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Sprawozdanie z realizacji laboratorium KRI nr 5
BGP 2

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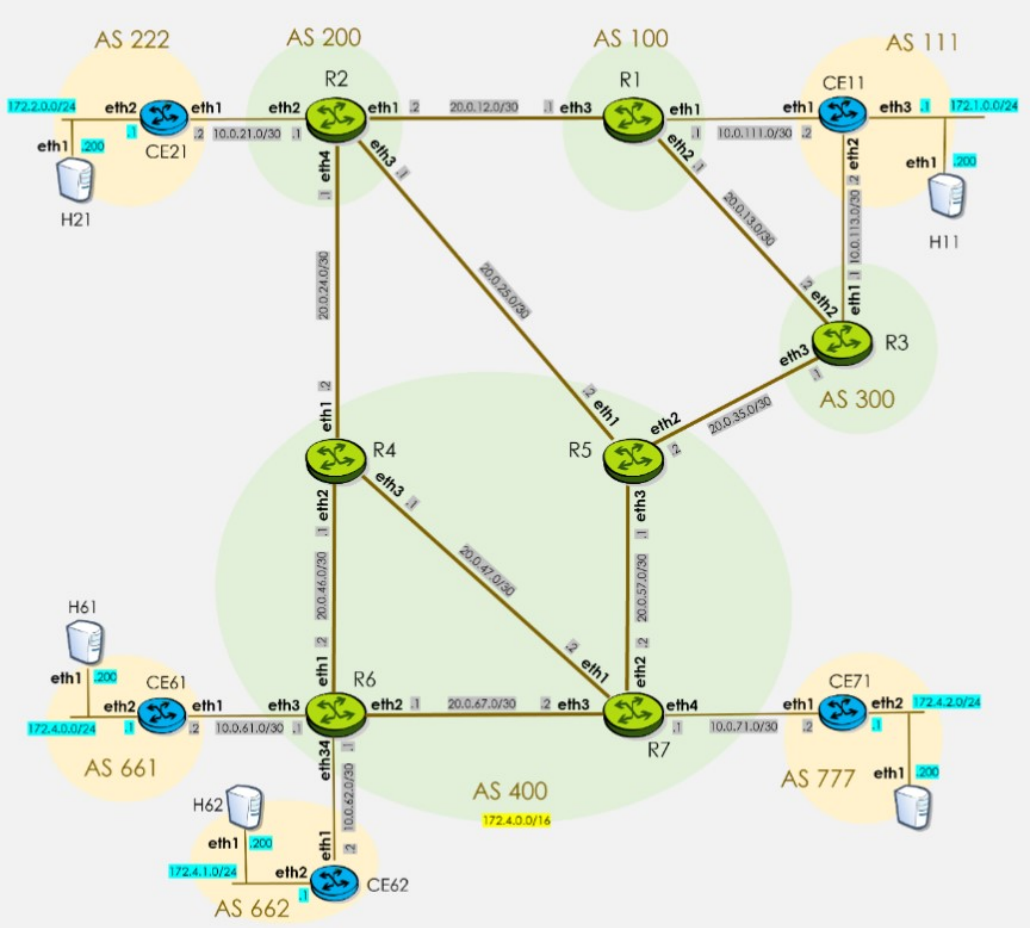
Spis treści

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: Przypisanie adresów IP

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



Rys. 1: Topologia wykorzystywanej sieci

Dla wszystkich routerów **RX** (gdzie X jest liczbą od 1 do 7) zostały przypisane adresy loopback. Adresy te są przypisywane w taki sposób, że adres routera RX to X.X.X.X/32. Poza tym cała adresacja OSPF w **AS400** została już wcześniej przygotowana przez autorów zadania laboratoryjnego. Poniżej została pokazana początkowa konfiguracja routerów **RX**

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

Current configuration:
!
frr version 8.5_git
frr defaults traditional
hostname R1
no ipv6 forwarding
!
interface eth1
 ip address 10.0.111.1/30
exit
!
interface eth2
 ip address 20.0.12.1/30
exit
!
interface eth3
 ip address 20.0.13.1/30
exit
!
interface lo
 ip address 1.1.1.1/32
exit
!
router bgp 100
 no bgp ebgp-requires-policy
 neighbor 10.0.111.2 remote-as 111
exit
!
end
R1# cofn ter
% Unknown command: cofn ter
R1# conf terminal
R1(config)#
```

(a) Początkowa konfiguracja na routerze **R1**

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

Current configuration:
!
frr version 8.5_git
frr defaults traditional
hostname R2
no ipv6 forwarding
!
interface eth1
 ip address 20.0.12.2/30
exit
!
interface eth2
 ip address 10.0.21.1/24
exit
!
interface eth3
 ip address 20.0.25.1/30
exit
!
interface eth4
 ip address 20.0.24.1/30
exit
!
interface lo
 ip address 2.2.2.2/32
exit
!
router bgp 200
 no bgp ebgp-requires-policy
 neighbor 10.0.21.2 remote-as 222
exit
!
end
```

(b) Początkowa konfiguracja na routerze **R2**

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

Current configuration:
!
frr version 8.5_git
frr defaults traditional
hostname R3
no ipv6 forwarding
!
interface eth1
 ip address 10.0.113.1/30
exit
!
interface eth2
 ip address 20.0.13.2/30
exit
!
interface eth3
 ip address 20.0.35.1/30
exit
!
interface lo
 ip address 3.3.3.3/32
exit
!
router bgp 300
 neighbor 10.0.113.2 remote-as 111
exit
!
end
```

(a) Początkowa konfiguracja na routerze **R3**

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

Current configuration:
!
frr version 8.5_git
frr defaults traditional
hostname R4
no ipv6 forwarding
!
interface eth1
 ip address 20.0.24.2/30
exit
!
interface eth2
 ip address 20.0.46.1/30
exit
!
interface eth3
 ip address 20.0.47.1/30
exit
!
interface lo
 ip address 4.4.4.4/32
exit
!
router ospf
 network 4.4.4.4/32 area 0
 network 20.0.46.0/30 area 0
 network 20.0.47.0/30 area 0
exit
!
end
```

(b) Początkowa konfiguracja na routerze **R4**

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

Current configuration:
!
frr version 8.5_git
frr defaults traditional
hostname R5
no ipv6 forwarding
!
interface eth1
 ip address 20.0.25.2/30
exit
!
interface eth2
 ip address 20.0.35.2/30
exit
!
interface eth3
 ip address 20.0.57.1/30
exit
!
interface lo
 ip address 5.5.5.5/32
exit
!
router ospf
 network 5.5.5.5/32 area 0
 network 20.0.57.0/30 area 0
exit
!
end
```

(a) Początkowa konfiguracja na routerze **R5**

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

Current configuration:
!
frr version 8.5_git
frr defaults traditional
hostname R6
no ipv6 forwarding
!
interface eth1
 ip address 20.0.46.2/30
exit
!
interface eth2
 ip address 20.0.67.1/30
exit
!
interface eth3
 ip address 10.0.61.1/30
exit
!
interface eth4
 ip address 10.0.62.1/30
exit
!
interface lo
 ip address 6.6.6.6/32
exit
!
router bgp 400
 no bgp ebgp-requires-policy
 neighbor 10.0.61.2 remote-as 661
 neighbor 10.0.62.2 remote-as 662
exit
!
router ospf
 network 6.6.6.6/32 area 0
 network 20.0.46.0/30 area 0
 network 20.0.67.0/30 area 0
exit
!
end
```

(b) Początkowa konfiguracja na routerze **R6**

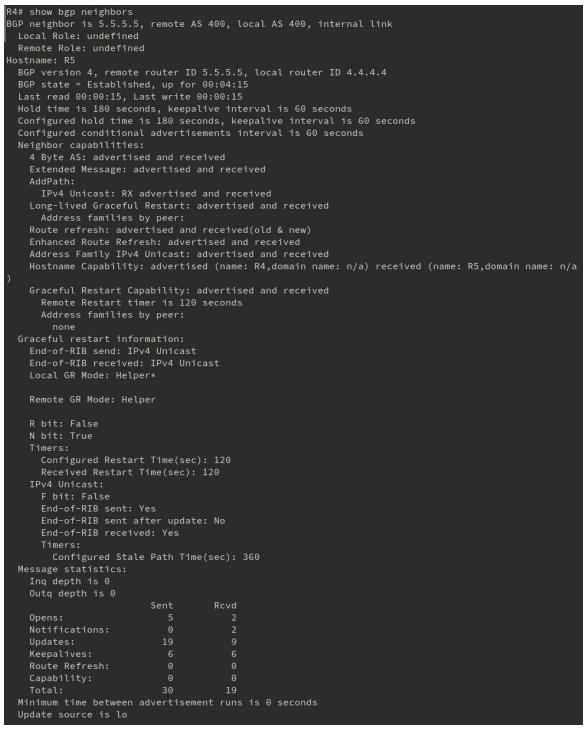
```
R7# show running-config
Building configuration...

Current configuration:
!
frr version 8.5_git
frr defaults traditional
hostname R7
no ipv6 forwarding
!
interface eth1
 ip address 20.0.47.2/30
exit
!
interface eth2
 ip address 20.0.57.2/30
exit
!
interface eth3
 ip address 20.0.67.2/30
exit
!
interface eth4
 ip address 10.0.71.1/30
exit
!
interface lo
 ip address 7.7.7.7/32
exit
!
router bgp 400
 no bgp ebgp-requires-policy
 neighbor 10.0.71.2 remote-as 777
exit
!
router ospf
 network 7.7.7.7/32 area 0
 network 20.0.47.0/30 area 0
 network 20.0.57.0/30 area 0
 network 20.0.67.0/30 area 0
exit
!
end
```

Rys. 5: Początkowa konfiguracja na routerze **R7**

2. Zadanie B: Podstawowa konfiguracja BGP

2.1. Zadanie B1

W ramach tego zadania mieliśmy stworzyć Route Reflector dla **AS400** na routerze **R4**



```
R4# show bgp neighbors
BGP neighbor is 5.5.5.5, remote AS 400, local AS 400, internal link
  Local Role: undefined
  Remote Role: undefined
Hostname: R5
  BGP version 4, remote router ID 5.5.5.5, local router ID 4.4.4.4
  BGP state = Established, up for 00:04:15
  Last read 00:00:15, Last write 00:00:15
  Hold time is 180 seconds, keepalive interval is 60 seconds
  Configured hold time is 180 seconds, keepalive interval is 60 seconds
  Configured conditional advertisements interval is 60 seconds
  Neighbor capabilities:
    4 Byte AS: advertised and received
    Extended Message: advertised and received
    AddPath:
      IPv4 Unicast: RX advertised and received
    Long-lived Graceful Restart: advertised and received
      Address families by peer:
    Route refresh: advertised and received(old & new)
    Enhanced Route Refresh: advertised and received
    Address Family IPv4 Unicast: advertised and received
    Hostname Capability: advertised (name: R4,domain name: n/a) received (name: R5,domain name: n/a
)
    Graceful Restart Capability: advertised and received
      Remote Restart timer is 120 seconds
      Address families by peer:
        none
  Graceful restart information:
    End-of-RIB send: IPv4 Unicast
    End-of-RIB received: IPv4 Unicast
    Local GR Mode: Helper*

    Remote GR Mode: Helper

    R bit: False
    N bit: True
    Timers:
      Configured Restart Time(sec): 120
      Received Restart Time(sec): 120
    IPv4 Unicast:
      F bit: False
      End-of-RIB sent: Yes
      End-of-RIB sent after update: No
      End-of-RIB received: Yes
      Timers:
        Configured Stale Path Time(sec): 360
  Message statistics:
    Inq depth is 0
    Outq depth is 0
                         Sent       Rcvd
    Opens:                  5          2
    Notifications:          0          2
    Updates:               19          9
    Keepalives:             6          6
    Route Refresh:          0          0
    Capability:             0          0
    Total:                 30         19
  Minimum time between advertisement runs is 0 seconds
  Update source is lo
```

```
 For address family: IPv4 Unicast
  Update group 6, subgroup 8
  Packet Queue length 0
  Route-Reflector Client
  NEXT_HOP is always this router
  Community attribute sent to this neighbor(all)
  2 accepted prefixes

  Connections established 2; dropped 1
  Last reset 00:04:17,  No AFI/SAFI activated for peer
  Internal BGP neighbor may be up to 255 hops away.
Local host: 4.4.4.4, Local port: 179
Foreign host: 5.5.5.5, Foreign port: 37447
Nexthop: 4.4.4.4
Nexthop global: ::
Nexthop local: ::
BGP connection: non shared network
BGP Connect Retry Timer in Seconds: 120
Estimated round trip time: 5 ms
Read thread: on  Write thread: on  FD used: 25

BGP neighbor is 6.6.6.6, remote AS 400, local AS 400, internal link
  Local Role: undefined
  Remote Role: undefined
Hostname: R6
  BGP version 4, remote router ID 6.6.6.6, local router ID 4.4.4.4
  BGP state = Established, up for 00:04:13
  Last read 00:00:13, Last write 00:00:13
  Hold time is 180 seconds, keepalive interval is 60 seconds
  Configured hold time is 180 seconds, keepalive interval is 60 seconds
  Configured conditional advertisements interval is 60 seconds
  Neighbor capabilities:
    4 Byte AS: advertised and received
    Extended Message: advertised and received
    AddPath:
      IPv4 Unicast: RX advertised and received
    Long-lived Graceful Restart: advertised and received
      Address families by peer:
    Route refresh: advertised and received(old & new)
    Enhanced Route Refresh: advertised and received
    Address Family IPv4 Unicast: advertised and received
    Hostname Capability: advertised (name: R4,domain name: n/a) received (name: R6,domain name: n/a
)
    Graceful Restart Capability: advertised and received
      Remote Restart timer is 120 seconds
      Address families by peer:
        none
  Graceful restart information:
    End-of-RIB send: IPv4 Unicast
    End-of-RIB received: IPv4 Unicast
    Local GR Mode: Helper*

    Remote GR Mode: Helper

    R bit: False
    N bit: True
    Timers:
      Configured Restart Time(sec): 120
      Received Restart Time(sec): 120
```

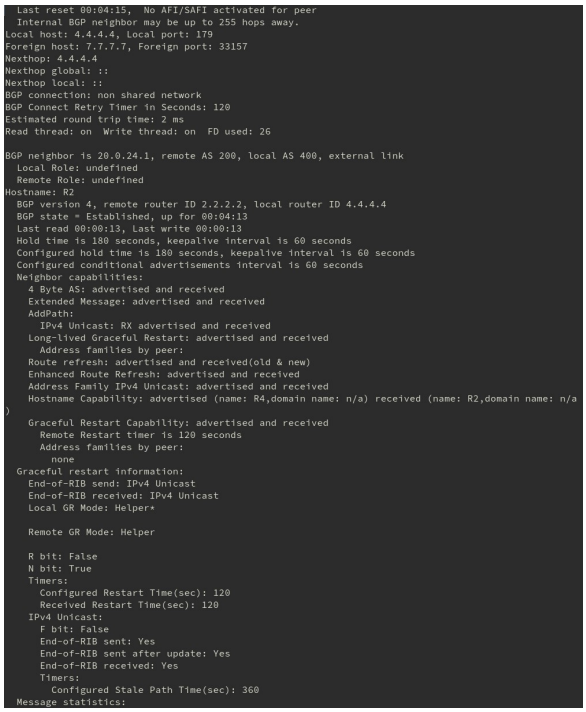
(a) Wynik wykonania *show ip bgp neighbors* na **R4** (cześć 1)(b) Wynik wykonania *show ip bgp neighbors* na **R4** (cześć 2)

```
    IPv4 Unicast:
      F bit: False
      End-of-RIB sent: Yes
      End-of-RIB sent after update: Yes
      End-of-RIB received: Yes
      Timers:
        Configured Stale Path Time(sec): 360
  Message statistics:
    Inq depth is 0
    Outq depth is 0
                         Sent       Rcvd
    Opens:                  7          4
    Notifications:          3          0
    Updates:               30         15
    Keepalives:           150        150
    Route Refresh:          0          0
    Capability:             0          0
    Total:                190        169
  Minimum time between advertisement runs is 0 seconds
  Update source is lo

 For address family: IPv4 Unicast
  Update group 6, subgroup 8
  Packet Queue length 0
  Route-Reflector Client
  NEXT_HOP is always this router
  Community attribute sent to this neighbor(all)
  4 accepted prefixes

  Connections established 3; dropped 2
  Last reset 00:04:15,  User reset
  Message received that caused BGP to send a NOTIFICATION:
    FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFF
    005E0104 019000B4 06060606 41020601
    04000100 01020280 00020202 00020246
    00020641 04000001 90020206 00020645
    04000101 01020649 04025236 00020440
    02407802 09470700 01018000 0000
  Internal BGP neighbor may be up to 255 hops away.
Local host: 4.4.4.4, Local port: 39027
Foreign host: 6.6.6.6, Foreign port: 179
Nexthop: 4.4.4.4
Nexthop global: ::
Nexthop local: ::
BGP connection: non shared network
BGP Connect Retry Timer in Seconds: 120
Estimated round trip time: 3 ms
Read thread: on  Write thread: on  FD used: 27

BGP neighbor is 7.7.7.7, remote AS 400, local AS 400, internal link
  Local Role: undefined
  Remote Role: undefined
Hostname: R7
  BGP version 4, remote router ID 7.7.7.7, local router ID 4.4.4.4
  BGP state = Established, up for 00:04:13
  Last read 00:00:13, Last write 00:00:13
  Hold time is 180 seconds, keepalive interval is 60 seconds
  Configured hold time is 180 seconds, keepalive interval is 60 seconds
```

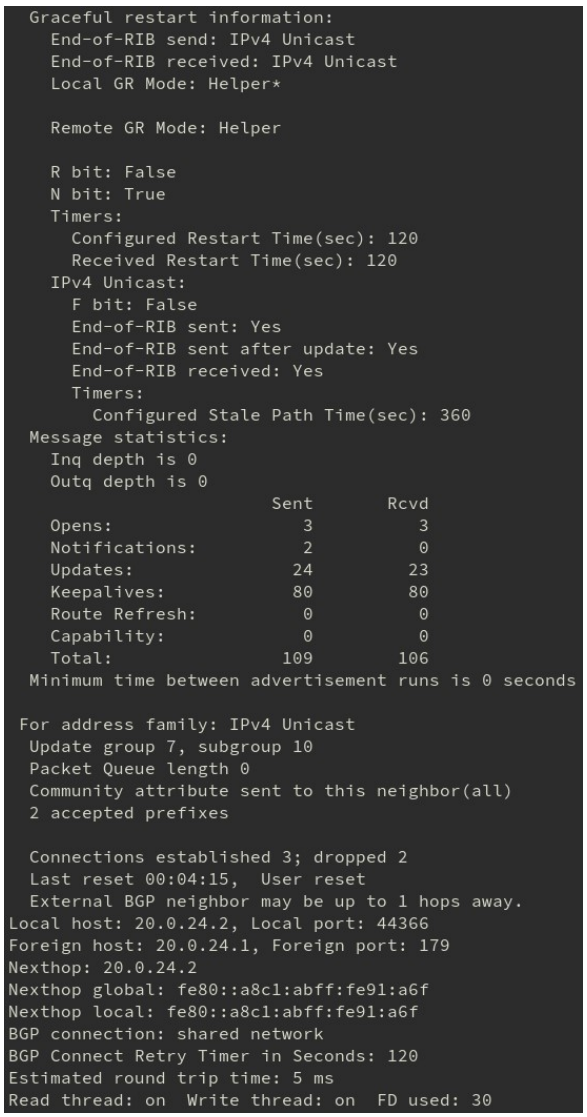
(a) Wynik wykonania *show ip bgp neighbors* na **R4** (cześć 3)

```
  Configured conditional advertisements interval is 60 seconds
  Neighbor capabilities:
    4 Byte AS: advertised and received
    Extended Message: advertised and received
    AddPath:
      IPv4 Unicast: RX advertised and received
    Long-lived Graceful Restart: advertised and received
      Address families by peer:
    Route refresh: advertised and received(old & new)
    Enhanced Route Refresh: advertised and received
    Address Family IPv4 Unicast: advertised and received
    Hostname Capability: advertised (name: R4,domain name: n/a) received (name: R7,domain name: n/a
)
    Graceful Restart Capability: advertised and received
      Remote Restart timer is 120 seconds
      Address families by peer:
        none
  Graceful restart information:
    End-of-RIB send: IPv4 Unicast
    End-of-RIB received: IPv4 Unicast
    Local GR Mode: Helper*

    Remote GR Mode: Helper

    R bit: False
    N bit: True
    Timers:
      Configured Restart Time(sec): 120
      Received Restart Time(sec): 120
    IPv4 Unicast:
      F bit: False
      End-of-RIB sent: Yes
      End-of-RIB sent after update: Yes
      End-of-RIB received: Yes
      Timers:
        Configured Stale Path Time(sec): 360
  Message statistics:
    Inq depth is 0
    Outq depth is 0
                         Sent       Rcvd
    Opens:                  6          2
    Notifications:          2          0
    Updates:               30         10
    Keepalives:           148        148
    Route Refresh:          0          0
    Capability:             0          0
    Total:                186        160
  Minimum time between advertisement runs is 0 seconds
  Update source is lo

 For address family: IPv4 Unicast
  Update group 6, subgroup 8
  Packet Queue length 0
  Route-Reflector Client
  NEXT_HOP is always this router
  Community attribute sent to this neighbor(all)
  2 accepted prefixes

  Connections established 3; dropped 2
  Last reset 00:04:15,  No AFI/SAFI activated for peer
```

(b) Wynik wykonania *show ip bgp neighbors* na **R4** (cześć 4)



(a) Wynik wykonania *show ip bgp neighbors* na **R4** (cześć 5)



(b) Wynik wykonania *show ip bgp neighbors* na **R4** (cześć 6)

```
R4# show ip bgp summary

IPv4 Unicast Summary (VRF default):
BGP router identifier 4.4.4.4, local AS number 400 vrf-id 0
BGP table version 43
RIB entries 15, using 2880 bytes of memory
Peers 4, using 2870 KiB of memory

Neighbor        V         AS   MsgRcvd   MsgSent   TblVer  InQ OutQ  Up/Down State/PfxRcd   PfxSnt
Desc
5.5.5.5         4        400        23        34        0    0    0 00:08:45            2        8
N/A
6.6.6.6         4        400       173       194        0    0    0 00:08:43            4        8
N/A
7.7.7.7         4        400       164       190        0    0    0 00:08:43            2        8
N/A
20.0.24.1       4        200       110       113        0    0    0 00:08:43            2        8
N/A
```

Rys. 9: Wynik wykonania *show ip bgp summary* na **R4**

```
R5# show ip bgp summary

IPv4 Unicast Summary (VRF default):
BGP router identifier 5.5.5.5, local AS number 400 vrf-id 0
BGP table version 33
RIB entries 15, using 2880 bytes of memory
Peers 4, using 2870 KiB of memory

Neighbor        V         AS   MsgRcvd   MsgSent   TblVer  InQ OutQ  Up/Down State/PfxRcd   PfxSnt Desc
4.4.4.4         4        400        33        25        0    0    0 00:10:01            8        2 N/A
7.7.7.7         4        400       168       174        0    0    0 00:10:01            2        2 N/A
20.0.25.1       4        200       115       111        0    0    0 00:10:01            2        8 N/A
20.0.35.1       4        300       121       110        0    0    0 00:10:01            0        8 N/A

Total number of neighbors 4
```

Rys. 10: Wynik wykonania *show ip bgp summary* na **R5**

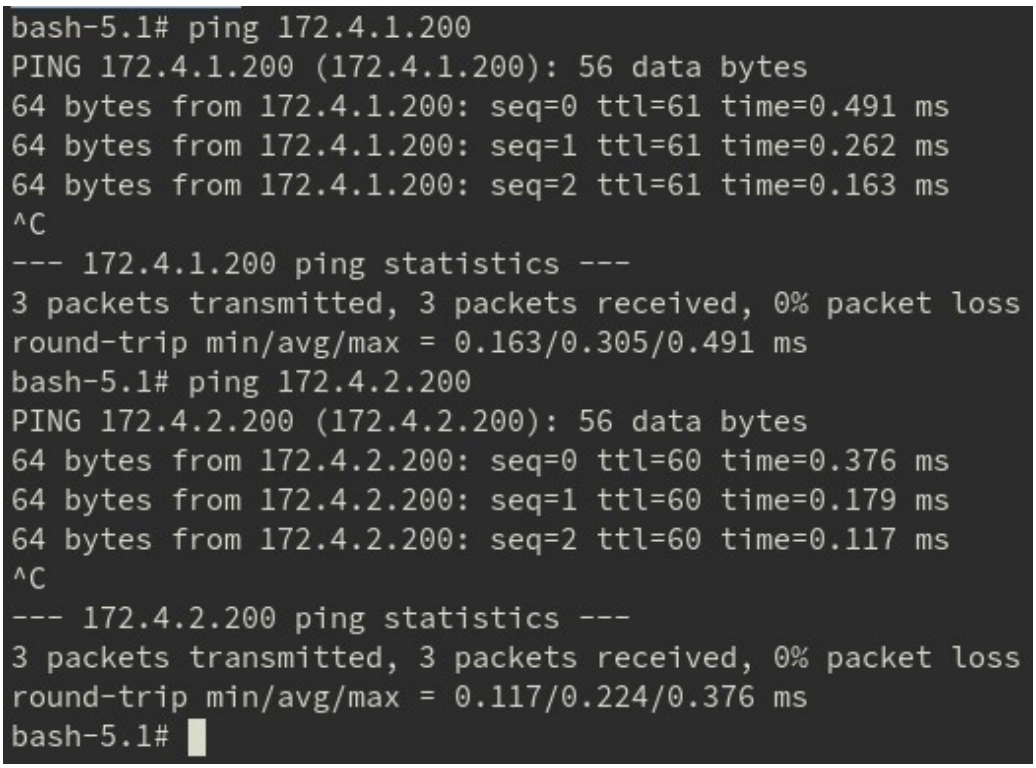
```
R6# show ip bgp summary

IPv4 Unicast Summary (VRF default):
BGP router identifier 6.6.6.6, local AS number 400 vrf-id 0
BGP table version 17
RIB entries 15, using 2880 bytes of memory
Peers 4, using 2870 KiB of memory

Neighbor        V         AS   MsgRcvd   MsgSent   TblVer  InQ OutQ  Up/Down State/PfxRcd   PfxSnt Desc
4.4.4.4         4        400       193       175        0    0    0 00:10:31            4        4 N/A
7.7.7.7         4        400       159       161        0    0    0 02:33:24            2        4 N/A
10.0.61.2       4        661       181       184        0    0    0 02:43:11            1        8 N/A
10.0.62.2       4        662       180       181        0    0    0 02:43:13            1        8 N/A

Total number of neighbors 4
```

Rys. 11: Wynik wykonania *show ip bgp summary* na **R6**

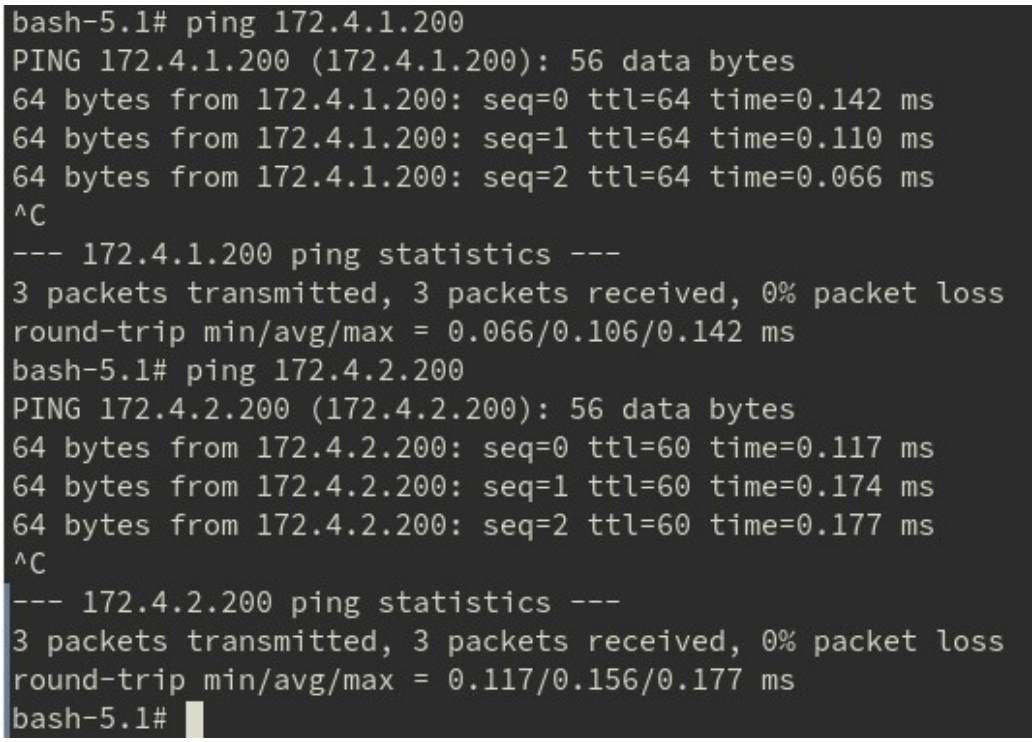
```
R7# show ip bgp summary

IPv4 Unicast Summary (VRF default):
BGP router identifier 7.7.7.7, local AS number 400 vrf-id 0
BGP table version 26
RIB entries 15, using 2880 bytes of memory
Peers 4, using 2870 KiB of memory

Neighbor        V         AS   MsgRcvd   MsgSent   TblVer  InQ OutQ  Up/Down State/PfxRcd   PfxSnt Desc
4.4.4.4         4        400       192       169        0    0    0 00:10:55            6        2 N/A
5.5.5.5         4        400       171       168        0    0    0 00:10:57            2        2 N/A
6.6.6.6         4        400       160       160        0    0    0 02:33:48            4        2 N/A
10.0.71.2       4        777       178       180        0    0    0 02:43:38            1        8 N/A

Total number of neighbors 4
```

Rys. 12: Wynik wykonania *show ip bgp summary* na **R7**

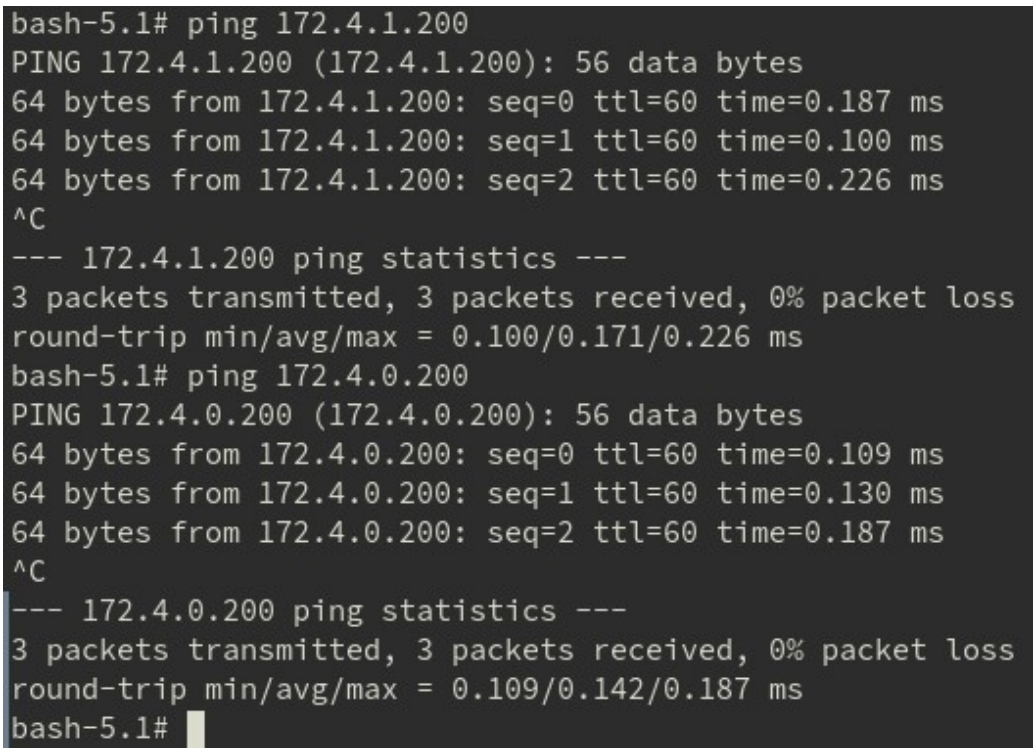
Powyżej można zobaczyć, jakie zostały zestawione relacje sąsiedztwa między routerami w **AS400** podczas konfiguracji **iBGP** oraz tworzenia Route Reflectora na **R4**. Warto zauważyć, że pomimo tego, że **R4** nie ma bezpośredniego połączenia z **R5** to i tak zestawiliśmy sąsiedztwo między nimi. Zapewnia to wymianę informacji między wszystkimi routerami w **AS400**. Poniżej przedstawione zostały wyniki *ping* pomiędzy klientami sieci **AS400**.



Rys. 13: Wynik wykonania *ping* na **H61**



Rys. 14: Wynik wykonania *ping* na **H62**



Rys. 15: Wynik wykonania *ping* na **H71**

2.2. Zadanie B2

Zgodnie z poleceniem zestawiliśmy wszystkie pozostałe sesje eBGP. Poniżej przedstawiono wyniki wykonania komend *show ip bgp summary* dla wszystkich routerów po dokonaniu konfiguracji **eBGP**.

```
R1# show ip bgp summary

IPv4 Unicast Summary (VRF default):
BGP router identifier 1.1.1.1, local AS number 100 vrf-id 0
BGP table version 41
RIB entries 5, using 960 bytes of memory
Peers 3, using 2153 KiB of memory

Neighbor        V         AS   MsgRcvd   MsgSent   TblVer  InQ OutQ  Up/Down State/PfxRcd   PfxSnt Desc
10.0.111.2      4        111       306       300        0    0    0 04:35:38            1        3 N/A
20.0.12.2       4        200       234       230        0    0    0 03:13:27            2        3 N/A
20.0.13.2       4        300        67        66        0    0    0 01:00:36            0        3 N/A

Total number of neighbors 3
```

Rys. 16: Wynik wykonania *show ip bgp summary* na **R1**

```
R2# show ip bgp summary

IPv4 Unicast Summary (VRF default):
BGP router identifier 2.2.2.2, local AS number 200 vrf-id 0
BGP table version 7
RIB entries 13, using 2496 bytes of memory
Peers 3, using 2153 KiB of memory

Neighbor        V         AS   MsgRcvd   MsgSent   TblVer  InQ OutQ  Up/Down State/PfxRcd   PfxSnt Desc
10.0.21.2       4        222        88        90        0    0    0 01:19:37            1        7 N/A
20.0.24.2       4        400         9        11        0    0    0 00:01:27            6        7 N/A
20.0.25.2       4        400         4        11        0    0    0 00:01:03            0        7 N/A
```

Rys. 17: Wynik wykonania *show ip bgp summary* na **R2**

```
R3# show ip bgp summary

IPv4 Unicast Summary (VRF default):
BGP router identifier 3.3.3.3, local AS number 300 vrf-id 0
BGP table version 67
RIB entries 5, using 960 bytes of memory
Peers 3, using 2153 KiB of memory

Neighbor        V         AS   MsgRcvd   MsgSent   TblVer  InQ OutQ  Up/Down State/PfxRcd   PfxSnt Desc
10.0.113.2      4        111       305       315        0    0    0 04:34:29            2        3 N/A
20.0.13.1       4        100       287       172        0    0    0 00:59:31            3        3 N/A
20.0.35.2       4        400       239       253        0    0    0 02:01:53            0        3 N/A
```

Rys. 18: Wynik wykonania *show ip bgp summary* na **R3**

```
R4# show ip bgp summary

IPv4 Unicast Summary (VRF default):
BGP router identifier 4.4.4.4, local AS number 400 vrf-id 0
BGP table version 8
RIB entries 15, using 2880 bytes of memory
Peers 3, using 2153 KiB of memory

Neighbor        V         AS   MsgRcvd   MsgSent   TblVer  InQ OutQ  Up/Down State/PfxRcd   PfxSnt Desc
6.6.6.6         4        400        98       106        0    0    0 01:29:11            4        8 N/A
7.7.7.7         4        400        94       105        0    0    0 01:28:13            2        8 N/A
20.0.24.1       4        200        28        28        0    0    0 00:19:29            2        8 N/A

Total number of neighbors 3
```

Rys. 19: Wynik wykonania *show ip bgp summary* na **R4**

```
R5# show ip bgp  summary

IPv4 Unicast Summary (VRF default):
BGP router identifier 5.5.5.5, local AS number 400 vrf-id 0
BGP table version 2
RIB entries 3, using 576 bytes of memory
Peers 3, using 2153 KiB of memory

Neighbor        V         AS   MsgRcvd   MsgSent   TblVer  InQ OutQ  Up/Down State/PfxRcd   PfxSnt Desc
7.7.7.7         4        400        75        75        0    0    0 01:09:13            2        0 N/A
20.0.25.1       4        200         8         3        0    0    0 00:00:49            0        0 N/A
20.0.35.1       4        300         3         3        0    0    0 00:00:41            0        0 N/A

Total number of neighbors 3
```

Rys. 20: Wynik wykonania *show ip bgp summary* na **R5**

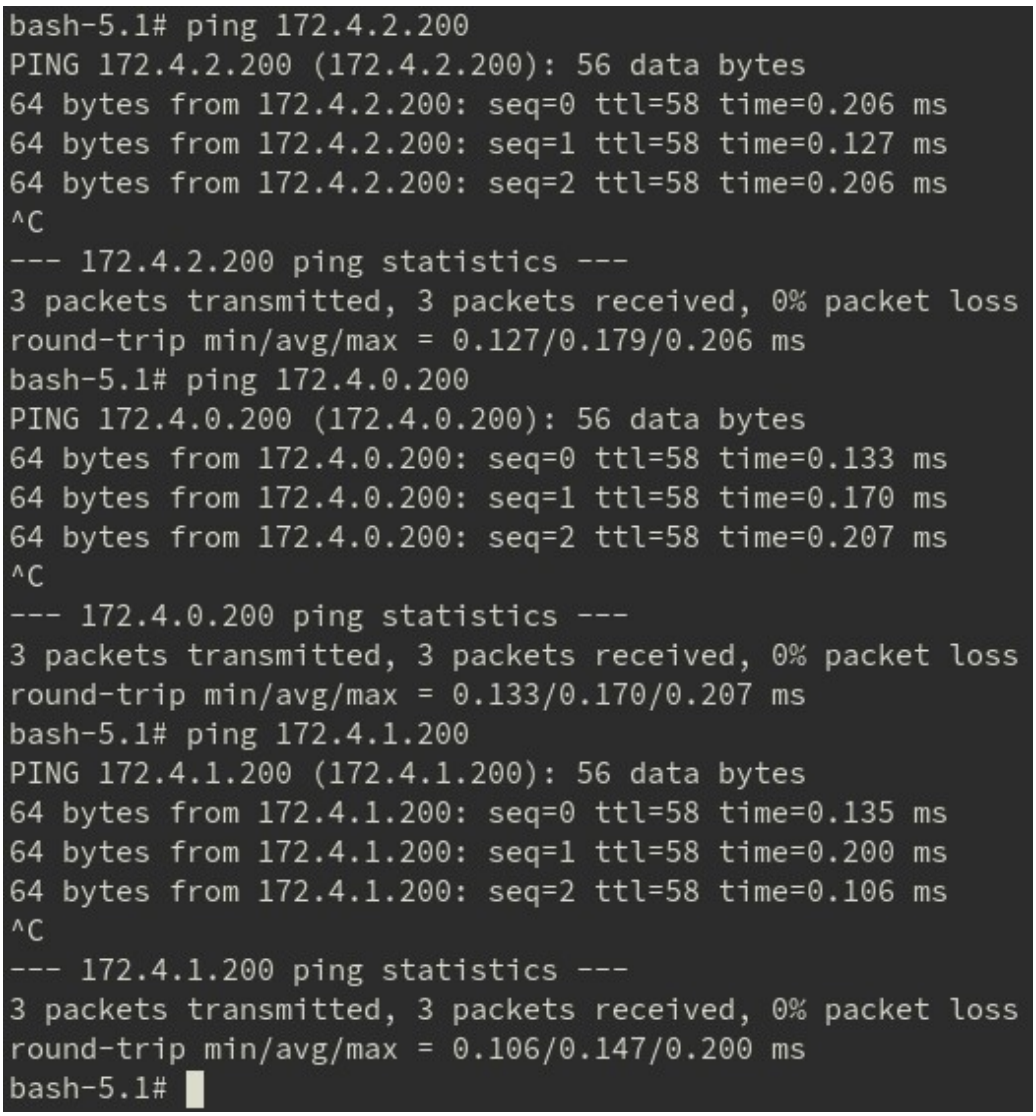
```
R6# show ip bgp summary

IPv4 Unicast Summary (VRF default):
BGP router identifier 6.6.6.6, local AS number 400 vrf-id 0
BGP table version 8
RIB entries 13, using 2496 bytes of memory
Peers 4, using 2870 KiB of memory

Neighbor        V         AS   MsgRcvd   MsgSent   TblVer  InQ OutQ  Up/Down State/PfxRcd   PfxSnt Desc
4.4.4.4         4        400        84        81        0    0    0 01:11:34            3        4 N/A
7.7.7.7         4        400        76        78        0    0    0 01:10:14            2        4 N/A
10.0.61.2       4        661        91        94        0    0    0 01:20:01            1        7 N/A
10.0.62.2       4        662        90        91        0    0    0 01:20:03            1        7 N/A

Total number of neighbors 4
```

Rys. 21: Wynik wykonania *show ip bgp summary* na **R5**

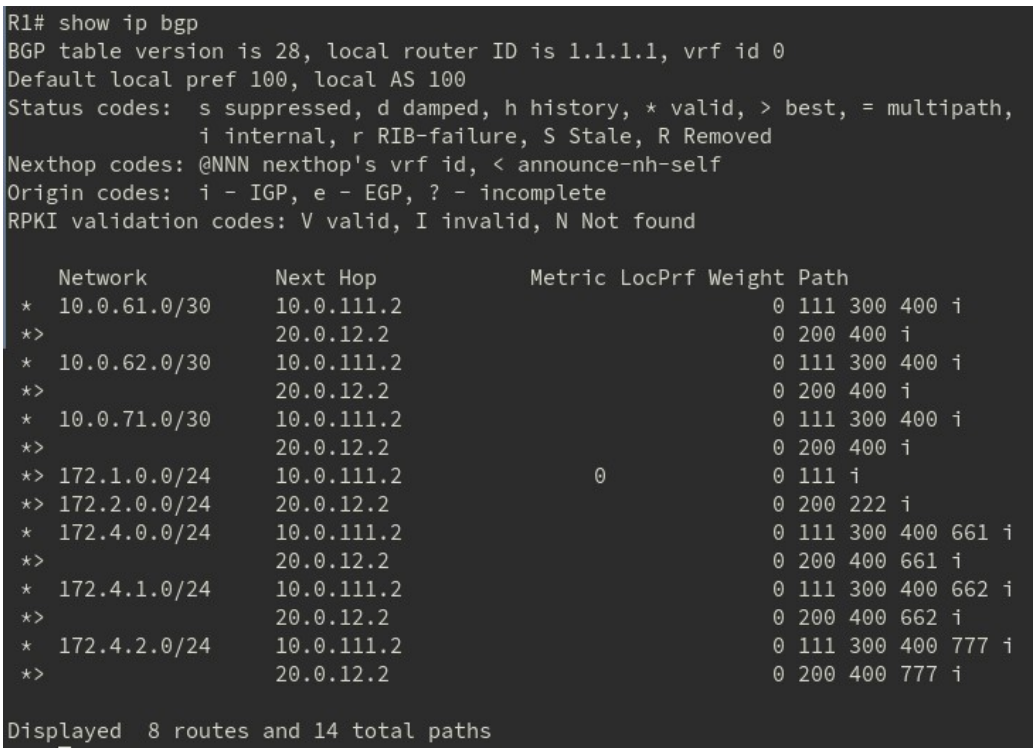
```
R7# show ip bgp summary

IPv4 Unicast Summary (VRF default):
BGP router identifier 7.7.7.7, local AS number 400 vrf-id 0
BGP table version 9
RIB entries 13, using 2496 bytes of memory
Peers 4, using 2870 KiB of memory

Neighbor        V         AS   MsgRcvd   MsgSent   TblVer  InQ OutQ  Up/Down State/PfxRcd   PfxSnt Desc
4.4.4.4         4        400        83        77        0    0    0 01:10:40            5        2 N/A
5.5.5.5         4        400        72        76        0    0    0 01:09:56            0        2 N/A
6.6.6.6         4        400        77        77        0    0    0 01:10:18            4        2 N/A
10.0.71.2       4        777        90        92        0    0    0 01:20:08            1        7 N/A

Total number of neighbors 4
```

Rys. 22: Wynik wykonania *show ip bgp summary* na **R5**

Następnie sprawdziliśmy możliwość połączenia pomiędzy **H11**, a klientami z **AS400**.



Rys. 23: Wynik wykonania *ping* na **H11** do hostów z **AS400**



```
R1# show ip bgp
BGP table version is 28, local router ID is 1.1.1.1, vrf id 0
Default local pref 100, local AS 100
Status codes:  s suppressed, d damped, h history, * valid, > best, = multipath,
               i internal, r RIB-failure, S Stale, R Removed
Nexthop codes: @NNN nexthop's vrf id, < announce-nh-self
Origin codes:  i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

    Network          Next Hop            Metric LocPrf Weight Path
 *  10.0.61.0/30     10.0.111.2                             0 111 300 400 i
 *>                  20.0.12.2                              0 200 400 i
 *  10.0.62.0/30     10.0.111.2                             0 111 300 400 i
 *>                  20.0.12.2                              0 200 400 i
 *  10.0.71.0/30     10.0.111.2                             0 111 300 400 i
 *>                  20.0.12.2                              0 200 400 i
 *> 172.1.0.0/24     10.0.111.2               0             0 111 i
 *> 172.2.0.0/24     20.0.12.2                              0 200 222 i
 *  172.4.0.0/24     10.0.111.2                             0 111 300 400 661 i
 *>                  20.0.12.2                              0 200 400 661 i
 *  172.4.1.0/24     10.0.111.2                             0 111 300 400 662 i
 *>                  20.0.12.2                              0 200 400 662 i
 *  172.4.2.0/24     10.0.111.2                             0 111 300 400 777 i
 *>                  20.0.12.2                              0 200 400 777 i

Displayed  8 routes and 14 total paths
```

Rys. 24: Wynik wykonania *show ip bgp* na **R1**

Na powyższym zdjęciu można zaobserwować, że wszystkie sieci występujące w naszej topologi są dostępne dla **R1** oznacza to, że udało nam się prawidłowo dokonać konfiguracji BGP dla zadanej topologii.

2.3. Zadanie B3

W tym zadaniu mieliśmy z agregować adres **172.4.0.0/16** z **AS400** do zewnętrznych sieci. Nie zmieniając przy tym routingu **iBGP** w **AS400**. Poniżej można zobaczyć konfigurację, która została wykonana w tym celu oraz dowody na poprawność rozwiązania.

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

Current configuration:
!
frr version 8.5_git
frr defaults traditional
hostname R4
no ipv6 forwarding
!
ip route 172.4.0.0/16 Null0
!
interface eth1
 ip address 20.0.24.2/30
exit
!
interface eth2
 ip address 20.0.46.1/30
exit
!
interface eth3
 ip address 20.0.47.1/30
exit
!
interface lo
 ip address 4.4.4.4/32
exit
!
router bgp 400
 no bgp ebgp-requires-policy
 neighbor 5.5.5.5 remote-as 400
 neighbor 5.5.5.5 update-source lo
 neighbor 6.6.6.6 remote-as 400
 neighbor 6.6.6.6 update-source lo
 neighbor 7.7.7.7 remote-as 400
 neighbor 7.7.7.7 update-source lo
 neighbor 20.0.24.1 remote-as 200
 !
 address-family ipv4 unicast
  network 172.4.0.0/16
  neighbor 5.5.5.5 route-reflector-client
  neighbor 5.5.5.5 next-hop-self
  neighbor 6.6.6.6 route-reflector-client
  neighbor 6.6.6.6 next-hop-self
  neighbor 7.7.7.7 route-reflector-client
  neighbor 7.7.7.7 next-hop-self
  neighbor 20.0.24.1 route-map Mapa out
 exit-address-family
exit
!
router ospf
 network 4.4.4.4/32 area 0
 network 20.0.46.0/30 area 0
 network 20.0.47.0/30 area 0
exit
!
ip prefix-list List seq 5 permit 172.4.0.0/16
!
route-map Mapa permit 10
 match ip address prefix-list List
exit
!
end
R4#
```

Rys. 25: Wynik wykonania *show running-config* na **R1**

```
R1# show ip bgp
BGP table version is 41, local router ID is 1.1.1.1, vrf id 0
Default local pref 100, local AS 100
Status codes:  s suppressed, d damped, h history, * valid, > best, = multipath,
               i internal, r RIB-failure, S Stale, R Removed
Nexthop codes: @NNN nexthop's vrf id, < announce-nh-self
Origin codes:  i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

    Network          Next Hop            Metric LocPrf Weight Path
 *> 172.1.0.0/24     10.0.111.2               0             0 111 i
 *> 172.2.0.0/24     20.0.12.2                              0 200 222 i
 *  172.4.0.0/16     10.0.111.2                             0 111 300 400 i
 *>                  20.0.12.2                              0 200 400 i

Displayed  3 routes and 4 total paths
```

Rys. 26: Wynik wykonania *show ip bgp* na **R1**

```
R2# show ip bgp
BGP table version is 72, local router ID is 2.2.2.2, vrf id 0
Default local pref 100, local AS 200
Status codes:  s suppressed, d damped, h history, * valid, > best, = multipath,
               i internal, r RIB-failure, S Stale, R Removed
Nexthop codes: @NNN nexthop's vrf id, < announce-nh-self
Origin codes:  i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

    Network          Next Hop            Metric LocPrf Weight Path
 *> 172.1.0.0/24     20.0.12.1                              0 100 111 i
 *> 172.2.0.0/24     10.0.21.2                0             0 222 i
 *= 172.4.0.0/16     20.0.25.2                0             0 400 i
 *>                  20.0.24.2                0             0 400 i

Displayed  3 routes and 4 total paths
```

Rys. 27: Wynik wykonania *show ip bgp* na **R2**

```
R3# show ip bgp
BGP table version is 63, local router ID is 3.3.3.3, vrf id 0
Default local pref 100, local AS 300
Status codes:  s suppressed, d damped, h history, * valid, > best, = multipath,
               i internal, r RIB-failure, S Stale, R Removed
Nexthop codes: @NNN nexthop's vrf id, < announce-nh-self
Origin codes:  i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

    Network          Next Hop            Metric LocPrf Weight Path
 *> 172.2.0.0/24     10.0.113.2                             0 111 100 200 222 i
 *> 172.4.0.0/16     20.0.35.2                0             0 400 i

Displayed  2 routes and 2 total paths
R3#
```

Rys. 28: Wynik wykonania *show ip bgp* na **R3**

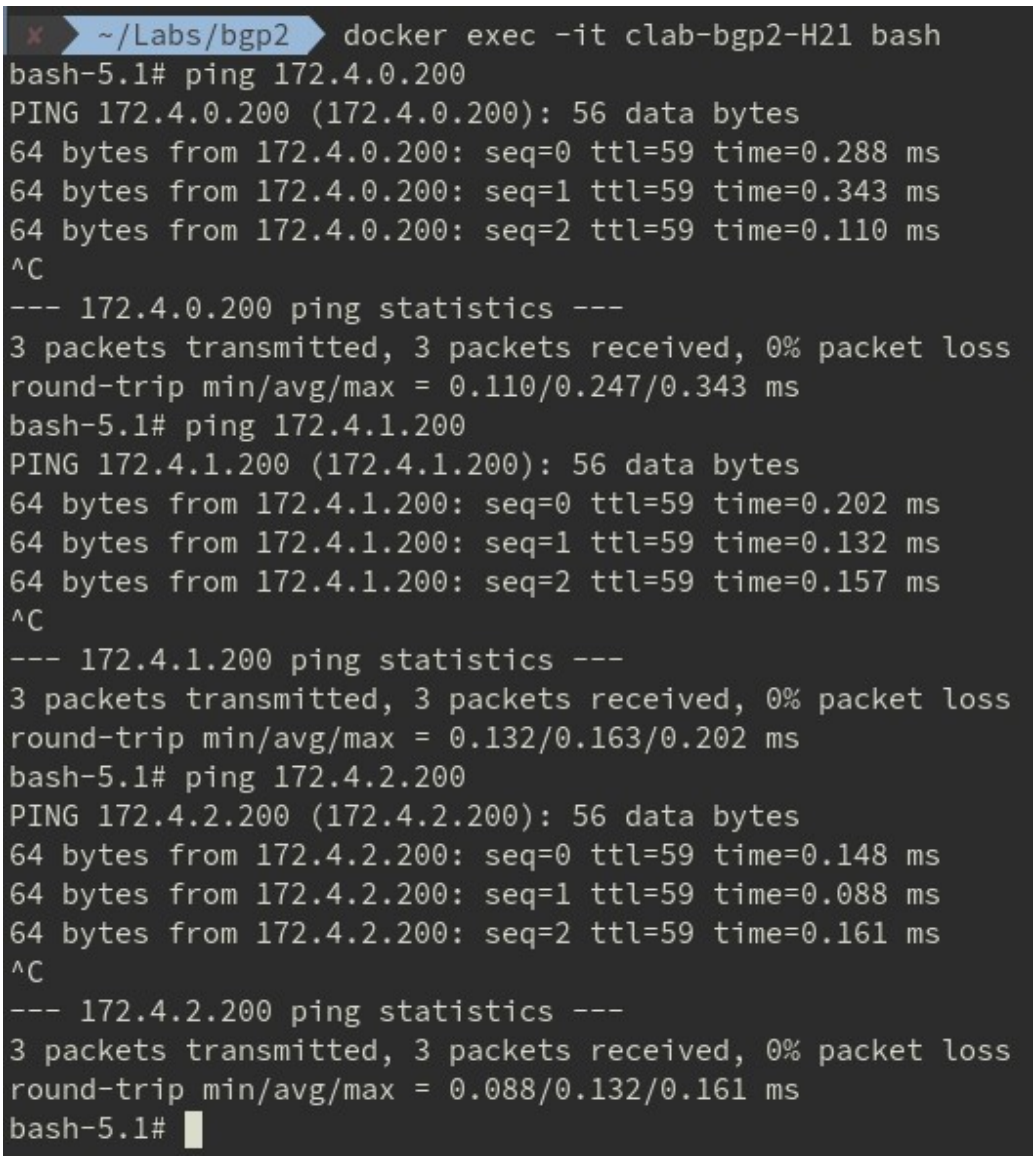
```
R4# show ip bgp
BGP table version is 46, local router ID is 4.4.4.4, vrf id 0
Default local pref 100, local AS 400
Status codes:  s suppressed, d damped, h history, * valid, > best, = multipath,
               i internal, r RIB-failure, S Stale, R Removed
Nexthop codes: @NNN nexthop's vrf id, < announce-nh-self
Origin codes:  i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

    Network          Next Hop            Metric LocPrf Weight Path
 *>i10.0.61.0/30     6.6.6.6                  0    100      0 i
 *>i10.0.62.0/30     6.6.6.6                  0    100      0 i
 *>i10.0.71.0/30     7.7.7.7                  0    100      0 i
 *>i172.1.0.0/24     5.5.5.5                       100      0 200 100 111 i
 *>i172.2.0.0/24     5.5.5.5                       100      0 200 222 i
 *> 172.4.0.0/16     0.0.0.0                  0         32768 i
 *>i172.4.0.0/24     6.6.6.6                  0    100      0 661 i
 *>i172.4.1.0/24     6.6.6.6                  0    100      0 662 i
 *>i172.4.2.0/24     7.7.7.7                  0    100      0 777 i
```

Rys. 29: Wynik wykonania *show ip bgp* na **R4**

Można zauważyć, że w sieciach na zewnątrz **AS400** agregowana jest sieć **172.4.0.0/16** natomiast w wewnątrz **AS400** wszystko pozostało niezmienione.

```
~/Labs/bgp2 docker exec -it clab-bgp2-H11 bash
bash-5.1# ping 172.4.0.200
PING 172.4.0.200 (172.4.0.200): 56 data bytes
64 bytes from 172.4.0.200: seq=0 ttl=58 time=0.184 ms
^[[A64 bytes from 172.4.0.200: seq=1 ttl=58 time=0.182 ms
64 bytes from 172.4.0.200: seq=2 ttl=58 time=0.176 ms
^C
--- 172.4.0.200 ping statistics ---
3 packets transmitted, 3 packets received, 0% packet loss
round-trip min/avg/max = 0.176/0.180/0.184 ms
bash-5.1# ping 172.4.1.200
PING 172.4.1.200 (172.4.1.200): 56 data bytes
64 bytes from 172.4.1.200: seq=0 ttl=58 time=0.134 ms
64 bytes from 172.4.1.200: seq=1 ttl=58 time=0.143 ms
64 bytes from 172.4.1.200: seq=2 ttl=58 time=0.121 ms
^C
--- 172.4.1.200 ping statistics ---
3 packets transmitted, 3 packets received, 0% packet loss
round-trip min/avg/max = 0.121/0.132/0.143 ms
bash-5.1# ping 172.4.2.200
PING 172.4.2.200 (172.4.2.200): 56 data bytes
64 bytes from 172.4.2.200: seq=0 ttl=58 time=0.126 ms
64 bytes from 172.4.2.200: seq=1 ttl=58 time=0.125 ms
64 bytes from 172.4.2.200: seq=2 ttl=58 time=0.198 ms
^C
--- 172.4.2.200 ping statistics ---
3 packets transmitted, 3 packets received, 0% packet loss
round-trip min/avg/max = 0.125/0.149/0.198 ms
bash-5.1#
```

Rys. 30: Wynik wykonania *show ip route bgp* na **R1**



Rys. 31: Wynik wykonania *show ip route bgp* na **R1**

2.4. Zadanie B4

W ramach tego zadania skonfigurowaliśmy **AS200** przy użyciu atrybutu **MED** w taki sposób, żeby ruch otrzymywany z **AS400** pochodził od router **R5**. Konfiguracja dokonana na **R2** oraz dowody na działanie rozwiązania zostały zamieszczone poniżej w postaci zdjęć.

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

Current configuration:
!
frr version 8.5_git
frr defaults traditional
hostname R2
no ipv6 forwarding
!
interface eth1
 ip address 20.0.12.2/30
exit
!
interface eth2
 ip address 10.0.21.1/24
exit
!
interface eth3
 ip address 20.0.25.1/30
exit
!
interface eth4
 ip address 20.0.24.1/30
exit
!
interface lo
 ip address 2.2.2.2/32
exit
!
router bgp 200
 no bgp ebgp-requires-policy
 neighbor 10.0.21.2 remote-as 222
 neighbor 20.0.12.1 remote-as 100
 neighbor 20.0.24.2 remote-as 400
 neighbor 20.0.25.2 remote-as 400
 !
 address-family ipv4 unicast
  neighbor 20.0.24.2 route-map medMapa out
 exit-address-family
exit
!
route-map medMapa permit 10
 match ip address any
 set metric 5
exit
!
end
R2#
```

Rys. 32: Wynik wykonania *show running-config* na **R2**

```
R2# show ip route bgp
Codes: K - kernel route, C - connected, S - static, R - RIP,
       O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
       T - Table, v - VNC, V - VNC-Direct, A - Babel, F - PBR,
       f - OpenFabric,
       > - selected route, * - FIB route, q - queued, r - rejected, b - backup
       t - trapped, o - offload failure

B>* 172.1.0.0/24 [20/0] via 20.0.12.1, eth1, weight 1, 03:24:25
B>* 172.2.0.0/24 [20/0] via 10.0.21.2, eth2, weight 1, 04:46:35
B>* 172.4.0.0/16 [20/0] via 20.0.24.2, eth4, weight 1, 00:02:01
  *                     via 20.0.25.2, eth3, weight 1, 00:02:01
R2#
```

Rys. 33: Wynik wykonania *show ip rotue bgp* na **R2**

```
bash-5.1# traceroute 172.2.0.200
traceroute to 172.2.0.200 (172.2.0.200), 30 hops max, 46 byte packets
 1  172.4.2.1 (172.4.2.1)  0.007 ms  0.011 ms  0.008 ms
 2  10.0.71.1 (10.0.71.1)  0.007 ms  0.008 ms  0.005 ms
 3  20.0.47.1 (20.0.47.1)  0.005 ms  0.009 ms  0.006 ms
 4  20.0.25.1 (20.0.25.1)  0.006 ms  0.013 ms  0.009 ms
 5  10.0.21.2 (10.0.21.2)  0.205 ms  0.224 ms  0.112 ms
 6  172.2.0.200 (172.2.0.200)  0.006 ms  0.008 ms  0.005 ms
bash-5.1#
```

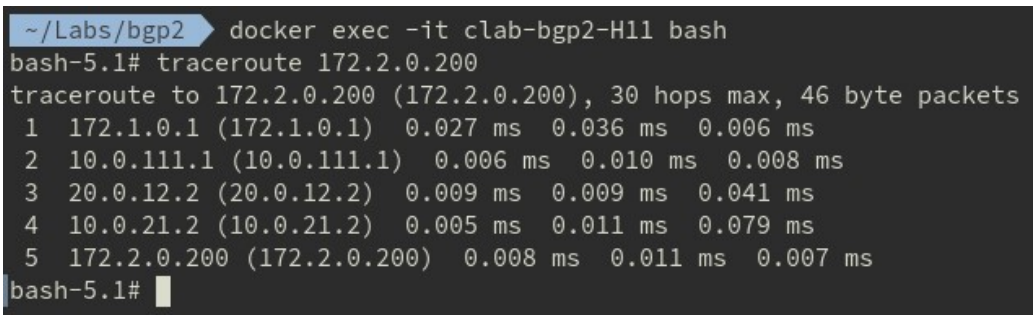
Rys. 34: Traceroute przed zmianami

```
bash-5.1# traceroute 172.2.0.200
traceroute to 172.2.0.200 (172.2.0.200), 30 hops max, 46 byte packets
 1  172.4.2.1 (172.4.2.1)  0.008 ms  0.010 ms  0.007 ms
 2  10.0.71.1 (10.0.71.1)  0.006 ms  0.008 ms  0.006 ms
 3  20.0.57.1 (20.0.57.1)  0.006 ms  0.010 ms  0.007 ms
 4  20.0.25.1 (20.0.25.1)  0.007 ms  0.019 ms  0.014 ms
 5  10.0.21.2 (10.0.21.2)  0.013 ms  0.010 ms  0.126 ms
 6  172.2.0.200 (172.2.0.200)  0.008 ms  0.017 ms  0.012 ms
```

Rys. 35: Traceroute po zmianach (część 1)

```
~/Labs/bgp2 docker exec -it clab-bgp2-H61 bash
bash-5.1# traceroute 172.2.0.200
traceroute to 172.2.0.200 (172.2.0.200), 30 hops max, 46 byte packets
 1  172.4.0.1 (172.4.0.1)  0.007 ms  0.008 ms  0.006 ms
 2  10.0.61.1 (10.0.61.1)  0.006 ms  0.017 ms  0.012 ms
 3  20.0.67.2 (20.0.67.2)  0.012 ms  0.016 ms  0.008 ms
 4  20.0.57.1 (20.0.57.1)  0.008 ms  0.009 ms  0.006 ms
 5  20.0.25.1 (20.0.25.1)  0.007 ms  0.016 ms  0.013 ms
 6  10.0.21.2 (10.0.21.2)  0.013 ms  0.016 ms  0.013 ms
 7  172.2.0.200 (172.2.0.200)  0.012 ms  0.007 ms  0.006 ms
bash-5.1#
```

Rys. 36: Traceroute po zmianach (część 2)



Rys. 37: Traceroute po zmianach (część 3)

2.5. Zadanie B5

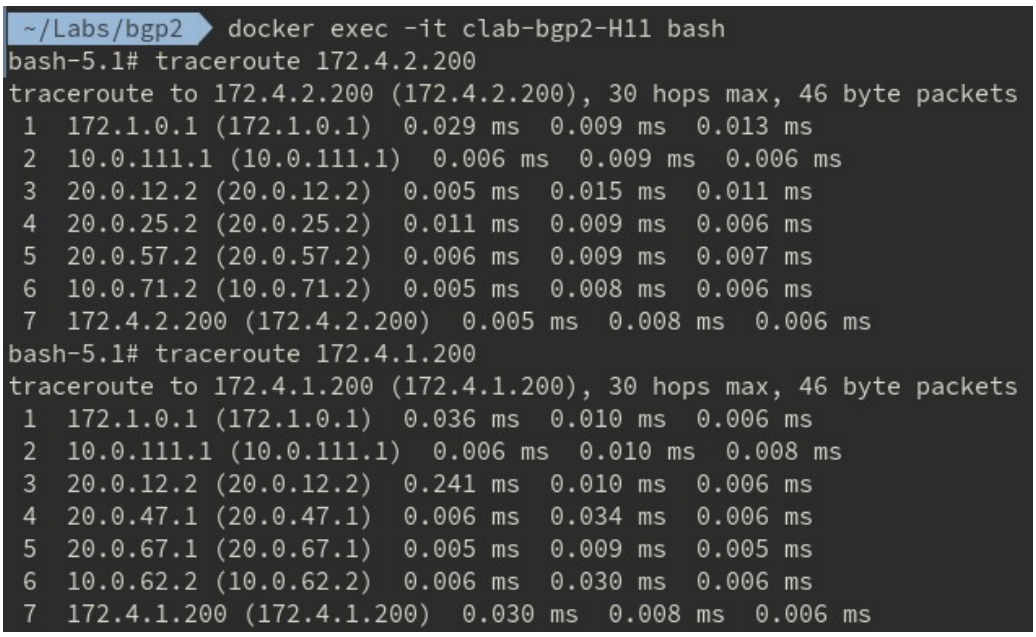
W ostatnim zadaniu mieliśmy skonfigurować **R3** w taki sposób, żeby ruch między **AS111** i **AS400** nie odbywał się przy jego użyciu. W tym celu postanowiliśmy wykorzystać atrybut **community**. Chcielibyśmy zaznaczyć, że nie jest to jedyny możliwy sposób rozwiązanie tego problemu. Alternatywą może być wykorzystanie odpowiednich **access list**. Postanowiliśmy jednak skorzystać z możliwości, jakie daje nam atrybut **community**, ponieważ wcześniej nie mieliśmy okazji się z nim bliżej zapoznać.

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

Current configuration:
!
frr version 8.5_git
frr defaults traditional
hostname R5
no ipv6 forwarding
!
ip route 172.4.0.0/16 Null0
!
interface eth1
 ip address 20.0.25.2/30
exit
!
interface eth2
 ip address 20.0.35.2/30
exit
!
interface eth3
 ip address 20.0.57.1/30
exit
!
interface lo
 ip address 5.5.5.5/32
exit
!
router bgp 400
 no bgp ebgp-requires-policy
 neighbor 4.4.4.4 remote-as 400
 neighbor 4.4.4.4 update-source lo
 neighbor 7.7.7.7 remote-as 400
 neighbor 7.7.7.7 update-source lo
 neighbor 20.0.25.1 remote-as 200
 neighbor 20.0.35.1 remote-as 300
 !
 address-family ipv4 unicast
  neighbor 4.4.4.4 next-hop-self
  neighbor 7.7.7.7 next-hop-self
  neighbor 20.0.25.1 route-map Mapa out
  neighbor 20.0.35.1 route-map 22 out
 exit-address-family
exit
!
router ospf
 network 5.5.5.5/32 area 0
 network 20.0.57.0/30 area 0
exit
!
ip prefix-list List seq 5 permit 172.4.0.0/16
ip prefix-list 22 seq 5 permit 20.0.35.2/32
!
route-map Mapa permit 10
 match ip address prefix-list List
exit
!
route-map 22 permit 10
 match ip address prefix-list 22
 set community no-export
exit
!
end
R5#
```

Rys. 38: Konfiguracja **R5**

```
R3# show ip bgp neighbors 20.0.35.2
BGP neighbor is 20.0.35.2, remote AS 400, local AS 300, external link
  Local Role: undefined
  Remote Role: undefined
Hostname: R5
  BGP version 4, remote router ID 5.5.5.5, local router ID 3.3.3.3
  BGP state = Established, up for 01:54:06
  Last read 00:00:06, Last write 00:00:06
  Hold time is 180 seconds, keepalive interval is 60 seconds
  Configured hold time is 180 seconds, keepalive interval is 60 seconds
  Configured conditional advertisements interval is 60 seconds
  Neighbor capabilities:
    4 Byte AS: advertised and received
    Extended Message: advertised and received
    AddPath:
      IPv4 Unicast: RX advertised and received
    Long-lived Graceful Restart: advertised and received
      Address families by peer:
    Route refresh: advertised and received(old & new)
    Enhanced Route Refresh: advertised and received
    Address Family IPv4 Unicast: advertised and received
    Hostname Capability: advertised (name: R3,domain name: n/a) received (name: R5,domain name: n/a)
    Graceful Restart Capability: advertised and received
      Remote Restart timer is 120 seconds
      Address families by peer:
        none
  Graceful restart information:
    End-of-RIB send: IPv4 Unicast
    End-of-RIB received: IPv4 Unicast
    Local GR Mode: Helper*

    Remote GR Mode: Helper

    R bit: False
    N bit: True
    Timers:
      Configured Restart Time(sec): 120
      Received Restart Time(sec): 120
    IPv4 Unicast:
      F bit: False
      End-of-RIB sent: Yes
      End-of-RIB sent after update: No
      End-of-RIB received: Yes
      Timers:
        Configured Stale Path Time(sec): 360
  Message statistics:
    Inq depth is 0
    Outq depth is 0
                         Sent       Rcvd
    Opens:                  5          3
    Notifications:          0          4
    Updates:               48         34
    Keepalives:           189        189
    Route Refresh:          4          2
    Capability:             0          0
    Total:                246        232
  Minimum time between advertisement runs is 0 seconds

 For address family: IPv4 Unicast
  Update group 1, subgroup 1
  Packet Queue length 0
  Community attribute sent to this neighbor(all)
  0 accepted prefixes

  Connections established 3; dropped 2
  Last reset 01:54:08,  No AFI/SAFI activated for peer
  External BGP neighbor may be up to 1 hops away.
Local host: 20.0.35.1, Local port: 179
Foreign host: 20.0.35.2, Foreign port: 43288
Nexthop: 20.0.35.1
Nexthop global: fe80::a8c1:abff:fe1c:2f12
Nexthop local: fe80::a8c1:abff:fe1c:2f12
BGP connection: shared network
BGP Connect Retry Timer in Seconds: 120
Estimated round trip time: 17 ms
Read thread: on  Write thread: on  FD used: 26
```

Rys. 39: Zmiana w sąsiedztwie z **R5** na **R3**



Rys. 40: Wyniki *traceroute* po dokonaniu zmian