Žilinská univerzita v Žiline
Fakulta riadenia a informatiky

Projektovanie sietí 1

BGP

Jakub Suroviak
Michal Hrašna

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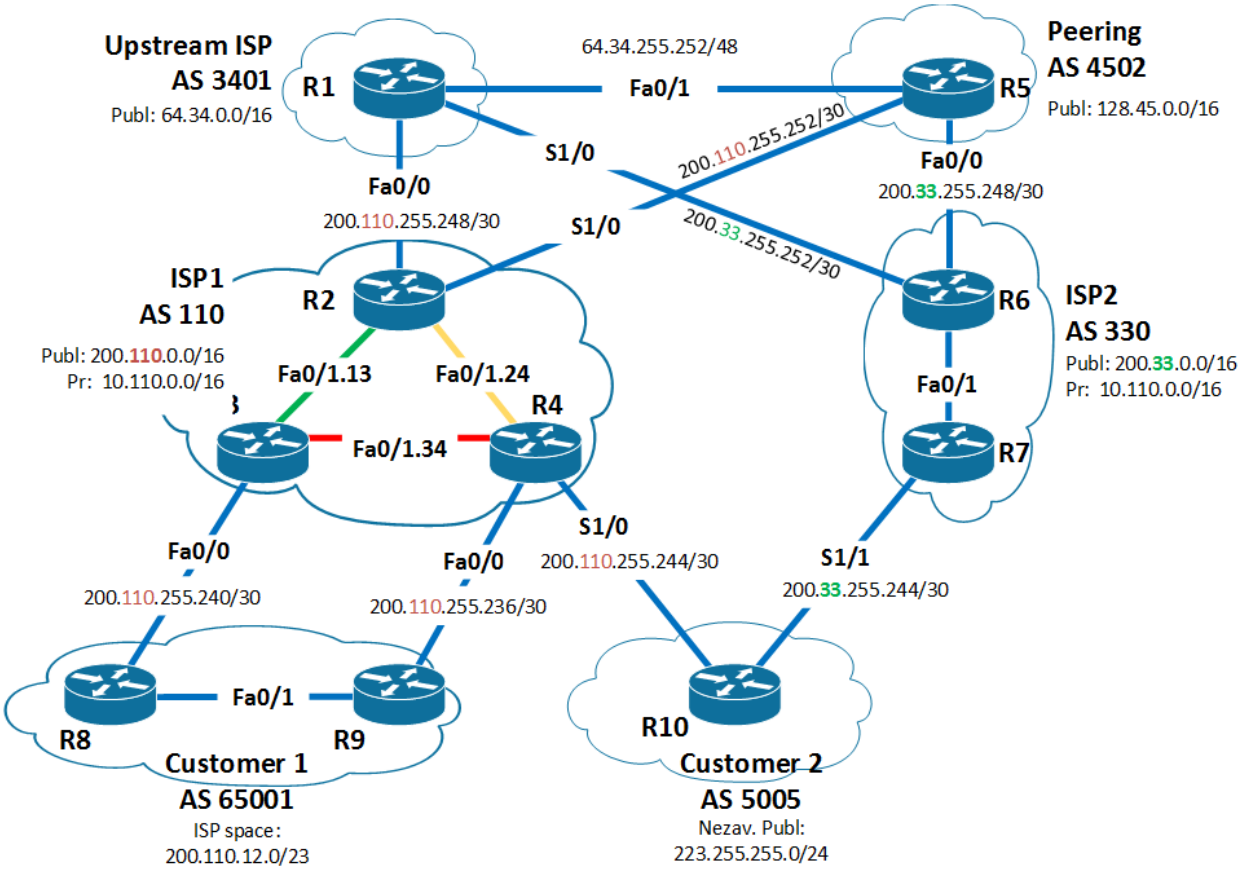
1. Obsah

2. Zadanie

- Použiť IGP OSPF alebo IS-IS -IS (L2 only) single area dizajn, priame p2p prepojenia
    - ISP1, ISP2
- Distribúcia internetových statických smerovacích záznamov z AS3401, AS4502 a zákaznických smerovacích záznamov z AS65001, AS5005, AS330
- Zabezpečiť plnú konektivitu prostredníctvom iBGP alebo eBGP protokolov pre zákaznícké a internetové smer. Záznamy
    - Kontrola, či interné ISP adresy nie sú propagované
    - Prepísať privátne AS65001
    - Sumarizácia
- Kontrola konektivity medzi zákazníckymi a internetovými smerovacími záznamami
- Definovať vlastnú politiku - použiť community, community alter LP, AS-PATH filtering, prepending, atď
- Primárne linky R3-R8, R4-R10
- Distribuovať iba default, AS5005 a peering prefixy do AS65001
- AS5005 nesme byť nikdy transit
- Peering iba pre ISP1 a ISP2, nie pre prefixy naučené z Upstream ISP
- Overiť funkčnosť nastavenia politiky vhodnými výpadkami liniek a smerovačov
- Overiť, či je možné odkloniť celú prevádzku (upstream, downstream) na linke R4-R10 v prípade plánovanej údržby (linka musí byť plne funkčna a BGP spojenie propaguje všetky prefixy)

3. Topológia



4. Adresovanie

Router	Interface	IP+Maska
R1	Lo0	64.34.x.1 /32 (x->od 1 po 44)
	Fa0/0	200.110.255.249/30
	Fa0/1	64.34.255.253/30
	S1/0	200.33.255.253/30
R2	Lo0	10.110.255.2/32
	Fa0/0	200.110.255.250/30
	Fa0/1.23	10.110.23.2/24
	Fa0/1.24	10.110.24.2/24
R3	Lo0	10.110.255.3/32
	Fa0/0	200.110.255.245/30
	Fa0/1.23	10.110.23.3/24
	Fa0/1.34	10.110.34.3/24
R4	Lo0	10.110.255.4/30
	Fa0/0	200.110.255.237/30
	Fa0/1.24	10.110.24.4/24
	Fa0/1.34	10.110.34.4/24
	S1/0	200.110.255.245/30
R5	Lo0	128.45.1.1
	Fa0/0	200.33.255.249/30
	Fa0/1	64.34.255.254/30
	S1/0	200.110.255.254/30
R6	Lo0	10.33.255.6/32
	Fa0/0	200.33.255.250/30
	Fa0/1	10.33.67.6/24
	S1/0	200.33.255.254/30
R7	Lo0	10.33.255.7/32
	Lo1	200.33.7.1/32
	Fa0/1	10.33.67.7/24
	S1/1	200.33.255.245/30

R8	Lo0	10.255.255.8/32
	Lo1	200.110.12.1/26
	Lo2	200.110.12.65/26
	Lo3	200.110.12.129/26
	Lo4	200.110.12.193/26
	Fa0/0	200.110.255.242/30
	Fa0/1	192.168.89.8/24
R9	Lo0	10.255.255.9/32
	Lo1	200.110.13.1/26
	Lo2	200.110.13.65/26
	Lo3	200.110.13.129/26
	Lo4	200.110.13.193/26
	Fa0/0	200.110.255.238/30
	Fa0/1	192.168.89.9/24
R10	Lo0	10.255.255.10/32
	S1/0	200.110.255.246/30
	S1/1	200.30.255.246/30

5. Použiť IGP OSPF alebo IS-IS -IS (L2 only) single area dizajn, priame p2p prepojenia

Rozhodli sme sa všade použiť smerovací protokol IS-IS. Čiže u ISP1, čo boli routre R2-R3-R4 , ďalej u ISP2 na routroch R6-R7 a aj u zákazníka 1 na routroch R8-R9. Na všetkých týchto routroch sme použili L2-only prepoje. Ďalej sme na všetkých prepojoch nastavili point-to-point prepoje.

```
R3#sh isis nei
System Id      Type Interface   IP Address      State Holdtime Circuit Id
R2             L2   Fa0/1.23    10.110.23.2     UP    23       R3.01
R4             L2   Fa0/1.34    10.110.34.4     UP    9        R4.02

R7(config-if)#do sh isis nei
System Id      Type Interface   IP Address      State Holdtime Circuit Id
R6             L2   Fa0/1       10.33.67.6      INIT  24       R7.01

R9(config-if)#do sh isis nei
System Id      Type Interface   IP Address      State Holdtime Circuit Id
R8             L2   Fa0/1       192.168.89.8    UP    28       R9.01
```

6. Distribúcia internetových statických smerovacích záznamov z AS3401, AS4502 a zákaznických smerovacích záznamov z AS65001, AS5005, AS330

Redistribúciu z daných AS sme vyriešili príkazom `redistribute connected` a príkazom `redistribute isis level-2`. Nasledujúci výpis potvrdzuje plnú konektivitu.

```
R3#sh ip route
...
      10.0.0.0/8 is variably subnetted, 13 subnets, 2 masks
B        10.33.67.0/24 [200/0] via 10.110.255.2, 00:56:47
B        10.33.255.6/32 [200/0] via 10.110.255.2, 00:56:47
B        10.33.255.7/32 [200/0] via 10.110.255.2, 00:56:17
C        10.110.23.0/24 is directly connected, FastEthernet0/1.23
L        10.110.23.3/32 is directly connected, FastEthernet0/1.23
i L2     10.110.24.0/24 [115/20] via 10.110.34.4, 02:34:25,
FastEthernet0/1.34
                        [115/20] via 10.110.23.2, 02:34:25,
FastEthernet0/1.23
C        10.110.34.0/24 is directly connected, FastEthernet0/1.34
L        10.110.34.3/32 is directly connected, FastEthernet0/1.34
i L2     10.110.255.2/32
           [115/20] via 10.110.23.2, 03:12:20, FastEthernet0/1.23
C        10.110.255.3/32 is directly connected, Loopback0
i L2     10.110.255.4/32
           [115/20] via 10.110.34.4, 02:34:26, FastEthernet0/1.34
B        10.110.255.8/32 [20/0] via 200.110.255.242, 00:01:31
B        10.110.255.9/32 [200/0] via 10.110.255.4, 01:59:21
      64.0.0.0/8 is variably subnetted, 45 subnets, 2 masks
B        64.34.1.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.2.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.3.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.4.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.5.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.6.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.7.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.8.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.9.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.10.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.11.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.12.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.13.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.14.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.15.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.16.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.17.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.18.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.19.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.20.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.21.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.22.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.23.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.24.0/24 [200/0] via 10.110.255.2, 02:02:53
```

```
B        64.34.25.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.26.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.27.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.28.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.29.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.30.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.31.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.32.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.33.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.34.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.35.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.36.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.37.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.38.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.39.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.40.0/24 [200/0] via 10.110.255.2, 02:02:53
B        64.34.41.0/24 [200/0] via 10.110.255.2, 02:02:54
B        64.34.42.0/24 [200/0] via 10.110.255.2, 02:02:54
B        64.34.43.0/24 [200/0] via 10.110.255.2, 02:02:54
B        64.34.254.0/24 [200/0] via 10.110.255.2, 02:05:07
B        64.34.255.252/30 [200/0] via 10.110.255.2, 02:02:54
      128.45.0.0/32 is subnetted, 1 subnets
B        128.45.1.1 [200/0] via 10.110.255.2, 00:51:54
B     192.168.89.0/24 [20/0] via 200.110.255.242, 00:01:32
      200.33.7.0/32 is subnetted, 1 subnets
B        200.33.7.1 [200/0] via 10.110.255.2, 00:49:11
      200.33.255.0/30 is subnetted, 3 subnets
B        200.33.255.244 [200/0] via 10.110.255.2, 00:56:19
B        200.33.255.248 [200/0] via 10.110.255.2, 01:01:46
B        200.33.255.252 [200/0] via 10.110.255.2, 02:02:54
B     200.110.0.0/16 [200/0] via 0.0.0.0, 00:01:32, Null0
      200.110.12.0/26 is subnetted, 4 subnets
B        200.110.12.0 [20/0] via 200.110.255.242, 00:01:32
B        200.110.12.64 [20/0] via 200.110.255.242, 00:01:32
B        200.110.12.128 [20/0] via 200.110.255.242, 00:01:32
B        200.110.12.192 [20/0] via 200.110.255.242, 00:01:32
      200.110.13.0/26 is subnetted, 4 subnets
B        200.110.13.0 [20/20] via 200.110.255.242, 00:01:32
B        200.110.13.64 [20/20] via 200.110.255.242, 00:01:32
B        200.110.13.128 [20/20] via 200.110.255.242, 00:01:32
B        200.110.13.192 [20/0] via 200.110.255.242, 00:01:32
      200.110.255.0/24 is variably subnetted, 6 subnets, 2 masks
B        200.110.255.236/30 [20/10] via 200.110.255.242, 00:01:32
C        200.110.255.240/30 is directly connected, FastEthernet0/0
L        200.110.255.241/32 is directly connected, FastEthernet0/0
i L2     200.110.255.244/30
           [115/10] via 10.110.34.4, 02:34:27, FastEthernet0/1.34
i L2     200.110.255.248/30
           [115/10] via 10.110.23.2, 03:12:22, FastEthernet0/1.23
i L2     200.110.255.252/30
           [115/10] via 10.110.23.2, 03:12:22, FastEthernet0/1.23
```

7. Zabezpečiť plnú konektivitu prostredníctvom iBGP alebo eBGP protokolov pre zákaznícke a internetové smer.

iBGP sme nastavili tak, aby sme komunikovali so susedmi (v tej istej AS) prostredníctvom loopbacku. Pred eBGP, čiže externých susedov sme nastavili IP adresu suseda spolu s číslom AS do ktorého patrí.

Príklad konfigurácie na routri R3:

```
router bgp 110
 bgp log-neighbor-changes
 no bgp default ipv4-unicast
 neighbor 10.110.255.2 remote-as 110
 neighbor 10.110.255.2 update-source Loopback0
 neighbor 10.110.255.4 remote-as 110
 neighbor 10.110.255.4 update-source Loopback0
 neighbor 200.110.255.242 remote-as 65001
 !
 address-family ipv4
  neighbor 10.110.255.2 activate
  neighbor 10.110.255.2 next-hop-self
  neighbor 10.110.255.4 activate
  neighbor 10.110.255.4 next-hop-self
  neighbor 200.110.255.242 activate
 exit-address-family
!
```

8. Kontrola, či interné ISP adresy nie sú propagované

Najprv sme docielili to, že preposielame všetky siete, čiže aj tie privátne. Naším ďalším krokom bolo dosiahnuť aby sa tieto privátne siete nepreposielali ďalej. Dosiahli sme to pomocou prefix-listov.
Z AS 65001 sme nechceli propagovať adresy z adresného priestoru 200.110.12.0/23. Vyriešili sme to tak, že z tohto adresného priestoru sme propagovali len adresy z maskou menšou ako 32 a zároveň väčšou ako 26.

Príkazy, ktoré bolo treba zadať na routri R8 obdobne aj na R9:

```
ip prefix-list pl1 permit 200.110.12.0/23 le 32

route-map PL permit 10
 match ip address prefix-list pl1
```

Konfigurácia:

```
router bgp 65001
 bgp log-neighbor-changes
 no bgp default ipv4-unicast
 neighbor 10.110.255.9 remote-as 65001
 neighbor 10.110.255.9 update-source Loopback0
 neighbor 200.110.255.241 remote-as 110
 !
 address-family ipv4
  redistribute connected route-map ISIS2BGP
  redistribute isis level-2 route-map ISIS2BGP
```

```
  neighbor 10.110.255.9 activate
  neighbor 10.110.255.9 next-hop-self
  neighbor 200.110.255.241 activate
  neighbor 200.110.255.241 route-map PL out
 exit-address-family
!
```

Pred týmto krokom bolo možné vidieť napríklad na routri R2 po zobrazení smerovacej tabuľky

```
B        64.34.255.252/30 [20/0] via 200.110.255.249, 03:15:27
      128.45.0.0/32 is subnetted, 1 subnets
B        128.45.1.1 [20/0] via 200.110.255.254, 02:04:27
B     192.168.89.0/24 [200/0] via 10.110.255.4, 00:25:47
      200.33.7.0/32 is subnetted, 1 subnets
```

Následne sa sieť 192.168.89.0/24 zo smerovacej tabuľky stratila.

```
      128.45.0.0/32 is subnetted, 1 subnets
B        128.45.1.1 [20/0] via 200.110.255.254, 03:25:28
      200.33.7.0/32 is subnetted, 1 subnets
B        200.33.7.1 [20/0] via 200.110.255.249, 03:22:45
      200.33.255.0/30 is subnetted, 3 subnets
```

9. Prepísať privátne AS65001

Ďalšou úlohou bolo zatajiť existenciu AS65001. Túto úlohu sme vyriešili použitím príkazov v AS110, v ktorom mohli routre vidieť AS65001 ale v iných AS už nie.

Konfigurácia na R2:

```
router bgp 110
address-family ipv4
nei 200.110.255.249 remove-private-as
nei 200.110.255.254 remove-private-as
```

Konfigurácia na R4:

```
router bgp 110
address-family ipv4
neighbor 200.110.255.246 remove-private-as
```

Pred zadaním týchto príkazov bol výpis na routri R10

```
R10(config)#do sh ip bgp
...
*   200.33.255.252/30
                      200.110.255.245                          0 110 3401 ?
 *>                   200.33.255.245          10               0 330 ?
 *   200.110.0.0/16   200.33.255.245                           0 330 4502 110
65001 i
 *>                   200.110.255.245          0               0 110 65001 i

Tie isté riadky po zadaní príkazov:
*   200.33.255.252/30
```

```
                      200.110.255.245                         0 110 3401 ?
 *>                   200.33.255.245          10              0 330 ?
 *   200.110.0.0/16   200.33.255.245                          0 330 4502 110
i
 *>                   200.110.255.245          0              0 110 i
```

10. Sumarizácia

Sumarizáciu sme použili na zákazníka 1 respektíve AS65001 z adresným rozsahom 200.110.12.0/23. Pre sumarizáciu sme použili adresný rozsah 200.110.0.0/16.

```
router bgp 110
address-family ipv4
aggregate-address 200.110.0.0 255.255.0.0 summary-only as-set
```

Toto však spôsobilo, že siete z AS65001 nemali konektivitu z routrom R2. Riešením bolo vytvorenie route-mapy, ktorá priradá danej sieti origin igp. Prefix-list vyhľadá tieto siete z rozsahu 200.110.0.0/16-32.

```
ip prefix-list AS110 permit 200.110.0.0/16 le 32
route-map ISIS2BGP permit 10
match ip address prefix-list AS110
set origin igp

Route mapu aktivujeme pomocou príkazu
router bgp 110
address-family ipv4


address-family ipv4
  aggregate-address 200.110.0.0 255.255.0.0 as-set summary-only
  redistribute connected route-map ISIS2BGP
  redistribute isis level-2 route-map ISIS2BGP
  neighbor 10.110.255.2 activate
  neighbor 10.110.255.2 send-community
  neighbor 10.110.255.2 next-hop-self
  neighbor 10.110.255.2 unsuppress-map MyAS2BGP
  neighbor 10.110.255.3 activate
  neighbor 10.110.255.3 send-community
  neighbor 10.110.255.3 next-hop-self
  neighbor 200.110.255.238 activate
  neighbor 200.110.255.238 default-originate
  neighbor 200.110.255.238 remove-private-as
  neighbor 200.110.255.238 route-map ToR9 out
  neighbor 200.110.255.246 activate
  neighbor 200.110.255.246 send-community
  neighbor 200.110.255.246 remove-private-as
  neighbor 200.110.255.246 route-map FromR10 in
 exit-address-family
```

V routovacej tabuľke teraz nájdeme sumarizáciu:

```
B     200.110.0.0/16 [200/0] via 10.110.255.4, 01:55:20
```

11. Kontrola konektivity medzi zákaznícky mi a internetovými smerovacími záznamami

```
R1(tcl)#foreach address {
+>(tcl)#64.34.1.1
+>(tcl)#200.110.255.245
+>(tcl)#200.110.255.237
+>(tcl)#128.45.1.1
+>(tcl)#200.33.255.250
+>(tcl)#10.33.67.7} {
+>(tcl)#ping $address }
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 64.34.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 8/8/8 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 200.110.255.245, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 140/197/236 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 200.110.255.237, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 60/142/204 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 128.45.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 96/104/124 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 200.33.255.250, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 140/174/204 ms
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.33.67.7, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 96/159/188 ms


R8#ping 200.110.255.246
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 200.110.255.246, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 188/225/272 ms
R8#ping 200.110.255.254
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 200.110.255.254, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 132/177/252 ms


R10#ping 200.110.255.250
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 200.110.255.250, timeout is 2 seconds:
```

```
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 228/263/288 ms
```

12. Definovať vlastnú politiku - použiť community, community alter LP, AS-PATH filtering, prepending, atď

Rozhodli sme sa vyskúšať si prepending a to tak, že sme ovplyvnili router R10 aby zvýhodňoval trasu k routru R4 oproti R7. Urobili sme to tak, že na trase R10-R7 sme umelo predĺžili cestu a to konkrétne tak, že R7 bolo o štyri AS5005 ďalej ako bez tejto zmeny.

Konfigurácia R10:

```
route-map toR7 permit 10
set as-path prepend 5005 5005 5005 5005
router bgp 5005
address-family ipv4
nei 200.33.255.245 route-map toR7 out
```

Výpis z R7:

```
R7(config-router-af)#do sh ip bgp 223.255.255.0/24 long
BGP table version is 425, local router ID is 10.33.255.7
Status codes: s suppressed, d damped, h history, * valid, > best, i -
internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-
Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>i 223.255.255.0    10.33.255.6              0     60      0 3401 110
5005 ?
 *                    200.33.255.246           0             0 5005 5005
5005 5005 5005 ?
```

13. Primárne linky R3-R8, R4-R10

Na to aby sme preferovali linku R3-R8 a nie R4-R9 sme zmenili preferenciu R4-R9 na nižšiu a na linke R3-R8 sme dali väčšiu.

Konfigurácia R8:

```
ip prefix-list R4R9 permit 200.110.25.236/30
route-map PreferR3R8 permit 10
match ip address prefix-list R4R9
set local-preference 50

route-map PreferR3R8 permit 20
set local-preference 150

router bgp 65001
address-family ipv4
nei 200.110.255.241 route-map PreferR3R8 in
```

Pred:

```
R8(config-router-af)#do sh ip bgp
...
     Network          Next Hop            Metric LocPrf Weight Path
 * i 0.0.0.0          10.110.255.9             0    100      0 110 i
```

Po:

```
R8(config-router-af)#do sh ip bgp
...
     Network          Next Hop            Metric LocPrf Weight Path
 *>  0.0.0.0          200.110.255.241                  150      0 110 i
 *>  10.33.67.0/24    200.110.255.241                  150      0 110 4502 330
?
 *>  10.33.255.6/32   200.110.255.241                  150      0 110 4502 330
?
 *>  10.33.255.7/32   200.110.255.241                  150      0 110 4502 330
?
```

V opačnom smere sme sa rozhodli na ovplyvnenie trasy zmeniť metriku na routri R8 a R9. Na R8 sme dali pochopiteľne menšiu aby sme preferovali cestu R3-R8.

Konfigurácia:

R8:

```
route-map ToR3 permit 10
set metric 1
router bgp 65001
address-family ipv4
nei 200.110.255.241 route-map ToR3 out
```

R9:

```
route-map ToR4 permit 10
set metric 1000
router bgp 65001
address-family ipv4
nei 200.110.255.237 route-map ToR4 out
```

```
R4(config-router-af)#do sh ip bgp
...
s   200.110.12.0/26  200.110.255.238       1000             0 65001 i
 s>i                 10.110.255.3             1     60       0 65001 i
 s   200.110.12.64/26 200.110.255.238       1000             0 65001 i
 s>i                 10.110.255.3             1     60       0 65001 i
 s   200.110.12.128/26
                      200.110.255.238       1000             0 65001 i
 s>i                 10.110.255.3             1     60       0 65001 i
 s   200.110.12.192/26
                      200.110.255.238       1000             0 65001 i
```

Overenie – traceroute z R10 na loopback R8 ide po linke R10->R4->R3->R8:

```
R10(config-router-af)#do traceroute 10.110.255.8
```

```
Type escape sequence to abort.
Tracing the route to 10.110.255.8
VRF info: (vrf in name/id, vrf out name/id)
  1 200.110.255.245 144 msec 96 msec 96 msec
  2 10.110.34.3 184 msec 184 msec 164 msec
  3 200.110.255.242 [AS 110] 224 msec 188 msec 188 msec
```

Zmenu sme mali spraviť aj medzi routrami R4-R10. Tu sme sa rozhodli pre zmenu váhy (weight).

R10:

```
route-map fromR4 permit 10
set weight 300
router bgp 5005
address-family ipv4
neigh 200.110.255.245 route-map fromR4 in
do clear ip bgp 200.110.255.245 in
```

Pred:

```
R10(config-router-af)#do sh ip bgp
...
     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.33.67.0/24    200.33.255.245           0             0 330 ?
 *>  10.33.255.6/32   200.33.255.245          20             0 330 ?
 *>  10.33.255.7/32   200.33.255.245           0             0 330 ?
 *>  10.110.255.8/32  200.33.255.245                         0 330 3401 110
i
 *>  10.110.255.9/32  200.33.255.245                         0 330 3401 110
i
```

Po:

```
R10(config-router-af)#do sh ip bgp
...
     Network          Next Hop            Metric LocPrf Weight Path
 *>  10.33.67.0/24    200.110.255.245                       300 110 4502 330
?
 *                    200.33.255.245           0             0 330 ?
 *>  10.33.255.6/32   200.110.255.245                       300 110 4502 330
?
 *                    200.33.255.245          20             0 330 ?
 *>  10.33.255.7/32   200.110.255.245                       300 110 4502 330
?
 *                    200.33.255.245           0             0 330 ?
 *>  10.110.255.8/32  200.110.255.245                       300 110 i
 *                    200.33.255.245                         0 330 3401 110
i
 *>  10.110.255.9/32  200.110.255.245                       300 110 i
 *                    200.33.255.245                         0 330 3401 110
i
```

Tým istým princípom sme zmenili váhu aj pre opačný smer.

14. Distribuovať iba default, AS5005 a peering prefixy do AS65001

Distribúcia iba default-routu sme nastavilina routroch R3 a R4.

R3:

```
router bgp 110
address-fam ipv4
nei 200.110.255.238 route-map ToR8 out
nei 200.110.255.238 default-originate
```

R4:

```
router bgp 110
address-fam ipv4
nei 200.110.255.242 route-map ToR8 out
nei 200.110.255.242 default-originate
```

Pred:

```
R9(config-router-af)#do sh ip route
...
Gateway of last resort is not set

      10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
B        10.33.67.0/24 [200/0] via 10.110.255.8, 01:08:24
B        10.33.255.6/32 [200/0] via 10.110.255.8, 01:08:24
B        10.33.255.7/32 [200/0] via 10.110.255.8, 01:08:24
```

Po:

```
R9(config-router-af)#do sh ip route
...
Gateway of last resort is 200.110.255.241 to network 0.0.0.0

B*    0.0.0.0/0 [20/0] via 200.110.255.241, 00:00:50
      10.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
B        10.33.67.0/24 [20/0] via 200.110.255.241, 01:11:44
B        10.33.255.6/32 [20/0] via 200.110.255.241, 01:11:44
B        10.33.255.7/32 [20/0] via 200.110.255.241, 01:11:44
```

Na routroch R3 a R4 sme nastavili aj peering

R3:

```
ip as-path access-list 1 permit _4502_
ip as-path access-list 1 permit _5005$
route-map ToR8 permit 10
match as-path 1
```

R4:

```
ip as-path access-list 1 permit _4502_
ip as-path access-list 1 permit _5005$
route-map ToR9 permit 10
match as-path 1
```

Pred:

```
R8(config-router-af)#do sh ip bgp
...
```

```
    Network          Next Hop            Metric LocPrf Weight Path
 *>  0.0.0.0          200.110.255.241                150      0 110 i
 *>  10.110.255.8/32  0.0.0.0                    0         32768 i
 *>  10.110.255.9/32  192.168.89.9              20         32768 i
```

Po:

```
R8(config-router-af)#do sh ip bgp
...
     Network          Next Hop            Metric LocPrf Weight Path
 *>  0.0.0.0          200.110.255.241                150      0 110 i
 *>  10.33.67.0/24    200.110.255.241                150      0 110 4502 330
?
 *>  10.33.255.6/32   200.110.255.241                150      0 110 4502 330
?
 *>  10.33.255.7/32   200.110.255.241                150      0 110 4502 330
?
```

15. AS5005 nesme byť nikdy transit

Komunikácia medzi ISP1 a ISP2 by nemala prechádzať cez zákazníka 2. To sme ošetrili nasledujúcimi príkazmi na routri R10. Odosielam len tie siete, ktoré majú as path prázdny reťazec. Ostatné sa zahadzujú.

R10:

```
ip as-path access-list 1 deny ^$
ip as-path access-list 1 permit .*
route-map ToR7c permit 1
match as-path 1
```

16. Peering iba pre ISP1 a ISP2, nie pre prefixy naučené z Upstream ISP

Na routri R5 sme v tomto kroku nastavil, ktoré siete R5 nemá posielať routrom R2 a R6, respektíve ktoré má posielať routru R1.

Na routri R5 sme zadali príkazy:

```
ip as-path access-list 1 permit ^$
ip as-path access-list 2 deny _3401_
ip as-path access-list 2 permit .*
router bgp 4502
address-family ipv4
nei 200.33.255.250 filter-list 2 out
nei 200.110.255.253 filter-list 2 out
nei 64.34.255.253 filter-list 1 out
```

Výsledkom je zredukovanie BGP tabuľky na routroch R1 a R2.

```
R1#sh ip bgp regexp _4502_
...
     Network          Next Hop            Metric LocPrf Weight Path
 *   10.33.67.0/24    200.110.255.250                        0 110 4502 330
?
```

```
 *   10.33.255.6/32   200.110.255.250                      0 110 4502 330
?
 *   10.33.255.7/32   200.110.255.250                      0 110 4502 330
?
 *   64.34.255.252/30 200.33.255.254                       0 330 4502 ?
 *                    64.34.255.254            0           0 4502 ?
 *   128.45.1.1/32    200.33.255.254                       0 330 4502 ?
 *                    200.110.255.250                      0 110 4502 ?
 *>                   64.34.255.254            0           0 4502 ?
 *   200.33.7.1/32    200.110.255.250                      0 110 4502 330
?
 *   200.33.255.248/30
                       200.110.255.250                      0 110 4502 ?
 *>                   64.34.255.254            0           0 4502 ?
 *   200.110.0.0/16   200.33.255.254                       0 330 4502 110
i
 *   200.110.255.236/30
                       200.33.255.254                       0 330 4502
110 i
     Network          Next Hop            Metric LocPrf Weight Path
 *   200.110.255.240/30
                       200.33.255.254                       0 330 4502
110 i
 *   200.110.255.252/30
                       200.33.255.254                       0 330 4502 ?
 *                    64.34.255.254            0           0 4502 ?
 *   223.255.255.0    200.110.255.250                      0 110 4502 330
5005 5005 5005 5005 5005 ?



R2(config-router-af)#do sh ip bgp regexp _3401_
...
     Network          Next Hop            Metric LocPrf Weight Path
 *   10.33.67.0/24    200.110.255.249                      0 3401 330 ?
 *   10.33.255.6/32   200.110.255.249                      0 3401 330 ?
 *   10.33.255.7/32   200.110.255.249                      0 3401 330 ?
 *>  64.34.1.0/24     200.110.255.249          0           0 3401 ?
 *>  64.34.2.0/24     200.110.255.249          0           0 3401 ?
 *>  64.34.3.0/24     200.110.255.249          0           0 3401 ?
 *>  64.34.4.0/24     200.110.255.249          0           0 3401 ?
 *>  64.34.5.0/24     200.110.255.249          0           0 3401 ?
 *>  64.34.6.0/24     200.110.255.249          0           0 3401 ?
 *>  64.34.7.0/24     200.110.255.249          0           0 3401 ?
 *>  64.34.8.0/24     200.110.255.249          0           0 3401 ?
 *>  64.34.9.0/24     200.110.255.249          0           0 3401 ?
 *>  64.34.10.0/24    200.110.255.249          0           0 3401 ?
 *>  64.34.11.0/24    200.110.255.249          0           0 3401 ?
 *>  64.34.12.0/24    200.110.255.249          0           0 3401 ?
     Network          Next Hop            Metric LocPrf Weight Path
 *>  64.34.13.0/24    200.110.255.249          0           0 3401 ?
 *>  64.34.14.0/24    200.110.255.249          0           0 3401 ?
 *>  64.34.15.0/24    200.110.255.249          0           0 3401 ?
```

```
 *>  64.34.16.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.17.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.18.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.19.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.20.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.21.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.22.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.23.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.24.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.25.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.26.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.27.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.28.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.29.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.30.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.31.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.32.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.33.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.34.0/24    200.110.255.249          0             0 3401 ?
     Network          Next Hop            Metric LocPrf Weight Path
 *>  64.34.35.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.36.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.37.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.38.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.39.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.40.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.41.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.42.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.43.0/24    200.110.255.249          0             0 3401 ?
 *>  64.34.254.0/24   200.110.255.249          0             0 3401 i
 *>  64.34.255.252/30 200.110.255.249          0             0 3401 ?
 *   128.45.1.1/32    200.110.255.249                        0 3401 4502 ?
 *   200.33.7.1/32    200.110.255.249                        0 3401 330 ?
 *>  200.33.255.244/30
                      200.110.255.249                         0 3401 330 ?
 *   200.33.255.248/30
                      200.110.255.249                         0 3401 4502 ?
 *>  200.33.255.252/30
                      200.110.255.249          0              0 3401 ?
 *   200.110.255.248/30
                      200.110.255.249          0              0 3401 ?
 *   223.255.255.0    200.110.255.249                        0 3401 330
5005 5005 5005 5005 5005 ?
```

17. Overiť funkčnosť nastavenia politiky vhodnými výpadkami liniek a smerovačov

V smere R5->R8

```
R5#traceroute 200.110.13.1
Type escape sequence to abort.
Tracing the route to 200.110.13.1
VRF info: (vrf in name/id, vrf out name/id)
```

```
  1 200.110.255.253 88 msec 184 msec 188 msec
  2 10.110.23.3 256 msec 180 msec 220 msec
  3 200.110.255.242 [AS 110] 204 msec 148 msec 232 msec
  4 192.168.89.9 [AS 110] 300 msec 328 msec 264 msec
R5#ping  200.110.13.1 repeat 500
Type escape sequence to abort.
Sending 500, 100-byte ICMP Echos to 200.110.13.1, timeout is 2 seconds:
!!!!!!!!!!!!!!!.......................................................
.................!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!
Success rate is 85 percent (428/500), round-trip min/avg/max = 56/201/856
ms
R5#traceroute 200.110.13.1
Type escape sequence to abort.
Tracing the route to 200.110.13.1
VRF info: (vrf in name/id, vrf out name/id)
  1 200.110.255.253 188 msec 140 msec 140 msec
  2 10.110.24.4 256 msec 272 msec 200 msec
  3  *  *  *
  4
R5#traceroute 200.110.13.1
Type escape sequence to abort.
Tracing the route to 200.110.13.1
VRF info: (vrf in name/id, vrf out name/id)
  1 200.110.255.253 128 msec 140 msec 136 msec
  2 10.110.24.4 228 msec 116 msec 212 msec
  3 200.110.255.238 [AS 110] 200 msec 184 msec 308 msec
```

<u>V smere R8->R5:</u>

```
R8#traceroute 128.45.1.1
Type escape sequence to abort.
Tracing the route to 128.45.1.1
VRF info: (vrf in name/id, vrf out name/id)
  1 200.110.255.241 172 msec 140 msec 92 msec
  2 10.110.23.2 [AS 110] 200 msec 220 msec 216 msec
  3 200.110.255.254 [AS 110] 228 msec 192 msec 200 msec
R8#ping  128.45.1.1 repeat 500
Type escape sequence to abort.
Sending 500, 100-byte ICMP Echos to 128.45.1.1, timeout is 2 seconds:
!!!!!!!!!!!!!!!.......................................................
.................!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

```
!!!!!!!!!!
Success rate is 85 percent (428/500), round-trip min/avg/max = 36/227/812
ms
R8#traceroute 128.45.1.1
Type escape sequence to abort.
Tracing the route to 128.45.1.1
VRF info: (vrf in name/id, vrf out name/id)
  1 192.168.89.9 212 msec 220 msec 144 msec
  2 200.110.255.237 352 msec 224 msec 260 msec
  3 10.110.24.2 [AS 110] 328 msec 312 msec 172 msec
  4 200.110.255.254 [AS 110] 144 msec 324 msec 320 msec
```

Výsledkom bolo, že po vypnutí primárnej linky sa stratila na pár sekúnd konektivita. Spojenie sa potom obnovilo cez inú linku a po následnom zapnutí primárnej linky bola zase cesta cez túto primárnu linku.

18. Overiť, či je možné odkloniť celú prevádzku (upstream, downstream) na linke R4-R10 v prípade plánovanej údržby (linka musí byť plne funkčna a BGP spojenie propaguje všetky prefixy)

Našou úlohou bolo zabezpečiť, aby sa zmenila primárna linka R4<->R10 na R7<->R10. Pre overenie, či nastane nejaký výpadok sme skúšali ping počas zmeny primárnej linky.

Pred:

```
R5#traceroute 223.255.255.10
Type escape sequence to abort.
Tracing the route to 223.255.255.10
VRF info: (vrf in name/id, vrf out name/id)
  1 200.110.255.253 192 msec 192 msec 200 msec
  2 10.110.24.4 320 msec 288 msec 192 msec
  3 200.110.255.246 [AS 110] 360 msec 184 msec 284 msec
```

Po:

```
R5(config-router-af)#do traceroute 223.255.255.10
Type escape sequence to abort.
Tracing the route to 223.255.255.10
VRF info: (vrf in name/id, vrf out name/id)
  1 200.33.255.250 64 msec 52 msec 136 msec
  2 10.33.67.7 [AS 330] 320 msec 188 msec 192 msec
  3 200.33.255.246 [AS 330] 220 msec 252 msec 200 msec
```

Ping sme skúšali z routra R5:

```
R5(config-router-af)#do ping
Protocol [ip]:
Target IP address: 223.255.255.10
Repeat count [5]: 100
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]:
Sweep range of sizes [n]:
Type escape sequence to abort.
Sending 100, 100-byte ICMP Echos to 223.255.255.10, timeout is 2 seconds:
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

```
Success rate is 100 percent (100/100), round-trip min/avg/max = 60/225/692
ms
```

Ako je vidieť z pingu, tak žiadny výpadok sme nezaznamenali. V teste sme nevypli linku ako v predchádzajúcom cvičení, kde sa konektivita na pár sekúnd stratila, ale sme len zmenili route-mapu.