

MPLS

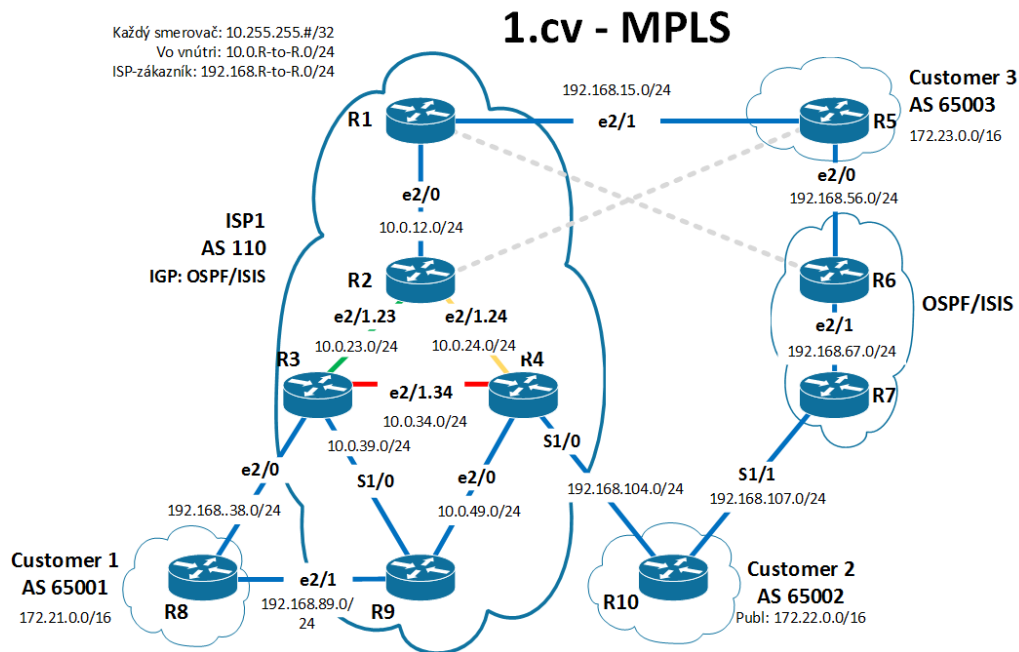
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Obsah

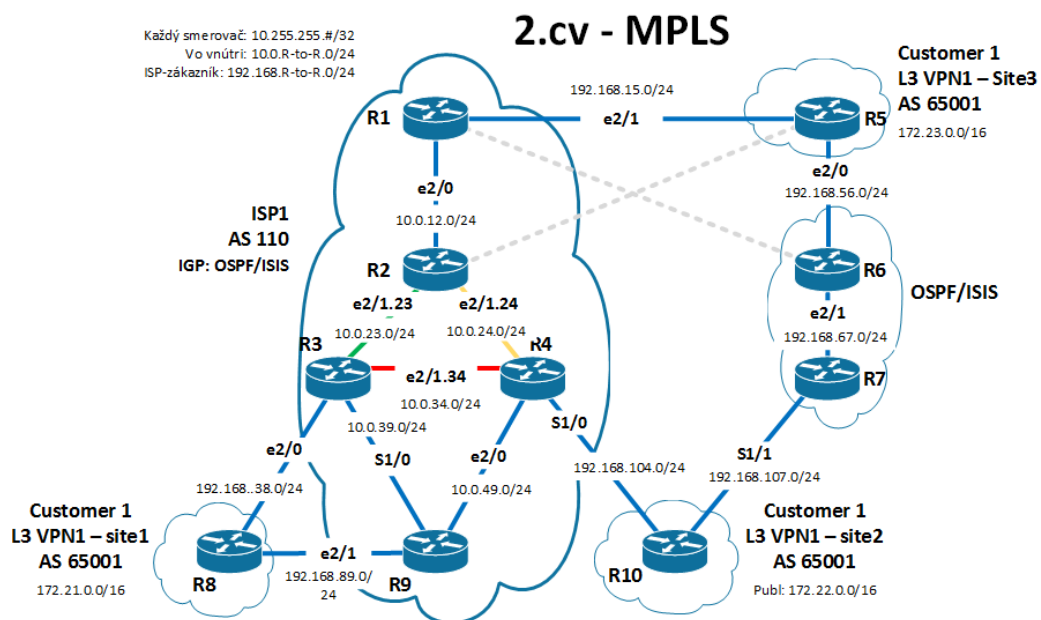
1.1	Topológia	3
1.2	Úlohy	6
1.2.1	IS–IS alebo OSPF	6
1.2.2	MPLS	6
1.2.3	LDP alebo RSVP	7
1.2.4	Router Reflector alebo konfederácie	8
1.2.5	Multiprotocol BGP	10
1.2.6	Hub & Spoke VPN	43
1.2.7	Draft Rosen	48

1.1 Topológia

Budeme konfigurovať smerovacie protokoly MPLS a IS-IS na topológii, ktorá je znázornená na obrázku 1. V rámci autonómnych systémov sme konfigurovali smerovacie protokoly IS-IS (pokiaľ má autonómny systém viac ako 2 smerovače) a BGP (iBGP). Medzi autonómnymi systémami sme konfigurovali len BGP (eBGP). IP adresácia je uvedená v tabuľke 1 a dopĺňa grafické znázornenie topológie na obrázku 1. Smerovače R6 a R7 sme nekonfigurovali.



Obr. 1: Topológia MPLS



Obr. 2: Topológia MPLS + L3 VPN

Tabuľka 1: IP adresácia

Smerovač	Rozhranie	IP adresa	Maska
R1	E2/0	10.0.12.1	255.255.255.0
	E2/1	192.168.15.1	255.255.255.0
	Lo0	10.255.255.1	255.255.255.255
R2	E2/0	10.0.12.2	255.255.255.0
	E2/1.23	10.0.23.2	255.255.255.0
	E2/1.24	10.0.24.2	255.255.255.0
	Lo0	10.255.255.2	255.255.255.255
R3	E2/0	192.168.38.3	255.255.255.0
	E2/1.23	10.0.23.3	255.255.255.0
	E2/1.34	10.0.34.3	255.255.255.0
	Lo0	10.255.255.3	255.255.255.255
R4	S1/0	192.168.104.4	255.255.255.0
	E2/0	10.0.49.4	255.255.255.0
	E2/1.24	10.0.24.4	255.255.255.0
	E2/1.34	10.0.34.4	255.255.255.0
	Lo0	10.255.255.4	255.255.255.255
R5	E2/0	192.168.56.5	255.255.255.0
	E2/1	192.168.15.5	255.255.255.0
	Lo0	10.255.255.5	255.255.255.255
	Lo1	172.23.0.1	255.255.0.0
R6	E2/0	192.168.56.6	255.255.255.0
	E2/1	192.168.67.6	255.255.255.0
	Lo0	10.255.255.6	255.255.255.255
R7	E2/1	192.168.67.7	255.255.255.0
	S1/1	192.168.107.7	255.255.255.0
	Lo0	10.255.255.7	255.255.255.255
R8	E2/0	192.168.38.8	255.255.255.0
	E2/1	192.168.89.8	255.255.255.0
	Lo0	10.255.255.8	255.255.255.0
	Lo1	172.21.0.1	255.255.0.0
R9	E2/0	10.0.49.9	255.255.255.0
	E2/1	192.168.89.9	255.255.255.0
	Lo0	10.255.255.9	255.255.255.255
	Lo1	172.21.0.1	255.255.0.0
R10	S1/0	192.168.104.10	255.255.255.0
	S1/1	192.168.107.10	255.255.255.0
	Lo0	10.255.255.10	255.255.255.255
	Lo1	172.22.0.1	255.255.0.0

1.2 Úlohy

1.2.1 IS–IS alebo OSPF

Popis

Ako vnútorný protokol sme zvolili IS-IS. Jeho konfigurácia je rovnaká ako v predchádzajúcich cvičeniach s ohľadom na aktuálny adresný plán.

Konfigurácia

IS-IS sme konfigurovali na R1, R2, R3, R4 a R9

```
R1(config)#router isis
  net 49.0002.0102.5525.5001.00
  exit
int e2/0
  ip router isis
  isis network point-to-point
int lo0
  ip router isis
```

Overenie

Konfiguráciu IS-IS sme overovali zobrazením IS-IS databázy.

```
R1# show isis database
```

1.2.2 MPLS

Popis

Základnú konfiguráciu MPLS sme robili podľa stránky “nil.uniza.sk”. Najprv zapneme “Cisco express forwarding” príkazom “ip cef”. Nakoniec zapneme MPLS príkazom “mpls ip”. Príkaz “mpls ip” sme použili iba na rozhraniach vnútri providerskej siete, nie na PE smerovačoch smerom k zákazníkom.

Konfigurácia

Aby sme zabezpečili konektivitu medzi jednotlivými zákazníkmi R5, R8 a R10, je potrebné nakonfigurovať BGP medzi týmito smerovačmi a ich susedmi v ISP1. Rovnako aj ohlasujeme požadovanú sieť zákazníka, v našom prípade Lo0. Na smerovači R2 BGP nekonfigurujeme.

```
R1 (config)#ip cef
mpls ip
mpls label protocol ldp
int serial1/0
  mpls ip
router bgp 65003
  neighbor 192.168.15.1 remote-as 110
  address-family ipv4 unicast
```

```
neighbor 192.168.15.1 activate
network 10.255.255.5 mask 255.255.255.255
```

Overenie

```
R10#sh ip bgp ipv4 unicast
...
```

	Network	Next Hop	Metric	LocPrf	Weight	Path
*>	10.255.255.5/32	192.168.104.4			0	110 110 i
*>	10.255.255.8/32	192.168.104.4			0	110 110 i
*>	10.255.255.10/32	0.0.0.0	0		32768	i
*>	172.21.0.0	192.168.104.4			0	110 110 ?
*>	172.22.0.0	0.0.0.0	0		32768	?
*>	172.23.0.0	192.168.104.4			0	110 110 ?

...

```
R10#traceroute 10.255.255.8 source 10
Type escape sequence to abort.
Tracing the route to 10.255.255.8
VRF info: (vrf in name/id, vrf out name/id)
 1 192.168.104.4 24 msec 16 msec 16 msec
 2 192.168.38.3 [AS 110] [MPLS: Label 26 Exp 0] 16 msec 36 msec 36 msec
 3 192.168.38.8 [AS 110] 68 msec * 52 msec
R10#
```

1.2.3 LDP alebo RSVP

Popis

Dohodli sme sa, že aktivujeme LDP značkovanie.

Konfigurácia

Na kažom providerskom smerovači sme v globálnom konfiguračnom režime aktivovali LDP príkazom:

```
mpls label protocol ldp
```

Overenie

```
R3#show mpls ldp disc
Local LDP Identifier:
 10.255.255.3:0
```

```
Discovery Sources:
Interfaces:
Serial1/0 (ldp): xmit/recv
    LDP Id: 10.255.255.9:0
Ethernet2/1.23 (ldp): xmit/recv
    LDP Id: 10.255.255.2:0
Ethernet2/1.34 (ldp): xmit/recv
    LDP Id: 10.255.255.4:
```

1.2.4 Router Reflector alebo konfederácie

Popis

V tomto prípade sme sa dohodli o nastavení Route Reflectora (RR) na smerovač R1. RR je BGP smerovač, ktorý obchádza pravidlo, že iBGP topológia musí byť "full-mesh" t.j. iBGP smerovač v jednej oblasti nešíri prefixy, ktoré sa naučil cez iBGP smerovač z inej oblasti.

Konfigurácia

Smerovače R3, R4 a R9 sme nastavovali ako museli nadviazať BGP s R1.

```
router bgp 110
neighbor 10.255.255.1 remote-as 110
neighbor 10.255.255.1 update-source Loopback0
address-family ipv4 unicast
    neighbor 10.255.255.1 activate
    neighbor 10.255.255.1 next-hop-self
network 10.255.255.3 mask 255.255.255.255
```

Potom nasledovala konfigurácia RR, teda smerovača R1.

R1

```
router bgp 110
neighbor 10.255.255.3 remote-as 110
neighbor 10.255.255.3 update-source 10
neighbor 10.255.255.4 remote-as 110
neighbor 10.255.255.4 update-source 10
neighbor 10.255.255.9 remote-as 110
neighbor 10.255.255.9 update-source 10
address-family ipv4 unicast
    neighbor 10.255.255.3 route-reflector-client
    neighbor 10.255.255.3 send-community extended
    neighbor 10.255.255.3 next-hop-self
    neighbor 10.255.255.3 activate
    neighbor 10.255.255.4 route-reflector-client
    neighbor 10.255.255.4 send-community extended
    neighbor 10.255.255.4 next-hop-self
    neighbor 10.255.255.4 activate
    neighbor 10.255.255.9 route-reflector-client
    neighbor 10.255.255.9 send-community extended
```



```
neighbor 10.255.255.9 next-hop-self
neighbor 10.255.255.9 activate
```

Overenie

Konektivita by mala byť v tomto prípade už všade. Presvedčíme sa pomocou tcl skriptu.

```
R1#tclsh
R1(tcl)#foreach address
+>(tcl)#10.255.255.1
+>(tcl)#10.255.255.2
+>(tcl)#10.255.255.3
+>(tcl)#10.255.255.4
+>(tcl)#10.255.255.5
+>(tcl)#10.255.255.6
+>(tcl)#10.255.255.7
+>(tcl)#10.255.255.8
+>(tcl)#10.255.255.9
+>(tcl)#10.255.255.10
+>(tcl)#
+>(tcl)#ping $address source 10.255.255.1
Sending 5, 100-byte ICMP Echos to 10.255.255.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 8/8/8 ms
Sending 5, 100-byte ICMP Echos to 10.255.255.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/22/28 ms
Sending 5, 100-byte ICMP Echos to 10.255.255.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 24/39/68 ms
Sending 5, 100-byte ICMP Echos to 10.255.255.4, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/33/52 ms
Sending 5, 100-byte ICMP Echos to 10.255.255.5, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/26/40 ms
Sending 5, 100-byte ICMP Echos to 10.255.255.8, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 72/88/100 ms
Sending 5, 100-byte ICMP Echos to 10.255.255.9, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 48/63/80 ms
Sending 5, 100-byte ICMP Echos to 10.255.255.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 72/79/100 ms
```

TODO - ZLE - nejak tam treba zakomponovat tie RED GREEN - urobit cez VRF PING

1.2.5 Multiprotocol BGP

Popis

Konfigurácia

```
R1(config)#do sh run
Building configuration...

Current configuration : 3764 bytes
!
! Last configuration change at 09:05:48 UTC Tue May 9 2017
upgrade fpd auto
version 15.3
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R1
!
boot-start-marker
boot-end-marker
!
aqm-register-fnf
!
!
no aaa new-model
!
!
!
ip vrf GREEN
  rd 100:2
  route-target export 110:2
  route-target import 110:2
!
ip vrf RED
  rd 110:1
  route-target export 110:1
  route-target import 110:1
!
!
!
!
no ip domain lookup
ip cef
no ipv6 cef
!
multilink bundle-name authenticated
```

```

mpls label protocol ldp
!
!
!
!
!
!
!
!
!
!
username admin privilege 15 secret 5 $1$eKi3$TJSJS.zu5o6JMF5F3h4bV1
!
redundancy
!
!
!
!
!
!
!
!
!
!
!
!
interface Loopback0
  ip address 10.255.255.1 255.255.255.255
  ip router isis
!
interface Loopback1
  ip vrf forwarding GREEN
  ip address 172.23.0.1 255.255.0.0
!
interface FastEthernet0/0
  no ip address
  shutdown
  duplex half
!
interface Serial1/0
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/1
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/2
  no ip address
  shutdown

```

```

    serial restart-delay 0
!
interface Serial1/3
    no ip address
    shutdown
    serial restart-delay 0
!
interface Serial1/4
    no ip address
    shutdown
    serial restart-delay 0
!
interface Serial1/5
    no ip address
    shutdown
    serial restart-delay 0
!
interface Serial1/6
    no ip address
    shutdown
    serial restart-delay 0
!
interface Serial1/7
    no ip address
    shutdown
    serial restart-delay 0
!
interface Ethernet2/0
    ip address 10.0.12.1 255.255.255.0
    ip router isis
    duplex half
    mpls ip
    isis network point-to-point
!
interface Ethernet2/1
    ip vrf forwarding RED
    ip address 192.168.15.1 255.255.255.0
    duplex half
!
interface Ethernet2/2
    no ip address
    shutdown
    duplex half
!
interface Ethernet2/3
    no ip address
    shutdown
    duplex half
!
interface Ethernet2/4
    no ip address

```

```

shutdown
duplex half
!
interface Ethernet2/5
no ip address
shutdown
duplex half
!
interface Ethernet2/6
no ip address
shutdown
duplex half
!
interface Ethernet2/7
no ip address
shutdown
duplex half
!
router isis
net 49.0001.0102.5525.5001.00
!
router bgp 110
bgp log-neighbor-changes
no bgp default ipv4-unicast
neighbor 10.255.255.3 remote-as 110
neighbor 10.255.255.3 update-source Loopback0
neighbor 10.255.255.4 remote-as 110
neighbor 10.255.255.4 update-source Loopback0
neighbor 10.255.255.9 remote-as 110
neighbor 10.255.255.9 update-source Loopback0
!
address-family ipv4
exit-address-family
!
address-family vpnv4
neighbor 10.255.255.3 activate
neighbor 10.255.255.3 send-community extended
neighbor 10.255.255.3 route-reflector-client
neighbor 10.255.255.4 activate
neighbor 10.255.255.4 send-community extended
neighbor 10.255.255.4 route-reflector-client
neighbor 10.255.255.9 activate
neighbor 10.255.255.9 send-community extended
neighbor 10.255.255.9 route-reflector-client
exit-address-family
!
address-family ipv4 vrf GREEN
redistribute connected
exit-address-family
!
address-family ipv4 vrf RED

```

```

    redistribute connected
    neighbor 192.168.15.5 remote-as 65001
    neighbor 192.168.15.5 activate
    neighbor 192.168.15.5 as-override
    exit-address-family
    !
ip forward-protocol nd
no ip http server
no ip http secure-server
!
!
!
!
mpls ldp router-id Loopback0 force
!
control-plane
!
!
mgcp behavior rsip-range tgcp-only
mgcp behavior comedia-role none
mgcp behavior comedia-check-media-src disable
mgcp behavior comedia-sdp-force disable
!
mgcp profile default
!
!
!
gatekeeper
    shutdown
!
!
line con 0
    exec-timeout 120 0
    logging synchronous
    login local
    stopbits 1
line aux 0
    stopbits 1
line vty 0 4
    privilege level 15
    no login
    transport input all
line vty 5 15
    privilege level 15
    no login
    transport input all
!
!
end

```

```

R1(config)#
=====
R2(config-subif)#do sh run
Building configuration...

Current configuration : 2739 bytes
!
! Last configuration change at 09:06:53 UTC Tue May 9 2017
upgrade fpd auto
version 15.3
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R2
!
boot-start-marker
boot-end-marker
!
aqm-register-fnf
!
!
no aaa new-model
!
!
!
!
!
!
no ip domain lookup
ip cef
no ipv6 cef
!
multilink bundle-name authenticated
mpls label protocol ldp
!
!
!
!
!
!
!
!
!
username admin privilege 15 secret 5 $1$QNaa$DSiUgQZG.ZRbem2tUy4nv.
!
redundancy
!
!
!
!

```

```

!
!
!
!
!
!
!
!
interface Loopback0
  ip address 10.255.255.2 255.255.255.255
  ip router isis
!
interface FastEthernet0/0
  no ip address
  shutdown
  duplex half
!
interface Serial1/0
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/1
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/2
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/3
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/4
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/5
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/6
  no ip address
  shutdown
  serial restart-delay 0

```



```

!
interface Serial1/7
  no ip address
  shutdown
  serial restart-delay 0
!
interface Ethernet2/0
  ip address 10.0.12.2 255.255.255.0
  ip router isis
  duplex half
  mpls ip
  isis network point-to-point
!
interface Ethernet2/1
  no ip address
  shutdown
  duplex half
  isis network point-to-point
!
interface Ethernet2/1.23
  encapsulation dot1Q 23
  ip address 10.0.23.2 255.255.255.0
  ip router isis
  mpls ip
  isis network point-to-point
!
interface Ethernet2/1.24
  encapsulation dot1Q 24
  ip address 10.0.24.2 255.255.255.0
  ip router isis
  mpls ip
  isis network point-to-point
!
interface Ethernet2/2
  no ip address
  shutdown
  duplex half
!
interface Ethernet2/3
  no ip address
  shutdown
  duplex half
!
interface Ethernet2/4
  no ip address
  shutdown
  duplex half
!
interface Ethernet2/5
  no ip address
  shutdown

```

```

    duplex half
!
interface Ethernet2/6
    no ip address
    shutdown
    duplex half
!
interface Ethernet2/7
    no ip address
    shutdown
    duplex half
!
router isis
    net 49.0001.0102.5525.5002.00
!
ip forward-protocol nd
no ip http server
no ip http secure-server
!
!
!
!
!
mpls ldp router-id Loopback0 force
!
control-plane
!
!
mgcp behavior rsip-range tgcp-only
mgcp behavior comedia-role none
mgcp behavior comedia-check-media-src disable
mgcp behavior comedia-sdp-force disable
!
mgcp profile default
!
!
!
gatekeeper
    shutdown
!
!
line con 0
    exec-timeout 120 0
    logging synchronous
    login local
    stopbits 1
line aux 0
    stopbits 1
line vty 0 4
    privilege level 15
    no login

```

```

    transport input all
line vty 5 15
    privilege level 15
    no login
    transport input all
!
!
end

R2(config-subif)#
=====
R3(config)#do sh run
Building configuration...

Current configuration : 3254 bytes
!
! Last configuration change at 09:08:12 UTC Tue May 9 2017
upgrade fpd auto
version 15.3
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R3
!
boot-start-marker
boot-end-marker
!
aqm-register-fnf
!
!
no aaa new-model
!
!
!
ip vrf RED
    rd 110:1
    route-target export 110:1
    route-target import 110:1
!
!
!
!
no ip domain lookup
ip cef
no ipv6 cef
!
multilink bundle-name authenticated
mpls label protocol ldp
!
!
```

```

!
!
!
!
!
!
!
username admin privilege 15 secret 5 $1$ierK$7ZnPCJ2hvc7ypP11a//Tc.
!
redundancy
!
!
!
!
!
!
!
!
!
!
!
!
interface Loopback0
  ip address 10.255.255.3 255.255.255.255
  ip router isis
!
interface FastEthernet0/0
  no ip address
  shutdown
  duplex half
!
interface Serial1/0
  ip address 10.0.39.3 255.255.255.0
  ip router isis
  mpls ip
  serial restart-delay 0
!
interface Serial1/1
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/2
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/3
  no ip address
  shutdown
  serial restart-delay 0

```

```

!
interface Serial1/4
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/5
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/6
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/7
  no ip address
  shutdown
  serial restart-delay 0
!
interface Ethernet2/0
  ip vrf forwarding RED
  ip address 192.168.38.3 255.255.255.0
  duplex half
!
interface Ethernet2/1
  no ip address
  duplex half
  isis network point-to-point
!
interface Ethernet2/1.23
  encapsulation dot1Q 23
  ip address 10.0.23.3 255.255.255.0
  ip router isis
  mpls ip
  isis network point-to-point
!
interface Ethernet2/1.34
  encapsulation dot1Q 34
  ip address 10.0.34.3 255.255.255.0
  ip router isis
  mpls ip
  isis network point-to-point
!
interface Ethernet2/2
  no ip address
  shutdown
  duplex half
!
interface Ethernet2/3

```

```

no ip address
shutdown
duplex half
!
interface Ethernet2/4
no ip address
shutdown
duplex half
!
interface Ethernet2/5
no ip address
shutdown
duplex half
!
interface Ethernet2/6
no ip address
shutdown
duplex half
!
interface Ethernet2/7
no ip address
shutdown
duplex half
!
router isis
net 49.0001.0102.5525.5003.00
!
router bgp 110
bgp log-neighbor-changes
neighbor 10.255.255.1 remote-as 110
neighbor 10.255.255.1 update-source Loopback0
!
address-family vpnv4
neighbor 10.255.255.1 activate
neighbor 10.255.255.1 send-community extended
exit-address-family
!
address-family ipv4 vrf RED
redistribute connected
neighbor 192.168.38.8 remote-as 65001
neighbor 192.168.38.8 activate
neighbor 192.168.38.8 as-override
exit-address-family
!
ip forward-protocol nd
no ip http server
no ip http secure-server
!
!
!
!

```

```

!
mpls ldp router-id Loopback0 force
!
control-plane
!
!
mgcp behavior rsip-range tgcp-only
mgcp behavior comedia-role none
mgcp behavior comedia-check-media-src disable
mgcp behavior comedia-sdp-force disable
!
mgcp profile default
!
!
!
gatekeeper
  shutdown
!
!
line con 0
  exec-timeout 120 0
  logging synchronous
  login local
  stopbits 1
line aux 0
  stopbits 1
line vty 0 4
  privilege level 15
  no login
  transport input all
line vty 5 15
  privilege level 15
  no login
  transport input all
!
!
end

=====
R4(config)#
*May  9 09:46:52.772: %LDP-5-NBRCHG: LDP Neighbor 10.255.255.3:0 (1) is UP
R4(config)#do sh run
Building configuration...

Current configuration : 3599 bytes
!
! Last configuration change at 09:09:38 UTC Tue May 9 2017
upgrade fpd auto
version 15.3
service timestamps debug datetime msec
service timestamps log datetime msec

```

```

no service password-encryption
!
hostname R4
!
boot-start-marker
boot-end-marker
!
aqm-register-fnf
!
!
no aaa new-model
!
!
!
ip vrf GREEN
  rd 110:2
  route-target export 110:2
  route-target import 110:2
!
ip vrf RED
  rd 110:1
  route-target export 110:1
  route-target import 110:1
!
!
!
!
no ip domain lookup
ip cef
no ipv6 cef
!
multilink bundle-name authenticated
mpls label protocol ldp
!
!
!
!
!
!
!
!
!
username admin privilege 15 secret 5 $1$Eu2a$rgRjxOvteTJdNyTEKValI/
!
redundancy
!
!
!
!
!
!
!

```



```

!
!
!
!
!
!
interface Loopback0
  ip address 10.255.255.4 255.255.255.255
  ip router isis
!
interface Loopback1
  ip vrf forwarding GREEN
  ip address 172.22.0.1 255.255.0.0
!
interface FastEthernet0/0
  no ip address
  shutdown
  duplex half
!
interface Serial1/0
  ip vrf forwarding RED
  ip address 192.168.104.4 255.255.255.0
  serial restart-delay 0
!
interface Serial1/1
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/2
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/3
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/4
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/5
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/6
  no ip address

```

```

shutdown
serial restart-delay 0
!
interface Serial1/7
no ip address
shutdown
serial restart-delay 0
!
interface Ethernet2/0
ip address 10.0.49.4 255.255.255.0
ip router isis
duplex half
mpls ip
isis network point-to-point
!
interface Ethernet2/1
no ip address
duplex half
isis network point-to-point
!
interface Ethernet2/1.23
isis network point-to-point
!
interface Ethernet2/1.24
encapsulation dot1Q 24
ip address 10.0.24.4 255.255.255.0
ip router isis
mpls ip
isis network point-to-point
!
interface Ethernet2/1.34
encapsulation dot1Q 34
ip address 10.0.34.4 255.255.255.0
ip router isis
mpls ip
isis network point-to-point
!
interface Ethernet2/2
no ip address
shutdown
duplex half
!
interface Ethernet2/3
no ip address
shutdown
duplex half
!
interface Ethernet2/4
no ip address
shutdown
duplex half

```

```

!
interface Ethernet2/5
  no ip address
  shutdown
  duplex half
!
interface Ethernet2/6
  no ip address
  shutdown
  duplex half
!
interface Ethernet2/7
  no ip address
  shutdown
  duplex half
!
router isis
  net 49.0001.0102.5525.5004.00
!
router bgp 110
  bgp log-neighbor-changes
  neighbor 10.255.255.1 remote-as 110
  neighbor 10.255.255.1 update-source Loopback0
!
  address-family vpnv4
    neighbor 10.255.255.1 activate
    neighbor 10.255.255.1 send-community extended
  exit-address-family
!
  address-family ipv4 vrf GREEN
    redistribute connected
  exit-address-family
!
  address-family ipv4 vrf RED
    redistribute connected
    neighbor 192.168.104.10 remote-as 65001
    neighbor 192.168.104.10 activate
    neighbor 192.168.104.10 as-override
  exit-address-family
!
ip forward-protocol nd
no ip http server
no ip http secure-server
!
!
!
!
!
mpls ldp router-id Loopback0 force
!
control-plane

```

```

!
!
mgcp behavior rsip-range tgcp-only
mgcp behavior comedia-role none
mgcp behavior comedia-check-media-src disable
mgcp behavior comedia-sdp-force disable
!
mgcp profile default
!
!
!
gatekeeper
  shutdown
!
!
line con 0
  exec-timeout 120 0
  logging synchronous
  login local
  stopbits 1
line aux 0
  stopbits 1
line vty 0 4
  privilege level 15
  no login
  transport input all
line vty 5 15
  privilege level 15
  no login
  transport input all
!
!
end

=====
R5(config)#do sh run
Building configuration...

Current configuration : 2432 bytes
!
! Last configuration change at 09:10:04 UTC Tue May 9 2017
upgrade fpd auto
version 15.3
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R5
!
boot-start-marker
boot-end-marker

```

```

!
aqm-register-fnf
!
!
no aaa new-model
!
!
!
!
!
!
no ip domain lookup
ip cef
no ipv6 cef
!
multilink bundle-name authenticated
!
!
!
!
!
!
!
!
!
username admin privilege 15 secret 5 $1$n4c4$fjx3bLiFEXqL3tjOX2tda/
!
redundancy
!
!
!
!
!
!
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address 10.255.255.5 255.255.255.255
!
interface Loopback1
 ip address 172.23.0.1 255.255.0.0
!
interface FastEthernet0/0
 no ip address
 shutdown
 duplex half
!

```

```

interface Serial1/0
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/1
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/2
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/3
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/4
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/5
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/6
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/7
  no ip address
  shutdown
  serial restart-delay 0
!
interface Ethernet2/0
  no ip address
  shutdown
  duplex half
!
interface Ethernet2/1
  ip address 192.168.15.5 255.255.255.0
  duplex half
!
interface Ethernet2/2
  no ip address

```

```

    shutdown
    duplex half
    !
interface Ethernet2/3
    no ip address
    shutdown
    duplex half
    !
interface Ethernet2/4
    no ip address
    shutdown
    duplex half
    !
interface Ethernet2/5
    no ip address
    shutdown
    duplex half
    !
interface Ethernet2/6
    no ip address
    shutdown
    duplex half
    !
interface Ethernet2/7
    no ip address
    shutdown
    duplex half
    !
router bgp 65001
    bgp log-neighbor-changes
    network 172.23.0.0
    redistribute connected
    neighbor 192.168.15.1 remote-as 110
    !
ip forward-protocol nd
no ip http server
no ip http secure-server
    !
    !
    !
    !
    !
control-plane
    !
    !
mgcp behavior rsip-range tgcp-only
mgcp behavior comedia-role none
mgcp behavior comedia-check-media-src disable
mgcp behavior comedia-sdp-force disable
    !

```

```
mgcp profile default
```

```
!  
!  
!
```

```
gatekeeper
```

```
shutdown
```

```
!  
!
```

```
line con 0
```

```
exec-timeout 120 0
```

```
logging synchronous
```

```
login local
```

```
stopbits 1
```

```
line aux 0
```

```
stopbits 1
```

```
line vty 0 4
```

```
privilege level 15
```

```
no login
```

```
transport input all
```

```
line vty 5 15
```

```
privilege level 15
```

```
no login
```

```
transport input all
```

```
!  
!
```

```
end
```

```
=====
```

```
R8(config-router)#do sh run
```

```
Building configuration...
```

```
Current configuration : 1943 bytes
```

```
!
```

```
! Last configuration change at 09:10:47 UTC Tue May 9 2017
```

```
upgrade fpd auto
```

```
version 15.3
```

```
service timestamps debug datetime msec
```

```
service timestamps log datetime msec
```

```
no service password-encryption
```

```
!
```

```
hostname R8
```

```
!
```

```
boot-start-marker
```

```
boot-end-marker
```

```
!
```

```
aqm-register-fnf
```

```
!
```

```
!
```

```
no aaa new-model
```

```
!
```

```
!
```

```
!
```



```

!
!
!
no ip domain lookup
ip cef
no ipv6 cef
!
multilink bundle-name authenticated
!
!
!
!
!
!
!
!
!
!
username admin privilege 15 secret 5 $1$Mq.F$L/F7f8cDOy57qHWHgR/1v1
!
redundancy
!
!
!
!
!
!
!
!
!
!
!
!
interface Loopback0
  ip address 10.255.255.8 255.255.255.255
!
interface Loopback1
  ip address 172.21.0.1 255.255.0.0
!
interface FastEthernet0/0
  no ip address
  shutdown
  duplex half
!
interface Ethernet2/0
  ip address 192.168.38.8 255.255.255.0
  duplex half
!
interface Ethernet2/1
  ip address 192.168.89.8 255.255.255.0
  duplex half
!

```

```

interface Ethernet2/2
  no ip address
  shutdown
  duplex half
!
interface Ethernet2/3
  no ip address
  shutdown
  duplex half
!
interface Ethernet2/4
  no ip address
  shutdown
  duplex half
!
interface Ethernet2/5
  no ip address
  shutdown
  duplex half
!
interface Ethernet2/6
  no ip address
  shutdown
  duplex half
!
interface Ethernet2/7
  no ip address
  shutdown
  duplex half
!
router bgp 65001
  bgp router-id 10.255.255.8
  bgp log-neighbor-changes
  network 172.21.0.0
  redistribute connected
  neighbor 192.168.38.3 remote-as 110
  neighbor 192.168.89.9 remote-as 110
!
ip forward-protocol nd
no ip http server
no ip http secure-server
!
!
!
!
!
!
control-plane
!
!
mgcp behavior rsip-range tgcp-only

```

```

mgcp behavior comedia-role none
mgcp behavior comedia-check-media-src disable
mgcp behavior comedia-sdp-force disable
!
mgcp profile default
!
!
!
gatekeeper
shutdown
!
!
line con 0
exec-timeout 120 0
logging synchronous
login local
stopbits 1
line aux 0
stopbits 1
line vty 0 4
privilege level 15
no login
transport input all
line vty 5 15
privilege level 15
no login
transport input all
!
!
end

=====
R9(config)#do sh run
Building configuration...

Current configuration : 3100 bytes
!
! Last configuration change at 09:11:23 UTC Tue May 9 2017
upgrade fpd auto
version 15.3
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R9
!
boot-start-marker
boot-end-marker
!
aqm-register-fnf
!

```

```

!
no aaa new-model
!
!
!
ip vrf RED
  rd 110:1
  route-target export 110:1
  route-target import 110:1
!
!
!
!
no ip domain lookup
ip cef
no ipv6 cef
!
multilink bundle-name authenticated
mpls label protocol ldp
!
!
!
!
!
!
!
!
!
!
username admin privilege 15 secret 5 $1$9Xfg$w5/FVeQ3L3lr67UN.zzch.
!
redundancy
!
!
!
!
!
!
!
!
!
!
!
interface Loopback0
  ip address 10.255.255.9 255.255.255.255
  ip router isis
!
interface Loopback1
  ip address 172.21.0.1 255.255.0.0
!
interface FastEthernet0/0

```

```

no ip address
shutdown
duplex half
!
interface Serial1/0
ip address 10.0.39.9 255.255.255.0
ip router isis
mpls ip
serial restart-delay 0
!
interface Serial1/1
no ip address
shutdown
serial restart-delay 0
!
interface Serial1/2
no ip address
shutdown
serial restart-delay 0
!
interface Serial1/3
no ip address
shutdown
serial restart-delay 0
!
interface Serial1/4
no ip address
shutdown
serial restart-delay 0
!
interface Serial1/5
no ip address
shutdown
serial restart-delay 0
!
interface Serial1/6
no ip address
shutdown
serial restart-delay 0
!
interface Serial1/7
no ip address
shutdown
serial restart-delay 0
!
interface Ethernet2/0
ip address 10.0.49.9 255.255.255.0
ip router isis
duplex half
mpls ip
isis network point-to-point

```

```

!
interface Ethernet2/1
 ip vrf forwarding RED
 ip address 192.168.89.9 255.255.255.0
 duplex half
!
interface Ethernet2/2
 no ip address
 shutdown
 duplex half
!
interface Ethernet2/3
 no ip address
 shutdown
 duplex half
!
interface Ethernet2/4
 no ip address
 shutdown
 duplex half
!
interface Ethernet2/5
 no ip address
 shutdown
 duplex half
!
interface Ethernet2/6
 no ip address
 shutdown
 duplex half
!
interface Ethernet2/7
 no ip address
 shutdown
 duplex half
!
router isis
 net 49.0001.0102.5525.5009.00
!
router bgp 110
 bgp router-id 10.255.255.9
 bgp log-neighbor-changes
 neighbor 10.255.255.1 remote-as 110
 neighbor 10.255.255.1 update-source Loopback0
!
 address-family vpnv4
  neighbor 10.255.255.1 activate
  neighbor 10.255.255.1 send-community extended
 exit-address-family
!
 address-family ipv4 vrf RED

```

```

    redistribute connected
    neighbor 192.168.89.8 remote-as 65001
    neighbor 192.168.89.8 activate
    neighbor 192.168.89.8 as-override
    exit-address-family
    !
    ip forward-protocol nd
    no ip http server
    no ip http secure-server
    !
    !
    !
    !
    !
    mpls ldp router-id Loopback0 force
    !
    control-plane
    !
    !
    mgcp behavior rsip-range tgcp-only
    mgcp behavior comedia-role none
    mgcp behavior comedia-check-media-src disable
    mgcp behavior comedia-sdp-force disable
    !
    mgcp profile default
    !
    !
    !
    gatekeeper
    shutdown
    !
    !
    line con 0
    exec-timeout 120 0
    logging synchronous
    login local
    stopbits 1
    line aux 0
    stopbits 1
    line vty 0 4
    privilege level 15
    no login
    transport input all
    line vty 5 15
    privilege level 15
    no login
    transport input all
    !
    !
    end
=====

```

```

R10(config-if)#do sh run
Building configuration...

Current configuration : 1941 bytes
!
! Last configuration change at 09:12:01 UTC Tue May 9 2017
upgrade fpd auto
version 15.3
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R10
!
boot-start-marker
boot-end-marker
!
aqm-register-fnf
!
!
no aaa new-model
!
!
!
!
!
!
no ip domain lookup
ip cef
no ipv6 cef
!
multilink bundle-name authenticated
!
!
!
!
!
!
!
!
!
!
username admin privilege 15 secret 5 $1$B5L1$Z/2grhIGcOAdN05y9r17M1
!
redundancy
!
!
!
!
!
!
!
!
!

```



```

!
!
!
!
!
interface Loopback0
  ip address 10.255.255.10 255.255.255.255
!
interface Loopback1
  ip address 172.22.0.1 255.255.0.0
!
interface FastEthernet0/0
  no ip address
  shutdown
  duplex half
!
interface Serial1/0
  ip address 192.168.104.10 255.255.255.0
  serial restart-delay 0
!
interface Serial1/1
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/2
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/3
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/4
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/5
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/6
  no ip address
  shutdown
  serial restart-delay 0
!
interface Serial1/7

```

```

no ip address
shutdown
serial restart-delay 0
!
router bgp 65001
  bgp log-neighbor-changes
  network 172.22.0.0
  redistribute connected
  neighbor 192.168.104.4 remote-as 110
!
ip forward-protocol nd
no ip http server
no ip http secure-server
!
!
!
!
!
!
control-plane
!
!
mgcp behavior rsip-range tgcp-only
mgcp behavior comedia-role none
mgcp behavior comedia-check-media-src disable
mgcp behavior comedia-sdp-force disable
!
mgcp profile default
!
!
!
gatekeeper
  shutdown
!
!
line con 0
  exec-timeout 120 0
  logging synchronous
  login local
  stopbits 1
line aux 0
  stopbits 1
line vty 0 4
  privilege level 15
  no login
  transport input all
line vty 5 15
  privilege level 15
  no login
  transport input all
!

```

```
!  
end  
  
R10 (config-if) #
```

Overenie

1.2.6 Hub & Spoke VPN

Popis

Topológia bola pozmenená tak, že namiesto dvoch rôznych zákazníkov RED a GREEN budeme mať iba jedného, ktorý má tri pobočky s rovnakým ASN 65001.

Adresovanie ostáva rovnaké, len pobočkám sme pridali nové siete na rozhraní Loopback1.

R5 lo1 172.23.0.1 /16

R8 lo1 172.21.0.1 /16

R10 lo1 172.22.0.1 /16

Na prepojenie týchto pobočiek sme využili VPN. V prvom kroku bolo potrebné na smerovačoch R5, R8 a R10 vypnúť bežiaci BGP (no router bgp 65001/2/3), keďže nastala zmena AS oproti pôvodnému zadaniu.

Ďalším krokom bola aktivácia VRF (Virtual Routing Instance) pre pobočky na každom provider edge (PE) smerovači v AS 110 (R1, R3, R4 a R9). Aby sa vytvorila unikátna VPN cesta pre daného zákazníka, bolo potrebné definovať Route Distinguisher (RD) a následne aj Route Target (RT).

Potom danú VRF treba priradiť rozhraniám, ktoré smerujú k zákazníkom. Následne bolo potrebné nadviazať BGP susedstvá medzi PE smerovačmi a CE smerovačmi v zákazníckom AS 65001 vytvorením VRF tabuľky.

Úlohou bolo zmeniť predošlú konfiguráciu tak, aby smerovač R1 bol hubom pre ostatné PE smerovače a R5 hubom pre zákaznícke CE smerovače (viď obr. 3). Medzi týmito dvomi smerovačmi v topológii tiež pribudla linka, avšak fyzickú máme k dispozícii len jednu, preto sme museli vytvoriť pre jedného dve podrozhrania: jedno pre odosielanie dát “spoke” smerovačom, druhé pre príjem správ od nich. Tým pádom je nutné fyzické rozhranie e2/1 rozdeliť na dve sub-rozhrania a na nich vytvoriť dve samostatné VRF pre import a export (viď obr. 4). Predtým sme však museli odstrániť staré VRF z predošlých cvičení, príkazom no ip vrf z1.

Každý smerovač: 10.255.255.#/32
Vo vnútri: 10.0.R-to-R.0/24
ISP-zákazník: 192.168.R-to-R.0/24



Konfigurácia

R5 (CE smerovač)

```
router bgp 65001
  address-family ipv4 unicast
    network 10.255.255.5 mask 255.255.255.255
    network 172.23.0.0 mask 255.255.255.0
  neighbor 192.168.15.1 activate
```

Pokračovali sme konfiguráciou

R1

```
no ip vrf RED
```

```
ip vrf Z1_DOWN
  rd 110:1001
  route-target import 110:1001
```

```
ip vrf Z1_UP
  rd 110:1000
  route-target export 110:1000
```

```
interface Ethernet2/1
  no ip address
  duplex half
```

```
interface Ethernet2/1.15
  encapsulation dot1Q 15
  ip vrf forwarding Z1_UP
  ip address 192.168.15.1 255.255.255.0
```

```
interface Ethernet2/1.51
  encapsulation dot1Q 51
  ip vrf forwarding Z1_DOWN
  ip address 192.168.51.1 255.255.255.0
```

```
router bgp 110
  address-family ipv4
    neighbor 10.255.255.3 activate
    neighbor 10.255.255.4 activate
    neighbor 10.255.255.9 activate
  exit-address-family
```

```
address-family ipv4 vrf Z1_DOWN
  redistribute connected
  neighbor 192.168.51.5 remote-as 65001
  neighbor 192.168.51.5 activate
  neighbor 192.168.51.5 as-override
  exit-address-family
```

```

address-family ipv4 vrf Z1_UP
 redistribute connected
 redistribute static
 neighbor 192.168.15.5 remote-as 65001
 neighbor 192.168.15.5 activate
 neighbor 192.168.15.5 as-override
 default-information originate
 exit-address-family

ip route vrf Z1_UP 0.0.0.0 0.0.0.0 192.168.15.5
mpls ldp router-id Loopback0
=====
R3#
!namiesto RED dal:
no ip vrf RED

int eth2/0
 ip addr 192.168.38.3

ip vrf Z1_SPOKE
 rd 110:1001
 route-target export 110:1001
 route-target import 110:1000

interface Ethernet2/0
 ip vrf forwarding Z1_SPOKE

router bgp 110
 address-family ipv4 vrf Z1_SPOKE
 redistribute connected
 neighbor 192.168.38.8 remote-as 65001
 neighbor 192.168.38.8 activate
 neighbor 192.168.38.8 as-override
 exit-address-family
=====
R4#sh run
!ip brf GREEN a RED zmazal a dal:

int s1/0
 ip addr 192.168.104.4 255.255.255.0

int e2/0
 ip addr 10.0.49.4 255.255.255.0

ip vrf Z1_SPOKE
 rd 110:1001
 route-target export 110:1001
 route-target import 110:1000

interface Serial1/0
 ip vrf forwarding Z1_SPOKE

```

```

router bgp 110
!namiesto RED a GREEN dal:

address-family ipv4 vrf Z1_SPOKE
 redistribute connected
 neighbor 192.168.104.10 remote-as 65001
 neighbor 192.168.104.10 activate
 neighbor 192.168.104.10 as-override
exit-address-family
=====
R9#
!ip vrf RED zmenil na:

ip vrf Z1_SPOKE
 rd 110:1001
 route-target export 110:1001
 route-target import 110:1000

interface Ethernet2/1
 ip addr 192.168.89.9 255.255.255.0
 ip vrf forwarding Z1_SPOKE

router bgp 110
!namiesto RED dal:

address-family ipv4 vrf Z1_SPOKE
 redistribute connected
 neighbor 192.168.38.8 remote-as 65001
 neighbor 192.168.38.8 activate
 neighbor 192.168.38.8 as-override
exit-address-family
=====
R5

interface Ethernet2/1
 no ip address

interface Ethernet2/1.15
 encapsulation dot1Q 15
 ip address 192.168.15.5 255.255.255.0

interface Ethernet2/1.51
 encapsulation dot1Q 51
 ip address 192.168.51.5 255.255.255.0

router bgp 65001
 network 10.255.255.5 mask 255.255.255.255
 neighbor 192.168.51.1 remote-as 110

```

Parameter as-override zabezpečí, aby smerovače nezhadzovali siete, ktoré prechádzajú do rovnakého AS (65001). Príkaz redistribute connected distribuuje všetky pripojené siete zákazníka v rámci BGP. Tieto príkazy zadáme na smerovačoch R1 smerom k R5, na R9 k R8 a na R4 k R10.

Konfigurácia CE smerovačov je podobná, využíva však address-family, pretože zákazníci sa o VRF nezaujímajú. Na smerovačoch R5, R8 a R10 musíme zmeniť predošlú konfiguráciu BGP, teda pôvodné AS nahradíme AS 65001, ohlásime ich vlastné siete a aktivujeme spojenie na suseda.

```
R5 (CE smerovač)
router bgp 65001
  address-family ipv4 unicast
    network 10.255.255.5 mask 255.255.255.255
    network 172.23.0.0 mask 255.255.255.0
  neighbor 192.168.15.1 activate
```

Overenie

Zadaním tohto príkazu sa presunie záznam z globálnej smerovacej tabuľky do smerovacej tabuľky vrf z1. Po zadaní príkazu je takisto potrebné na ňom znovu zadať IP adresu. Overenie, že sa rozhranie pridalo do danej VRF, vykonáme príkazom “sh ip vrf”.

```
R1#show ip vrf
TODO
```

Po správnej konfigurácii by sa na CE smerovačoch v BGP tabuľke pre ipv4 unicast mali objaviť všetky ohlasované siete smerovačov R5, R8 a R10 (Lo0 aj Lo1).

```
R5#sh ip bgp ipv4 unicast
TODO
```

Rovnako sme použili Traceroute z R5 lo1 na R10 lo1

```
R5#traceroute 172.22.0.1 source 172.23.0.1
TODO
```

1.2.7 Draft Rosen

Popis

Darth Vader je multicastová MPLS technológia. Pochádza z inej galaxie. Prvá zmienka bola v seriáli StarWars :)

Konfigurácia

Najprv zrusíme všetko, čo sme nakonfigurovali pre hub and spoke. Potom:

r1 r5 treba vratit na jednu linku (zrusit trunky).

```
no int eth2/1.15
no int eth2/1.51
int eth2/1
ip addr 192.168.15.# 255.255.255.0
```

Vymažeme IPčku druhého spätného subinterfejsu eth2/1.51 “192.168.51.1” z neighborov v BGP na R5

no neighbor 192.168.51.1 remote-as 110

Najprv vymazeme VRFky z Hub & Spoke

```
!R1
no ip vrf Z1_DOWN
no ip vrf Z1_UP
```

```
!R3, R4, R9
no ip vrf Z1_SPOKE
```

Vytvorime novu VRFku pre klienta GREEN. Route target import a export bude rovnaky. Novu VRFku nastavime na R1, R3, R4 a R9.

```
ip vrf GREEN
  rd 110:2
  route-target both 110:2
```

Aplikujeme VRFky na interfacey R1, R3, R4 a R9 a nanovo nahodime ipcky na interfejsoch:

```
!R1
R1(config)#int eth2/1
R1(config-if)#ip vrf forwarding GREEN
% Interface Ethernet2/1 IPv4 disabled and address(es) removed due to enabling V
R1(config-if)#ip addr 192.168.15.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#router bgp 110
R1(config-router)#address-family ipv4 vrf GREEN
R1(config-router-af)#redistribute connected
R1(config-router-af)#neighbor 192.168.15.5 remote-as 65001
R1(config-router-af)#neighbor 192.168.15.5 activa
*May 16 10:10:08.158: %BGP-5-ADJCHANGE: neighbor 192.168.15.5 vpn vrf GREEN Up
R1(config-router-af)#neighbor 192.168.15.5 activate
R1(config-router-af)#neighbor 192.168.15.5 as-ov
R1(config-router-af)#neighbor 192.168.15.5 as-override
```

KONFIGURACIA DRAFT ROSEN mdt id pre zakaznika 239.10.10.10 - GREEN. v sieti zakaznika rozbehnut PIM sparse mode. RP bude R1, v sieti zakaznika to bude r5. konfiguruje zakaznicke route r8-r10. staticky join na r10 a pingat nanho.

Na vsetkych routoch:

```
ip multicast-routing
```

Na PE routroch 1,3,4,9

```
ip multicast-routing vrf GREEN
```

Na providerských routroch zadať pre všetky interfejsy (aj na loopback0) príkaz

```
ip pim sparse-mode
```

aby sme zapli PIM Sparse Mode, kvôli sireníu multicastov. V trojuholníku staci dávať príkaz iba na subinterfejsy. Rovnako urobíme aj na CE routroch, ale iba pre interfejsy smerujúce na PE routre.

Nastavíme RP pre providera na R1 a pre zákazníka na R5.
PE routre

```
ip pim rp-address 10.255.255.1
```

Zákaznícke CE routre

```
ip pim rp-address 172.23.0.1
```

Na PE routroch použijeme príkazy

```
ip vrf GREEN  
mdt default 239.10.10.10
```

Tak ho priradíme do multicastovej skupiny.

Na PE routroch musíme nastaviť zákaznícky RP pre VRF GREEN.

```
R9(config)#ip pim vrf GREEN rp-address 172.23.0.1
```

Na CE routroch priradíme loopback do multicastovej skupiny

```
int lo0  
ip igmp join-group 239.10.10.10
```

Overenie – Základná MP–BGP konektivita

```
show ip route vrf GREEN  
show ip vrf
```

```
R4(config-router-af)#do sh ip route vrf GREEN
```

Routing Table: GREEN

...

Gateway of last resort is not set

```
10.0.0.0/32 is subnetted, 3 subnets  
B      10.255.255.5 [200/0] via 10.255.255.1, 00:08:23  
B      10.255.255.8 [200/0] via 10.255.255.3, 00:03:21
```

```

B      10.255.255.10 [20/0] via 192.168.104.10, 00:00:23
B      172.21.0.0/16 [200/0] via 10.255.255.3, 00:03:21
B      172.22.0.0/16 [20/0] via 192.168.104.10, 00:00:23
B      172.23.0.0/16 [200/0] via 10.255.255.1, 00:08:23
B      192.168.15.0/24 [200/0] via 10.255.255.1, 00:08:53
B      192.168.38.0/24 [200/0] via 10.255.255.3, 00:04:05
B      192.168.56.0/24 [200/0] via 10.255.255.1, 00:08:23
B      192.168.89.0/24 [200/0] via 10.255.255.3, 00:03:21
B      192.168.104.0/24 is variably subnetted, 2 subnets, 2 masks
C      192.168.104.0/24 is directly connected, Serial1/0
L      192.168.104.4/32 is directly connected, Serial1/0
B      192.168.107.0/24 [20/0] via 192.168.104.10, 00:00:23

```

R8#show ip bgp ipv4 unicast

BGP table version is 42, local router ID is 10.255.255.8

Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
x best-external, a additional-path, c RIB-compressed,

Origin codes: i - IGP, e - EGP, ? - incomplete

RPKI validation codes: V valid, I invalid, N Not found

	Network	Next Hop	Metric	LocPrf	Weight	Path
*	10.255.255.5/32	192.168.89.9			0	110 110 i
*>		192.168.38.3			0	110 110 i
*>	10.255.255.8/32	0.0.0.0	0		32768	?
*	10.255.255.10/32	192.168.89.9			0	110 110 ?
*>		192.168.38.3			0	110 110 ?
*>	172.21.0.0	0.0.0.0	0		32768	i
*	172.22.0.0	192.168.89.9			0	110 110 i
*>		192.168.38.3			0	110 110 i
*	172.23.0.0	192.168.89.9			0	110 110 i
*>		192.168.38.3			0	110 110 i
*	192.168.15.0	192.168.89.9			0	110 ?
*>		192.168.38.3			0	110 ?
*	192.168.38.0	192.168.89.9			0	110 ?
*		192.168.38.3	0		0	110 ?
	Network	Next Hop	Metric	LocPrf	Weight	Path
*>		0.0.0.0	0		32768	?
*	192.168.56.0	192.168.89.9			0	110 110 ?
*>		192.168.38.3			0	110 110 ?
*	192.168.89.0	192.168.89.9	0		0	110 ?
*		192.168.38.3			0	110 ?
*>		0.0.0.0	0		32768	?
*	192.168.104.0	192.168.89.9			0	110 ?
*>		192.168.38.3			0	110 ?
*	192.168.107.0	192.168.89.9			0	110 110 ?
*>		192.168.38.3			0	110 110 ?

```
R8#ping 172.22.0.1 source 172.21.0.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.22.0.1, timeout is 2 seconds:
Packet sent with a source address of 172.21.0.1
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 52/56/60 ms
```

```
R4(config-router-af)#do ping vrf GREEN 172.23.0.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.23.0.1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 52/59/72 ms
```

=====

OVERENIE Multicastovych tunelov

=====

```
R1(config)#ip pim rp-address 10.255.255.1
R1(config)#
*May 16 10:59:35.306: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel0
*May 16 10:59:35.474: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel1
```

Ide aj multicastový ping

```
R5#ping 239.10.10.10 repeat 2
Type escape sequence to abort.
Sending 2, 100-byte ICMP Echos to 239.10.10.10, timeout is 2 seconds:

Reply to request 0 from 172.23.0.1, 32 ms
Reply to request 0 from 172.21.0.1, 84 ms
Reply to request 0 from 172.22.0.1, 80 ms
Reply to request 1 from 172.23.0.1, 8 ms
Reply to request 1 from 172.21.0.1, 80 ms
Reply to request 1 from 172.22.0.1, 80 ms
```

Zaver