

Distribúcia multicastovej prevádzky

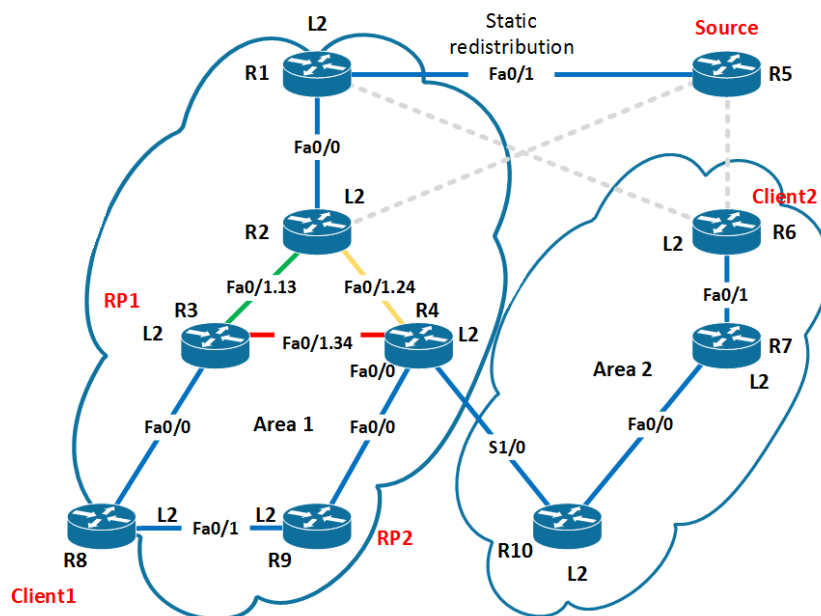
Andrej Šišila, Marián Vachalík

Obsah

1.1	Topológia	3
1.2	Úlohy	4
1.2.1	Použiť IS-IS (L2 only) single area dizajn, priame p2p prepojenia medzi R2, R3, R4	4
1.2.2	Nakonfigurovať PIM-SM s jedným statickým RP	4
1.2.3	Nakonfigurovať Source a Receiver1 a 2 podľa zadania	4
1.2.4	Nakonfigurovať SPARSE mód	15
1.2.5	Zabezpečiť RP redundanciu	18
1.2.6	Zmerať konvergenciu v prípade výpadku	23

1.1 Topológia

Budeme konfigurovať distribúciu multicastovej prevádzky so smerovacím protokolom IS-IS na topológii, ktorá je znázornená na obrázku 1. IP adresácia je uvedená v tabuľke 1 a dopĺňa grafické znázornenie topológie na obrázku 1.



Obr. 1: Topológia IS-IS

Tabuľka 1: IP adresácia

Smerovač	Funkcia	Rozhranie	IP adresa	Maska
R1	L2	Fa0/0	10.0.12.1	255.255.255.0
		Fa0/1	10.100.15.1	255.255.255.0
		Lo0	10.255.255.1	255.255.255.255
R2	L2	Fa0/0	10.0.12.2	255.255.255.0
		Fa0/1	10.100.234.2	255.255.255.0
		Lo0	10.255.255.2	255.255.255.255
R3	L1/L2	Fa0/0	10.1.38.3	255.255.255.0
		Fa0/1	10.0.234.3	255.255.255.0
		S1/0	10.2.39.3	255.255.255.252
		Lo0	10.255.255.3	255.255.255.255
R4	L1/L2	Fa0/0	10.2.49.4	255.255.255.0
		Fa0/1	10.0.234.4	255.255.255.0
		S1/0	10.3.104.4	255.255.255.252
		Lo0	10.255.255.4	255.255.255.255
R5	Smerovač iného systému	Fa0/1	10.100.15.5	255.255.255.0
		Lo0	10.255.255.5	255.255.255.255
R6	L1	Fa0/0	10.4.67.6	255.255.255.0
		Lo0	10.255.255.6	255.255.255.255
R7	L1	Fa0/1	10.4.67.7	255.255.255.0
		S1/1	10.4.107.7	255.255.255.0
		Lo0	10.255.255.7	255.255.255.255
R8	L1	Fa0/0	10.1.38.8	255.255.255.0
		Lo0	10.255.255.8	255.255.255.255
R9	L1	Fa0/0	10.2.49.9	255.255.255.0
		S1/0	10.2.39.9	255.255.255.0
		Lo0	10.255.255.9	255.255.255.255
R10	L1/L2	S1/0	10.3.104.10	255.255.255.0
		S1/1	10.4.107.10	255.255.255.0
		Lo0	10.255.255.10	255.255.255.255

1.2 Úlohy

1.2.1 Použiť IS-IS (L2 only) single area dizajn, priame p2p prepojenia medzi R2, R3, R4

1.2.2 Nakonfigurovať PIM-SM s jedným statickým RP

1.2.3 Nakonfigurovať Source a Receiver1 a 2 podľa zadania

Popis

Dohodli sme sa, že budeme používať iba smerovací protokol IS-IS. Subrozhranie “.13” a VLAN 13 sme premenovali na “.23” a VLAN 23, lebo sieť je medzi smerovačmi R2 a R3 (23), a nie medzi R1 a R3 (13).

Konfigurácia

```
=====
DENSE MODE
=====

R1
ena
conf t
hostname R1
no ip domain-lookup
username admin privil 15 secret admin
line con 0
    login local
    logging syn
    exec-time 120
line vty 0 15
    privilege level 15
    no login
int f0/0
    ip addr 10.1.12.1 255.255.255.0
    ip router isis
    isis network point-to-point
    no shut
int lo0
    ip addr 10.255.255.1 255.255.255.255
    ip router isis
    no shut
int f0/1
    ip addr 10.100.15.1 255.255.255.0
    no shut
router isis
    net 49.0001.0102.5525.5001.00
    passive-interface lo0
    is-type level-2
    metric-style wide
    redistribute static
    redistribute connected
    exit
ip route 10.255.255.5 255.255.255.255 f0/1 10.100.15.5

!aktivujeme multicast smerovanie
ip multicast-routing
int range f0/0 - 1
    ip pim dense-mode
int lo0
    ip pim dense-mode
    exit

R2
ena
conf t
```

```

hostname R2
no ip domain-lookup
username admin privil 15 secret admin
line con 0
    login local
    logging syn
    exec-time 120
line vty 0 15
    privilege level 15
    no login
int f0/0
    ip addr 10.1.12.2 255.255.255.0
    ip router isis
    isis network point-to-point
    no shut
int lo0
    ip addr 10.255.255.2 255.255.255.255
    ip router isis
    no shut
int f0/1
    no ip add
    isis network point-to-point
    no sh
int f0/1.23
    encap dot1q 23
    ip addr 10.1.23.2 255.255.255.0
    ip router isis
int f0/1.24
    encap dot1q 24
    ip addr 10.1.24.2 255.255.255.0
    ip router isis
router isis
    net 49.0001.0102.5525.5002.00
    passive-interface lo0
    is-type level-2
    metric-style wide
    exit

!aktivujeme multicast smerovanie
ip multicast-routing
int f0/0
    ip pim dense-mode
int f0/1.23
    ip pim dense-mode
int f0/1.24
    ip pim dense-mode
int lo0
    ip pim dense-mode
    exit

```

```

R3
ena
conf t
hostname R3
no ip domain-lookup
username admin privil 15 secret admin
line con 0
    login local
    logging syn
    exec-time 120
line vty 0 15
    privilege level 15
    no login
int f0/0
    ip addr 10.1.38.3 255.255.255.0
    ip router isis
    isis network point-to-point
    no shut
int lo0
    ip addr 10.255.255.3 255.255.255.255
    ip router isis
    no shut
int f0/1
    no ip addr
    isis network point-to-point
    no shut
int f0/1.23
    encap dot1q 23
    ip addr 10.1.23.3 255.255.255.0
    ip router isis
int f0/1.34
    encap dot1q 34
    ip addr 10.1.34.3 255.255.255.0
    ip router isis
router isis
    net 49.0001.0102.5525.5003.00
    passive-interface lo0
    is-type level-2
    metric-style wide
    exit

!aktivujeme multicast smerovanie
ip multicast-routing
int f0/0
    ip pim dense-mode
int f0/1.23
    ip pim dense-mode
int f0/1.34
    ip pim dense-mode
int lo0

```

```

    ip pim dense-mode
    exit

R4
ena
conf t
hostname R4
no ip domain-lookup
username admin privil 15 secret admin
line con 0
    login local
    logging syn
    exec-time 120
line vty 0 15
    privilege level 15
    no login
int f0/0
    ip addr 10.1.49.4 255.255.255.0
    ip router isis
    isis network point-to-point
    no shut
int lo0
    ip addr 10.255.255.4 255.255.255.255
    ip router isis
    no shut
int f0/1
    no ip addr
    isis network point-to-point
    no sh
int f0/1.24
    encaps dot1q 24
    ip addr 10.1.24.4 255.255.255.0
    ip router isis
int f0/1.34
    encaps dot1q 34
    ip addr 10.1.34.4 255.255.255.0
    ip router isis
int s1/0
    ip addr 10.1.104.4 255.255.255.0
    ip router isis
    no shut
router isis
    net 49.0001.0102.5525.5004.00
    passive-interface lo0
    is-type level-2
    metric-style wide
    exit

!aktivujeme multicast smerovanie
ip multicast-routing

```



```

int f0/0
    ip pim dense-mode
int f0/1.24
    ip pim dense-mode
int f0/1.34
    ip pim dense-mode
int s1/0
    ip pim dense-mode
int lo0
    ip pim dense-mode
exit

```

```

R5
ena
conf t
hostname R5
no ip domain-lookup
username admin privil 15 secret admin
line con 0
    login local
    logging syn
    exec-time 120
line vty 0 15
    privilege level 15
    no login
int lo0
    ip addr 10.255.255.5 255.255.255.255
    no shut
int f0/1
    ip addr 10.100.15.5 255.255.255.0
    no shut
ip route 0.0.0.0 0.0.0.0 f0/1 10.100.15.1

```

```

R6
ena
conf t
hostname R6
no ip domain-lookup
username admin privil 15 secret admin
line con 0
    login local
    logging syn
    exec-time 120
line vty 0 15
    privilege level 15
    no login
int f0/1

```

```

    ip addr 10.2.67.6 255.255.255.0
    ip router isis
    isis network point-to-point
    no shut
int lo0
    ip addr 10.255.255.6 255.255.255.255
    ip router isis
    no shut
int lo1
    ip add 10.255.255.66 255.255.255.255
    ip router isis
    ip igmp join-group 239.0.0.1
router isis
    net 49.0002.0102.5525.5006.00
    passive-interface lo0
    is-type level-2
    metric-style wide
    exit

```

```

!aktivujeme multicast smerovanie
ip multicast-routing
int range f0/1
    ip pim dense-mode
    exit
int lo0
    ip pim dense-mode
    exit
int lo1
    ip pim dense-mode
    exit

```

```

R7
ena
conf t
hostname R7
no ip domain-lookup
username admin privil 15 secret admin
line con 0
    login local
    logging syn
    exec-time 120
line vty 0 15
    privilege level 15
    no login
int f0/1
    ip addr 10.2.67.7 255.255.255.0
    ip router isis
    isis network point-to-point
    no shut
int lo0

```

```

    ip addr 10.255.255.7 255.255.255.255
    ip router isis
    no shut
int f0/0
    ip addr 10.2.107.7 255.255.255.0
    Ip router isis
    isis network point-to-point
    no shut
router isis
    net 49.0002.0102.5525.5007.00
    passive-interface lo0
    is-type level-2
    metric-style wide
    exit

!aktivujeme multicast smerovanie
ip multicast-routing
int range f0/0 - 1
    ip pim dense-mode
    exit
int lo0
    ip pim dense-mode
    exit

```

```

R8
ena
conf t
hostname R8
no ip domain-lookup
username admin privil 15 secret admin
line con 0
    login local
    logging syn
    exec-time 120
line vty 0 15
    privilege level 15
    no login
int f0/0
    ip addr 10.1.38.8 255.255.255.0
    ip router isis
    isis network point-to-point
    no shut
int lo0
    ip addr 10.255.255.8 255.255.255.255
    ip router isis
    no shut
int lo1
    ip add 10.255.255.88 255.255.255.255

```

```

    ip router isis
    ip igmp join-group 239.0.0.1
int f0/1
    ip addr 10.1.89.8 255.255.255.0
    Ip router isis
    isis network point-to-point
    no shut
router isis
    net 49.0001.0102.5525.5008.00
    passive-interface lo0
    is-type level-2
    metric-style wide
    exit

!aktivujeme multicast smerovanie
ip multicast-routing
int range f0/0 - 1
    ip pim dense-mode
    exit
int lo0
    ip pim dense-mode
    exit
int lo1
    ip pim dense-mode
    exit


R9
ena
conf t
hostname R9
no ip domain-lookup
username admin privl 15 secret admin
line con 0
    login local
    logging syn
    exec-time 120
line vty 0 15
    privilege level 15
    no login
int f0/0
    ip addr 10.1.49.9 255.255.255.0
    ip router isis
    isis network point-to-point
    no shut
int lo0
    ip addr 10.255.255.9 255.255.255.255
    ip router isis

```

```

    no shut
int f0/1
    ip addr 10.1.89.9 255.255.255.0
    ip router isis
    isis network point-to-point
    no shut
router isis
    net 49.0001.0102.5525.5009.00
    passive-interface lo0
    is-type level-2
    metric-style wide
    exit

!aktivujeme multicast smerovanie
ip multicast-routing
int range f0/0 - 1
    ip pim dense-mode
    exit
int lo0
    ip pim dense-mode

R10
ena
conf t
hostname R10
no ip domain-lookup
username admin privil 15 secret admin
line con 0
    login local
    logging syn
    exec-time 120
line vty 0 15
    privilege level 15
    no login
int s1/0
    ip addr 10.1.104.10 255.255.255.0
    ip router isis
    no shut
int lo0
    ip addr 10.255.255.10 255.255.255.255
    ip router isis
    no shut
int f0/0
    ip addr 10.2.107.10 255.255.255.0
    ip router isis
    isis network point-to-point
    no shut
router isis
    net 49.0002.0102.5525.5010.00
    passive-interface lo0

```

```

    is-type level-2
    metric-style wide
    exit

!aktivujeme multicast smerovanie
ip multicast-routing
int f0/0
    ip pim dense-mode
    exit
int s1/0
    ip pim dense-mode
    exit
int lo0
    ip pim dense-mode
    exit

```



Overenie

R5#ping 239.0.0.1

Type escape sequence to abort.

Sending 1, 100-byte ICMP Echos to 239.0.0.1, timeout is 2 seconds:

Reply to request 0 from 10.1.38.8, 68 ms

Reply to request 0 from 10.2.67.6, 132 ms

R8#sh ip pim interface

Address	Interface	Ver/ Mode	Nbr Count	Query Intvl	DR Prior	DR
10.255.255.88	Loopback1	v2/D	0	30	1	10.255.255.88
10.1.38.8	FastEthernet0/0	v2/D	1	30	1	10.1.38.8
10.1.89.8	FastEthernet0/1	v2/D	1	30	1	10.1.89.9
10.255.255.8	Loopback0	v2/D	0	30	1	10.255.255.8

Po vykonaní ping-u na IP adresu multicastovej skupiny nám prišli odpovede z oboch klientských smerovačov: R6 a R8. Výpis príkazu “show ip pim interface” zo smerovača R8 dokazuje, že všetky rozhrania sú nastavené v “DENSE” móde (v stĺpci “Ver/Mode” vidíme D, čo indikuje aktívny “DENSE” mód).



1.2.4 Nakonfigurovať SPARSE mód

Popis

Konfigurujeme "SPARSE" mód bez záložného RP. "SPARSE" mód, na rozdiel od "DENSE" módu, nezahlcuje sieť správami na odpojenie od skupiny (tzv. "PRUNE" správy). Namiesto toho posiela multicastový tok iba tým, ktorí si o to požiadajú tzv. "JOIN" správou. Na preposielanie týchto správ sa používa zdieľaný strom, ktorého "koreňom" je Rendezvous (čítaj *randevú*) Point (ďalej len RP smerovač). RP smerovač pozná všetky zdroje, z ktorých sa šíri multicastový tok a následne ho preposiela multicastovým klientom.



Konfigurácia

```
=====
SPARSE MODE
=====

R1
!aktivujeme multicast smerovanie
ip multicast-routing
int range f0/0 - 1
    ip pim sparse-mode
int lo0
    ip pim sparse-mode
exit
ip pim rp-addr 10.255.255.3

R2
!aktivujeme multicast smerovanie
ip multicast-routing
int f0/0
    ip pim sparse-mode
int f0/1.23
    ip pim sparse-mode
int f0/1.24
    ip pim sparse-mode
int lo0
    ip pim sparse-mode
exit
ip pim rp-addr 10.255.255.3

R3
!aktivujeme multicast smerovanie
ip multicast-routing
int f0/0
    ip pim sparse-mode
int f0/1.23
    ip pim sparse-mode
int f0/1.34
    ip pim sparse-mode
```

```
int lo0
    ip pim sparse-mode
    exit
ip pim rp-addr 10.255.255.3
```

```
R4
!aktivujeme multicast smerovanie
ip multicast-routing
int f0/0
    ip pim sparse-mode
int f0/1.24
    ip pim sparse-mode
int f0/1.34
    ip pim sparse-mode
int s1/0
    ip pim sparse-mode
int lo0
    ip pim sparse-mode
    exit
ip pim rp-addr 10.255.255.3
```

```
R6
!aktivujeme multicast smerovanie
ip multicast-routing
int range f0/1
    ip pim sparse-mode
    exit
int lo0
    ip pim sparse-mode
    exit
int lo1
    ip pim sparse-mode
    exit
ip pim rp-addr 10.255.255.3
```

```
R7
!aktivujeme multicast smerovanie
ip multicast-routing
int range f0/0 - 1
    ip pim sparse-mode
    exit
int lo0
    ip pim sparse-mode
    exit
ip pim rp-addr 10.255.255.3
```

```
R8
!aktivujeme multicast smerovanie
ip multicast-routing
```



```

int range f0/0 - 1
    ip pim sparse-mode
    exit
int lo0
    ip pim sparse-mode
    exit
int lo1
    ip pim sparse-mode
    exit
ip pim rp-addr 10.255.255.3

```

```

R9
!aktivujeme multicast smerovanie
ip multicast-routing
int range f0/0 - 1
    ip pim sparse-mode
    exit
int lo0
    ip pim sparse-mode
ip pim rp-addr 10.255.255.3

```

```

R10
!aktivujeme multicast smerovanie
ip multicast-routing
int f0/0
    ip pim sparse-mode
    exit
int s1/0
    ip pim sparse-mode
    exit
int lo0
    ip pim sparse-mode
    exit
ip pim rp-addr 10.255.255.3

```

Overenie

```
R5#ping 239.0.0.1
```

Type escape sequence to abort.

Sending 1, 100-byte ICMP Echos to 239.0.0.1, timeout is 2 seconds:

Reply to request 0 from 10.1.38.8, 60 ms

Reply to request 0 from 10.2.67.6, 124 ms

```
R3#sh ip pim int
```

Address	Interface	Ver/ Mode	Nbr Count	Query Intvl	DR Prior	DR
10.1.38.3	FastEthernet0/0	v2/S	1	30	1	10.1.38.8
10.1.23.3	FastEthernet0/1.23	v2/S	1	30	1	10.1.23.3
10.1.34.3	FastEthernet0/1.34	v2/S	1	30	1	10.1.34.4
10.255.255.3	Loopback0	v2/S	0	30	1	10.255.255.3

```
R1#sh ip pim rp
```

```
Group: 239.0.0.1, RP: 10.255.255.3, v2, uptime 00:06:22, expires never
Group: 224.0.1.40, RP: 10.255.255.3, v2, uptime 00:07:07, expires never
```

```
R1#sh ip igmp groups
```

```
IGMP Connected Group Membership
Group Address Interface Uptime Expires Last Reporter Group
Account
```

224.0.1.40	FastEthernet0/0	00:35:38	00:02:21	10.1.12.2	
------------	-----------------	----------	----------	-----------	--

Rovnako ako pri "DENSE" móde, pri ping-u na IP adresu multicastovej skupiny prichádzali odpovede od klientov 10.1.38.8 (R8) a 10.2.67.6 (R6). Výpis príkazu "show ip pim interface" hovorí, že rozhrania na smerovači R3 sú v "SPARSE" móde (viď písmeno S v stĺpci "Ver/Mode", čo značí aktívny "SPARSE" mód). Z výpisu príkazu "show ip pim rp" vidíme IP adresu multicastovej skupiny pre klientov a IP adresu RP smerovača, čo je adresa loopback0 rozhrania pre R3. Vo výpise príkazu "show ip igmp groups" vidíme, že smerovač R1 patrí do multicastovej skupiny 224.0.1.40, čo je AutoRP Discovery. AutoRP je Cisco implementácia hľadania záložného RP smerovača pomocou RP-Mapper smerovača. Do tejto skupiny patria predvolene všetky Cisco smerovače.



1.2.5 Zabezpečiť RP redundanciu

Popis

V "SPARSE-DENSE" móde môžeme nastaviť záložný RP, ktorý bude vybraný pomocou BSR. "SPARSE" mód je používaný na šírenie multicastového toku, "DENSE" mód na šírenie informácie o prítomnosti RP smerovača.

Konfigurácia

```
=====
SPARSE-DENSE MODE
=====

R1
!aktivujeme multicast smerovanie
ip multicast-routing
int range f0/0 - 1
    ip pim sparse-dense-mode
```

```
int lo0
  ip pim sparse-dense-mode
  exit
no ip pim rp-addr 10.255.255.3
```

```
R2
!aktivujeme multicast smerovanie
ip multicast-routing
int f0/0
  ip pim sparse-dense-mode
int f0/1.23
  ip pim sparse-dense-mode
int f0/1.24
  ip pim sparse-dense-mode
int lo0
  ip pim sparse-dense-mode
  exit
no ip pim rp-addr 10.255.255.3
```

```
R3
!aktivujeme multicast smerovanie
ip multicast-routing
int f0/0
  ip pim sparse-dense-mode
int f0/1.23
  ip pim sparse-dense-mode
int f0/1.34
  ip pim sparse-dense-mode
int lo0
  ip pim sparse-dense-mode
  exit
no ip pim rp-addr 10.255.255.3
ip pim rp-candidate lo0
```

```
R4
!aktivujeme multicast smerovanie
ip multicast-routing
int f0/0
  ip pim sparse-dense-mode
int f0/1.24
  ip pim sparse-dense-mode
int f0/1.34
  ip pim sparse-dense-mode
int s1/0
  ip pim sparse-dense-mode
int lo0
  ip pim sparse-dense-mode
  exit
no ip pim rp-addr 10.255.255.3
```

```
R6
!aktivujeme multicast smerovanie
ip multicast-routing
int range f0/1
    ip pim sparse-dense-mode
    exit
int lo0
    ip pim sparse-dense-mode
    exit
int lo1
    ip pim sparse-dense-mode
    exit
no ip pim rp-addr 10.255.255.3
```

```
R7
!aktivujeme multicast smerovanie
ip multicast-routing
int range f0/0 - 1
    ip pim sparse-dense-mode
    exit
int lo0
    ip pim sparse-dense-mode
    exit
no ip pim rp-addr 10.255.255.3
```

```
R8
!aktivujeme multicast smerovanie
ip multicast-routing
int range f0/0 - 1
    ip pim sparse-dense-mode
    exit
int lo0
    ip pim sparse-dense-mode
    exit
int lo1
    ip pim sparse-dense-mode
    exit
no ip pim rp-addr 10.255.255.3
```

```
R9
!aktivujeme multicast smerovanie
ip multicast-routing
int range f0/0 - 1
    ip pim sparse-dense-mode
    exit
int lo0
```

```

    ip pim sparse-dense-mode
no ip pim rp-addr 10.255.255.3
ip pim bsr-candidate lo0

```

```

R10
!aktivujeme multicast smerovanie
ip multicast-routing
int f0/0
    ip pim sparse-dense-mode
    exit
int s1/0
    ip pim sparse-dense-mode
    exit
int lo0
    ip pim sparse-dense-mode
    exit
no ip pim rp-addr 10.255.255.3

```

Overenie

R5#ping 239.0.0.1

Type escape sequence to abort.

Sending 1, 100-byte ICMP Echos to 239.0.0.1, timeout is 2 seconds:

Reply to request 0 from 10.1.89.8, 76 ms

Reply to request 0 from 10.2.67.6, 136 ms

R4#sh ip pim rp

Group: 239.0.0.1, RP: 10.255.255.3, v2, uptime 00:04:27, expires 00:02:19

R4#sh ip pim int

Address	Interface	Ver/ Mode	Nbr Count	Query Intvl	DR Prior	DR
10.1.49.4	FastEthernet0/0	v2/SD	1	30	1	10.1.49.9
10.1.24.4	FastEthernet0/1.24	v2/SD	1	30	1	10.1.24.4
10.1.34.4	FastEthernet0/1.34	v2/SD	1	30	1	10.1.34.4
10.1.104.4	Serial1/0	v2/SD	1	30	1	0.0.0.0
10.255.255.4	Loopback0	v2/SD	0	30	1	10.255.255.4

```

-----
R9#sh ip igmp groups
IGMP Connected Group Membership
Group Address  Interface      Uptime        Expires       Last Reporter  Group
Accounted
224.0.1.39     FastEthernet0/0 00:11:57     00:01:57     10.1.49.4
224.0.1.40     FastEthernet0/0 01:03:32     00:02:59     10.1.49.4
-----

```

```

R4#show ip pim autorp
AutoRP Information:
  AutoRP is enabled.
PIM AutoRP Statistics: Sent/Received
  RP Announce: 0/184, RP Discovery: 188/160
-----

```

Power Tools

```

R6#mstat 10.100.15.5 224.0.1.40
Type escape sequence to abort.
Mtrace from 10.100.15.5 to 10.2.67.6 via group 224.0.1.40
From source (?) to destination (?)
Waiting to accumulate statistics.....
Results after 10 seconds:

```

Source	Response	Dest	Packet Statistics For	Only For Traffic
			All Multicast Traffic	From 10.100.15.5
			Lost/Sent = Pct Rate	To 224.0.1.40
10.100.15.5	10.2.67.6			
	rtt 87	ms		
v	hop 87	ms		
10.100.15.1				
10.1.12.1	?			
	ttl 0			
v	hop -8	s	0/0 = --% 0 pps	0/0 = --% 0 pps
10.1.12.2				
10.1.24.2	?			
	ttl 1			
v	hop 2576	ms	0/0 = --% 0 pps	0/0 = --% 0 pps
10.1.24.4				
10.1.104.4	?			
	ttl 2			
v	hop 15	s	0/0 = --% 0 pps	0/0 = --% 0 pps

```

10.1.104.10
10.2.107.10      ?
    |      ^      ttl  3
    v      |      hop -8  s      0/0 = --%      0 pps      0/0 = --%      0 pps
10.2.107.7
10.2.67.7        ?
    |      ^      ttl  4
    v      |      hop -1  s      0/0 = --%      0 pps      0/0 = --%      0 pps
10.2.67.6        ?
    |      _      ttl  5
    v      |      hop  0  ms      0      0 pps      0      0 pps
10.2.67.6        10.2.67.6
Receiver         Query Source

```

Po ping-u na multicastovú adresu prišli odpovede od oboch klientských smerovačov: R6 a R8. Výpis príkazu “sh ip pim rp” ukazuje, že RP smerovač je R3, o čom hovorí adresa loopback0 rozhrania. Výpis príkazu “show ip pim interface” hovorí, že všetky rozhrania na smerovači R4 sú v “SPARSE-DENSE” móde. Príkaz “show ip igmp groups” ukazuje, že smerovač R9 patrí do multicastových skupín: 224.0.1.40 (RP Discovery) a 224.0.1.39 (RP Announce). Tým, že patrí aj do skupiny “RP Announce” oznamuje ostatným smerovačom, že môže byť kandidátom na RP, čo je dôkaz, že záložný RP je v pohotovosti. Príkaz “show ip pim autorp” zo smerovača R4 hovorí, že “AutoRP” protokol na vyhľadanie záložného RP smerovača je aktívny, čo je dôkaz, že smerovač R4 funguje správne ako “RP Mapper”. Nakoniec príkaz “mstat” vykreslil zdieľaný strom od zdroja (R5) ku klientovi (R6) cez multicastovú skupinu 224.0.1.40.

1.2.6 Zmerať konvergenciu v prípade výpadku

Popis

Vypili sme linku “Fa0/1.23” medzi R2 a R3 zmenou IP adresy na chybnú (z 10.1.23.3 na 10.2.23.3).

Konfigurácia

```

R3(config)#int f0/1
R3(config-if)#int f0/1.23
R3(config-subif)#ip address 10.2.23.3 255.255.255.248
*Mar  2 23:53:39.844: %PIM-5-DRCHG: DR change from neighbor 10.1.23.3 to
10.2.23.3 on interface FastEthernet0/1.23

```

Kontrola konverencie zo smerovača R5:

```

R5#ping
Protocol [ip]:

```

```

Target IP address: 10.255.255.8
Repeat count [5]: 10000000
Datagram size [100]:
Timeout in seconds [2]: 1
Extended commands [n]:
Sweep range of sizes [n]:
Type escape sequence to abort.
Sending 10000000, 100-byte ICMP Echos to 10.255.255.8, timeout is 1 seconds:
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!.
Success rate is 98 percent (770/785), round-trip min/avg/max = 56/81/112 ms

```

Nakoniec sme merali konvergenciu pri celkovom výpadku RP (R3).

```

*Mar  5 23:05:28.230: %PIM-5-NBRCHG: neighbor 10.1.23.3 UP on interface
FastEthernet0/1.23
*Mar  5 23:05:28.282: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to
10.1.23.3 on interface FastEthernet0/1.23

```

```

R1#show ip pim rp mapping
PIM Group-to-RP Mappings

```

```

Group(s) 224.0.0.0/4
  RP 10.255.255.3 (?), v2
    Info source: 10.255.255.9 (?), via bootstrap, priority 0, holdtime 150
    Uptime: 4d20h, expires: 00:02:13

```

Kontrola ukázala, že zmena RP smerovača na R9 po výpadku R3 sa uskutočnila za cca 50ms, avšak smerovaciemu protokolu IS-IS trvalo približne 14 sekúnd, kým aj klientský smerovač R8 získal konektivitu so zvyškom siete.