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Sprawozdanie z realizacji laboratorium KRI nr 3
PIM-SM

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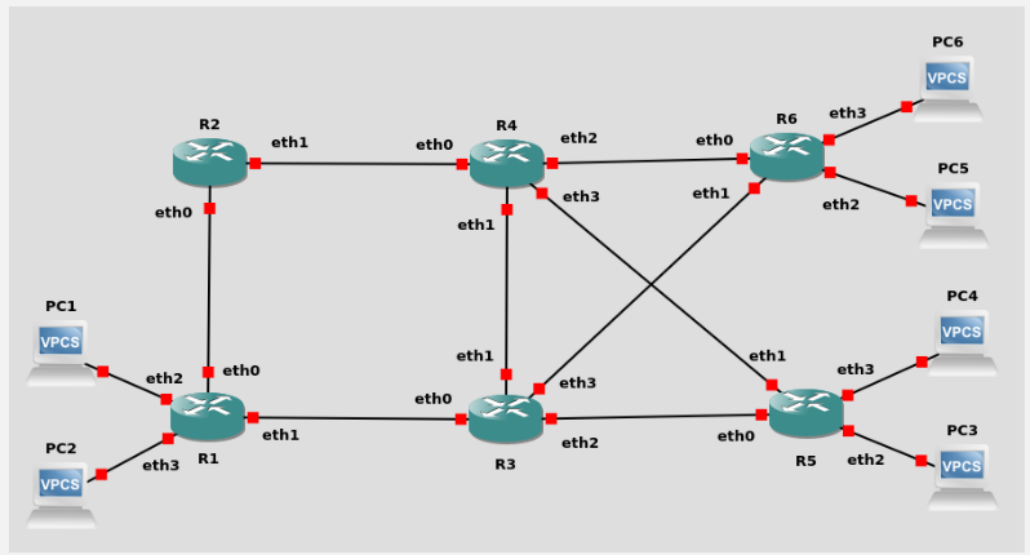
Spis treści

Wstęp

Niniejszy dokument to sprawozdanie z realizacji laboratorium w ramach przedmiotu KRI. Oświadczamy, że ta praca, stanowiąca podstawę do uznania osiągnięcia efektów uczenia się z przedmiotu KRI, została wykonana przez nas samodzielnie.

1. Zadanie A: Początkowa konfiguracja sieci

W ramach tego laboratorium otrzymaliśmy skonfigurowaną sieć, której topologia i adresacja są przedstawione poniżej.



Rys. 1: Topologia emulowanej sieci

Subnet		Subnet address
R1-R2		192.168.12.0/24
R2-R4		192.168.24.0/24
R3-R4		192.168.34.0/24
R1-R3		192.168.13.0/24
R3-R5		192.168.35.0/24
R3-R6		192.168.36.0/24
R4-R5		192.168.45.0/24
R4-R6		192.168.46.0/24
PC1-R1		192.168.1.0/24
PC2-R1		192.168.2.0/24
PC3-R5		192.168.3.0/24
PC4-R5		192.168.4.0/24
PC5-R6		192.168.5.0/24
PC6-R6		192.168.6.0/24
Router	Interface	Address
R1	L0	1.1.1.1/32
R2	L0	2.2.2.2/32
R3	L0	3.3.3.3/32
R4	L0	4.4.4.4/32
R5	L0	5.5.5.5/32
R6	L0	6.6.6.6/32

Table 1. Addressing plan

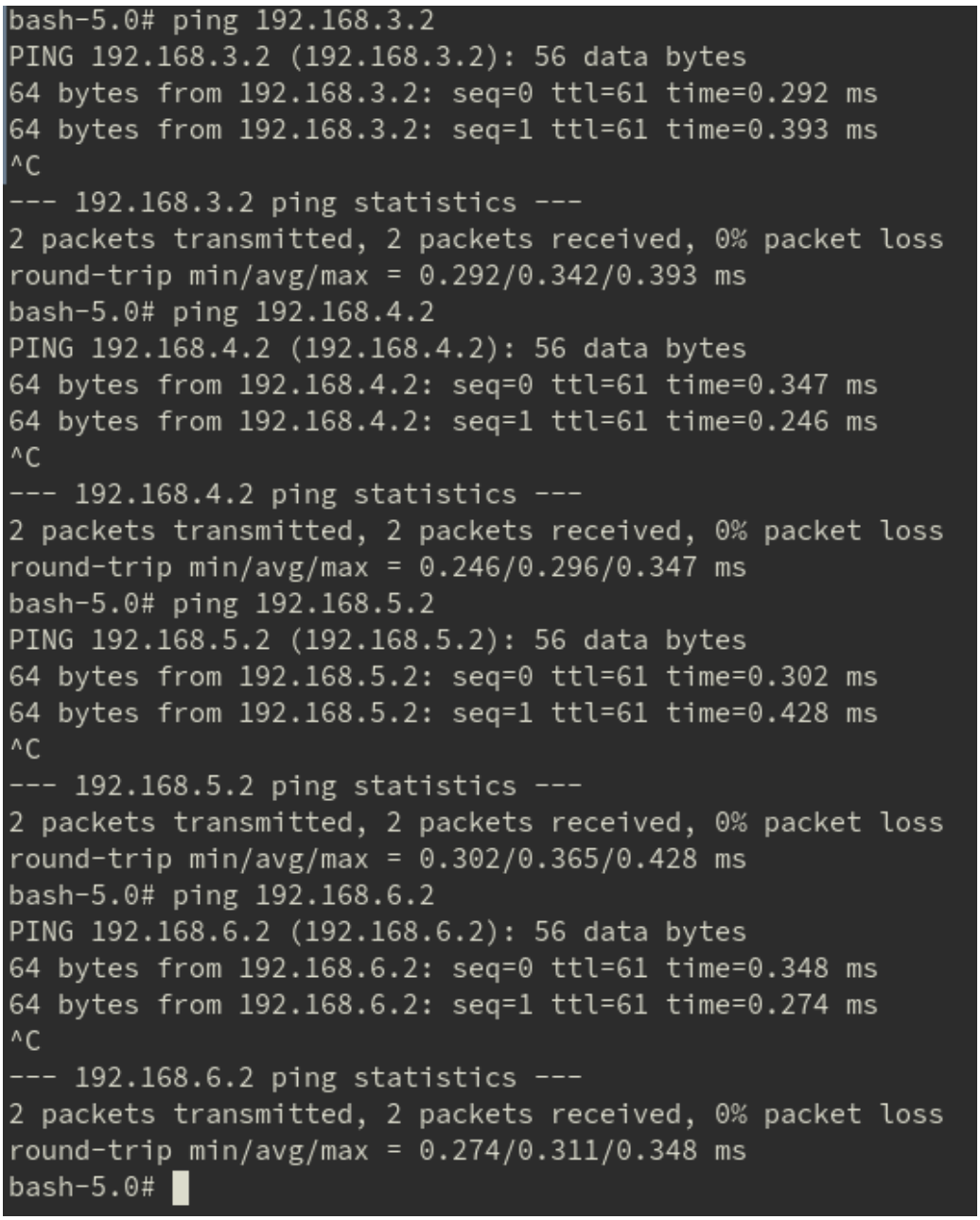
Rys. 2: Adresacja emulowanej sieci

2. Zadanie B: Konfiguracja OSPF

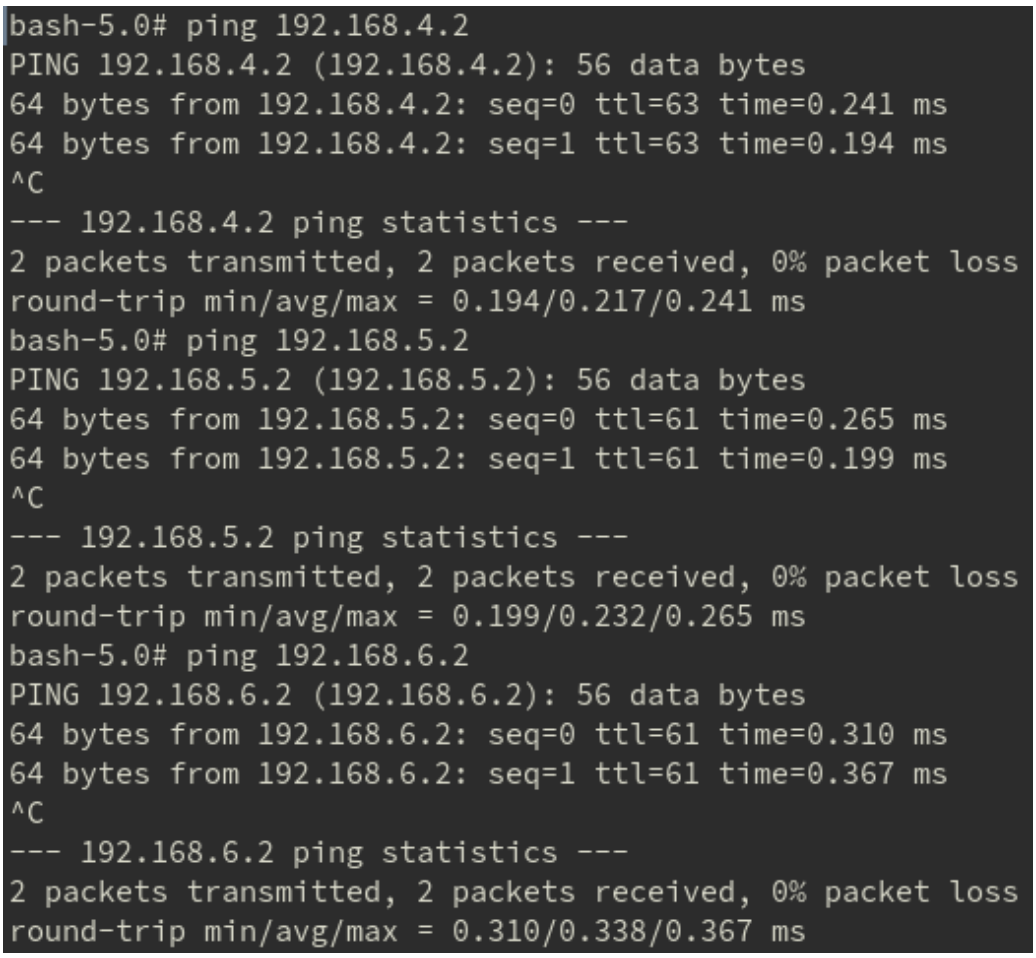
W celu przetestowania poprawności konfiguracji i działania połączeń OSPF wykonane zostały polecenia *ping* testujące każde z łączy między *PC*, ponieważ protokół OSPF jest typu link-state tzn. każdy router zawiera informację o całej topologi sieci uznaliśmy, że sprawdzanie połączeń dokonamy z eliminacją powtarzający się tras tj. w momencie, gdy sprawdziliśmy PC1 → PC5 to nie sprawdzaliśmy PC5 → PC1

```
bash-5.0# ping 192.168.2.2
PING 192.168.2.2 (192.168.2.2): 56 data bytes
64 bytes from 192.168.2.2: seq=0 ttl=63 time=0.636 ms
64 bytes from 192.168.2.2: seq=1 ttl=63 time=0.252 ms
^C
--- 192.168.2.2 ping statistics ---
2 packets transmitted, 2 packets received, 0% packet loss
round-trip min/avg/max = 0.252/0.444/0.636 ms
bash-5.0# ping 192.168.3.2
PING 192.168.3.2 (192.168.3.2): 56 data bytes
64 bytes from 192.168.3.2: seq=0 ttl=61 time=0.471 ms
64 bytes from 192.168.3.2: seq=1 ttl=61 time=0.242 ms
^C
--- 192.168.3.2 ping statistics ---
2 packets transmitted, 2 packets received, 0% packet loss
round-trip min/avg/max = 0.242/0.356/0.471 ms
bash-5.0# ping 192.168.4.2
PING 192.168.4.2 (192.168.4.2): 56 data bytes
64 bytes from 192.168.4.2: seq=0 ttl=61 time=0.543 ms
64 bytes from 192.168.4.2: seq=1 ttl=61 time=0.366 ms
^C
--- 192.168.4.2 ping statistics ---
2 packets transmitted, 2 packets received, 0% packet loss
round-trip min/avg/max = 0.366/0.454/0.543 ms
bash-5.0# ping 192.168.5.2
PING 192.168.5.2 (192.168.5.2): 56 data bytes
64 bytes from 192.168.5.2: seq=0 ttl=61 time=0.315 ms
64 bytes from 192.168.5.2: seq=1 ttl=61 time=0.176 ms
^C
--- 192.168.5.2 ping statistics ---
2 packets transmitted, 2 packets received, 0% packet loss
round-trip min/avg/max = 0.176/0.245/0.315 ms
bash-5.0# ping 192.168.6.2
PING 192.168.6.2 (192.168.6.2): 56 data bytes
64 bytes from 192.168.6.2: seq=0 ttl=61 time=0.317 ms
64 bytes from 192.168.6.2: seq=1 ttl=61 time=0.479 ms
^C
--- 192.168.6.2 ping statistics ---
2 packets transmitted, 2 packets received, 0% packet loss
round-trip min/avg/max = 0.317/0.398/0.479 ms
bash-5.0#
```

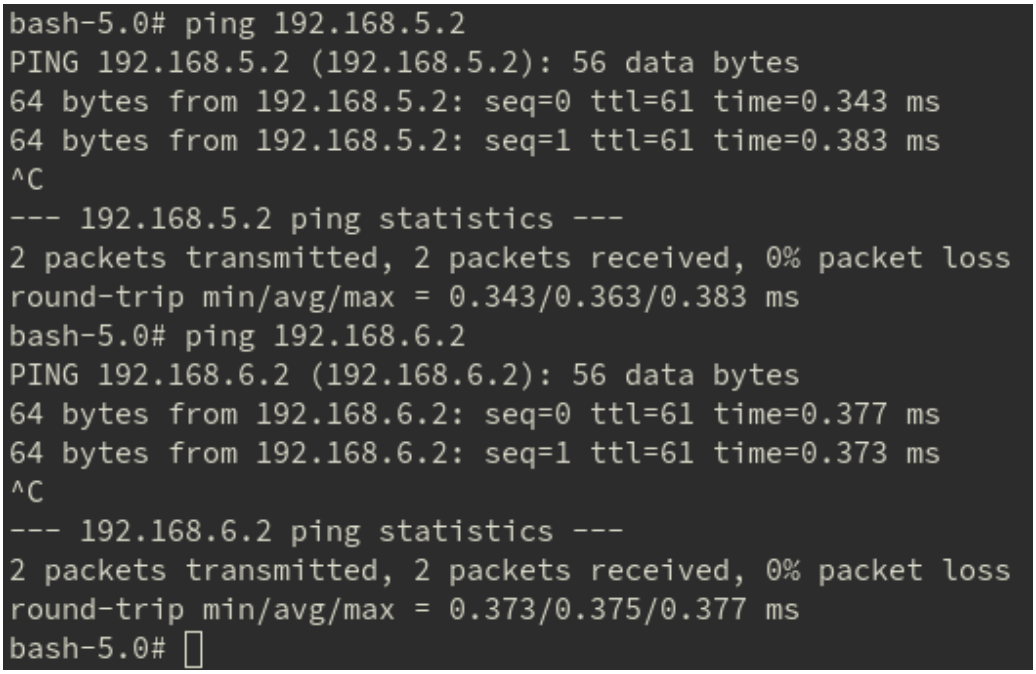
Rys. 3: Wynik wykonania *ping* na **PC1**



Rys. 4: Wynik wykonania *ping* na **PC2**



Rys. 5: Wynik wykonania *ping* na **PC3**



Rys. 6: Wynik wykonania *ping* na **PC4**

```
bash-5.0# ping 192.168.6.2
PING 192.168.6.2 (192.168.6.2): 56 data bytes
64 bytes from 192.168.6.2: seq=0 ttl=63 time=0.182 ms
64 bytes from 192.168.6.2: seq=1 ttl=63 time=0.169 ms
^C
--- 192.168.6.2 ping statistics ---
2 packets transmitted, 2 packets received, 0% packet loss
round-trip min/avg/max = 0.169/0.175/0.182 ms
bash-5.0#
```

Rys. 7: Wynik wykonania *ping* na **PC5**

3. Zadanie C: Konfiguracja PIM-SM

3.1. Zadanie C1

Po konfiguracji routerów zgodnie z instrukcją laboratoryjną zostały wykonane następujące komendy w celu weryfikacji poprawności konfiguracji PIM-SM:

- show ip mroute
- show ip pim neighbour
- show ip pim interface
- show ip pim interface detail
- show running config

3.1.1. Wyniki komend dla R1

```
R1# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source  Group  Flags  Proto  Input  Output  TTL  Uptime
```

Rys. 8: Wynik wykonania *show ip mroute* na **R1**

```
R1# show ip pim neighbor
 Interface  Neighbor      Uptime    Holdtime  DR Pri
 eth0       192.168.12.2  00:03:28  00:01:16  1
 eth1       192.168.13.3  00:03:09  00:01:35  1
```

Rys. 9: Wynik wykonania *show ip pim neighbour* na **R1**

```
R1# show ip pim interface
 Interface  State  Address       PIM Nbrs  PIM DR        FHR  IfChannels
 eth0       up     192.168.12.1  1         192.168.12.2  0    0
 eth1       up     192.168.13.1  1         192.168.13.3  0    0
 eth2       up     192.168.1.1   0         local         0    0
 eth3       up     192.168.2.1   0         local         0    0
 pimreg     up     0.0.0.0       0         local         0    0
```

Rys. 10: Wynik wykonania *show ip pim interface* na **R1**

```
R1# show ip pim interface detail
Interface  : eth0
State      : up
Address    : 192.168.12.1 (primary)

PIM Neighbors
-------------
192.168.12.2    : up for 00:03:49, holdtime expires in 00:01:25


Designated Router
-----------------
Address   : 192.168.12.2
Priority  : 1(0)
Uptime    : 00:03:49
Elections : 1
Changes   : 1


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : 00:00:10
StatStart      : 00:04:47
Receive        : 9
Receive Failed : 0
Send           : 10
Send Failed    : 0
Generation ID  : 2842489b


Flags
-----
All Multicast   : no
Broadcast       : yes
Deleted         : no
Interface Index : 32
Multicast       : yes
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                    : yes
Effective Propagation Delay  : 500 msec
Effective Override Interval  : 2500 msec
Join Prune Override Interval : 3000 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 500 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 2500 msec
```

(a) Wynik wykonania *show ip pim interface detail* na **R1** (cz. 1)

```
BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes


Interface  : eth1
State      : up
Address    : 192.168.13.1 (primary)

PIM Neighbors
-------------
192.168.13.3    : up for 00:03:30, holdtime expires in 00:01:44


Designated Router
-----------------
Address   : 192.168.13.3
Priority  : 1(0)
Uptime    : 00:03:30
Elections : 1
Changes   : 1


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : 00:00:29
StatStart      : 00:05:04
Receive        : 9
Receive Failed : 0
Send           : 12
Send Failed    : 0
Generation ID  : 70ee6af2


Flags
-----
All Multicast   : no
Broadcast       : yes
Deleted         : no
Interface Index : 34
Multicast       : yes
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                    : yes
Effective Propagation Delay  : 500 msec
Effective Override Interval  : 2500 msec
Join Prune Override Interval : 3000 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 500 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 2500 msec
```

(b) Wynik wykonania *show ip pim interface detail* na **R1** (cz. 2)

```
BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes


Interface  : eth2
State      : up
Address    : 192.168.1.1 (primary)

Designated Router
-----------------
Address   : 192.168.1.1
Priority  : 1(0)
Uptime    : --:--:--
Elections : 0
Changes   : 0


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : 00:00:21
StatStart      : 00:04:39
Receive        : 0
Receive Failed : 0
Send           : 10
Send Failed    : 0
Generation ID  : 437a2f67


Flags
-----
All Multicast   : no
Broadcast       : yes
Deleted         : no
Interface Index : 36
Multicast       : yes
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                    : yes
Effective Propagation Delay  : 0 msec
Effective Override Interval  : 0 msec
Join Prune Override Interval : 0 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 0 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 0 msec
```

(a) Wynik wykonania *show ip pim interface detail* na **R1** (cz. 3)

```
BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes


Interface  : pimreg
State      : up
Address    : * (primary)

Designated Router
-----------------
Address   : *
Priority  : 1(0)
Uptime    : --:--:--
Elections : 0
Changes   : 0


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : --:--:--
StatStart      : 00:15:44
Receive        : 0
Receive Failed : 0
Send           : 0
Send Failed    : 0
Generation ID  : 00000000


Flags
-----
All Multicast   : no
Broadcast       : no
Deleted         : no
Interface Index : 2
Multicast       : no
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                    : yes
Effective Propagation Delay  : 0 msec
Effective Override Interval  : 0 msec
Join Prune Override Interval : 0 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 0 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 0 msec


BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes
```

(b) Wynik wykonania *show ip pim interface detail* na **R1** (cz. 4)

```
R1# show running-config
Building configuration...

Current configuration:
!
frr version 8.5_git
frr defaults traditional
hostname R1
no ipv6 forwarding
ip pim rp 192.168.24.2 224.10.0.0/16
ip pim spt-switchover infinity-and-beyond
!
interface eth0
 ip address 192.168.12.1/24
 ip pim
 mpls enable
exit
!
interface eth1
 ip address 192.168.13.1/24
 ip pim
 mpls enable
exit
!
interface eth2
 ip address 192.168.1.1/24
 ip igmp
 ip pim
 mpls enable
exit
!
interface eth3
 ip address 192.168.2.1/24
 ip igmp
 ip pim
 mpls enable
exit
!
interface lo
 ip address 1.1.1.1/32
 mpls enable
exit
!
router ospf
 network 1.1.1.1/32 area 0
 network 192.168.1.0/24 area 0
 network 192.168.2.0/24 area 0
 network 192.168.12.0/24 area 0
 network 192.168.13.0/24 area 0
exit
!
end
```

Rys. 13: Wynik wykonania *show running config* na **R1**

3.1.2. Wyniki komend dla R2

```
R2# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source  Group  Flags  Proto  Input  Output  TTL  Uptime
```

Rys. 14: Wynik wykonania *show ip mroute* na **R2**

```
R2# show ip pim neighbor
 Interface  Neighbor      Uptime    Holdtime  DR Pri
 eth0       192.168.12.1  00:04:50  00:01:24  1
 eth1       192.168.24.4  00:03:59  00:01:16  1
```

Rys. 15: Wynik wykonania *show ip pim neighbour* na **R2**

```
R2# show ip pim interface
 Interface  State  Address       PIM Nbrs  PIM DR        FHR  IfChannels
 eth0       up     192.168.12.2  1         local         0    0
 eth1       up     192.168.24.2  1         192.168.24.4  0    0
 pimreg     up     0.0.0.0       0         local         0    0
```

Rys. 16: Wynik wykonania *show ip pim interface* na **R2**

```
R2# show ip pim interface detail
Interface  : eth0
State      : up
Address    : 192.168.12.2 (primary)

PIM Neighbors
-------------
192.168.12.1    : up for 00:05:02, holdtime expires in 00:01:42


Designated Router
-----------------
Address   : 192.168.12.2
Priority  : 1(0)
Uptime    : --:--:--
Elections : 1
Changes   : 0


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : 00:00:27
StatStart      : 00:05:02
Receive        : 11
Receive Failed : 0
Send           : 12
Send Failed    : 0
Generation ID  : 4cc7713f


Flags
-----
All Multicast   : no
Broadcast       : yes
Deleted         : no
Interface Index : 42
Multicast       : yes
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                    : yes
Effective Propagation Delay  : 500 msec
Effective Override Interval  : 2500 msec
Join Prune Override Interval : 3000 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 500 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 2500 msec
```

(a) Wynik wykonania *show ip pim interface detail* na **R2** (cz. 1)

```
BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes


Interface  : eth1
State      : up
Address    : 192.168.24.2 (primary)

PIM Neighbors
-------------
192.168.24.4    : up for 00:04:11, holdtime expires in 00:01:33


Designated Router
-----------------
Address   : 192.168.24.4
Priority  : 1(0)
Uptime    : 00:04:11
Elections : 1
Changes   : 1


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : 00:00:18
StatStart      : 00:04:56
Receive        : 10
Receive Failed : 0
Send           : 11
Send Failed    : 0
Generation ID  : 68ec124b


Flags
-----
All Multicast   : no
Broadcast       : yes
Deleted         : no
Interface Index : 40
Multicast       : yes
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                    : yes
Effective Propagation Delay  : 500 msec
Effective Override Interval  : 2500 msec
Join Prune Override Interval : 3000 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 500 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 2500 msec
```

(b) Wynik wykonania *show ip pim interface detail* na **R2** (cz. 2)

```
BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes


Interface  : pimreg
State      : up
Address    : * (primary)

Designated Router
-----------------
Address   : *
Priority  : 1(0)
Uptime    : --:--:--
Elections : 0
Changes   : 0


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : --:--:--
StatStart      : 00:16:53
Receive        : 0
Receive Failed : 0
Send           : 0
Send Failed    : 0
Generation ID  : 00000000


Flags
-----
All Multicast   : no
Broadcast       : no
Deleted         : no
Interface Index : 2
Multicast       : no
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                     : yes
Effective Propagation Delay   : 0 msec
Effective Override Interval   : 0 msec
Join Prune Override Interval : 0 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 0 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 0 msec


BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes
```

(a) Wynik wykonania *show ip pim interface detail* na **R2** (cz. 3)

```
R2# show running-config
Building configuration...

Current configuration:
!
frr version 8.5_git
frr defaults traditional
hostname R2
no ipv6 forwarding
ip pim rp 192.168.24.2 224.10.0.0/16
!
interface eth0
 ip address 192.168.12.2/24
 ip pim
 mpls enable
exit
!
interface eth1
 ip address 192.168.24.2/24
 ip pim
 mpls enable
exit
!
interface lo
 ip address 2.2.2.2/32
 mpls enable
exit
!
router ospf
 network 2.2.2.2/32 area 0
 network 192.168.12.0/24 area 0
 network 192.168.24.0/24 area 0
exit
!
end
```

(b) Wynik wykonania *show running config* na **R2**

3.1.3. Wyniki komend dla R3

```
R3# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source  Group  Flags  Proto  Input  Output  TTL  Uptime
```

Rys. 19: Wynik wykonania *show ip mroute* na **R3**

```
R3# show ip pim neighbor
 Interface  Neighbor      Uptime    Holdtime  DR Pri
 eth0       192.168.13.1  00:05:07  00:01:37  1
 eth1       192.168.34.4  00:04:25  00:01:20  1
 eth2       192.168.35.5  00:03:59  00:01:16  1
 eth3       192.168.36.6  00:03:13  00:01:32  1
```

Rys. 20: Wynik wykonania *show ip pim neighbour* na **R3**

```
R3# show ip pim interface
 Interface  State  Address       PIM Nbrs  PIM DR        FHR  IfChannels
 eth0       up     192.168.13.3  1         local         0    0
 eth1       up     192.168.34.3  1         192.168.34.4  0    0
 eth2       up     192.168.35.3  1         192.168.35.5  0    0
 eth3       up     192.168.36.3  1         192.168.36.6  0    0
 pimreg     up     0.0.0.0       0         local         0    0
```

Rys. 21: Wynik wykonania *show ip pim interface* na **R3**

```
R3# show ip pim interface detail
Interface  : eth0
State      : up
Address    : 192.168.13.3 (primary)

PIM Neighbors
-------------
192.168.13.1    : up for 00:05:23, holdtime expires in 00:01:21


Designated Router
-----------------
Address   : 192.168.13.3
Priority  : 1(0)
Uptime    : --:--:--
Elections : 1
Changes   : 0


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : 00:00:06
StatStart      : 00:05:23
Receive        : 11
Receive Failed : 0
Send           : 12
Send Failed    : 0
Generation ID  : 7419dd05


Flags
-----
All Multicast   : no
Broadcast       : yes
Deleted         : no
Interface Index : 48
Multicast       : yes
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                    : yes
Effective Propagation Delay  : 500 msec
Effective Override Interval  : 2500 msec
Join Prune Override Interval : 3000 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 500 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 2500 msec


BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes
```

(a) Wynik wykonania *show ip pim interface detail* na **R3** (cz. 1)

```
Interface  : eth1
State      : up
Address    : 192.168.34.3 (primary)

PIM Neighbors
-------------
192.168.34.4    : up for 00:04:41, holdtime expires in 00:01:33


Designated Router
-----------------
Address   : 192.168.34.4
Priority  : 1(0)
Uptime    : 00:04:41
Elections : 1
Changes   : 1


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : 00:00:18
StatStart      : 00:05:17
Receive        : 11
Receive Failed : 0
Send           : 12
Send Failed    : 0
Generation ID  : 4c6bd97f


Flags
-----
All Multicast   : no
Broadcast       : yes
Deleted         : no
Interface Index : 50
Multicast       : yes
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                    : yes
Effective Propagation Delay  : 500 msec
Effective Override Interval  : 2500 msec
Join Prune Override Interval : 3000 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 500 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 2500 msec


BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes
```

(b) Wynik wykonania *show ip pim interface detail* na **R3** (cz. 2)

```
Interface  : eth2
State      : up
Address    : 192.168.35.3 (primary)

PIM Neighbors
-------------
192.168.35.5    : up for 00:04:15, holdtime expires in 00:01:30


Designated Router
-----------------
Address   : 192.168.35.5
Priority  : 1(0)
Uptime    : 00:04:15
Elections : 1
Changes   : 1


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : 00:00:15
StatStart      : 00:05:06
Receive        : 10
Receive Failed : 0
Send           : 11
Send Failed    : 0
Generation ID  : 6569c7a1


Flags
-----
All Multicast   : no
Broadcast       : yes
Deleted         : no
Interface Index : 44
Multicast       : yes
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                    : yes
Effective Propagation Delay  : 500 msec
Effective Override Interval  : 2500 msec
Join Prune Override Interval : 3000 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 500 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 2500 msec


BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes
```

(a) Wynik wykonania *show ip pim interface detail* na **R3** (cz. 3)

```
Interface  : eth3
State      : up
Address    : 192.168.36.3 (primary)

PIM Neighbors
-------------
192.168.36.6    : up for 00:03:29, holdtime expires in 00:01:15


Designated Router
-----------------
Address   : 192.168.36.6
Priority  : 1(0)
Uptime    : 00:03:29
Elections : 1
Changes   : 1


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : 00:00:00
StatStart      : 00:05:00
Receive        : 8
Receive Failed : 0
Send           : 11
Send Failed    : 0
Generation ID  : 23ba6fb0


Flags
-----
All Multicast   : no
Broadcast       : yes
Deleted         : no
Interface Index : 46
Multicast       : yes
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                    : yes
Effective Propagation Delay  : 500 msec
Effective Override Interval  : 2500 msec
Join Prune Override Interval : 3000 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 500 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 2500 msec


BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes
```

(b) Wynik wykonania *show ip pim interface detail* na **R3** (cz. 4)

```
Interface  : pimreg
State      : up
Address    : * (primary)

Designated Router
-----------------
Address   : *
Priority  : 1(0)
Uptime    : --:--:--
Elections : 0
Changes   : 0


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : --:--:--
StatStart      : 00:17:30
Receive        : 0
Receive Failed : 0
Send           : 0
Send Failed    : 0
Generation ID  : 00000000


Flags
-----
All Multicast   : no
Broadcast       : no
Deleted         : no
Interface Index : 2
Multicast       : no
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                     : yes
Effective Propagation Delay   : 0 msec
Effective Override Interval   : 0 msec
Join Prune Override Interval : 0 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 0 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 0 msec


BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes
```

(a) Wynik wykonania *show ip pim interface detail* na **R3** (cz. 5)

```
R3# show running-config
Building configuration...

Current configuration:
!
frr version 8.5_git
frr defaults traditional
hostname R3
no ipv6 forwarding
ip pim rp 192.168.24.2 224.10.0.0/16
ip pim spt-switchover infinity-and-beyond
!
interface eth0
 ip address 192.168.13.3/24
 ip pim
 mpls enable
exit
!
interface eth1
 ip address 192.168.34.3/24
 ip pim
 mpls enable
exit
!
interface eth2
 ip address 192.168.35.3/24
 ip pim
 mpls enable
exit
!
interface eth3
 ip address 192.168.36.3/24
 ip pim
 mpls enable
exit
!
interface lo
 ip address 3.3.3.3/32
 mpls enable
exit
!
router ospf
 network 3.3.3.3/32 area 0
 network 192.168.13.0/24 area 0
 network 192.168.34.0/24 area 0
 network 192.168.35.0/24 area 0
 network 192.168.36.0/24 area 0
exit
!
end
```

(b) Wynik wykonania *show running config* na **R3**

3.1.4. Wyniki komend dla R4

```
R4# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source  Group  Flags  Proto  Input  Output  TTL  Uptime
```

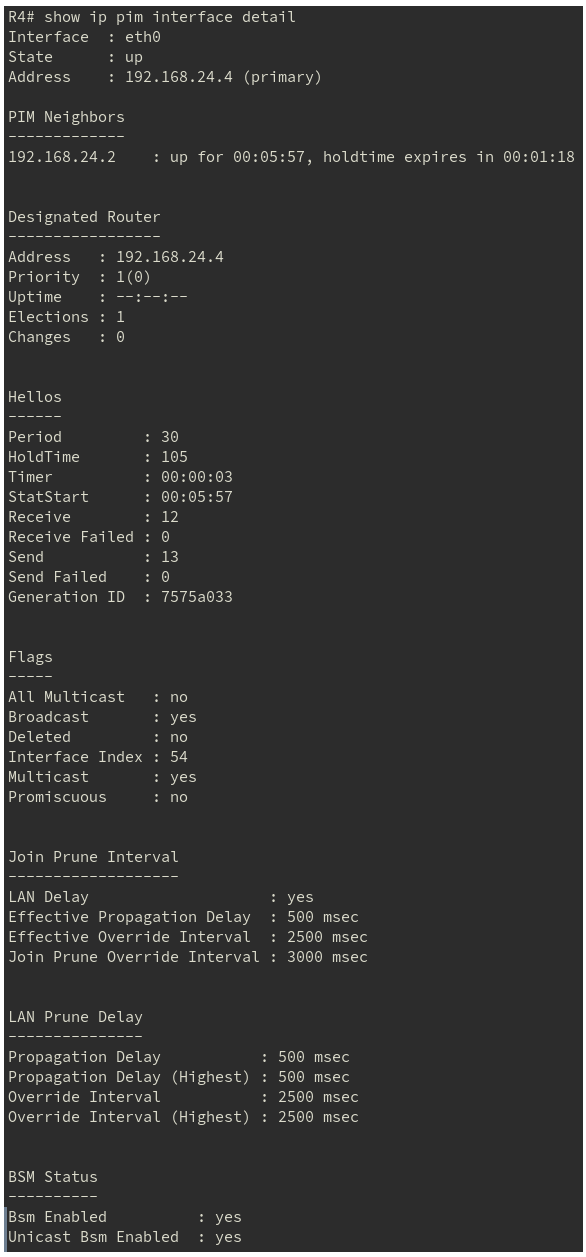
Rys. 25: Wynik wykonania *show ip mroute* na **R4**

```
R4# show ip pim neighbor
 Interface  Neighbor      Uptime    Holdtime  DR Pri
 eth0       192.168.24.2  00:05:48  00:01:27  1
 eth1       192.168.34.3  00:05:38  00:01:37  1
 eth2       192.168.46.6  00:04:34  00:01:41  1
 eth3       192.168.45.5  00:05:05  00:01:40  1
```

Rys. 26: Wynik wykonania *show ip pim neighbour* na **R4**

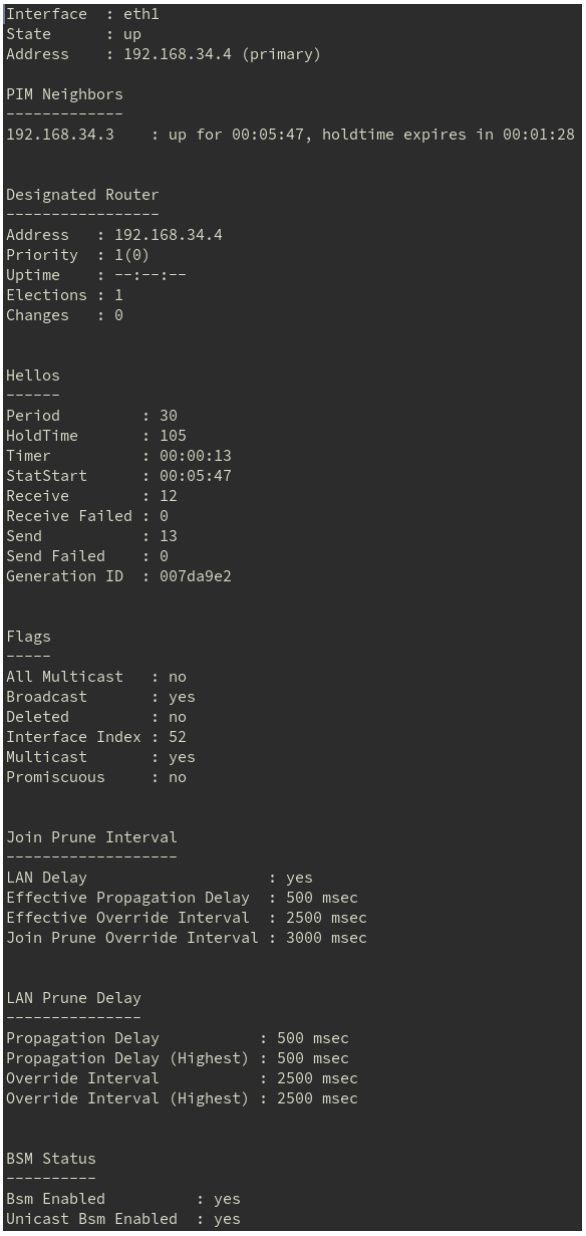
```
R4# show ip pim interface
 Interface  State  Address       PIM Nbrs  PIM DR        FHR  IfChannels
 eth0       up     192.168.24.4  1         local         0    0
 eth1       up     192.168.34.4  1         local         0    0
 eth2       up     192.168.46.4  1         192.168.46.6  0    0
 eth3       up     192.168.45.4  1         192.168.45.5  0    0
 pimreg     up     0.0.0.0       0         local         0    0
```

Rys. 27: Wynik wykonania *show ip pim interface* na **R4**



```
R4# show ip pim interface detail
Interface  : eth0
State      : up
Address    : 192.168.24.4 (primary)

PIM Neighbors
-------------
192.168.24.2    : up for 00:05:57, holdtime expires in 00:01:18


Designated Router
-----------------
Address   : 192.168.24.4
Priority  : 1(0)
Uptime    : --:--:--
Elections : 1
Changes   : 0


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : 00:00:03
StatStart      : 00:05:57
Receive        : 12
Receive Failed : 0
Send           : 13
Send Failed    : 0
Generation ID  : 7575a033


Flags
-----
All Multicast   : no
Broadcast       : yes
Deleted         : no
Interface Index : 54
Multicast       : yes
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                    : yes
Effective Propagation Delay  : 500 msec
Effective Override Interval  : 2500 msec
Join Prune Override Interval : 3000 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 500 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 2500 msec


BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes
```

(a) Wynik wykonania *show ip pim interface detail* na **R4** (cz. 1)



```
Interface  : eth1
State      : up
Address    : 192.168.34.4 (primary)

PIM Neighbors
-------------
192.168.34.3    : up for 00:05:47, holdtime expires in 00:01:28


Designated Router
-----------------
Address   : 192.168.34.4
Priority  : 1(0)
Uptime    : --:--:--
Elections : 1
Changes   : 0


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : 00:00:13
StatStart      : 00:05:47
Receive        : 12
Receive Failed : 0
Send           : 13
Send Failed    : 0
Generation ID  : 007da9e2


Flags
-----
All Multicast   : no
Broadcast       : yes
Deleted         : no
Interface Index : 52
Multicast       : yes
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                    : yes
Effective Propagation Delay  : 500 msec
Effective Override Interval  : 2500 msec
Join Prune Override Interval : 3000 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 500 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 2500 msec


BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes
```

(b) Wynik wykonania *show ip pim interface detail* na **R4** (cz. 2)

```
Interface  : eth2
State      : up
Address    : 192.168.46.4 (primary)

PIM Neighbors
-------------
192.168.46.6    : up for 00:04:43, holdtime expires in 00:01:32


Designated Router
-----------------
Address   : 192.168.46.6
Priority  : 1(0)
Uptime    : 00:04:43
Elections : 1
Changes   : 1


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : 00:00:17
StatStart      : 00:05:39
Receive        : 11
Receive Failed : 0
Send           : 12
Send Failed    : 0
Generation ID  : 063e2d70


Flags
-----
All Multicast   : no
Broadcast       : yes
Deleted         : no
Interface Index : 56
Multicast       : yes
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                    : yes
Effective Propagation Delay  : 500 msec
Effective Override Interval  : 2500 msec
Join Prune Override Interval : 3000 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 500 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 2500 msec


BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes
```

(a) Wynik wykonania *show ip pim interface detail* na **R4** (cz. 3)

```
Interface  : eth3
State      : up
Address    : 192.168.45.4 (primary)

PIM Neighbors
-------------
192.168.45.5    : up for 00:05:14, holdtime expires in 00:01:31


Designated Router
-----------------
Address   : 192.168.45.5
Priority  : 1(0)
Uptime    : 00:05:14
Elections : 1
Changes   : 1


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : 00:00:16
StatStart      : 00:05:31
Receive        : 12
Receive Failed : 0
Send           : 12
Send Failed    : 0
Generation ID  : 21cf5b01


Flags
-----
All Multicast   : no
Broadcast       : yes
Deleted         : no
Interface Index : 58
Multicast       : yes
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                    : yes
Effective Propagation Delay  : 500 msec
Effective Override Interval  : 2500 msec
Join Prune Override Interval : 3000 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 500 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 2500 msec


BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes
```

(b) Wynik wykonania *show ip pim interface detail* na **R4** (cz. 4)

```
Interface  : pimreg
State      : up
Address    : * (primary)

Designated Router
-----------------
Address   : *
Priority  : 1(0)
Uptime    : --:--:--
Elections : 0
Changes   : 0


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : --:--:--
StatStart      : 00:18:33
Receive        : 0
Receive Failed : 0
Send           : 0
Send Failed    : 0
Generation ID  : 00000000


Flags
-----
All Multicast   : no
Broadcast       : no
Deleted         : no
Interface Index : 2
Multicast       : no
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                     : yes
Effective Propagation Delay   : 0 msec
Effective Override Interval   : 0 msec
Join Prune Override Interval : 0 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 0 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 0 msec


BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes
```

(a) Wynik wykonania *show ip pim interface detail* na **R4** (cz. 5)

```
R4# show running-config
Building configuration...

Current configuration:
!
frr version 8.5_git
frr defaults traditional
hostname R4
no ipv6 forwarding
ip pim rp 192.168.24.2 224.10.0.0/16
ip pim spt-switchover infinity-and-beyond
!
interface eth0
 ip address 192.168.24.4/24
 ip pim
 mpls enable
exit
!
interface eth1
 ip address 192.168.34.4/24
 ip pim
 mpls enable
exit
!
interface eth2
 ip address 192.168.46.4/24
 ip pim
 mpls enable
exit
!
interface eth3
 ip address 192.168.45.4/24
 ip pim
 mpls enable
exit
!
interface lo
 ip address 4.4.4.4/32
 mpls enable
exit
!
router ospf
 network 4.4.4.4/32 area 0
 network 192.168.24.0/24 area 0
 network 192.168.34.0/24 area 0
 network 192.168.45.0/24 area 0
 network 192.168.46.0/24 area 0
exit
!
end
```

(b) Wynik wykonania *show running config* na **R4**

3.1.5. Wyniki komend dla R5

```
R5# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source  Group  Flags  Proto  Input  Output  TTL  Uptime
```

Rys. 31: Wynik wykonania *show ip mroute* na **R5**

```
R5# show ip pim neighbor
 Interface  Neighbor       Uptime    Holdtime  DR Pri
 eth0       192.168.35.3   00:05:39  00:01:36  1
 eth1       192.168.45.4   00:05:32  00:01:42  1
```

Rys. 32: Wynik wykonania *show ip pim neighbour* na **R5**

```
R5# show ip pim interface
 Interface  State  Address       PIM Nbrs  PIM DR  FHR  IfChannels
 eth0       up     192.168.35.5  1         local   0    0
 eth1       up     192.168.45.5  1         local   0    0
 eth2       up     192.168.3.1   0         local   0    0
 eth3       up     192.168.4.1   0         local   0    0
 pimreg     up     0.0.0.0       0         local   0    0
```

Rys. 33: Wynik wykonania *show ip pim interface* na **R5**

```
R5# show ip pim interface detail
Interface  : eth0
State      : up
Address    : 192.168.35.5 (primary)

PIM Neighbors
-------------
192.168.35.3    : up for 00:05:47, holdtime expires in 00:01:28


Designated Router
-----------------
Address   : 192.168.35.5
Priority  : 1(0)
Uptime    : --:--:--
Elections : 1
Changes   : 0


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : 00:00:13
StatStart      : 00:05:47
Receive        : 12
Receive Failed : 0
Send           : 13
Send Failed    : 0
Generation ID  : 76d1635f


Flags
-----
All Multicast   : no
Broadcast       : yes
Deleted         : no
Interface Index : 66
Multicast       : yes
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                   : yes
Effective Propagation Delay  : 500 msec
Effective Override Interval  : 2500 msec
Join Prune Override Interval : 3000 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 500 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 2500 msec


BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes
```

(a) Wynik wykonania *show ip pim interface detail* na **R5** (cz. 1)

```
Interface  : eth1
State      : up
Address    : 192.168.45.5 (primary)

PIM Neighbors
-------------
192.168.45.4    : up for 00:05:40, holdtime expires in 00:01:35


Designated Router
-----------------
Address   : 192.168.45.5
Priority  : 1(0)
Uptime    : --:--:--
Elections : 1
Changes   : 0


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : 00:00:20
StatStart      : 00:05:40
Receive        : 12
Receive Failed : 0
Send           : 13
Send Failed    : 0
Generation ID  : 348f7a45


Flags
-----
All Multicast   : no
Broadcast       : yes
Deleted         : no
Interface Index : 60
Multicast       : yes
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                   : yes
Effective Propagation Delay  : 500 msec
Effective Override Interval  : 2500 msec
Join Prune Override Interval : 3000 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 500 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 2500 msec


BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes
```

(b) Wynik wykonania *show ip pim interface detail* na **R5** (cz. 2)

```
Interface  : eth2
State      : up
Address    : 192.168.3.1 (primary)

Designated Router
-----------------
Address   : 192.168.3.1
Priority  : 1(0)
Uptime    : --:--:--
Elections : 0
Changes   : 0


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : 00:00:26
StatStart      : 00:05:33
Receive        : 0
Receive Failed : 0
Send           : 12
Send Failed    : 0
Generation ID  : 27129340


Flags
-----
All Multicast   : no
Broadcast       : yes
Deleted         : no
Interface Index : 62
Multicast       : yes
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                     : yes
Effective Propagation Delay   : 0 msec
Effective Override Interval   : 0 msec
Join Prune Override Interval : 0 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 0 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 0 msec


BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes
```

(a) Wynik wykonania *show ip pim interface detail* na **R5** (cz. 3)

```
Interface  : eth3
State      : up
Address    : 192.168.4.1 (primary)

Designated Router
-----------------
Address   : 192.168.4.1
Priority  : 1(0)
Uptime    : --:--:--
Elections : 0
Changes   : 0


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : 00:00:07
StatStart      : 00:05:23
Receive        : 0
Receive Failed : 0
Send           : 11
Send Failed    : 0
Generation ID  : 1fe44652


Flags
-----
All Multicast   : no
Broadcast       : yes
Deleted         : no
Interface Index : 64
Multicast       : yes
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                     : yes
Effective Propagation Delay   : 0 msec
Effective Override Interval   : 0 msec
Join Prune Override Interval : 0 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 0 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 0 msec


BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes
```

(b) Wynik wykonania *show ip pim interface detail* na **R5** (cz. 4)

```
Interface  : pimreg
State      : up
Address    : * (primary)

Designated Router
-----------------
Address   : *
Priority  : 1(0)
Uptime    : --:--:--
Elections : 0
Changes   : 0


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : --:--:--
StatStart      : 00:18:56
Receive        : 0
Receive Failed : 0
Send           : 0
Send Failed    : 0
Generation ID  : 00000000


Flags
-----
All Multicast   : no
Broadcast       : no
Deleted         : no
Interface Index : 2
Multicast       : no
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                     : yes
Effective Propagation Delay   : 0 msec
Effective Override Interval   : 0 msec
Join Prune Override Interval : 0 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 0 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 0 msec


BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes
```

(a) Wynik wykonania *show ip pim interface detail* na **R5** (cz. 5)

```
R5# show running-config
Building configuration...

Current configuration:
!
frr version 8.5_git
frr defaults traditional
hostname R5
no ipv6 forwarding
ip pim rp 192.168.24.2 224.10.0.0/16
ip pim spt-switchover infinity-and-beyond
!
interface eth0
 ip address 192.168.35.5/24
 ip pim
 mpls enable
exit
!
interface eth1
 ip address 192.168.45.5/24
 ip pim
 mpls enable
exit
!
interface eth2
 ip address 192.168.3.1/24
 ip igmp
 ip pim
 mpls enable
exit
!
interface eth3
 ip address 192.168.4.1/24
 ip igmp
 ip pim
 mpls enable
exit
!
interface lo
 ip address 5.5.5.5/32
 mpls enable
exit
!
router ospf
 network 5.5.5.5/32 area 0
 network 192.168.3.0/24 area 0
 network 192.168.4.0/24 area 0
 network 192.168.35.0/24 area 0
 network 192.168.45.0/24 area 0
exit
!
end
```

(b) Wynik wykonania *show running config* na **R5**

3.1.6. Wyniki komend dla R6

```
R6# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source  Group  Flags  Proto  Input  Output  TTL  Uptime
```

Rys. 37: Wynik wykonania *show ip mroute* na **R6**

```
R6# show ip pim neighbor
 Interface  Neighbor      Uptime    Holdtime  DR Pri
 eth0       192.168.46.4  00:05:29  00:01:15  1
 eth1       192.168.36.3  00:05:21  00:01:23  1
```

Rys. 38: Wynik wykonania *show ip pim neighbour* na **R6**

```
R6# show ip pim interface
 Interface  State  Address       PIM Nbrs  PIM DR  FHR  IfChannels
 eth0       up     192.168.46.6  1         local   0    0
 eth1       up     192.168.36.6  1         local   0    0
 eth2       up     192.168.5.1   0         local   0    0
 eth3       up     192.168.6.1   0         local   0    0
 pimreg     up     0.0.0.0       0         local   0    0
```

Rys. 39: Wynik wykonania *show ip pim interface* na **R6**

```
Interface  : eth0
State      : up
Address    : 192.168.46.6 (primary)

PIM Neighbors
-------------
192.168.46.4    : up for 00:05:40, holdtime expires in 00:01:35


Designated Router
-----------------
Address   : 192.168.46.6
Priority  : 1(0)
Uptime    : --:--:--
Elections : 1
Changes   : 0


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : 00:00:20
StatStart      : 00:05:40
Receive        : 12
Receive Failed : 0
Send           : 13
Send Failed    : 0
Generation ID  : 78a11247


Flags
-----
All Multicast   : no
Broadcast       : yes
Deleted         : no
Interface Index : 72
Multicast       : yes
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                    : yes
Effective Propagation Delay  : 500 msec
Effective Override Interval  : 2500 msec
Join Prune Override Interval : 3000 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 500 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 2500 msec


BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes
```

(a) Wynik wykonania *show ip pim interface detail* na **R6** (cz. 1)

```
Interface  : eth1
State      : up
Address    : 192.168.36.6 (primary)

PIM Neighbors
-------------
192.168.36.3    : up for 00:05:32, holdtime expires in 00:01:42


Designated Router
-----------------
Address   : 192.168.36.6
Priority  : 1(0)
Uptime    : --:--:--
Elections : 1
Changes   : 0


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : 00:00:27
StatStart      : 00:05:32
Receive        : 12
Receive Failed : 0
Send           : 13
Send Failed    : 0
Generation ID  : 24a73ac7


Flags
-----
All Multicast   : no
Broadcast       : yes
Deleted         : no
Interface Index : 74
Multicast       : yes
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                    : yes
Effective Propagation Delay  : 500 msec
Effective Override Interval  : 2500 msec
Join Prune Override Interval : 3000 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 500 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 2500 msec


BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes
```

(b) Wynik wykonania *show ip pim interface detail* na **R6** (cz. 2)

```
Interface  : eth2
State      : up
Address    : 192.168.5.1 (primary)

Designated Router
-----------------
Address   : 192.168.5.1
Priority  : 1(0)
Uptime    : --:--:--
Elections : 0
Changes   : 0


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : 00:00:05
StatStart      : 00:05:24
Receive        : 0
Receive Failed : 0
Send           : 11
Send Failed    : 0
Generation ID  : 282dc5aa


Flags
-----
All Multicast   : no
Broadcast       : yes
Deleted         : no
Interface Index : 68
Multicast       : yes
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                     : yes
Effective Propagation Delay   : 0 msec
Effective Override Interval   : 0 msec
Join Prune Override Interval : 0 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 0 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 0 msec


BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes
```

(a) Wynik wykonania *show ip pim interface detail* na **R6** (cz. 3)

```
Interface  : eth3
State      : up
Address    : 192.168.6.1 (primary)

Designated Router
-----------------
Address   : 192.168.6.1
Priority  : 1(0)
Uptime    : --:--:--
Elections : 0
Changes   : 0


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : 00:00:14
StatStart      : 00:05:15
Receive        : 0
Receive Failed : 0
Send           : 11
Send Failed    : 0
Generation ID  : 1d558015


Flags
-----
All Multicast   : no
Broadcast       : yes
Deleted         : no
Interface Index : 70
Multicast       : yes
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                     : yes
Effective Propagation Delay   : 0 msec
Effective Override Interval   : 0 msec
Join Prune Override Interval : 0 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 0 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 0 msec


BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes
```

(b) Wynik wykonania *show ip pim interface detail* na **R6** (cz. 4)

```
Interface  : pimreg
State      : up
Address    : * (primary)

Designated Router
-----------------
Address   : *
Priority  : 1(0)
Uptime    : --:--:--
Elections : 0
Changes   : 0


Hellos
------
Period         : 30
HoldTime       : 105
Timer          : --:--:--
StatStart      : 00:19:23
Receive        : 0
Receive Failed : 0
Send           : 0
Send Failed    : 0
Generation ID  : 00000000


Flags
-----
All Multicast   : no
Broadcast       : no
Deleted         : no
Interface Index : 2
Multicast       : no
Promiscuous     : no


Join Prune Interval
-------------------
LAN Delay                    : yes
Effective Propagation Delay  : 0 msec
Effective Override Interval  : 0 msec
Join Prune Override Interval : 0 msec


LAN Prune Delay
---------------
Propagation Delay           : 500 msec
Propagation Delay (Highest) : 0 msec
Override Interval           : 2500 msec
Override Interval (Highest) : 0 msec


BSM Status
----------
Bsm Enabled          : yes
Unicast Bsm Enabled  : yes
```

(a) Wynik wykonania *show ip pim interface detail* na **R6** (cz. 5)

```
R6# show running-config
Building configuration...

Current configuration:
!
frr version 8.5_git
frr defaults traditional
hostname R6
no ipv6 forwarding
ip pim rp 192.168.24.2 224.10.0.0/16
ip pim spt-switchover infinity-and-beyond
!
interface eth0
 ip address 192.168.46.6/24
 ip pim
 mpls enable
exit
!
interface eth1
 ip address 192.168.36.6/24
 ip pim
 mpls enable
exit
!
interface eth2
 ip address 192.168.5.1/24
 ip igmp
 ip pim
 mpls enable
exit
!
interface eth3
 ip address 192.168.6.1/24
 ip igmp
 ip pim
 mpls enable
exit
!
interface lo
 ip address 6.6.6.6/32
 mpls enable
exit
!
router ospf
 network 6.6.6.6/32 area 0
 network 192.168.5.0/24 area 0
 network 192.168.6.0/24 area 0
 network 192.168.36.0/24 area 0
 network 192.168.46.0/24 area 0
exit
!
end
```

(b) Wynik wykonania *show running config* na **R6**

3.1.7. Weryfikacja konfiguracji RP

Weryfikacja została przeprowadzona z użyciem *show ip pim rp-info* dla każdego routera.

```
R1# show ip pim rp-info
 RP address    group/prefix-list  OIF   I am RP  Source  Group-Type
 192.168.24.2  224.10.0.0/16      eth0  no       Static  ASM
```

(a) Wynik wykonania *show ip pim rp-info* na **R1**

```
R2# show ip pim rp-info
 RP address    group/prefix-list  OIF   I am RP  Source  Group-Type
 192.168.24.2  224.10.0.0/16      eth1  yes      Static  ASM
```

(b) Wynik wykonania *show ip pim rp-info* na **R2**

```
R3# show ip pim rp-info
 RP address    group/prefix-list  OIF   I am RP  Source  Group-Type
 192.168.24.2  224.10.0.0/16      eth1  no       Static  ASM
```

(a) Wynik wykonania *show ip pim rp-info* na **R3**

```
R4# show ip pim rp-info
 RP address    group/prefix-list  OIF   I am RP  Source  Group-Type
 192.168.24.2  224.10.0.0/16      eth0  no       Static  ASM
```

(b) Wynik wykonania *show ip pim rp-info* na **R4**

```
R5# show ip pim rp-info
 RP address    group/prefix-list  OIF   I am RP  Source  Group-Type
 192.168.24.2  224.10.0.0/16      eth1  no       Static  ASM
```

(a) Wynik wykonania *show ip pim rp-info* na **R5**

```
R6# show ip pim rp-info
 RP address    group/prefix-list  OIF   I am RP  Source  Group-Type
 192.168.24.2  224.10.0.0/16      eth0  no       Static  ASM
```

(b) Wynik wykonania *show ip pim rp-info* na **R6**

Można zauważyć, że jedynie R2 jest RP, więc konfiguracja przebiegła pomyślnie.

3.2. Zadanie C2: start odbiorników i źródeł multicast

```
R1# show ip pim join
 Interface  Address       Source       Group       State  Uptime    Expire  Prune
 eth0       192.168.12.1  192.168.1.2  224.10.0.1  JOIN   00:00:12  02:38   --:--

R1# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source       Group       Flags  Proto  Input  Output  TTL  Uptime
 192.168.1.2  224.10.0.1  SF     PIM    eth2   eth0    1    00:01:46
```

(a) Wynik wykonania *show ip pim join* i *show ip mroute* na **R1**

```
R1# show ip pim join
 Interface  Address       Source       Group       State  Uptime    Expire  Prune
 eth0       192.168.12.1  192.168.1.2  224.10.0.1  JOIN   00:05:19  02:31   --:--

R1# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source       Group       Flags  Proto  Input  Output  TTL  Uptime
 192.168.1.2  224.10.0.1  SFT    PIM    eth2   eth0    1    00:06:44
```

(b) Wynik wykonania *show ip pim join* i *show ip mroute* na **R1**

```
R2# show ip pim join
 Interface  Address       Source  Group       State  Uptime    Expire  Prune
 eth1       192.168.24.2  *       224.10.0.1  JOIN   00:00:18  03:23   --:--

R2# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source       Group       Flags  Proto  Input  Output  TTL  Uptime
 *            224.10.0.1  S      none   eth1   none    0    --:--:--
 192.168.1.2  224.10.0.1  ST     STAR   eth0   eth1    1    00:01:54
```

(a) Wynik wykonania *show ip pim join* i *show ip mroute* na **R2**

```
R2# show ip pim join
 Interface  Address       Source  Group       State  Uptime    Expire  Prune
 eth1       192.168.24.2  *       224.10.0.1  JOIN   00:05:23  03:18   --:--

R2# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source       Group       Flags  Proto  Input  Output  TTL  Uptime
 *            224.10.0.1  S      none   eth1   none    0    --:--:--
 192.168.1.2  224.10.0.1  ST     STAR   eth0   eth1    1    00:06:47
```

(b) Wynik wykonania *show ip pim join* i *show ip mroute* na **R2**

```
R3# show ip pim join
 Interface  Address  Source  Group  State  Uptime  Expire  Prune

R3# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source  Group  Flags  Proto  Input  Output  TTL  Uptime
```

(a) Wynik wykonania *show ip pim join* i *show ip mroute* na **R3**

```
R3# show ip pim join
 Interface  Address  Source  Group  State  Uptime  Expire  Prune

R3# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source  Group  Flags  Proto  Input  Output  TTL  Uptime
```

(b) Wynik wykonania *show ip pim join* i *show ip mroute* na **R3**

```
R4# show ip pim join
 Interface  Address       Source  Group       State  Uptime    Expire  Prune
 eth3       192.168.45.4  *       224.10.0.1  JOIN   00:01:09  03:15   --:--

R4# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source  Group       Flags  Proto  Input  Output  TTL  Uptime
 *       224.10.0.1  S      PIM    eth0   eth3    1    00:02:11
```

(a) Wynik wykonania *show ip pim join* i *show ip mroute* na **R4**

```
R4# show ip pim join
 Interface  Address       Source  Group       State  Uptime    Expire  Prune
 eth2       192.168.46.4  *       224.10.0.1  JOIN   00:00:50  03:25   --:--
 eth3       192.168.45.4  *       224.10.0.1  JOIN   00:05:31  02:54   --:--

R4# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source  Group       Flags  Proto  Input  Output  TTL  Uptime
 *       224.10.0.1  S      PIM    eth0   eth2    1    00:06:29
                            PIM           eth3    1
```

(b) Wynik wykonania *show ip pim join* i *show ip mroute* na **R4**

```
R5# show ip pim join
 Interface  Address      Source  Group       State   Uptime    Expire  Prune
 eth2       192.168.3.1  *       224.10.0.1  NOINFO  --:--:--  --:--   --:--

R5# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source  Group       Flags  Proto  Input  Output  TTL  Uptime
 *       224.10.0.1  SC     IGMP   eth1   eth2    1    00:01:22
```

(a) Wynik wykonania *show ip pim join* i *show ip mroute* na **R5**

```
R5# show ip pim join
 Interface  Address      Source  Group       State   Uptime    Expire  Prune
 eth2       192.168.3.1  *       224.10.0.1  NOINFO  --:--:--  --:--   --:--

R5# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source  Group       Flags  Proto  Input  Output  TTL  Uptime
 *       224.10.0.1  SC     IGMP   eth1   eth2    1    00:05:35
```

(b) Wynik wykonania *show ip pim join* i *show ip mroute* na **R5**

```
R6# show ip pim join
 Interface  Address  Source  Group  State  Uptime  Expire  Prune

R6# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source  Group  Flags  Proto  Input  Output  TTL  Uptime
```

(a) Wynik wykonania *show ip pim join* i *show ip mroute* na **R6**

```
R6# show ip pim join
 Interface  Address      Source  Group       State   Uptime    Expire  Prune
 eth2       192.168.5.1  *       224.10.0.1  NOINFO  --:--:--  --:--   --:--

R6# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source  Group       Flags  Proto  Input  Output  TTL  Uptime
 *       224.10.0.1  SC     IGMP   eth0   eth2    1    00:00:59
```

(b) Wynik wykonania *show ip pim join* i *show ip mroute* na **R6**

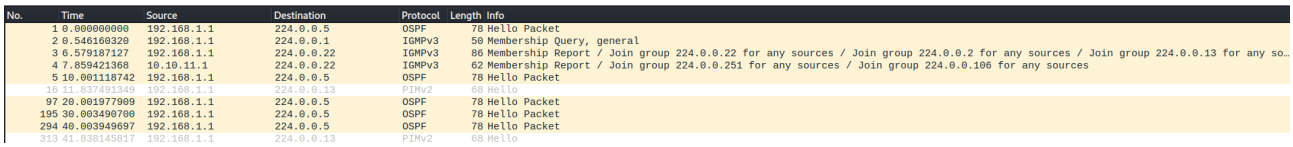
Trasa strumienia multicast to: $PC1 \rightarrow R1 \rightarrow R2 \rightarrow R4 \rightarrow R5 \rightarrow PC3$

Ścieżka jest wyznaczana z R1 do R2, który jest RP, a następnie z R2 do R5. W obu przypadkach ta ścieżka jest wyznaczona w sposób minimalizujący koszty, które w tym przypadku na każdym połączeniu są identyczne, dlatego najkrótsza ścieżka jest optymalna.

Przy ustawieniu RP na R2 eth0 ścieżka wygląda następująco: $PC1 \rightarrow R1 \rightarrow R2 \rightarrow R1 \rightarrow R3 \rightarrow R5 \rightarrow PC3$

Trasa wygląda w ten sposób, ponieważ ustawiany interfejs jest zawsze interfejsem wyjściowym z routera RP, dlatego niezależnie od tego czy istnieją bardziej optymalne ścieżki do odbiornika to strumień multicast na początku i tak będzie forwardowany przy użyciu określonego przez nas interfejsu.
Po uruchomieniu drugiego odbiorcy na PC5 trasa ścieżki do niego wygląda następująco: $PC1 \rightarrow R1 \rightarrow R2 \rightarrow R4 \rightarrow R6 \rightarrow PC5$

Trasa do pierwszego odbiornika pozostała taka sama.



No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	192.168.1.1	224.0.0.5	OSPF	78	Hello Packet
2	0.546160320	192.168.1.1	224.0.0.1	IGMPv3	50	Membership Query, general
3	6.579187127	192.168.1.1	224.0.0.22	IGMPv3	86	Membership Report / Join group 224.0.0.22 for any sources / Join group 224.0.0.2 for any sources / Join group 224.0.0.13 for any so…
4	7.859421368	10.10.11.1	224.0.0.22	IGMPv3	62	Membership Report / Join group 224.0.0.251 for any sources / Join group 224.0.0.106 for any sources
5	10.001118742	192.168.1.1	224.0.0.5	OSPF	78	Hello Packet
16	11.837491349	192.168.1.1	224.0.0.13	PIMv2	68	Hello
97	20.001977909	192.168.1.1	224.0.0.5	OSPF	78	Hello Packet
195	30.003490700	192.168.1.1	224.0.0.5	OSPF	78	Hello Packet
294	40.003949697	192.168.1.1	224.0.0.5	OSPF	78	Hello Packet
313	41.638145817	192.168.1.1	224.0.0.13	PIMv2	68	Hello

Rys. 52: Zapis Wireshark na połączeniu pomiędzy **PC1**, a **R1**

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	192.168.12.1	224.0.0.5	OSPF	82	Hello Packet
3	0.865825307	192.168.24.2	192.168.1.1	PIMv2	52	Register-stop
4	2.252381069	192.168.12.2	224.0.0.5	OSPF	82	Hello Packet
5	5.469704979	192.168.12.2	224.0.0.13	PIMv2	68	Join/Prune
12	6.050451297	02:42:0a:0a:00:03	02:42:0a:0a:00:02	ARP	42	Who has 192.168.12.1? Tell 192.168.12.2
13	6.050470462	02:42:0a:0a:00:02	02:42:0a:0a:00:03	ARP	42	Who has 192.168.12.2? Tell 192.168.12.1
14	6.050528549	02:42:0a:0a:00:02	02:42:0a:0a:00:03	ARP	42	192.168.12.1 is at 02:42:0a:0a:00:02
15	6.050531751	02:42:0a:0a:00:03	02:42:0a:0a:00:02	ARP	42	192.168.12.2 is at 02:42:0a:0a:00:03
55	10.000947645	192.168.12.1	224.0.0.5	OSPF	82	Hello Packet
78	12.252364761	192.168.12.2	224.0.0.5	OSPF	82	Hello Packet
154	20.002435079	192.168.12.1	224.0.0.5	OSPF	82	Hello Packet
165	21.029792974	192.168.12.2	224.0.0.13	PIMv2	68	Join/Prune
166	21.036873778	192.168.12.1	224.0.0.13	PIMv2	68	Hello
167	21.037198049	192.168.12.2	224.0.0.13	PIMv2	68	Hello
180	22.253764164	192.168.12.2	224.0.0.5	OSPF	82	Hello Packet
257	30.002883571	192.168.12.1	224.0.0.5	OSPF	82	Hello Packet

Rys. 53: Zapis Wireshark na połączeniu pomiędzy **R1**, a **R2**

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	192.168.24.2	224.0.0.5	OSPF	82	Hello Packet
2	7.218971558	192.168.24.4	224.0.0.5	OSPF	82	Hello Packet
3	10.000713747	192.168.24.2	224.0.0.5	OSPF	82	Hello Packet
4	13.215733446	192.168.24.4	224.0.0.13	PIMv2	68	Join/Prune
45	17.219297303	192.168.24.4	224.0.0.5	OSPF	82	Hello Packet
73	20.000666452	192.168.24.2	224.0.0.5	OSPF	82	Hello Packet
75	20.091675743	192.168.24.4	224.0.0.13	PIMv2	68	Join/Prune
78	20.259888849	192.168.24.2	224.0.0.13	PIMv2	68	Hello
79	20.260066814	192.168.24.4	224.0.0.13	PIMv2	68	Hello
147	27.219389389	192.168.24.4	224.0.0.5	OSPF	82	Hello Packet
175	30.002068635	192.168.24.2	224.0.0.5	OSPF	82	Hello Packet
247	37.220153166	192.168.24.4	224.0.0.5	OSPF	82	Hello Packet
276	40.002478165	192.168.24.2	224.0.0.5	OSPF	82	Hello Packet
348	47.225331284	192.168.24.4	224.0.0.5	OSPF	82	Hello Packet
376	50.003356597	192.168.24.2	224.0.0.5	OSPF	82	Hello Packet
380	50.261113296	192.168.24.2	224.0.0.13	PIMv2	68	Hello
381	50.261226765	192.168.24.4	224.0.0.13	PIMv2	68	Hello
450	57.225233342	192.168.24.4	224.0.0.5	OSPF	82	Hello Packet
478	60.009175968	192.168.24.2	224.0.0.5	OSPF	82	Hello Packet
549	67.225715133	192.168.24.4	224.0.0.5	OSPF	82	Hello Packet
577	70.009155629	192.168.24.2	224.0.0.5	OSPF	82	Hello Packet

Rys. 54: Zapis Wireshark na połączeniu pomiędzy **R2**, a **R4**

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	192.168.45.4	224.0.0.5	OSPF	82	Hello Packet
2	2.551130009	192.168.45.5	224.0.0.5	OSPF	82	Hello Packet
3	5.880693100	192.168.45.4	224.0.0.13	PIMv2	68	Hello
4	5.880838941	192.168.45.5	224.0.0.13	PIMv2	68	Hello
5	10.000522695	192.168.45.4	224.0.0.5	OSPF	82	Hello Packet
6	12.551148319	192.168.45.5	224.0.0.5	OSPF	82	Hello Packet
7	15.996770530	192.168.45.5	224.0.0.13	PIMv2	68	Join/Prune
48	20.000754466	192.168.45.4	224.0.0.5	OSPF	82	Hello Packet
74	22.552471672	192.168.45.5	224.0.0.5	OSPF	82	Hello Packet
147	30.000811060	192.168.45.4	224.0.0.5	OSPF	82	Hello Packet
172	32.553122489	192.168.45.5	224.0.0.5	OSPF	82	Hello Packet
206	35.880876076	192.168.45.5	224.0.0.13	PIMv2	68	Hello
207	35.881063117	192.168.45.4	224.0.0.13	PIMv2	68	Hello
249	40.001528176	192.168.45.4	224.0.0.5	OSPF	82	Hello Packet
275	42.554494879	192.168.45.5	224.0.0.5	OSPF	82	Hello Packet
350	50.006745621	192.168.45.4	224.0.0.5	OSPF	82	Hello Packet
376	52.556137750	192.168.45.5	224.0.0.5	OSPF	82	Hello Packet
450	60.006671210	192.168.45.4	224.0.0.5	OSPF	82	Hello Packet
476	62.556868422	192.168.45.5	224.0.0.5	OSPF	82	Hello Packet
509	65.880496013	192.168.45.5	224.0.0.13	PIMv2	68	Join/Prune
510	65.880859025	192.168.45.5	224.0.0.13	PIMv2	68	Hello
511	65.881064830	192.168.45.4	224.0.0.13	PIMv2	68	Hello

Rys. 55: Zapis Wireshark na połączeniu pomiędzy **R4**, a **R5**

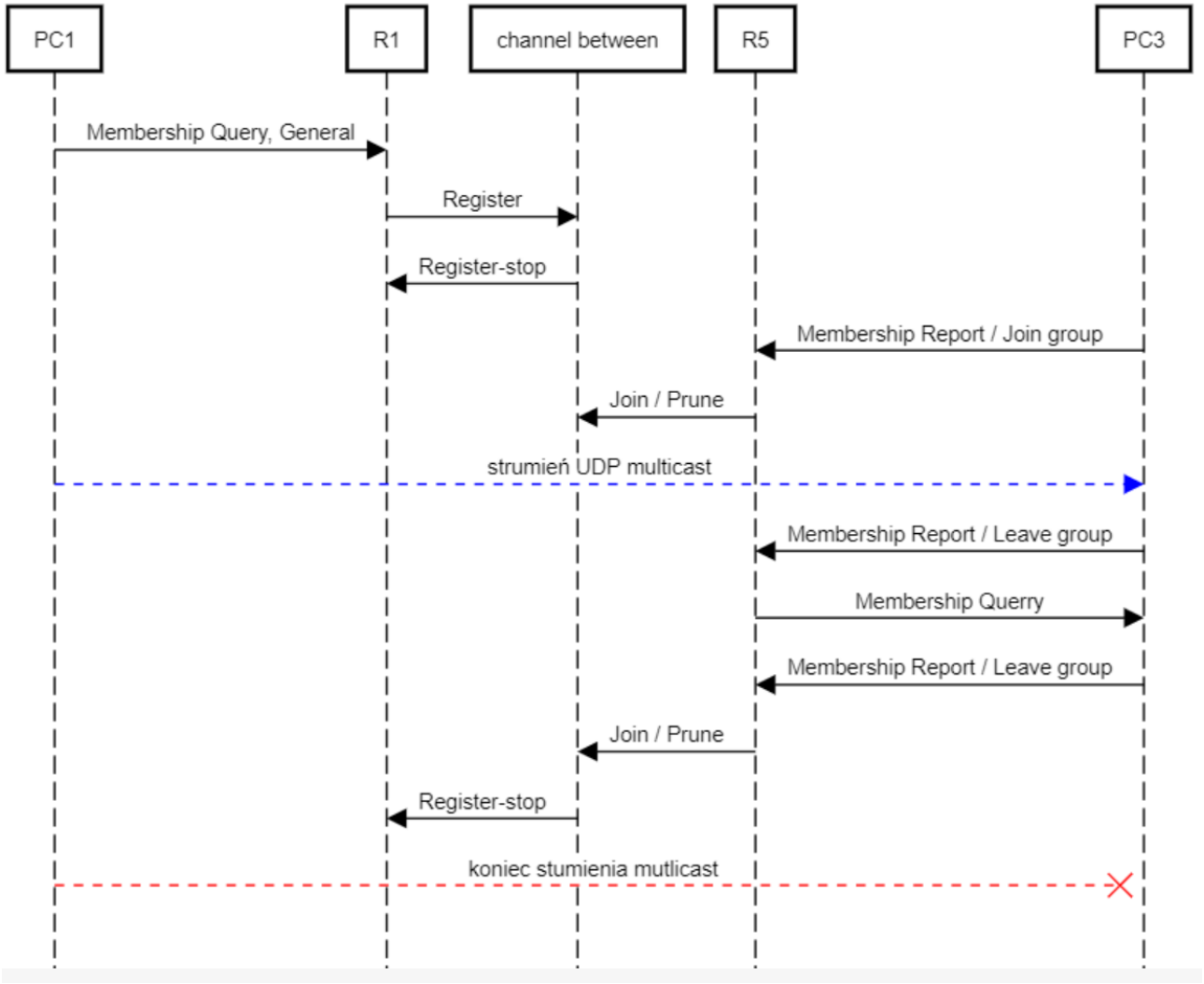
No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	10.10.13.1	224.0.0.22	IGMPv3	62	Membership Report / Join group 224.0.0.251 for any sources / Join group 224.0.0.106 for any sources
2	0.255841059	192.168.3.1	224.0.0.22	IGMPv3	86	Membership Report / Join group 224.0.0.22 for any sources / Join group 224.0.0.2 for any sources / Join group 224.0.0.13
3	5.939709963	192.168.3.1	224.0.0.5	OSPF	78	Hello Packet
4	15.939734311	192.168.3.1	224.0.0.5	OSPF	78	Hello Packet
5	16.358196187	192.168.3.1	224.0.0.13	PIMv2	68	Hello
6	19.383801501	192.168.3.2	224.0.0.22	IGMPv3	54	Membership Report / Join group 224.10.0.1 for any sources
11	19.812246792	192.168.3.2	224.0.0.22	IGMPv3	54	Membership Report / Join group 224.10.0.1 for any sources
73	25.941053526	192.168.3.1	224.0.0.5	OSPF	78	Hello Packet
170	35.941701373	192.168.3.1	224.0.0.5	OSPF	78	Hello Packet
270	45.943080098	192.168.3.1	224.0.0.5	OSPF	78	Hello Packet
275	46.351883367	192.168.3.1	224.0.0.13	PIMv2	68	Hello
371	55.944734046	192.168.3.1	224.0.0.5	OSPF	78	Hello Packet
470	65.945478265	192.168.3.1	224.0.0.5	OSPF	78	Hello Packet
568	75.946080111	192.168.3.1	224.0.0.5	OSPF	78	Hello Packet
573	76.352752757	192.168.3.1	224.0.0.13	PIMv2	68	Hello
668	85.946727076	192.168.3.1	224.0.0.5	OSPF	78	Hello Packet
767	95.948984285	192.168.3.1	224.0.0.5	OSPF	78	Hello Packet
793	99.656694378	192.168.3.2	224.0.0.22	IGMPv3	54	Membership Report / Leave group 224.10.0.1
794	99.657097245	192.168.3.1	224.10.0.1	IGMPv3	50	Membership Query, specific for group 224.10.0.1
795	100.288610671	192.168.3.2	224.0.0.22	IGMPv3	54	Membership Report / Leave group 224.10.0.1
796	100.289234161	192.168.3.1	224.10.0.1	IGMPv3	50	Membership Query, specific for group 224.10.0.1
797	100.657225030	192.168.3.1	224.10.0.1	IGMPv3	50	Membership Query, specific for group 224.10.0.1
798	101.657972773	192.168.3.1	224.10.0.1	IGMPv3	50	Membership Query, specific for group 224.10.0.1
799	105.949421470	192.168.3.1	224.0.0.5	OSPF	78	Hello Packet
800	106.355393000	192.168.3.1	224.0.0.13	PIMv2	68	Hello

Rys. 56: Zapis Wireshark na połączeniu pomiędzy **R5**, a **PC3**

Na powyższych zapisach Wireshark można zaobserwować jak zestawiana była transmisja multicast.

- Membership Report / Join - wiadomośc wysyłana przez hosta do najbliższego routera PIM umożliwia ona hostowi dołączanie do grup multicastowych. Kiedy host chce dołączyć do danej grupy multicastowej, wysyła wiadomość "membership report" (raport członkostwa) do routera, aby poinformować go o swoim zainteresowaniu otrzymywaniem pakietów multicastowych z tej grupy.
- Join / Prune - wiadomość wysyłana przez routery PIM służące do przekazywnia informacji o tym, że jakiś host chce dołączyć lub opuścić grupę multicast. Kiedy host dołącza do grupy multicastowej, wysyłana jest wiadomość "Join" aby poinformować go zainteresowaniu otrzymywaniem pakietów multicastowych z danej grupy. Natomiast, gdy host nie jest już zainteresowany daną grupą, wysyłana jest wiadomość "Prune", aby powiadomić routery, że host nie chce już otrzymywać pakietów multicastowych z tej grupy.
- Membership Query - wiadomość wysyłana przez router w celu sprawdzenia, czy istnieją aktywne hosty w danej grupie multicastowej. Jeśli w odpowiedzi na tę wiadomość router otrzyma odpowiednią wiadomość membership report od hosta, oznacza to, że host jest nadal zainteresowany otrzymywaniem pakietów multicastowych z tej grupy i router kontynuuje przekazywanie tych pakietów do hosta. W innym przypadku router uzna, że nie ma aktywnych hostów w danej grupie i router może zatrzymać przekazywanie pakietów multicastowych do tej grupy.

Na następnej stronie przedstawiliśmy ten proces za pomocą sekwencji wiadomości.



Rys. 57

3.3. Zadanie C3: definiowanie drugiego prefixu multicast

```
R1# show ip pim join
 Interface  Address       Source       Group       State   Uptime    Expire  Prune
 eth0       192.168.12.1  192.168.1.2  224.10.0.1  NOINFO  00:00:58  02:20   --:--
 eth0       192.168.12.1  192.168.2.2  224.20.0.1  NOINFO  00:01:01  02:15   --:--
 eth1       192.168.13.1  192.168.1.2  224.10.0.1  JOIN    00:01:10  03:16   --:--
 eth1       192.168.13.1  192.168.2.2  224.20.0.1  JOIN    00:01:14  03:16   --:--

R1# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source       Group       Flags  Proto  Input  Output  TTL  Uptime
 192.168.1.2  224.10.0.1  SFT    PIM    eth2   eth1    1    00:01:29
 192.168.2.2  224.20.0.1  SFT    PIM    eth3   eth1    1    00:01:27
```

(a) Wynik wykonania *show ip pim join* i *show ip mroute* na **R1**

```
R2# show ip pim join
 Interface  Address       Source       Group       State     Uptime    Expire  Prune
 eth1       192.168.24.2  *            224.10.0.1  JOIN      00:01:26  02:33   --:--
 eth1       192.168.24.2  192.168.1.2  224.10.0.1  SGRpt(P)  --:--:--  02:33   --:--
 eth1       192.168.24.2  *            224.20.0.1  JOIN      00:01:30  02:33   --:--
 eth1       192.168.24.2  192.168.2.2  224.20.0.1  SGRpt(P)  --:--:--  02:33   --:--

R2# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source       Group       Flags  Proto  Input  Output  TTL  Uptime
 *            224.10.0.1  S      none   eth1   none    0    --:--:--
 192.168.1.2  224.10.0.1  SRP    none   eth0   none    0    --:--:--
 *            224.20.0.1  S      none   eth1   none    0    --:--:--
 192.168.2.2  224.20.0.1  SRP    none   eth0   none    0    --:--:--
```

(b) Wynik wykonania *show ip pim join* i *show ip mroute* na **R2**

```
R3# show ip pim join
 Interface  Address       Source       Group       State  Uptime    Expire  Prune
 eth2       192.168.35.3  192.168.1.2  224.10.0.1  JOIN   00:01:19  03:16   --:--
 eth2       192.168.35.3  192.168.2.2  224.20.0.1  JOIN   00:01:23  03:16   --:--

R3# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source       Group       Flags  Proto  Input  Output  TTL  Uptime
 192.168.1.2  224.10.0.1  ST     PIM    eth0   eth2    1    00:01:23
 192.168.2.2  224.20.0.1  ST     PIM    eth0   eth2    1    00:01:27
```

(a) Wynik wykonania *show ip pim join* i *show ip mroute* na **R3**

```
R4# show ip pim join
 Interface  Address       Source       Group       State     Uptime    Expire  Prune
 eth2       192.168.46.4  *            224.10.0.1  JOIN      00:01:25  02:43   --:--
 eth2       192.168.46.4  *            224.20.0.1  JOIN      00:01:27  02:43   --:--
 eth3       192.168.45.4  *            224.10.0.1  JOIN      00:01:30  03:12   --:--
 eth3       192.168.45.4  192.168.1.2  224.10.0.1  SGRpt(P)  --:--:--  03:12   --:--
 eth3       192.168.45.4  *            224.20.0.1  JOIN      00:01:34  03:12   --:--
 eth3       192.168.45.4  192.168.2.2  224.20.0.1  SGRpt(P)  --:--:--  03:12   --:--

R4# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source       Group       Flags  Proto  Input  Output  TTL  Uptime
 *            224.10.0.1  S      PIM    eth0   eth2    1    00:01:31
                                 PIM           eth3    1
 192.168.1.2  224.10.0.1  SRP    none   eth0   none    0    --:--:--
 *            224.20.0.1  S      PIM    eth0   eth2    1    00:01:35
                                 PIM           eth3    1
 192.168.2.2  224.20.0.1  SRP    none   eth0   none    0    --:--:--
```

(b) Wynik wykonania *show ip pim join* i *show ip mroute* na **R4**

```
R5# show ip pim join
 Interface  Address      Source  Group       State   Uptime    Expire  Prune
 eth2       192.168.3.1  *       224.10.0.1  NOINFO  --:--:--  --:--   --:--
 eth3       192.168.4.1  *       224.20.0.1  NOINFO  --:--:--  --:--   --:--

R5# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source       Group       Flags  Proto  Input  Output  TTL  Uptime
 *            224.10.0.1  SC     IGMP   eth1   pimreg  1    00:01:38
                                 IGMP          eth2    1
 192.168.1.2  224.10.0.1  ST     STAR   eth0   eth2    1    00:01:38
 *            224.20.0.1  SC     IGMP   eth1   pimreg  1    00:01:42
                                 IGMP          eth3    1
 192.168.2.2  224.20.0.1  ST     STAR   eth0   eth3    1    00:01:42
```

(a) Wynik wykonania *show ip pim join* i *show ip mroute* na **R5**

```
R6# show ip pim join
 Interface  Address      Source  Group       State   Uptime    Expire  Prune
 eth2       192.168.5.1  *       224.10.0.1  NOINFO  --:--:--  --:--   --:--
 eth3       192.168.6.1  *       224.20.0.1  NOINFO  --:--:--  --:--   --:--

R6# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source  Group       Flags  Proto  Input  Output  TTL  Uptime
 *       224.10.0.1  SC     IGMP   eth0   eth2    1    00:01:40
 *       224.20.0.1  SC     IGMP   eth0   eth3    1    00:01:42
```

(b) Wynik wykonania *show ip pim join* i *show ip mroute* na **R6**

3.4. Zadanie C4: zmiana na najkrótszą ścieżkę

```
R1# show ip pim join
 Interface  Address       Source       Group       State   Uptime    Expire  Prune
 eth0       192.168.12.1  192.168.1.2  224.10.0.1  NOINFO  00:00:58  02:20   --:--
 eth0       192.168.12.1  192.168.2.2  224.20.0.1  NOINFO  00:01:01  02:15   --:--
 eth1       192.168.13.1  192.168.1.2  224.10.0.1  JOIN    00:01:10  03:16   --:--
 eth1       192.168.13.1  192.168.2.2  224.20.0.1  JOIN    00:01:14  03:16   --:--

R1# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source       Group       Flags  Proto  Input  Output  TTL  Uptime
 192.168.1.2  224.10.0.1  SFT    PIM    eth2   eth1    1    00:01:29
 192.168.2.2  224.20.0.1  SFT    PIM    eth3   eth1    1    00:01:27
```

(a) Wynik wykonania *show ip pim join* i *show ip mroute* na **R1**

```
R2# show ip pim join
 Interface  Address       Source       Group       State     Uptime    Expire  Prune
 eth1       192.168.24.2  *            224.10.0.1  JOIN      00:01:26  02:33   --:--
 eth1       192.168.24.2  192.168.1.2  224.10.0.1  SGRpt(P)  --:--:--  02:33   --:--
 eth1       192.168.24.2  *            224.20.0.1  JOIN      00:01:30  02:33   --:--
 eth1       192.168.24.2  192.168.2.2  224.20.0.1  SGRpt(P)  --:--:--  02:33   --:--

R2# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source       Group       Flags  Proto  Input  Output  TTL  Uptime
 *            224.10.0.1  S      none   eth1   none    0    --:--:--
 192.168.1.2  224.10.0.1  SRP    none   eth0   none    0    --:--:--
 *            224.20.0.1  S      none   eth1   none    0    --:--:--
 192.168.2.2  224.20.0.1  SRP    none   eth0   none    0    --:--:--
```

(b) Wynik wykonania *show ip pim join* i *show ip mroute* na **R2**

```
R3# show ip pim join
 Interface  Address       Source       Group       State  Uptime    Expire  Prune
 eth2       192.168.35.3  192.168.1.2  224.10.0.1  JOIN   00:01:19  03:16   --:--
 eth2       192.168.35.3  192.168.2.2  224.20.0.1  JOIN   00:01:23  03:16   --:--

R3# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source       Group       Flags  Proto  Input  Output  TTL  Uptime
 192.168.1.2  224.10.0.1  ST     PIM    eth0   eth2    1    00:01:23
 192.168.2.2  224.20.0.1  ST     PIM    eth0   eth2    1    00:01:27
```

(a) Wynik wykonania *show ip pim join* i *show ip mroute* na **R3**

```
R4# show ip pim join
 Interface  Address       Source       Group       State     Uptime    Expire  Prune
 eth2       192.168.46.4  *            224.10.0.1  JOIN      00:01:25  02:43   --:--
 eth2       192.168.46.4  *            224.20.0.1  JOIN      00:01:27  02:43   --:--
 eth3       192.168.45.4  *            224.10.0.1  JOIN      00:01:30  03:12   --:--
 eth3       192.168.45.4  192.168.1.2  224.10.0.1  SGRpt(P)  --:--:--  03:12   --:--
 eth3       192.168.45.4  *            224.20.0.1  JOIN      00:01:34  03:12   --:--
 eth3       192.168.45.4  192.168.2.2  224.20.0.1  SGRpt(P)  --:--:--  03:12   --:--

R4# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source       Group       Flags  Proto  Input  Output  TTL  Uptime
 *            224.10.0.1  S      PIM    eth0   eth2    1    00:01:31
                                 PIM           eth3    1
 192.168.1.2  224.10.0.1  SRP    none   eth0   none    0    --:--:--
 *            224.20.0.1  S      PIM    eth0   eth2    1    00:01:35
                                 PIM           eth3    1
 192.168.2.2  224.20.0.1  SRP    none   eth0   none    0    --:--:--
```

(b) Wynik wykonania *show ip pim join* i *show ip mroute* na **R4**

```
R5# show ip pim join
 Interface  Address      Source  Group       State   Uptime    Expire  Prune
 eth2       192.168.3.1  *       224.10.0.1  NOINFO  --:--:--  --:--   --:--
 eth3       192.168.4.1  *       224.20.0.1  NOINFO  --:--:--  --:--   --:--

R5# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source       Group       Flags  Proto  Input  Output  TTL  Uptime
 *            224.10.0.1  SC     IGMP   eth1   pimreg  1    00:01:38
                                 IGMP          eth2    1
 192.168.1.2  224.10.0.1  ST     STAR   eth0   eth2    1    00:01:38
 *            224.20.0.1  SC     IGMP   eth1   pimreg  1    00:01:42
                                 IGMP          eth3    1
 192.168.2.2  224.20.0.1  ST     STAR   eth0   eth3    1    00:01:42
```

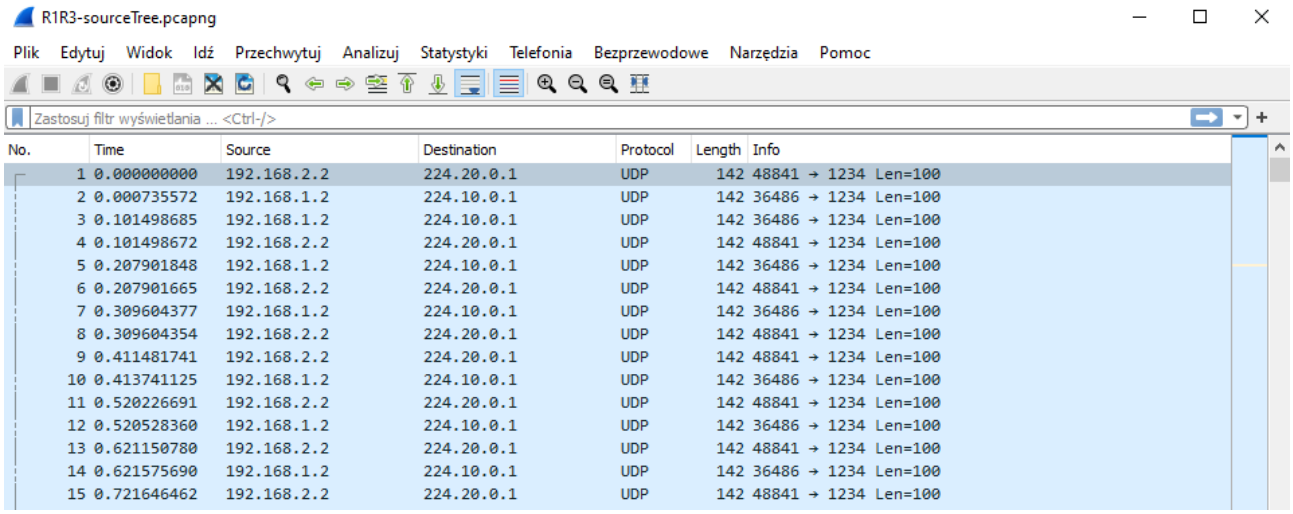
(a) Wynik wykonania *show ip pim join* i *show ip mroute* na **R5**

```
R6# show ip pim join
 Interface  Address      Source  Group       State   Uptime    Expire  Prune
 eth2       192.168.5.1  *       224.10.0.1  NOINFO  --:--:--  --:--   --:--
 eth3       192.168.6.1  *       224.20.0.1  NOINFO  --:--:--  --:--   --:--

R6# show ip mroute
IP Multicast Routing Table
Flags: S - Sparse, C - Connected, P - Pruned
       R - SGRpt Pruned, F - Register flag, T - SPT-bit set
 Source  Group       Flags  Proto  Input  Output  TTL  Uptime
 *       224.10.0.1  SC     IGMP   eth0   eth2    1    00:01:40
 *       224.20.0.1  SC     IGMP   eth0   eth3    1    00:01:42
```

(b) Wynik wykonania *show ip pim join* i *show ip mroute* na **R6**

Z powyższych zdjęć można stwierdzić, że ruch mutlicast dla PC podłączonych do router R5 odbywał się na najkrótszej drodze między źródłem a odbiornikiem, czyli w tym przypadku PC1 → R1 → R3 → R5 → PC3/PC4 Natomiast ruch multicast dla PC podłączonych do R6 odbywał się po takiej samej ścieżce jak wcześniej.

Potwierdzić to może, chociażby ruch wykryty przy pomocy programu WireShark. Na zdjęciach poniżej przedstawiony został ruch na łączach R1-R3 oraz R2-R4. Można na nich zauważyć, że ruch występuję zarówno na łączu R1-R3 (multicast skierowany bezpośrednio do PC3 i PC4), jak i na łączu R2-R4 (multicast skierowany do PC5 i PC6 poprzez router RP).



Rys. 64: Zapis Wireshark na połączeniu pomiędzy **R1**, a **R3**

R2R4-sourceTree.pcapng

Plik Edytuj Widok Idź Przechwytuj Analizuj Statystyki Telefonia Bezprzewodowe Narzędzia Pomoc

Zastosuj filtr wyświetlania ... <Ctrl-/>

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	192.168.24.4	224.0.0.5	OSPF	82	Hello Packet
2	1.533337076	192.168.24.4	224.0.0.13	PIMv2	68	Join/Prune
3	1.536268361	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
4	1.637588373	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
5	1.740750006	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
6	1.841260697	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
7	1.942055073	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
8	2.042496363	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
9	2.143127218	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
10	2.243457488	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
11	2.344705263	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
12	2.446565043	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
13	2.547379950	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
14	2.647707402	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
15	2.711399423	192.168.24.4	224.0.0.13	PIMv2	68	Hello
16	2.711508538	192.168.24.2	224.0.0.13	PIMv2	68	Hello
17	2.747990248	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
18	2.845684512	192.168.24.2	224.0.0.5	OSPF	82	Hello Packet
19	2.848219216	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
20	2.948627194	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
21	3.048938179	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
22	3.149310686	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
23	3.249713396	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
24	3.350432890	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
25	3.451251875	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
26	3.551832259	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
27	3.652602147	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
28	3.753981289	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
29	3.855285513	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
30	3.955708648	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
31	4.056753448	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
32	4.157384744	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100
33	4.257911178	192.168.1.2	224.10.0.1	UDP	142	51629 → 1234 Len=100

Rys. 65: Zapis Wireshark na połączeniu pomiędzy **R2**, a **R4**

Na koniec ponownie przełączyliśmy ruch na drzewo współdzielone i sprawdziliśmy, czy ruch na łączu R3-R1 został wstrzymany. Jak widać na poniższym zdjęciu po zmianie nie ma żadnych pakietów UDP, a większość ruchu na łączu to wiadomości "Hello" protokołu OSPF, co oznacza, że strumień multicast znowu prowadzony jest przy użyciu drzewa współdzielonego.

R1R3-sharedTree.pcapng

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Zastosuj filtr wyświetlania ... <Ctrl-/>

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	192.168.13.3	224.0.0.5	OSPF	82	Hello Packet
2	2.701693766	192.168.13.3	224.0.0.13	PIMv2	68	Hello
3	2.701821985	192.168.13.1	224.0.0.13	PIMv2	68	Hello
4	3.262546741	192.168.13.1	224.0.0.5	OSPF	82	Hello Packet
5	10.000198409	192.168.13.3	224.0.0.5	OSPF	82	Hello Packet
6	13.262552020	192.168.13.1	224.0.0.5	OSPF	82	Hello Packet
7	20.000920760	192.168.13.3	224.0.0.5	OSPF	82	Hello Packet
8	23.262786142	192.168.13.1	224.0.0.5	OSPF	82	Hello Packet
9	30.000854597	192.168.13.3	224.0.0.5	OSPF	82	Hello Packet
10	32.702643991	192.168.13.3	224.0.0.13	PIMv2	68	Hello
11	32.702748026	192.168.13.1	224.0.0.13	PIMv2	68	Hello
12	33.262878647	192.168.13.1	224.0.0.5	OSPF	82	Hello Packet
13	40.001359170	192.168.13.3	224.0.0.5	OSPF	82	Hello Packet
14	43.262901378	192.168.13.1	224.0.0.5	OSPF	82	Hello Packet
15	50.001375199	192.168.13.3	224.0.0.5	OSPF	82	Hello Packet

Rys. 66: Zapis Wireshark na połączeniu pomiędzy **R1**, a **R3**