ŽILINSKÁ UNIVERZITA V ŽILINE
Fakulta riadenia a informatiky

Projektovanie sietí 1

Zadanie č. 1: OSPF

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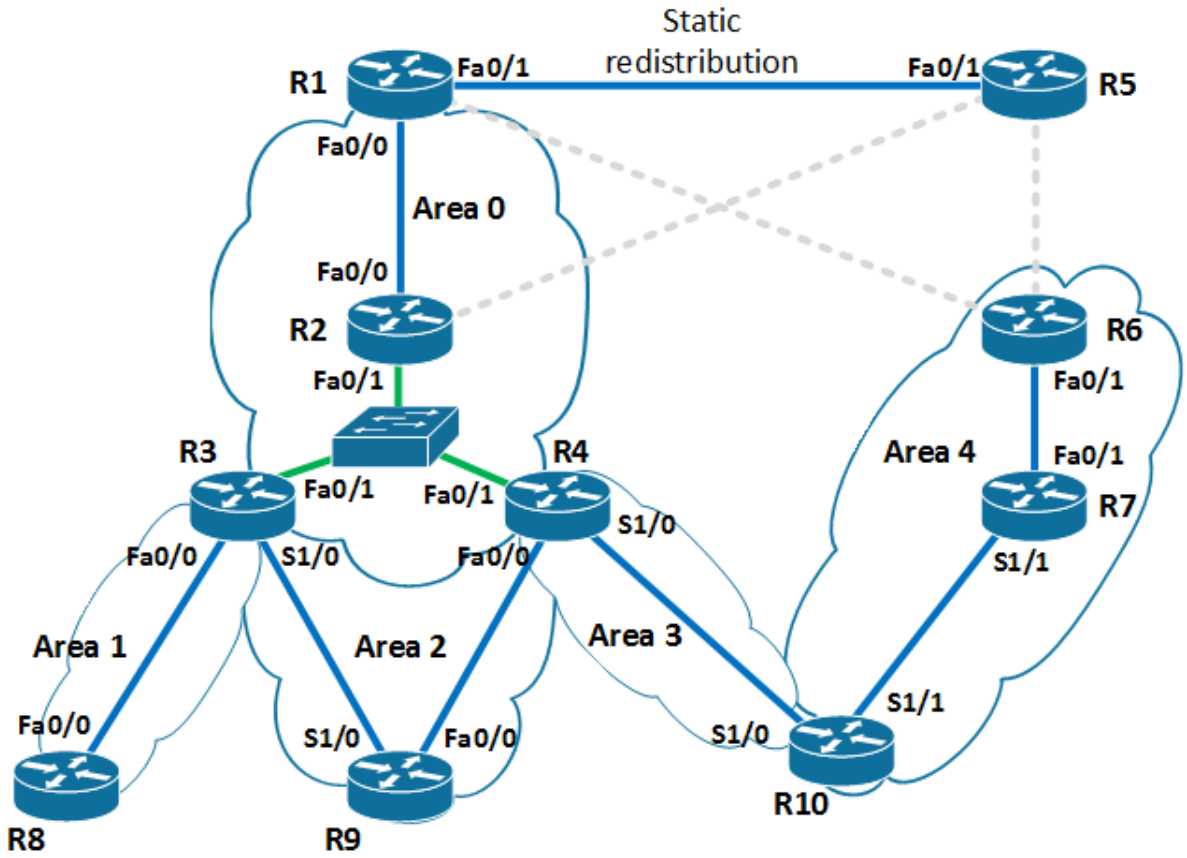
Zadanie

Úlohou bolo na smerovačoch v už vytvorenej topológii nakonfigurovať správne fungujúci smerovací protokol OSPF a overiť jeho funkčnosť a splnenie jednotlivých bodov zadania.

Topológia



Adresovanie

Smerovač	Interface	IP Adresa	Maska siete
R1	l0	10.255.255.1	255.255.255.255
	fa0/0	10.0.12.1	255.255.255.0
	fa0/1	10.0.15.1	255.255.255.0
R2	l0	10.255.255.2	255.255.255.255
	fa0/0	10.0.12.2	255.255.255.0
	fa0/1	10.0.234.1	255.255.255.0
R3	l0	10.255.255.3	255.255.255.255
	fa0/0	10.1.38.1	255.255.255.0
	fa0/1	10.0.234.2	255.255.255.0
	s1/0	10.2.39.1	255.255.255.0

R4	l0	10.255.255.4	255.255.255.255
	fa0/0	10.2.49.1	255.255.255.0
	fa0/1	10.0.234.3	255.255.255.0
	s1/0	10.3.40.1	255.255.255.0
R5	l0	10.255.255.5	255.255.255.255
	fa0/1	10.0.15.2	255.255.255.0
R6	l0	10.255.255.6	255.255.255.255
	fa0/1	10.4.67.1	255.255.255.0
R7	l0	10.255.255.7	255.255.255.255
	fa0/1	10.4.67.2	255.255.255.0
	s1/1	10.4.70.1	255.255.255.0
R8	l0	10.255.255.8	255.255.255.255
	fa0/0	10.1.38.2	255.255.255.0
R9	l0	10.255.255.9	255.255.255.255
	fa0/0	10.2.49.2	255.255.255.0
	s1/0	10.2.39.2	255.255.255.0
R10	l0	10.255.255.10	255.255.255.255
	s1/0	10.3.40.2	255.255.255.0
	s1/1	10.4.70.2	255.255.255.0

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Pozn.: Pre lepšiu prehľadnosť výpisov na smerovačoch sme z nich nepodstatné časti vymazali a dôležité časti zvýraznili hrubým písmom.

1. Nakonfigurovať OSPF s viacerými oblasťami

Na všetkých smerovačoch okrem R5 (z dôvodu, že sa nenachádza v oblastiach OSPF) sme aktivovali smerovací protokol OSPF a následne aj siete, ich masku a oblasť, do ktorých patria.
Kontrolu sme vykonali príkazom *show ip protocols* na jednotlivých smerovačoch, ktorý zobrazí typ smerovacieho protokolu a číslo procesu, ID smerovača a všetky siete a oblasti, pre ktoré vykonáva smerovanie.

```
4R3#sh ip protocols
Routing Protocol is "ospf 1"
  Router ID 10.255.255.3
  It is an area border router
  Number of areas in this router is 3. 2 normal 1 stub 0 nssa
  Routing for Networks:
    10.0.234.0 0.0.0.255 area 0
    10.1.38.0 0.0.0.255 area 1
    10.2.39.0 0.0.0.255 area 2

4R10#sh ip protocols
Routing Protocol is "ospf 1"
  Router ID 10.255.255.10
  Number of areas in this router is 3. 2 normal 1 stub 0 nssa
  Routing for Networks:
    10.3.40.0 0.0.0.255 area 3
    10.4.70.0 0.0.0.255 area 4
```

2. R2, R3, R4 broadcast spojenia prostredníctvom L2 prepínača, zvyšok spojení P2P

Na všetkých Fast Ethernet rozhraniach smerovačov z oblastí 1-4 (s výnimkou LAN siete medzi smerovačmi R2, R3, R4) sme použili príkaz *ip ospf network point-to-point*. Na sériových rozhraniach ho nebolo nutné použiť, pretože tie sú point-to-point defaultne.
Na výpisoch *show ip ospf interface brief* v stĺpci State vidíme typ spojenia pre jednotlivé rozhrania v daných sieťach. P2P znamená point-to-point spojenie, DR, BDR a DROTH značí, že smerovače sú v danej sieti broadcastovo prepojené L2 prepínačom a volil sa Designated Router a Backup Designated Router.

```
4R1#sh ip ospf interface brief
Interface    PID   Area            IP Address/Mask    Cost  State Nbrs F/C
Fa0/0        1     0               10.0.12.1/24       10    P2P   1/1
4R2#sh ip ospf interface brief
Interface    PID   Area            IP Address/Mask    Cost  State Nbrs F/C
Fa0/1        1     0               10.0.234.1/24      10    DR    2/2
Fa0/0        1     0               10.0.12.2/24       10    P2P   1/1
4R3#sh ip ospf interface brief
Interface    PID   Area            IP Address/Mask    Cost  State Nbrs F/C
Fa0/1        1     0               10.0.234.2/24      10    BDR   2/2
Fa0/0        1     1               10.1.38.1/24       10    P2P   1/1
```

```
Se1/0        1     2               10.2.39.1/24       5     P2P   1/1
4R4#sh ip ospf interface brief
Interface    PID   Area            IP Address/Mask    Cost  State Nbrs F/C
Fa0/1        1     0               10.0.234.3/24      10    DROTH 2/2
Fa0/0        1     2               10.2.49.1/24       10    P2P   1/1
Se1/0        1     3               10.3.40.1/24       64    P2P   1/1
4R7#sh ip ospf interface brief
Interface    PID   Area            IP Address/Mask    Cost  State Nbrs F/C
Se1/1        1     4               10.4.70.1/24       64    P2P   1/1
Fa0/1        1     4               10.4.67.2/24       10    P2P   1/1
```

3. Router-id - loopback0, passive-interface

Na každom smerovači sme nastavili jeho ID ako IP adresu jeho loopbacku a všetky loopbacky sme nastavili v ospf konfigurácii ako passive-interface.

```
4R1#sh ip ospf | sec Routing Process
 Routing Process "ospf 1" with ID 10.255.255.1
4R2#sh ip ospf | sec Routing Process
 Routing Process "ospf 1" with ID 10.255.255.2
4R3#sh ip ospf | sec Routing Process
 Routing Process "ospf 1" with ID 10.255.255.3
4R4#sh ip ospf | sec Routing Process
 Routing Process "ospf 1" with ID 10.255.255.4
4R5#sh ip ospf | sec Routing Process
 Routing Process "ospf 1" with ID 10.255.255.5
4R6#sh ip ospf | sec Routing Process
 Routing Process "ospf 1" with ID 10.255.255.6
4R7#sh ip ospf | sec Routing Process
 Routing Process "ospf 1" with ID 10.255.255.7
4R8#sh ip ospf | sec Routing Process
 Routing Process "ospf 1" with ID 10.255.255.8
4R9#sh ip ospf | sec Routing Process
 Routing Process "ospf 1" with ID 10.255.255.9
4R10#sh ip ospf | sec Routing Process
 Routing Process "ospf 1" with ID 10.255.255.10
```

Passive interface:

```
4R1#sh ip protocols | section Passive
  Passive Interface(s):
    Loopback0
4R2#sh ip protocols | section Passive
  Passive Interface(s):
    Loopback0
4R3#sh ip protocols | section Passive
  Passive Interface(s):
    Loopback0
4R4#sh ip protocols | section Passive
  Passive Interface(s):
    Loopback0
```

```
4R5#sh ip protocols | section Passive
  Passive Interface(s):
    Loopback0
4R6#sh ip protocols | section Passive
  Passive Interface(s):
    Loopback0
4R7#sh ip protocols | section Passive
  Passive Interface(s):
    Loopback0
4R8#sh ip protocols | section Passive
  Passive Interface(s):
    Loopback0
4R9#sh ip protocols | section Passive
  Passive Interface(s):
    Loopback0
4R10#sh ip protocols | section Passive
  Passive Interface(s):
    Loopback0
```

4. Area 1 – Totally Stubby

Do Totally Stubby oblasti sa nepreposielajú LSA3, LSA4 a LSA5 a neakceptuje LSA4 a LSA5. Nemá info o ASBR, externých sieťach, ani o sieťach z iných oblastí, nemôže obsahovať ASBR a má info len o intra area cestách.
Na smerovači R8 použijeme príkaz *area 1 stub* a na R3 *area 1 stub no-summary* (pretože je ABR).

```
4R8#sh ip ospf database

            OSPF Router with ID (10.255.255.8) (Process ID 1)

                Router Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.255.255.3    10.255.255.3    1827        0x8000002B 0x00DE79 2
10.255.255.8    10.255.255.8    1688        0x8000002C 0x0065EC 2

                Summary Net Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum
0.0.0.0         10.255.255.3    1828        0x80000024 0x00FE0F
```

5. Area 3 – Stub

Ako Totally Stubby, okrem toho, že má info o sieťach z iných oblastí, ale nie o ich topológii. Na všetkých smerovačoch v stub oblasti (R4 a R10) uvedieme príkaz *area 3 stub*. Nasledujúci výpis nám dá informáciu o type oblasti.

```
4R10#sh ip ospf | begin Area 3
    Area 3
        Number of interfaces in this area is 1
        It is a stub area
```

6. Area 4 – pripojenie pomocou virtuálnej linky

Túto úlohu nebolo prakticky možné splniť, pretože Area 3 je stub. Ak by nebola stub, oblasť area 4 by sme virtuálne pripojili príkazom *area 3 virtual-link 10.3.40.x* na smerovačoch R4 a R10.

7. Statická redistribúcia smerovacích záznamov z R5

Aby mohol smerovač R5 komunikovať s ostatnými smerovačmi v topológii, bolo potrebné na R1 nastaviť statickú redistribúciu príkazom *redistribute static subnets*, ktorý zabezpečí redistribúciu všetkých staticky smerovaných sietí, teda v našom prípade sieť k smerovaču R5.

```
4R1#sh ip route 10.255.255.5
Routing entry for 10.255.255.5/32
  Known via "static", distance 1, metric 0
  Redistributing via ospf 1
  Advertised by ospf 1 subnets
```

8. Kontrola DR prostredníctvom "ip ospf priority"

Na smerovači R2 sme na rozhraní fa0/1 (v sieti 10.0.234.0) nastavili prioritu 100 príkazom *ip ospf priority 100*, čo z neho urobilo DR a na R3 prioritu 50, vďaka čomu sa stal BDR. Overili sme to výpisom OSPF susedov na smerovači R4.

```
4R4#sh ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
10.255.255.2    100   FULL/DR         00:00:19    10.0.234.1FastEthernet0/1
10.255.255.3     50   FULL/BDR        00:00:19    10.0.234.2FastEthernet0/1
10.255.255.9      0   FULL/  -        00:00:19    10.2.49.2FastEthernet0/0
10.255.255.10     0   FULL/  -        00:00:19    10.3.40.2 Serial1/0
```

9. Kontrola OSPF databáz a smerovacích tabuliek

Príkazmi *show ip route* a *show ip ospf database* na jednotlivých smerovačoch sme overili ich smerovacie tabuľky a OSPF databázy. Uvedieme príklad na smerovači R3.

```
4R3#sh ip route
Gateway of last resort is not set
```

```
     10.0.0.0/8 is variably subnetted, 9 subnets, 3 masks
O       10.0.12.0/24 [110/20] via 10.0.234.1, 00:44:55, FastEthernet0/1
O       10.2.0.0/16 is a summary, 00:45:25, Null0
C       10.255.255.3/32 is directly connected, Loopback0
O E2    10.255.255.5/32 [110/20] via 10.0.234.1, 00:44:55, FastEthernet0/1
O IA    10.3.40.0/24 [110/74] via 10.0.234.3, 00:44:55, FastEthernet0/1
C       10.1.38.0/24 is directly connected, FastEthernet0/0
C       10.2.39.0/24 is directly connected, Serial1/0
O       10.2.49.0/24 [110/15] via 10.2.39.2, 00:45:27, Serial1/0
C       10.0.234.0/24 is directly connected, FastEthernet0/1

4R3#sh ip ospf database

            OSPF Router with ID (10.255.255.3) (Process ID 1)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.255.255.1    10.255.255.1    508         0x8000002D 0x000C87 2
10.255.255.2    10.255.255.2    821         0x800000C1 0x008E6B 3
10.255.255.3    10.255.255.3    671         0x80000003 0x008B94 1
10.255.255.4    10.255.255.4    675         0x80000095 0x006426 1

                Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.0.234.1      10.255.255.2    821         0x80000003 0x006AA0

                Summary Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
10.1.38.0       10.255.255.3    671         0x80000002 0x004DA6
10.2.0.0        10.255.255.3    671         0x80000002 0x00B26B
10.2.0.0        10.255.255.4    677         0x80000005 0x00D83C
10.3.40.0       10.255.255.4    677         0x80000028 0x00EAA7

                Router Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.255.255.3    10.255.255.3    673         0x8000002C 0x00DC7A 2
10.255.255.8    10.255.255.8    560         0x8000002D 0x0063ED 2

                Summary Net Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum
0.0.0.0         10.255.255.3    674         0x80000025 0x00FC10

                Router Link States (Area 2)

Link ID         ADV Router      Age         Seq#       Checksum Link count
10.255.255.3    10.255.255.3    674         0x8000002A 0x001E3E 2
10.255.255.4    10.255.255.4    679         0x8000002A 0x0054E7 2
```

```
10.255.255.9    10.255.255.9    237         0x8000002C 0x00DBBB 4

                Summary Net Link States (Area 2)

Link ID         ADV Router      Age         Seq#       Checksum
10.0.12.0       10.255.255.3    674         0x80000002 0x00DC28
10.0.12.0       10.255.255.4    679         0x80000002 0x00D62D
10.0.234.0      10.255.255.3    674         0x80000006 0x00DC4F
10.0.234.0      10.255.255.4    681         0x80000002 0x00DE50
10.1.38.0       10.255.255.3    676         0x80000028 0x0001CC
10.1.38.0       10.255.255.4    681         0x80000002 0x00AB3D
10.3.40.0       10.255.255.3    676         0x80000002 0x00A10E
10.3.40.0       10.255.255.4    681         0x80000002 0x003781

                Summary ASB Link States (Area 2)

Link ID         ADV Router      Age         Seq#       Checksum
10.255.255.1    10.255.255.3    676         0x80000002 0x0049C5
10.255.255.1    10.255.255.4    681         0x80000002 0x0043CA

                Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
10.255.255.5    10.255.255.1    1256        0x80000025 0x008AD7 0
```

10. Kontrola konektivity

Na smerovači R1 sme spustili skript, ktorý posiela pingy na všetky IP adresy rozhraní smerovačov v topológii. Odpovede sme dostali zo všetkých smerovačov okrem tých z Area 4.

```
R1(tcl)#foreach address {
+>(tcl)#10.0.15.1
+>(tcl)#10.0.15.2
+>(tcl)#10.0.12.1
+>(tcl)#10.0.12.2
+>(tcl)#10.0.234.1
+>(tcl)#10.0.234.2
+>(tcl)#10.0.234.3
+>(tcl)#10.1.38.1
+>(tcl)#10.1.38.2
+>(tcl)#10.2.39.1
+>(tcl)#10.2.39.2
+>(tcl)#10.2.49.1
+>(tcl)#10.2.49.2
+>(tcl)#10.3.40.1
+>(tcl)#10.3.40.2
+>(tcl)#10.4.70.1
+>(tcl)#10.4.70.2
+>(tcl)#10.4.67.1
+>(tcl)#10.4.67.2
```

```
+>(tcl)#} {
+>(tcl)#ping $address }

Sending 5, 100-byte ICMP Echos to 10.0.15.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/4 ms
Sending 5, 100-byte ICMP Echos to 10.0.15.2, timeout is 2 seconds:
.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 16/21/24 ms
Sending 5, 100-byte ICMP Echos to 10.0.12.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
Sending 5, 100-byte ICMP Echos to 10.0.12.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 8/16/20 ms
Sending 5, 100-byte ICMP Echos to 10.0.234.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/17/20 ms
Sending 5, 100-byte ICMP Echos to 10.0.234.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/36/44 ms
Sending 5, 100-byte ICMP Echos to 10.0.234.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/35/52 ms
Sending 5, 100-byte ICMP Echos to 10.1.38.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 24/37/44 ms
Sending 5, 100-byte ICMP Echos to 10.1.38.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 44/56/64 ms
Sending 5, 100-byte ICMP Echos to 10.2.39.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 24/35/44 ms
Sending 5, 100-byte ICMP Echos to 10.2.39.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 44/56/68 ms
Sending 5, 100-byte ICMP Echos to 10.2.49.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 44/57/76 ms
Sending 5, 100-byte ICMP Echos to 10.2.49.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 44/57/64 ms
Sending 5, 100-byte ICMP Echos to 10.3.40.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/36/44 ms
Sending 5, 100-byte ICMP Echos to 10.3.40.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 44/60/76 ms
Sending 5, 100-byte ICMP Echos to 10.4.70.1, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
Sending 5, 100-byte ICMP Echos to 10.4.70.2, timeout is 2 seconds:
.....
```

```
Success rate is 0 percent (0/5)
Sending 5, 100-byte ICMP Echos to 10.4.67.1, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
Sending 5, 100-byte ICMP Echos to 10.4.67.2, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
```

11. Area 2 – R3 primárny smerovač, R4 sekundárny smerovač

Prioritu R3 pred R4 sme vyriešili nastavením ceny príslušných strán na 5 a 10 (z oboch strán, aby nedochádzalo ku konfliktom) príkazom *ip ospf cost x* na príslušnom rozhraní.

```
4R9#show ip ospf interface brief
Interface    PID   Area            IP Address/Mask    Cost  State Nbrs F/C
Fa0/0        1     2               10.2.49.2/24       10    P2P   1/1
Se1/0        1     2               10.2.39.2/24       5     P2P   1/1
```

Správnosť sme následne overili pomocou príkazu *traceroute* zo smerovača R9 na R1 - všetky pakety boli smerované cez R3.

12. Skrátenie hello a dead-interval časovačov, zistenie funkčnosti vytrhnutím jednej z liniek smerom ku L2 prepínaču

Na jednotlivých rozhraniach sme na nastavenie hello intervalu použili príkaz *ip ospf hello-interval 5*, dead interval je automaticky štvornásobný.

```
4R1#sh ip ospf interface
FastEthernet0/0 is up, line protocol is up
  Internet Address 10.0.12.1/24, Area 0
  ...
  Timer intervals configured, Hello 5, Dead 20, Wait 20, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:03
  ...
```

Funkčnosť sme overili zhodením rozhrania fa0/1 na smerovači R4, po jeho zapnutí sa komunikácia obnovila do 5 sekúnd.