.0.0 0.0.255.255

deny tcp any 172.8.0.0 0.0.255.255

deny udp any 172.8.0.0 0.0.255.255

deny icmp any 172.8.0.0 0.0.255.255

permit ip any any

permit tcp any any

permit udp any any

permit icmp any any

exit

# Interfaces

interface GigabitEthernet 5/0

ip address 10.8.96.10 255.255.255.252

no shutdown

interface GigabitEthernet 6/0

```
ip address 10.8.96.13 255.255.255.252
no shutdown
```

```
interface GigabitEthernet 8/0
no shutdown
exit
```

```
interface GigabitEthernet 8/0.1
encapsulation dot1Q 10
ip address 10.8.0.1 255.255.255.0
```

```
interface GigabitEthernet 8/0.2
encapsulation dot1Q 20
ip address 10.8.2.1 255.255.255.192
```

```
interface GigabitEthernet 8/0.3
encapsulation dot1Q 30
ip address 10.8.3.1 255.255.255.128
```

```
interface GigabitEthernet 8/0.4
encapsulation dot1Q 40
ip address 10.8.3.129 255.255.255.128
```

```
interface GigabitEthernet 8/0.5
encapsulation dot1Q 50
ip address 10.8.4.1 255.255.255.192
exit
```

```
interface GigabitEthernet 9/0
ip address 10.8.96.17 255.255.255.252
ip access-group LPNET-ACL out
no shutdown
exit
```

```
# DHCP
service dhcp
```

```
ip dhcp pool SALES
network 10.8.0.0 255.255.255.0
default-router 10.8.0.1
```

```
dns-server 100.20.8.100
```

```
ip dhcp pool IT
```

```
network 10.8.2.0 255.255.255.192
```

```
default-router 10.8.2.1
```

```
dns-server 100.20.8.100
```

```
ip dhcp pool MGMT
```

```
network 10.8.3.0 255.255.255.128
```

```
default-router 10.8.3.1
```

```
dns-server 100.20.8.100
```

```
ip dhcp pool ADV
```

```
network 10.8.3.128 255.255.255.128
```

```
default-router 10.8.3.129
```

```
dns-server 100.20.8.100
```

```
exit
```

```
ip dhcp excluded-address 10.8.0.1
```

```
ip dhcp excluded-address 10.8.2.1
```

```
ip dhcp excluded-address 10.8.3.1
```

```
ip dhcp excluded-address 10.8.3.129
```

```
# Static route to LP network
```

```
ip route 172.8.0.0 255.255.252.0 10.8.96.18
```

```
# OSPF
```

```
router ospf 1
```

```
network 10.8.96.0 0.0.3.255 area 0
```

```
network 10.8.0.0 0.0.15.255 area 10
```

```
redistribute static subnets
```

```
exit
```

```
# Save config
```

```
CTRL-C
```

```
copy running-config startup-config
```

```
=====
```

```
# Banovo Brdo (BB) backbone router configuration
```

enable

configure terminal

# ACLs

```
ip access-list extended PUBLIC-SRVRS-ACL
permit tcp 10.8.2.0 0.0.0.255 host 100.20.8.100
permit tcp 10.8.2.0 0.0.0.255 host 100.20.8.101
permit tcp 10.8.2.0 0.0.0.255 host 100.20.8.102
permit udp host 10.8.16.3 host 100.20.8.100 eq 161
permit udp host 10.8.16.3 host 100.20.8.101 eq 161
permit udp host 10.8.16.3 host 100.20.8.102 eq 161
permit icmp host 10.8.16.3 host 100.20.8.100
permit icmp host 10.8.16.3 host 100.20.8.101
permit icmp host 10.8.16.3 host 100.20.8.102
permit tcp any host 100.20.8.101 eq 80
permit tcp any host 100.20.8.101 eq 443
permit tcp any host 100.20.8.102 eq 25
permit tcp any eq 25 host 100.20.8.102
permit tcp any host 100.20.8.102 eq 110
permit udp any host 100.20.8.100 eq 53
permit icmp any host 100.20.8.100
permit icmp any host 100.20.8.101
permit icmp any host 100.20.8.102
exit
```

```
ip access-list extended PRIVATE-SRVRS-ACL
permit tcp 10.8.0.0 0.0.15.255 host 10.8.16.2
permit udp 10.8.0.0 0.0.15.255 host 10.8.16.2
permit icmp 10.8.0.0 0.0.15.255 host 10.8.16.2
permit icmp any host 10.8.16.3 echo-reply
permit udp any eq 161 host 10.8.16.3
exit
```

```
ip access-list extended LPNET-SRVR-ACL
permit tcp host 10.8.96.33 host 10.8.96.34
permit udp host 10.8.96.33 host 10.8.96.34
permit icmp host 10.8.96.33 host 10.8.96.34
permit tcp host 10.8.96.37 host 10.8.96.38
permit udp host 10.8.96.37 host 10.8.96.38
```

```
permit icmp host 10.8.96.37 host 10.8.96.38
deny tcp 10.8.0.0 0.0.255.255 host 172.8.8.2
deny udp 10.8.0.0 0.0.255.255 host 172.8.8.2
deny icmp 10.8.0.0 0.0.255.255 host 172.8.8.2
permit ip any any
permit tcp any any
permit udp any any
permit icmp any any
exit
```

#### # Interfaces

```
interface GigabitEthernet 2/0
ip address 10.8.96.29 255.255.255.252
ip nat inside
ip access-group LPNET-SRVR-ACL out
no shutdown
```

```
interface GigabitEthernet 7/0
ip address 10.8.96.2 255.255.255.252
ip nat inside
no shutdown
```

```
interface GigabitEthernet 4/0
ip address 10.8.96.5 255.255.255.252
ip nat inside
no shutdown
```

```
interface GigabitEthernet 9/0
ip address 10.8.100.1 255.255.255.252
ip nat outside
no shutdown
exit
```

```
interface GigabitEthernet 8/0
no shutdown
exit
```

```
interface GigabitEthernet 8/0.1
encapsulation dot1Q 10
ip address 10.8.1.1 255.255.255.128
```

ip nat inside

interface GigabitEthernet 8/0.2  
encapsulation dot1Q 20  
ip address 10.8.2.65 255.255.255.192  
ip nat inside

interface GigabitEthernet 8/0.5  
encapsulation dot1Q 50  
ip address 10.8.4.65 255.255.255.192  
ip nat inside

interface GigabitEthernet 8/0.6  
encapsulation dot1Q 60  
ip address 10.8.16.1 255.255.252.0  
ip nat inside  
ip access-group PRIVATE-SRVRS-ACL out

interface GigabitEthernet 8/0.10  
encapsulation dot1Q 100  
ip address 100.20.8.97 255.255.255.224  
ip nat inside  
ip access-group PUBLIC-SRVRS-ACL out  
exit

# DHCP  
service dhcp

ip dhcp pool SALES  
network 10.8.1.0 255.255.255.128  
default-router 10.8.1.1  
dns-server 100.20.8.100

ip dhcp pool IT  
network 10.8.2.64 255.255.255.192  
default-router 10.8.2.65  
dns-server 100.20.8.100  
exit

ip dhcp excluded-address 10.8.1.1



```
ip dhcp excluded-address 10.8.2.65
```

```
# NAT
```

```
ip access-list standard IT-ACL
```

```
permit 10.8.2.0 0.0.0.255
```

```
exit
```

```
ip access-list standard CX-ACL
```

```
permit 10.8.128.0 0.0.0.255
```

```
permit 10.8.160.0 0.0.0.255
```

```
permit 10.8.192.0 0.0.0.255
```

```
permit 10.8.224.0 0.0.0.255
```

```
exit
```

```
ip access-list standard BUSINESS-ACL
```

```
permit 10.8.0.0 0.0.1.255
```

```
permit 10.8.3.0 0.0.0.127
```

```
permit 10.8.3.128 0.0.0.127
```

```
exit
```

```
ip access-list standard LPNET-ACL
```

```
permit 172.8.0.0 0.0.255.255
```

```
exit
```

```
ip nat pool ALFA-NET-IT 100.20.8.1 100.20.8.16 netmask 255.255.255.0
```

```
ip nat pool ALFA-NET-CX 100.20.8.17 100.20.8.32 netmask 255.255.255.0
```

```
ip nat pool ALFA-NET-BUSINESS 100.20.8.33 100.20.8.40 netmask 255.255.255.0
```

```
ip nat pool LPNET 100.20.8.41 100.20.8.41 netmask 255.255.255.0
```

```
ip nat inside source list IT-ACL pool ALFA-NET-IT overload
```

```
ip nat inside source list CX-ACL pool ALFA-NET-CX overload
```

```
ip nat inside source list BUSINESS-ACL pool ALFA-NET-BUSINESS overload
```

```
ip nat inside source list LPNET-ACL pool LPNET overload
```

```
# Static route to LP network
```

```
ip route 172.8.8.0 255.255.255.252 10.8.96.30
```

```
# Default static route to BGP Gateway
```

```
ip route 0.0.0.0 0.0.0.0 10.8.100.2
```

```
# OSPF
router ospf 1
network 10.8.96.0 0.0.3.255 area 0
network 10.8.0.0 0.0.15.255 area 10
network 10.8.16.0 0.0.3.255 area 20
redistribute static subnets
default-information originate
exit
```

```
# Save config
CTRL-C
copy running-config startup-config
```

---

```
# Customer 1 (Cx1) router RCx1 configuration
```

```
enable
```

```
configure terminal
```

```
# Interfaces
interface FastEthernet 1/0
ip address 192.168.8.30 255.255.255.192
ip nat inside
no shutdown
```

```
interface GigabitEthernet 0/0
ip address 10.8.224.1 255.255.255.0
ip nat outside
no shutdown
exit
```

```
# DHCP
service dhcp
ip dhcp pool CXLOCAL
network 192.168.8.0 255.255.255.192
default-router 192.168.8.30
dns-server 100.20.8.100
exit
```

```
ip dhcp excluded-address 192.168.8.1 192.168.8.9
ip dhcp excluded-address 192.168.8.30
ip dhcp excluded-address 192.168.8.31 192.168.8.62
```

```
# NAT
```

```
ip access-list standard CXLOCAL
permit 192.168.8.0 0.0.0.63
exit
```

```
ip nat pool ALFA-NET-KAL 10.8.224.1 10.8.224.1 netmask 255.255.255.0
ip nat inside source list CXLOCAL pool ALFA-NET-KAL overload
```

```
# OSPF
```

```
router ospf 1
router-id 10.8.224.1
area 204 stub no-summary
network 10.8.224.0 0.0.0.255 area 204
exit
```

```
# Save config
```

```
CTRL-C
```

```
copy running-config startup-config
```

```
=====
# Customer 2 (Cx2) router RCx2 configuration
```

```
enable
```

```
configure terminal
```

```
# Interfaces
```

```
interface FastEthernet 1/0
ip address 192.168.8.30 255.255.255.192
ip nat inside
no shutdown
```

```
interface GigabitEthernet 0/0
ip address 10.8.224.2 255.255.255.0
ip nat outside
no shutdown
```

exit

# DHCP

service dhcp

ip dhcp pool CXLOCAL

network 192.168.8.0 255.255.255.192

default-router 192.168.8.30

dns-server 100.20.8.100

exit

ip dhcp excluded-address 192.168.8.1 192.168.8.9

ip dhcp excluded-address 192.168.8.30

ip dhcp excluded-address 192.168.8.31 192.168.8.62

# NAT

ip access-list standard CXLOCAL

permit 192.168.8.0 0.0.0.63

exit

ip nat pool ALFA-NET-KAL 10.8.224.2 10.8.224.2 netmask 255.255.255.0

ip nat inside source list CXLOCAL pool ALFA-NET-KAL overload

# OSPF

router ospf 1

router-id 10.8.224.2

area 204 stub no-summary

network 10.8.224.0 0.0.0.255 area 204

exit

# Save config

CTRL-C

copy running-config startup-config

---

---

# LP's LP1 router configuration

enable

configure terminal

# Interfaces

```
interface GigabitEthernet 1/0
ip address 172.8.2.1 255.255.255.252
no shutdown
```

```
interface GigabitEthernet 2/0
ip address 172.8.2.5 255.255.255.252
no shutdown
```

```
interface GigabitEthernet 3/0
ip address 172.8.2.9 255.255.255.252
no shutdown
```

## Link to AlfaNET

```
interface GigabitEthernet 4/0
ip address 172.8.2.14 255.255.255.252
no shutdown
```

```
interface FastEthernet 5/0
ip address 172.8.0.1 255.255.255.192
no shutdown
exit
```

# DHCP

```
service dhcp
ip dhcp pool LPLOCAL
network 172.8.0.0 255.255.255.192
default-router 172.8.0.1
dns-server 100.20.8.100
exit
```

```
ip dhcp excluded-address 172.8.0.1
```

# Static route to the GRE tunnel

```
ip route 0.0.0.0 0.0.0.0 172.8.2.13
```

# RIP

```
router rip
version 2
network 172.8.0.0
```

```
default-information originate
exit
```

```
# Save config
CTRL-C
copy running-config startup-config
```

---

```
# LP's LP2 router configuration
```

```
enable
```

```
configure terminal
```

```
# Interfaces
```

```
interface GigabitEthernet 0/0
ip address 172.8.2.2 255.255.255.252
no shutdown
```

```
interface FastEthernet 1/0
ip address 172.8.0.65 255.255.255.192
no shutdown
exit
```

```
# DHCP
```

```
service dhcp
ip dhcp pool LPLOCAL
network 172.8.0.64 255.255.255.192
default-router 172.8.0.65
dns-server 100.20.8.100
exit
```

```
ip dhcp excluded-address 172.8.0.65
```

```
# RIP
```

```
router rip
version 2
network 172.8.0.0
exit
```

```
# Save config
CTRL-C
copy running-config startup-config
```

---

```
# LP's LP3 router configuration
```

```
enable
```

```
configure terminal
```

```
# Interfaces
```

```
interface GigabitEthernet 0/0
ip address 172.8.2.6 255.255.255.252
no shutdown
```

```
interface FastEthernet 1/0
ip address 172.8.0.129 255.255.255.192
no shutdown
exit
```

```
# DHCP
```

```
service dhcp
ip dhcp pool LPLOCAL
network 172.8.0.128 255.255.255.192
default-router 172.8.0.129
dns-server 100.20.8.100
exit
```

```
ip dhcp excluded-address 172.8.0.129
```

```
# RIP
```

```
router rip
version 2
network 172.8.0.0
exit
```

```
# Save config
```

```
CTRL-C
copy running-config startup-config
```

---

---

# LP's LP4 router configuration

enable

configure terminal

# Interfaces

interface GigabitEthernet 0/0

ip address 172.8.2.10 255.255.255.252

no shutdown

interface FastEthernet 1/0

ip address 172.8.0.193 255.255.255.192

no shutdown

exit

# DHCP

service dhcp

ip dhcp pool LPLOCAL

network 172.8.0.192 255.255.255.192

default-router 172.8.0.193

dns-server 100.20.8.100

exit

ip dhcp excluded-address 172.8.0.193

# RIP

router rip

version 2

network 172.8.0.0

exit

# Save config

CTRL-C

copy running-config startup-config

---

---

# LP's LP5 router configuration



enable

configure terminal

# Interfaces

interface GigabitEthernet 1/0

ip address 172.8.6.1 255.255.255.252

no shutdown

interface GigabitEthernet 2/0

ip address 172.8.6.5 255.255.255.252

no shutdown

## Link to AlfaNET

interface GigabitEthernet 3/0

ip address 172.8.6.10 255.255.255.252

no shutdown

interface FastEthernet 4/0

ip address 172.8.4.1 255.255.255.192

no shutdown

exit

# DHCP

service dhcp

ip dhcp pool LPLOCAL

network 172.8.4.0 255.255.255.192

default-router 172.8.4.1

dns-server 100.20.8.100

exit

ip dhcp excluded-address 172.8.4.1

# Static route to the GRE tunnel FIXME

ip route 0.0.0.0 0.0.0.0 172.8.6.9

# RIP

router rip

version 2

```
network 172.8.0.0
default-information originate
exit
```

```
# Save config
CTRL-C
copy running-config startup-config
```

---

```
# LP's LP6 router configuration
```

```
enable
```

```
configure terminal
```

```
# Interfaces
```

```
interface GigabitEthernet 0/0
ip address 172.8.6.2 255.255.255.252
no shutdown
```

```
interface FastEthernet 1/0
ip address 172.8.4.65 255.255.255.192
no shutdown
exit
```

```
# DHCP
```

```
service dhcp
ip dhcp pool LPLOCAL
network 172.8.4.64 255.255.255.192
default-router 172.8.4.65
dns-server 100.20.8.100
exit
```

```
ip dhcp excluded-address 172.8.4.65
```

```
# RIP
```

```
router rip
version 2
network 172.8.0.0
exit
```

```
# Save config
CTRL-C
copy running-config startup-config
```

---

```
# LP's LP7 router configuration
```

```
enable
```

```
configure terminal
```

```
# Interfaces
```

```
interface GigabitEthernet 0/0
ip address 172.8.6.6 255.255.255.252
no shutdown
```

```
interface FastEthernet 1/0
ip address 172.8.4.129 255.255.255.192
no shutdown
exit
```

```
# DHCP
```

```
service dhcp
ip dhcp pool LPLOCAL
network 172.8.4.128 255.255.255.192
default-router 172.8.4.129
dns-server 100.20.8.100
exit
ip dhcp excluded-address 172.8.4.129
```

```
# RIP
```

```
router rip
version 2
network 172.8.0.0
exit
```

```
# Save config
```

```
CTRL-C
copy running-config startup-config
```

## 4. Switching Configuration

### 4.1 Switch Configuration

```
# Switch L3SW1 configuration
```

```
enable
```

```
configure terminal
```

```
# Enable IP routing
```

```
ip routing
```

```
# Interfaces
```

```
interface GigabitEthernet 0/1
```

```
no switchport
```

```
ip address 10.8.96.18 255.255.255.252
```

```
no shutdown
```

```
## VLAN interface for a GRE tunnel
```

```
interface vlan 200
```

```
ip address 172.8.2.13 255.255.252.0
```

```
interface GigabitEthernet 0/2
```

```
switchport mode access
```

```
switchport access vlan 200
```

```
no shutdown
```

```
interface Tunnel 1
```

```
ip address 10.8.96.25 255.255.255.252
```

```
tunnel source GigabitEthernet 0/1
```

```
tunnel destination 10.8.96.22
```

```
interface Tunnel 2
```

```
ip address 10.8.96.33 255.255.255.252
```

```
tunnel source GigabitEthernet 0/1
```

```
tunnel destination 10.8.96.30
```

```
exit
```

# Static IP route to the other ends of GRE tunnels

ip route 172.8.4.0 255.255.252.0 10.8.96.26

ip route 172.8.8.0 255.255.255.0 10.8.96.34

# Static IP default route (for going out to the Internet)

ip route 0.0.0.0 0.0.0.0 10.8.96.17

# Set default gateway

ip default-gateway 10.8.96.17

# Save config

CTRL-C

copy running-config startup-config

---

---

# Switch L3SW2 configuration

enable

configure terminal

# Enable IP routing

ip routing

# Interfaces

interface GigabitEthernet 0/1

no switchport

ip address 10.8.96.22 255.255.255.252

no shutdown

## VLAN interface for a GRE tunnel

interface vlan 200

ip address 172.8.6.9 255.255.252.0

interface GigabitEthernet 0/2

switchport mode access

switchport access vlan 200

no shutdown

```
interface Tunnel 1
ip address 10.8.96.26 255.255.255.252
tunnel source GigabitEthernet 0/1
tunnel destination 10.8.96.18
```

```
interface Tunnel 3
ip address 10.8.96.37 255.255.255.252
tunnel source GigabitEthernet 0/1
tunnel destination 10.8.96.30
exit
```

```
# Static IP route to the other ends of GRE tunnels
ip route 172.8.0.0 255.255.252.0 10.8.96.25
ip route 172.8.8.0 255.255.255.0 10.8.96.38
```

```
# Static IP default route (for going out to the Internet)
ip route 0.0.0.0 0.0.0.0 10.8.96.21
```

```
# Set default gateway
ip default-gateway 10.8.96.21
```

```
# Save config
CTRL-C
copy running-config startup-config
```

```
=====
# Switch L3SW3 configuration
```

```
enable
```

```
configure terminal
```

```
# Enable IP routing
ip routing
```

```
# Interfaces
interface GigabitEthernet 0/1
no switchport
```

```
ip address 10.8.96.30 255.255.255.252
no shutdown
```

```
## VLAN interface for a GRE tunnel
interface vlan 200
ip address 172.8.8.1 255.255.255.252
```

```
interface GigabitEthernet 0/2
switchport mode access
switchport access vlan 200
no shutdown
```

```
interface Tunnel 2
ip address 10.8.96.34 255.255.255.252
tunnel source GigabitEthernet 0/1
tunnel destination 10.8.96.18
```

```
interface Tunnel 3
ip address 10.8.96.38 255.255.255.252
tunnel source GigabitEthernet 0/1
tunnel destination 10.8.96.22
exit
```

```
# Static IP route to the other ends of GRE tunnels
ip route 172.8.0.0 255.255.252.0 10.8.96.33
ip route 172.8.4.0 255.255.252.0 10.8.96.37
```

```
# Static IP default route (for going out to the Internet)
ip route 0.0.0.0 0.0.0.0 10.8.96.29
```

```
# Set default gateway
ip default-gateway 10.8.96.29
```

```
# Save config
CTRL-C
copy running-config startup-config
```

---

```
# Switch SW0 configuration
```

enable

configure terminal

# VLAN

vtp domain BANOVOBRDO

vtp mode server

## Links to other switches

interface GigabitEthernet 1/1

switchport mode trunk

switchport trunk native vlan 5

interface GigabitEthernet 2/1

switchport mode trunk

switchport trunk native vlan 5

exit

## Link to router

interface GigabitEthernet 0/1

switchport mode trunk

exit

## Links to end devices

interface FastEthernet 3/1

switchport mode access

switchport access vlan 10

spanning-tree portfast

spanning-tree bpduguard enable

interface FastEthernet 4/1

switchport mode access

switchport access vlan 20

spanning-tree portfast

spanning-tree bpduguard enable

interface FastEthernet 5/1

switchport mode access

switchport access vlan 20



```
spanning-tree portfast
spanning-tree bpduguard enable
exit
```

```
vlan 5
name NATIVE
vlan 10
name SALES
vlan 20
name IT
vlan 50
name SWCONTROL
vlan 60
name SERVERS
vlan 100
name PUBLIC
exit
```

```
## VLAN management virtual interface
interface vlan 50
ip address 10.8.4.66 255.255.255.192
no shutdown
exit
```

```
# Set default gateway
ip default-gateway 10.8.4.65
```

```
# Save config
CTRL-C
copy running-config startup-config
```

```
=====
# Switch SW1 configuration
```

```
enable
```

```
configure terminal
```

```
# VLAN
```

```
vtp domain BANOVBRDO
```

```
vtp mode client
```

```
interface GigabitEthernet 3/1
```

```
switchport mode trunk
```

```
switchport trunk native vlan 5
```

```
exit
```

```
interface GigabitEthernet 0/1
```

```
switchport mode access
```

```
switchport access vlan 100
```

```
spanning-tree portfast
```

```
spanning-tree bpduguard enable
```

```
interface GigabitEthernet 1/1
```

```
switchport mode access
```

```
switchport access vlan 100
```

```
spanning-tree portfast
```

```
spanning-tree bpduguard enable
```

```
interface GigabitEthernet 2/1
```

```
switchport mode access
```

```
switchport access vlan 100
```

```
spanning-tree portfast
```

```
spanning-tree bpduguard enable
```

```
exit
```

```
## VLAN management virtual interface
```

```
interface vlan 50
```

```
ip address 10.8.4.67 255.255.255.192
```

```
no shutdown
```

```
exit
```

```
# Set default gateway
```

```
ip default-gateway 10.8.4.65
```

```
# Save config
```

```
CTRL-C
```

```
copy running-config startup-config
```

---

---

```
# Switch SW2 configuration
```

```
enable
```

```
configure terminal
```

```
# VLAN
```

```
vtp domain BANOVBRDO
```

```
vtp mode client
```

```
interface GigabitEthernet 4/1
```

```
switchport mode trunk
```

```
switchport trunk native vlan 5
```

```
exit
```

```
interface GigabitEthernet 0/1
```

```
switchport mode access
```

```
switchport access vlan 60
```

```
spanning-tree portfast
```

```
spanning-tree bpduguard enable
```

```
interface GigabitEthernet 1/1
```

```
switchport mode access
```

```
switchport access vlan 60
```

```
spanning-tree portfast
```

```
spanning-tree bpduguard enable
```

```
exit
```

```
## VLAN management virtual interface
```

```
interface vlan 50
```

```
ip address 10.8.4.68 255.255.255.192
```

```
no shutdown
```

```
exit
```

```
# Set default gateway
```

```
ip default-gateway 10.8.4.65
```

```
# Save config
CTRL-C
copy running-config startup-config
```

---

```
# Switch SW3 configuration
```

```
enable
```

```
configure terminal
```

```
# VLAN
```

```
vtp domain CENTAR
```

```
vtp mode server
```

```
## Links to other switches
```

```
interface FastEthernet 0/1
```

```
switchport mode trunk
```

```
switchport trunk native vlan 5
```

```
interface FastEthernet 1/1
```

```
switchport mode trunk
```

```
switchport trunk native vlan 5
```

```
interface FastEthernet 2/1
```

```
switchport mode trunk
```

```
switchport trunk native vlan 5
```

```
exit
```

```
## Link to router
```

```
## Is there a way to specify native VLAN?
```

```
interface GigabitEthernet 3/1
```

```
switchport mode trunk
```

```
exit
```

```
vlan 5
```

```
name NATIVE
```

```
vlan 10
```

```
name SALES
```

```
vlan 20
```

```
name IT
```

```
vlan 30
name MGMT
vlan 40
name ADV
vlan 50
name SWCONTROL
exit
```

```
## VLAN management virtual interface
interface vlan 50
ip address 10.8.4.2 255.255.255.192
no shutdown
exit
```

```
# Set default gateway
ip default-gateway 10.8.4.1
```

```
# Save config
CTRL-C
copy running-config startup-config
```

```
=====
# Switch SW4 configuration
```

```
enable
```

```
configure terminal
```

```
# VLAN
vtp domain CENTAR
vtp mode client
```

```
interface FastEthernet 0/1
switchport mode trunk
switchport trunk native vlan 5
exit
```

```
interface FastEthernet 1/1
switchport mode access
```

```
switchport access vlan 30
spanning-tree portfast
spanning-tree bpduguard enable
```

```
interface FastEthernet 2/1
switchport mode access
switchport access vlan 20
spanning-tree portfast
spanning-tree bpduguard enable
```

```
interface FastEthernet 3/1
switchport mode access
switchport access vlan 40
spanning-tree portfast
spanning-tree bpduguard enable
```

```
interface FastEthernet 4/1
switchport mode access
switchport access vlan 10
spanning-tree portfast
spanning-tree bpduguard enable
exit
```

```
## VLAN management virtual interface
interface vlan 50
ip address 10.8.4.3 255.255.255.192
no shutdown
exit
```

```
# Set default gateway
ip default-gateway 10.8.4.1
```

```
# Save config
CTRL-C
copy running-config startup-config
```

---

---

```
# Switch SW5 configuration
```

enable

configure terminal

# VLAN

vtp domain CENTAR

vtp mode client

interface FastEthernet 0/1

switchport mode trunk

switchport trunk native vlan 5

exit

interface FastEthernet 1/1

switchport mode access

switchport access vlan 30

spanning-tree portfast

spanning-tree bpduguard enable

interface FastEthernet 2/1

switchport mode access

switchport access vlan 20

spanning-tree portfast

spanning-tree bpduguard enable

interface FastEthernet 3/1

switchport mode access

switchport access vlan 40

spanning-tree portfast

spanning-tree bpduguard enable

interface FastEthernet 4/1

switchport mode access

switchport access vlan 10

spanning-tree portfast

spanning-tree bpduguard enable

exit

## VLAN management virtual interface

```
interface vlan 50
ip address 10.8.4.4 255.255.255.192
no shutdown
exit
```

```
# Set default gateway
ip default-gateway 10.8.4.1
```

```
# Save config
CTRL-C
copy running-config startup-config
```

---

```
# Switch SW6 configuration
```

```
enable
```

```
configure terminal
```

```
# VLAN
vtp domain CENTAR
vtp mode client
```

```
interface FastEthernet 0/1
switchport mode trunk
switchport trunk native vlan 5
exit
```

```
interface FastEthernet 1/1
switchport mode access
switchport access vlan 30
spanning-tree portfast
spanning-tree bpduguard enable
```

```
interface FastEthernet 2/1
switchport mode access
switchport access vlan 20
spanning-tree portfast
spanning-tree bpduguard enable
```



```
interface FastEthernet 3/1
switchport mode access
switchport access vlan 40
spanning-tree portfast
spanning-tree bpduguard enable
```

```
interface FastEthernet 4/1
switchport mode access
switchport access vlan 10
spanning-tree portfast
spanning-tree bpduguard enable
exit
```

```
## VLAN management virtual interface
interface vlan 50
ip address 10.8.4.5 255.255.255.192
no shutdown
exit
```

```
# Set default gateway
ip default-gateway 10.8.4.1
```

```
# Save config
CTRL-C
copy running-config startup-config
```

---

---

```
# Switch SW7 configuration
```

```
enable
```

```
configure terminal
```

```
# VLAN
vlan 10
name SALES
vlan 20
name IT
```

vlan 50

name SWCONTROL

exit

## Link to router

## Is there a way to specify native VLAN?

interface FastEthernet 0/1

switchport mode trunk

exit

interface FastEthernet 1/1

switchport mode access

switchport access vlan 10

spanning-tree portfast

spanning-tree bpduguard enable

interface FastEthernet 2/1

switchport mode access

switchport access vlan 20

spanning-tree portfast

spanning-tree bpduguard enable

exit

## VLAN management virtual interface

interface vlan 50

ip address 10.8.4.194 255.255.255.192

no shutdown

exit

# Set default gateway

ip default-gateway 10.8.4.193

# Save config

CTRL-C

copy running-config startup-config

## 5. Security Measures

### 5.1 Access Control Lists (ACLs)

ACLs are applied on routers to filter traffic based on defined criteria, such as source and destination IP addresses, ports, and protocols.

# Cloud Provider

ACLs

```
ip access-list extended VIRTUAL-DC-ACL
permit tcp any host 200.8.1.2 eq 80
permit tcp any host 200.8.1.2 eq 443
permit tcp any host 200.8.1.3 eq 80
permit tcp any host 200.8.1.3 eq 443
permit tcp 100.20.8.0 0.0.0.15 host 200.8.1.2 eq 22
permit tcp 100.20.8.0 0.0.0.15 host 200.8.1.2 eq 23
permit tcp host 100.20.8.16 host 200.8.1.2 eq 22
permit tcp host 100.20.8.16 host 200.8.1.2 eq 23
deny tcp host 100.20.8.0 host 200.8.1.2
permit icmp any host 200.8.1.2
permit icmp any host 200.8.1.3
exit
```

# Zemun (Z) backbone router

# ACLs

```
ip access-list extended LPNET-ACL
permit tcp host 10.8.96.25 10.8.96.26
permit udp host 10.8.96.25 10.8.96.26
permit icmp host 10.8.96.25 10.8.96.26
permit tcp host 10.8.96.38 10.8.96.37
permit udp host 10.8.96.38 10.8.96.37
permit icmp host 10.8.96.38 10.8.96.37
deny tcp 10.8.0.0 0.0.255.255 172.8.0.0 0.0.255.255
deny udp 10.8.0.0 0.0.255.255 172.8.0.0 0.0.255.255
```

```
deny icmp 10.8.0.0 0.0.255.255 172.8.0.0 0.0.255.255
permit ip any any
permit tcp any any
permit udp any any
permit icmp any any
exit
```

# Kaludjerica (K) backbone router

# ACLs

```
ip access-list extended CX-ACL
deny tcp any 10.8.0.0 0.0.255.255
deny udp any 10.8.0.0 0.0.255.255
deny icmp any 10.8.0.0 0.0.255.255
deny tcp any 172.8.0.0 0.0.255.255
deny udp any 172.8.0.0 0.0.255.255
deny icmp any 172.8.0.0 0.0.255.255
permit ip any any
permit tcp any any
permit udp any any
permit icmp any any
exit
```

# Centar (C) backbone router configuration

# ACLs

```
ip access-list extended LPNET-ACL
permit tcp host 10.8.96.26 10.8.96.25
permit udp host 10.8.96.26 10.8.96.25
permit icmp host 10.8.96.26 10.8.96.25
permit tcp host 10.8.96.34 10.8.96.33
permit udp host 10.8.96.34 10.8.96.33
permit icmp host 10.8.96.34 10.8.96.33
deny tcp 10.8.0.0 0.0.255.255 172.8.0.0 0.0.255.255
deny udp 10.8.0.0 0.0.255.255 172.8.0.0 0.0.255.255
deny icmp 10.8.0.0 0.0.255.255 172.8.0.0 0.0.255.255
permit ip any any
permit tcp any any
permit udp any any
```

```
permit icmp any any
exit
```

```
# Banovo Brdo (BB) backbone router configuration
```

```
enable
```

```
configure terminal
```

```
# ACLs
```

```
ip access-list extended PUBLIC-SRVRS-ACL
permit tcp 10.8.2.0 0.0.0.255 host 100.20.8.100
permit tcp 10.8.2.0 0.0.0.255 host 100.20.8.101
permit tcp 10.8.2.0 0.0.0.255 host 100.20.8.102
permit udp host 10.8.16.3 host 100.20.8.100 eq 161
permit udp host 10.8.16.3 host 100.20.8.101 eq 161
permit udp host 10.8.16.3 host 100.20.8.102 eq 161
permit icmp host 10.8.16.3 host 100.20.8.100
permit icmp host 10.8.16.3 host 100.20.8.101
permit icmp host 10.8.16.3 host 100.20.8.102
permit tcp any host 100.20.8.101 eq 80
permit tcp any host 100.20.8.101 eq 443
permit tcp any host 100.20.8.102 eq 25
permit tcp any eq 25 host 100.20.8.102
permit tcp any host 100.20.8.102 eq 110
permit udp any host 100.20.8.100 eq 53
permit icmp any host 100.20.8.100
permit icmp any host 100.20.8.101
permit icmp any host 100.20.8.102
exit
```

```
ip access-list extended PRIVATE-SRVRS-ACL
permit tcp 10.8.0.0 0.0.15.255 host 10.8.16.2
permit udp 10.8.0.0 0.0.15.255 host 10.8.16.2
permit icmp 10.8.0.0 0.0.15.255 host 10.8.16.2
permit icmp any host 10.8.16.3 echo-reply
permit udp any eq 161 host 10.8.16.3
exit
```

```
ip access-list extended LPNET-SRVR-ACL
permit tcp host 10.8.96.33 host 10.8.96.34
```

```
permit udp host 10.8.96.33 host 10.8.96.34
permit icmp host 10.8.96.33 host 10.8.96.34
permit tcp host 10.8.96.37 host 10.8.96.38
permit udp host 10.8.96.37 host 10.8.96.38
permit icmp host 10.8.96.37 host 10.8.96.38
deny tcp 10.8.0.0 0.0.255.255 host 172.8.8.2
deny udp 10.8.0.0 0.0.255.255 host 172.8.8.2
deny icmp 10.8.0.0 0.0.255.255 host 172.8.8.2
permit ip any any
permit tcp any any
permit udp any any
permit icmp any any
exit
```

## 5.2 NAT and PAT

NAT, PAT used for security and efficiency:

# Banovo Brdo (BB) backbone router:

```
ip access-list standard IT-ACL
permit 10.8.2.0 0.0.0.255
exit
```

```
ip access-list standard CX-ACL
permit 10.8.128.0 0.0.0.255
permit 10.8.160.0 0.0.0.255
permit 10.8.192.0 0.0.0.255
permit 10.8.224.0 0.0.0.255
exit
```

```
ip access-list standard BUSINESS-ACL
permit 10.8.0.0 0.0.1.255
permit 10.8.3.0 0.0.0.127
permit 10.8.3.128 0.0.0.127
exit
```

```
ip access-list standard LPNET-ACL
permit 172.8.0.0 0.0.255.255
exit
```

```
ip nat pool ALFA-NET-IT 100.20.8.1 100.20.8.16 netmask 255.255.255.0
ip nat pool ALFA-NET-CX 100.20.8.17 100.20.8.32 netmask 255.255.255.0
ip nat pool ALFA-NET-BUSINESS 100.20.8.33 100.20.8.40 netmask 255.255.255.0
ip nat pool LPNET 100.20.8.41 100.20.8.41 netmask 255.255.255.0
```

```
ip nat inside source list IT-ACL pool ALFA-NET-IT overload
ip nat inside source list CX-ACL pool ALFA-NET-CX overload
ip nat inside source list BUSINESS-ACL pool ALFA-NET-BUSINESS overload
ip nat inside source list LPNET-ACL pool LPNET overload
```

# Customer 1 (Cx1) router

# NAT

```
ip access-list standard CXLOCAL
permit 192.168.8.0 0.0.0.63
exit
```

```
ip nat pool ALFA-NET-KAL 10.8.224.1 10.8.224.1 netmask 255.255.255.0
ip nat inside source list CXLOCAL pool ALFA-NET-KAL overload
```

# Customer 2 (Cx2) router

# NAT

```
ip access-list standard CXLOCAL
permit 192.168.8.0 0.0.0.63
exit
```

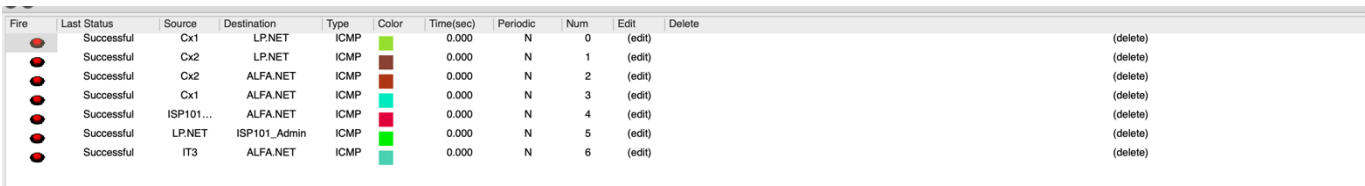
```
ip nat pool ALFA-NET-KAL 10.8.224.2 10.8.224.2 netmask 255.255.255.0
ip nat inside source list CXLOCAL pool ALFA-NET-KAL overload
```

# 6. Testing and Validation

## 6.1 Simulation

Packet Tracer was utilized to simulate and test the designed network. Packet Tracer is a network simulation tool that provides a virtual environment for designing, configuring, and testing network scenarios. The simulation process involves:

- **Network Topology Design:** The network topology, including routers, switches, PCs, servers, and other devices, was designed within Packet Tracer based on the specified requirements.
- **Configuration Implementation:** Using the designed topology, configurations were implemented on routers, switches, and other network devices according to the provided guidelines. Cisco Packet Tracer allows users to configure devices with a user-friendly interface similar to actual Cisco devices.
- **Traffic Simulation:** Packet Tracer allows the simulation of network traffic and communication between devices. This involves generating traffic, testing connectivity, and ensuring that data flows as expected.



Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
	Successful	Cx1	LP.NET	ICMP		0.000	N	0	(edit)	(delete)
	Successful	Cx2	LP.NET	ICMP		0.000	N	1	(edit)	(delete)
	Successful	Cx2	ALFA.NET	ICMP		0.000	N	2	(edit)	(delete)
	Successful	Cx1	ALFA.NET	ICMP		0.000	N	3	(edit)	(delete)
	Successful	ISP101...	ALFA.NET	ICMP		0.000	N	4	(edit)	(delete)
	Successful	LP.NET	ISP101_Admin	ICMP		0.000	N	5	(edit)	(delete)
	Successful	IT3	ALFA.NET	ICMP		0.000	N	6	(edit)	(delete)

Figure 2: ICMP PDU check

- **Verification of Redundancy and Failover:** The hierarchical design with redundancy at every layer, including multiple routers, multilayer switches, and ISP connections, was tested to verify failover mechanisms and ensure network resilience.



```

Cisco Packet Tracer PC Command Line 1.0
C:\>tracert 200.8.1.3

Tracing route to 200.8.1.3 over a maximum of 30 hops:

 1  0 ms      0 ms      0 ms      192.168.8.30
 2  0 ms      0 ms      0 ms      10.8.224.254
 3  0 ms      0 ms      0 ms      10.8.96.2
 4  0 ms      0 ms      0 ms      10.8.100.2
 5  0 ms      0 ms      0 ms      103.8.0.13
 6  0 ms      0 ms      0 ms      103.8.0.2
 7  0 ms      0 ms      0 ms      200.8.1.3

Trace complete.

```

Figure 3: traceroute successful

- DHCP and IP Address Allocation:** Dynamic Host Configuration Protocol (DHCP) functionality and IP address allocation were tested to ensure that devices received the correct IP addresses dynamically and that devices in the server room had static IP assignments.

IP Configuration

Interface: FastEthernet0

IP Configuration

☒ DHCP
 ☐ Static

IPv4 Address: 10.8.2.3

Subnet Mask: 255.255.255.192

Default Gateway: 10.8.2.1

DNS Server: 100.20.8.100

Figure 4: DHCP IP allocation

## 6.2 Troubleshooting

During the testing phase, several common troubleshooting steps were taken to address issues:

- Device Connectivity:** Ensured that all devices could communicate within their respective VLANs and across different departments. Verified inter-VLAN routing configurations on multilayer switches.
- DHCP Issues:** Investigated and resolved any DHCP-related issues, ensuring that DHCP servers were reachable and capable of assigning IP addresses to devices

dynamically.

- **Routing Configuration:** Verified the Open Shortest Path First (OSPF) routing configurations on routers and multilayer switches, ensuring proper routing table updates and communication between different departments.
- **Access Control Issues:** Reviewed and adjusted Access Control Lists (ACLs) to allow necessary traffic and deny unauthorized access.
- **Port Security:** Verified the configuration of port security on the Finance department's switchports to ensure that only one device could connect per port and that MAC addresses were correctly learned.

## 7. Results and Evaluation

### 7.1 Performance Metrics

Performance metrics, including network latency, throughput, redundancy testing, DHCP response time, inter-VLAN routing performance, security, QoS, and NAT/PAT functionality, were measured during testing to ensure optimal network operation.

```
C:\>ping 200.8.1.3

Pinging 200.8.1.3 with 32 bytes of data:

Reply from 200.8.1.3: bytes=32 time=1ms TTL=122
Reply from 200.8.1.3: bytes=32 time<1ms TTL=122
Reply from 200.8.1.3: bytes=32 time<1ms TTL=122
Reply from 200.8.1.3: bytes=32 time<1ms TTL=122

Ping statistics for 200.8.1.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms
```

*Figure 5: performance measure through ping time*

## 8. Conclusion

### 8.1 Summary

This network design will describe a highly structured network design with many interdependent parts. The major components will include an Internet Service Provider, a Cloud Provider, the AlfaNET core network, Customer Networks, and the LP Network. The different technologies are made overable so that communication can be accomplished. These include BGP, OSPF, static routing, VLANs, and GRE tunnels. The Layer 2 switches and Layer 3 switches are used for switching and routing traffic. ACL and NAT will be used for security. The key design considerations are redundancy for reliability, ACLs for security, and scalability for the future. Although QoS mechanisms can be used to prioritize critical traffic and enhance the overall network performance within a design, in this particular configuration, no QoS mechanisms have been specifically configured. Considering these components and technologies, network engineers can design and implement robust, secure, efficient network infrastructures.

### 8.2 Lessons Learned

Throughout the project, several valuable lessons have been learned:

#### 1. Network Design and Planning:

- Modular Design: It has been segmented into functional modules: ISP, Cloud Provider, AlfaNET, Backbone, Customer, LP Network, through which the network could be better structured and maintained.
- Redundancy: Redundant links and devices have been used to increase the reliability as well as the fault tolerance of the network.
- Security: ACLs are incorporated to control the traffic flow and restrict unauthorized access.
- Scalability: Scalable design of the network enables it to grow or expand further.

#### 2. Routing Protocols:

- BGP: BGP is inter-AS routing used between different networks.
- OSPF: OSPF is intra-AS routing used within the AlfaNET network.
- Static Routes: Static routes are applied for specific routes like default routes and routes to the specific networks.

#### 3. Switching and VLANs:

- VLANs: VLANs are used by dividing the network to different broadcast domains

- Layer 3 Switches: L3 switches use to route traffic between VLANs.
- GRE Tunnels: GRE tunnels create point-to-point networks among multiple sites.

## 9. References

1. <http://ieeexplore.ieee.org/document/6004127/>
2. <https://ieeexplore.ieee.org/document/1181812/>
3. [https://www.researchgate.net/publication/329259783\\_Five\\_years\\_at\\_the\\_edge\\_watching\\_internet\\_from\\_the\\_IS\\_P\\_network](https://www.researchgate.net/publication/329259783_Five_years_at_the_edge_watching_internet_from_the_IS_P_network)
4. [https://www.nctatechnicalpapers.com/Paper/2024/AI02\\_Ozer\\_6743\\_paper](https://www.nctatechnicalpapers.com/Paper/2024/AI02_Ozer_6743_paper)

## **10.Appendices**

Abbreviations:

ACL - Access Control List

DHCP - Dynamic Host Configuration Protocol

IP - Internet Protocol

OSPF - Open Shortest Path First

BGP-Border Gateway Protocol

VLAN - Virtual Local Area Network

NAT-Network Address Translation