Internet Architecture – Project Assignment for Final Project

For the topology shown in **Figure 1**, it is necessary to develop a technical solution for connecting, addressing, and routing traffic within the network. The given topology consists of several Autonomous Systems (AS) with assigned AS numbers: **100nn**, **200nn**, **300nn**, and **400nn** (Internet Service Provider - ISP). The network uses both IPv4 and IPv6 protocols. For IPv4 addressing, the public address range **55.nn.0.0/16** should be used, while for IPv6 addressing, the routing prefix **2001:33:EFnn::/48** is available. The topology should be implemented using Cisco 2901 routers and 2960 switches within the Cisco Packet Tracer network simulation environment.

Tasks:

1. **Provide a technical addressing solution** for the entire network. Note that only IPv4 addresses should be used within AS 100nn, AS 300nn, and AS 400nn, while both IPv4 and IPv6 address ranges should be used within AS 200nn. The expected number of computers on all listed LAN segments ranges from 70 to 126, except for the VLANs Development and Marketing (on router R5), where up to 200 computers are expected. For the VLAN dedicated to network device management, use a private address range of your choice. Present the addressing scheme in tabular form.
2. **Define all necessary interfaces** of the routers and switches in the network and assign appropriate IP parameters. Present the interfaces and assigned parameters in tabular form.
3. **Implement three VLANs** within the LAN segment connected to router R5: Development, Marketing, and a VLAN for network device management. The Development and Marketing VLANs should support connecting up to 200 computers per VLAN. Provide configuration excerpts for network devices that enable the implementation of all VLANs, as well as routing between the Development and Marketing VLANs. Remote access to the switches should be enabled through the management VLAN, specifically from the administrator's computer connected to port 15 on SW2. Traffic to and from the management VLAN should not be routed to other VLANs or the rest of the network. On both switches, assign ports 1–3 to the Development VLAN and ports 4–6 to the Marketing VLAN.
4. **Router R4 should not be included** in the internal routing protocol within AS 100nn; instead, routing in this part of the network should be resolved using static routes. Provide configuration excerpts of the network devices that enable the implementation of static routing.
5. **Implement routing within AS 100nn** using the internal routing protocol multi-area OSPF. It is necessary to define three OSPF areas and display them in a diagram. Since router R4 should not be included in the internal routing protocol, make sure that the routes to LAN 4 and LAN 5 are redistributed within OSPF. Provide configuration excerpts of the network devices that enable the implementation of routing.
6. **Router R8 should not be included** in the internal routing protocol within Autonomous System AS 200nn. Instead, routing within this part of the network—both for IPv4 and IPv6—should be implemented using static routes. Provide configuration excerpts of the network devices that enable the implementation of static routing.

7. **Within AS 200nn, routing should be implemented using the EIGRP internal routing protocol.** EIGRP must be configured to support both IPv4 and IPv6 routing. Since Router R8 should not be part of the internal routing protocol, it is necessary to ensure that the route to LAN 8 is redistributed within EIGRP (for both IPv4 and IPv6). Provide configuration excerpts of the network devices that enable the implementation of this routing.
8. **Within AS 300nn, routing should be implemented using the RIPv2 internal routing protocol.** Provide configuration excerpts of the network devices that enable the implementation of routing.
9. **Interconnection of Autonomous Systems AS 100nn, AS 200nn, and AS 300nn** with the Internet Service Provider router (ISP - AS 400nn), as well as interconnection between themselves, should be implemented using an external routing protocol. The external routing protocol must ensure that the link to the ISP is used as the primary link, while the link(s) to the other ASes are used as backup (the commands for selecting the primary link cannot be implemented in the simulator, but must be listed in the report). Additionally, the external routing protocol should provide routes only to the LAN and VLAN networks indicated in the diagram.
   Note: This task assumes that the external routing protocol provides route exchange for **IPv4 only**. Provide configuration excerpts of the network devices that enable the implementation of this routing.
10. **Routes obtained via the external routing protocol** must be redistributed through the internal routing protocols used within Autonomous Systems AS 100nn, AS 200nn, and AS 300nn. Provide configuration excerpts of the network devices that enable the implementation of this task.

In addition to the listed solutions, appropriate explanations must also be provided.

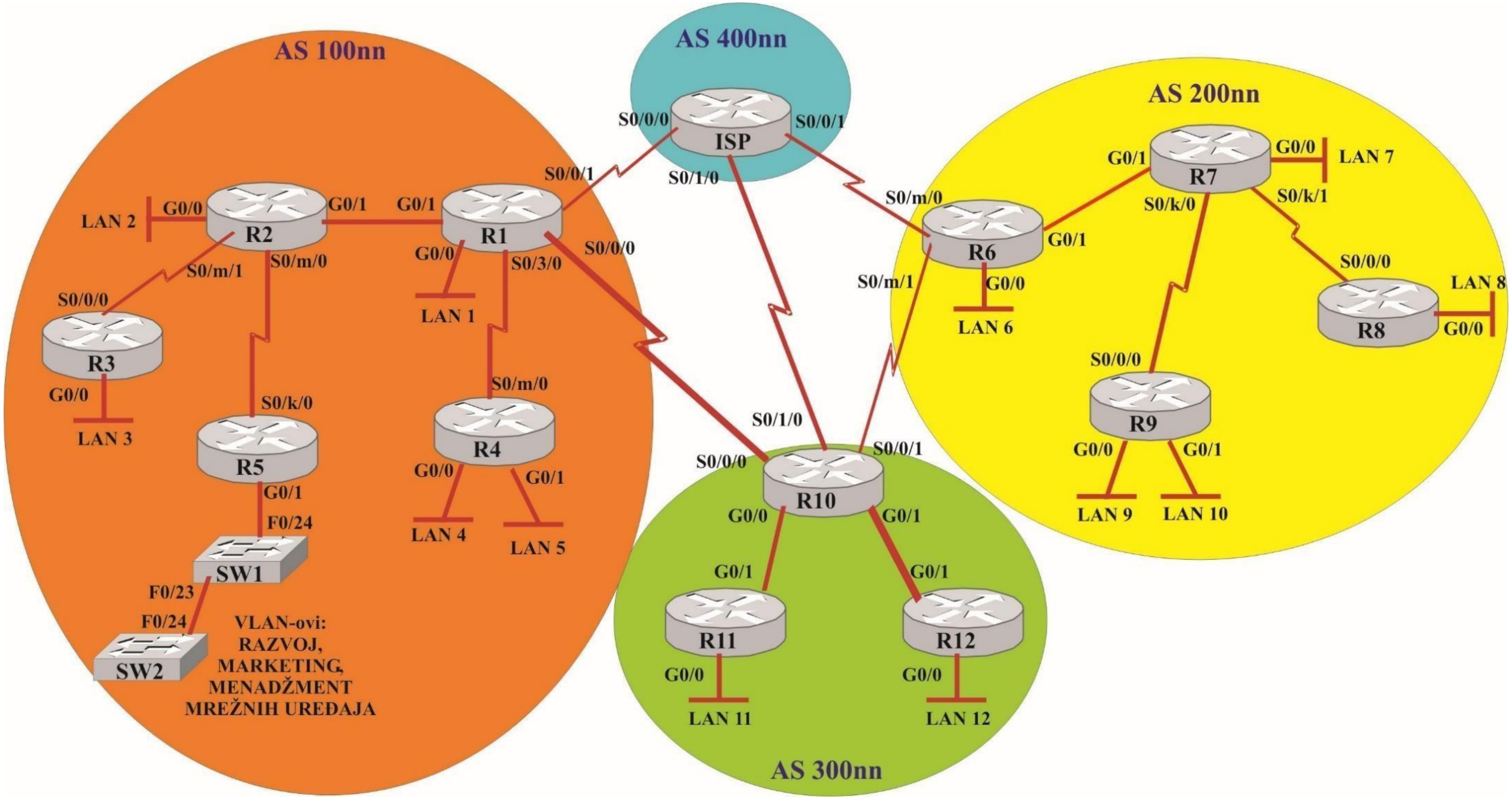

Figure 1 Network Topology

Task 1

The following tables present the technical addressing solution for the entire network as defined by the project assignment. We assigned IPv4 addresses to LAN segments LAN1–LAN12, where each should support between 70 and 126 hosts. We assumed the maximum number (126 hosts) plus 1 address for the router interface, resulting in 127 addresses, i.e., 8 bits in the host portion. On the links between routers, 2 addresses are required per link (i.e., 2 bits in the host portion). For the VLANs, we allocated 200 addresses for hosts, plus 3 addresses for switches, and 1 address for the R5 router interface, totaling 204 addresses, which also corresponds to 8 bits in the host portion. For IPv6 addressing, we have a significantly broader address space available for allocation, and addresses are assigned within AS 20008. To facilitate easier communication within the IPv6 domain, we also introduced Link-Local addresses.

IPv4 Table

ord. num.	Network address/mask		Topology to which it is assigned
1	192.168.0.0	/24	VLAN MENADZMENT
2	55.8.0.0	255.255.255.0	VLAN RAZVOJ
3	55.8.1.0	255.255.255.0	VLAN MARKETING
4	55.8.2.0	255.255.255.0	LAN1
5	55.8.3.0	255.255.255.0	LAN2
6	55.8.6.0	255.255.255.0	LAN3
7	55.8.4.0	255.255.255.0	LAN4
8	55.8.5.0	255.255.255.0	LAN5
9	55.8.7.0	255.255.255.0	LAN6
10	55.8.8.0	255.255.255.0	LAN7
11	55.8.9.0	255.255.255.0	LAN8
12	55.8.10.0	255.255.255.0	LAN9
13	55.8.11.0	255.255.255.0	LAN10
14	55.8.12.0	255.255.255.0	LAN11
15	55.8.13.0	255.255.255.0	LAN12
16	55.8.14.0	255.255.255.252	R2-R3
17	55.8.14.4	255.255.255.252	R2-R5
18	55.8.14.8	255.255.255.252	R1-R2
19	55.8.14.12	255.255.255.252	R1-R4
20	55.8.14.16	255.255.255.252	R1-ISP
21	55.8.14.20	255.255.255.252	R1-R10
22	55.8.14.24	255.255.255.252	R10-R11
23	55.8.14.28	255.255.255.252	R10-R12
24	55.8.14.32	255.255.255.252	ISP-R10

25	55.8.14.36	255.255.255.252	ISP-R6
26	55.8.14.40	255.255.255.252	R6-R10
27	55.8.14.44	255.255.255.252	R6-R7
28	55.8.14.48	255.255.255.252	R7-R8
29	55.8.14.52	255.255.255.252	R7-R9

IPv6 Table

ord. num.	Prefix/prefix length	Topology to which it is assigned
1	2001:33:EF08:1::/64	LAN6
2	2001:33:EF08:2::/64	LAN7
3	2001:33:EF08:3::/64	LAN8
4	2001:33:EF08:4::/64	LAN9
5	2001:33:EF08:5::/64	LAN10
6	2001:33:EF08:6::/64	R6-R7
7	2001:33:EF08:7::/64	R7-R8
8	2001:33:EF08:8::/64	R7-R9

Task 2

Based on task 1, we assign addresses to interfaces on routers and switches. On router R5 we have 1 physical interface, and we need to enable the connection of 3 VLANs, so we create subinterfaces on the interface where the VLANs are connected to the router.

Device	Interface	IPv4 parameters	IPv6 parameters
Router R1	Gig0/0	55.8.2.1 /24	/
	Gig0/1	55.8.14.9 /30	/
	S0/3/0	55.8.14.13 /30	/
	S0/0/1	55.8.14.17 /30	/
	S0/0/0	55.8.14.21 /30	/
Router R2	Gig0/0	55.8.3.1 /24	/
	Gig0/1	55.8.14.10 /30	/
	S0/0/1	55.8.14.1 /30	/
	S0/0/0	55.8.14.5 /30	/
Router R3	Gig0/0	55.8.6.1 /24	/
	S0/0/0	55.8.14.2 /30	/

Router R4	Gig0/0	55.8.4.1 /24	/
	Gig0/1	55.8.5.1 /24	/
	S0/0/0	55.8.14.14 /30	/
Router R5	Gig0/1.10	55.8.0.1 /24	/
	Gig0/1.20	55.8.1.1 /24	/
	S0/1/0	55.8.14.6 /30	/
Router R6	Gig0/0	55.8.7.1 /24	2001:33:EF08:1::1 Link-Local FE80::6
	Gig0/1	55.8.14.45 /30	2001:33:EF08:6::1 Link-Local FE80::6
	S0/0/0	55.8.14.37 /30	/
	S0/0/1	55.8.14.41 /30	/
Router R7	Gig0/0	55.8.8.1 /24	2001:33:EF08:2::1 Link-Local FE80::7
	Gig0/1	55.8.14.46 /30	2001:33:EF08:6::2 Link-Local FE80::7
	S0/1/0	55.8.14.53 /30	2001:33:EF08:8::1 Link-Local FE80::7
	S0/1/1	55.8.14.49 /30	2001:33:EF08:7::1 Link-Local FE80::7
Router R8	Gig0/0	55.8.9.1 /24	2001:33:EF08:3::1 Link-Local FE80::8
	S0/0/0	Rou /30	2001:33:EF08:7::2 Link-Local FE80::8
Router R9	Gig0/0	55.8.10.1 /24	2001:33:EF08:4::1 Link-Local FE80::9
	Gig0/1	55.8.11.1 /24	2001:33:EF08:5::1 Link-Local FE80::9
	S0/0/0	55.8.14.54 /30	2001:33:EF08:8::2 Link-Local FE80::9
Router R10	Gig0/0	55.8.14.25 /30	/
	Gig0/1	55.8.14.29 /30	/
	S0/0/0	55.8.14.22 /30	/
	S0/0/1	55.8.14.42 /30	/
	S0/1/0	55.8.14.33 /30	/
Router R11	Gig0/0	55.8.12.1 /24	/
	Gig0/1	55.8.14.26 /30	/

Router R12	Gig0/0	55.8.13.1 /24	/
	Gig0/1	55.8.14.30 /30	/
Router ISP	S0/0/0	55.8.14.18 /30	/
	S0/0/1	55.8.14.38 /30	/
	S0/1/0	55.8.14.34 /30	/
Switch SW1	VLAN MGMT	192.168.0.1 /24	/
Switch SW2	VLAN MGMT	192.168.0.2 /24	/

Task 3

Taking into account the specified ports, we configured the switches to enable access to the appropriate VLANs on those ports.When assigning addresses, we considered the requirement to support up to 200 computers in both the DEVELOPMENT and MARKETING VLANs. Ports 1–3 were assigned to the DEVELOPMENT VLAN, and ports 4–6 to the MARKETING VLAN.The command `switchport mode trunk` was used to configure interfaces connecting the two switches to operate in trunk mode, while the command `switchport mode access` was used to configure switch ports for a specific VLAN.

Router R5

interface
GigabitEthernet0/1.10
encapsulation dot1Q 10 ip
address 55.8.0.1 255.255.255.0
!
interface GigabitEthernet0/1.20
encapsulation dot1Q 20 ip address
55.8.1.1 255.255.255.0
!
interface Serial0/1/0 ip address
55.8.14.6 255.255.255.252
!

Router ISP interface Serial0/0/0 ip
address 55.8.8.18 255.255.255.252
!
interface Serial0/0/1 ip address 55.8.8.38
255.255.255.252 clock rate 2000000
!
interface Serial0/1/0 ip address
55.8.8.34 255.255.255.252 clock rate
2000000
!

Switch SW1

```
interface FastEthernet0/1
switchport access vlan 10
switchport mode access
!
interface FastEthernet0/2
switchport access vlan 10
switchport mode access
!
interface FastEthernet0/3
switchport access vlan 10
switchport mode access
!
interface FastEthernet0/4
switchport access vlan 20
switchport mode access
!
interface FastEthernet0/5
switchport access vlan 20
switchport mode access
!
interface FastEthernet0/6
switchport access vlan 20
switchport mode access
!
interface FastEthernet0/23
switchport mode trunk
!
interface FastEthernet0/24
switchport mode trunk
!
interface Vlan99 ip address
192.168.0.1 255.255.255.0
!
```

Switch SW2
interface FastEthernet0/1
switchport access vlan 10
switchport mode access
!
interface FastEthernet0/2
switchport access vlan 10
switchport mode access
!
interface FastEthernet0/3
switchport access vlan 10
switchport mode access
!
interface FastEthernet0/4
switchport access vlan 20
switchport mode access
!
interface FastEthernet0/5
switchport access vlan 20
switchport mode access
!
interface FastEthernet0/6
switchport access vlan 20
switchport mode access
!
interface FastEthernet0/15
switchport access vlan 99
switchport mode access
!
interface FastEthernet0/24
switchport mode trunk
!
interface Vlan99 ip address
192.168.0.2 255.255.255.0
!

Task 4

We configured a default static route (covering all traffic) for router R4, which routes through router R1, to which R4 is directly connected:

Router R4
S 55.8.4.0/23 [1/0] via 55.8.14.14
S* 0.0.0.0/0 [1/0] via 55.8.14.13

Task 5

Using the command router ospf 8 we set up the OSPF protocol. We defined three areas as in Figure 3. With network ip-address wildcard-mask area id we define the interfaces and the areas in which they are located.

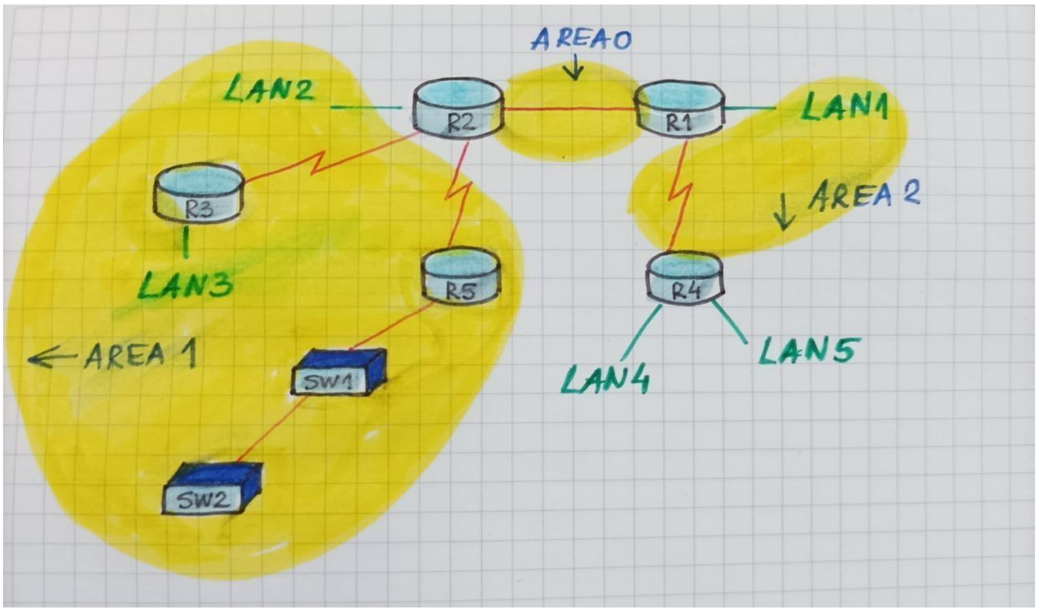

Figure 3

Router R1

router ospf 8 router-id 1.1.1.1
log-adjacency-changes redistribute
static subnets network 55.8.14.8
0.0.0.3 area 0 network 55.8.2.0
0.0.0.255 area 2 network 55.8.14.12
0.0.0.3 area 2
!
ip classless ip route 55.8.4.0
255.255.254.0 55.8.14.14
!

Router R2

router ospf 8 router-id 2.2.2.2 log-
adjacency-changes network
55.8.3.0 0.0.0.255 area 1 network
55.8.14.0 0.0.0.3 area 1 network
55.8.14.4 0.0.0.3 area 1 network
55.8.14.8 0.0.0.3 area 0
!

Router R3
router ospf 8 router-id 3.3.3.3 log-
adjacency-changes network
55.8.6.0 0.0.0.255 area 1 network
55.8.14.0 0.0.0.3 area 1
!

Router R5
router ospf 8 router-id 5.5.5.5 log-
adjacency-changes network
55.8.0.0 0.0.0.255 area 1 network
55.8.1.0 0.0.0.255 area 1 network
55.8.14.4 0.0.0.3 area 1
!

Task 6

Configured a default static route (includes all traffic) for router R8, which goes through router R7 to which R8 is directly connected.

Router 7 S 55.8.9.0/24 [1/0] via 55.8.14.50
Router 7 S 2001:33:EF08:3::/64 [1/0] via 2001:33:EF08:7::2

Router 8 S* 0.0.0.0/0 [1/0] via 55.8.14.49
Router 8 S ::/0 [1/0] via 2001:33:EF08:7::1

Task 7

In AS 20008, the task is to use the EIGRP protocol, so we enabled the mentioned protocol with the command router eigrp 20008 (we arbitrarily chose 20008), ensuring support for both IPv4 and IPv6 addresses. The command eigrp router-id <number> initiates the EIGRP protocol for IPv6 addresses.

Router R7
router eigrp
20008 eigrp router-id 7.7.7.7
redistribute static network
55.8.8.0 0.0.0.255 network
55.8.14.48 0.0.0.3 network
55.8.14.52 0.0.0.3 network
55.8.14.44 0.0.0.3
!
ipv6 router eigrp 20008
eigrp router-id 7.7.7.7 no
shutdown redistribute
static !

ip classless ip route 55.8.9.0
255.255.255.0 55.8.14.50
!
ip flow-export version 9
!
ipv6 route 2001:33:EF08:3::/64 2001:33:EF08:7::2
!

Router R6
router eigrp
20008 eigrp router-id
6.6.6.6 network 55.8.7.0
0.0.0.255 network 55.8.14.44
0.0.0.3
!
ipv6 router eigrp 20008
eigrp router-id 6.6.6.6 no
shutdown
!

Router R9
router eigrp
20008 eigrp router-id
9.9.9.9 network 55.8.10.0
0.0.0.255 network 55.8.11.0
0.0.0.255 network 55.8.14.52
0.0.0.3
!
ipv6 router eigrp 20008
eigrp router-id 9.9.9.9 no
shutdown
!

Task 8

Using the router rip, version 2 command, the RIPv2 protocol is configured in AS 30008.

Router 10
router rip
version 2
network 55.0.0.0
!

Router 11
router rip
version 2
network 55.0.0.0
!

Router 12
router rip
version 2
network
55.0.0.0
!

Task 9

Na ruterima R1 i R6 konfigurišemo BGP protokol čime omogućavamo komunikaciju AS 10008, AS 20008 , AS 30008 I AS 40008 sa ISP ruterom.
Naredbu weight smo dodali naknadno jer se u Packet Tracer-u ne koristi.
U zavisnosti od veličine weight-a biramo koji će ruter da se koristi kao primarni, a koji kao sekundarni.
Za primarni smo uzimali veći weight.

Router R1
router bgp 10008 bgp log-
neighborchanges neighbor 55.8.14.18
remoteas 40008 neighbor 55.8.14.18
weight 200 neighbor 55.8.14.22
remote-as
30008 neighbor 55.8.14.22 weight
100 network 55.8.2.0 mask
255.255.255.0 network 55.8.3.0 mask 255.255.255.0
network 55.8.6.0 mask 255.255.255.0 network
55.8.0.0 mask
255.255.255.0 network 55.8.1.0 mask
255.255.255.0 network 55.8.4.0 mask
255.255.254.0

Router R6
router bgp 20008 bgp
logneighbor-changes no
synchronization neighbor
55.8.14.38 remote-as
40008 neighbor
55.8.14.38 weight 200
neighbor 55.8.14.42
remote-as 30008

neighbor 55.8.14.42
weight 100 network
55.8.7.0 mask
255.255.255.0 network
55.8.8.0 mask
255.255.255.0 network
55.8.9.0 mask
255.255.255.0 network
55.8.10.0 mask
255.255.255.0 network
55.8.11.0 mask
255.255.255.0

Router R10
router bgp 30008 bgp log-neighborchanges
no synchronization neighbor
55.8.14.41 remote-as 20008 neighbor
55.8.14.41 weight 100 neighbor
55.8.14.34 remote-as 40008 neighbor
55.8.14.34 weight 200 neighbor
55.8.14.21 remote-as 10008 neighbor
55.8.14.21 weight 100 network
55.8.12.0 mask 255.255.255.0 network
55.8.13.0 mask 255.255.255.0

Router ISP
router bgp 40008 bgp log-neighborchanges
no synchronization neighbor 55.8.14.37
remote-as 20008 neighbor
55.8.14.17 remote-as 10008 neighbor
55.8.14.33 remote-as 30008

Task 10

On routers R1 and R6 and R10, it is necessary to redistribute the networks that are advertised via BGP on configure. Depending on which internal protocols are used, redistribution of BGP routes is done in the following ways:

Router R1
router ospf 8
redistribute bgp 10008 subnets

Router R6 router
eigrp 20008
redistribute bgp 20008 metric 1000000 100 255 1 1500

Router R10
router rip
default-information originate