



UNIVERSITY OF ŽILINA
Faculty of Management Science
and Informatics

Juniper JunOS

Marek Moravčík



Agenda

- Predstavenie Juniper Networks
- Predstavenie JunOS
- Navigácia v CLI
- Základná konfigurácia smerovača
- Statické smerovanie
- OSPFv2 a OSPFv3
- Porovnanie konfigurácie s Cisco IOS
- Access list



Juniper Networks

JUNIPER[®]
NETWORKS



Juniper Networks

- Americká spoločnosť, zal. 1996, California, USA
- Výrobca sieťových zariadení (IP siete)
 - Smerovače (Rady MX, PTX)
 - Prepínače (Rady EX, QFX)
 - Firewally (Rada SRX)
- Jednotný operačný systém JunOS
- Akvizícia NetScreen
 - Firewally SSG

Smerovače rady PTX

- PTX – modulárne core zariadenia
 - Využívané najmä v providerských sieťach
- Nástupca série T



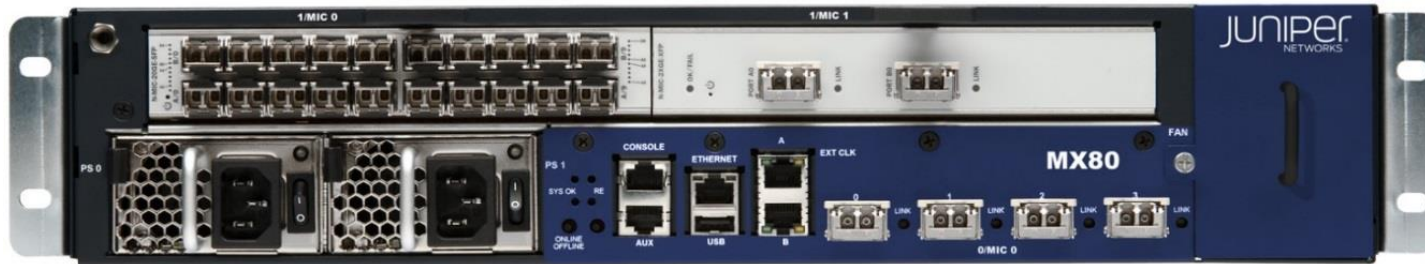
PTX 10008/10016



PTX 5000

Smerovače rady MX

- MX – modulárne core/enterprise zariadenia
- Smerovač MX40 bol prvým produktom Juniper-u



MX 80



MX 150

MX 480



MX 2020

Prepínače rady EX

- EX – ethernetové fixné 1U prepínače
 - Využívané v enterprise sieťach



EX 4300



EX 2200-C



EX 2200-24



EX 9214

Prepínače rady QFX

- QFX – ethernetové datacentrové prepínače



QFX 5210-64C



QFX 5110-32Q



QFX 10008

Firewally rady SRX

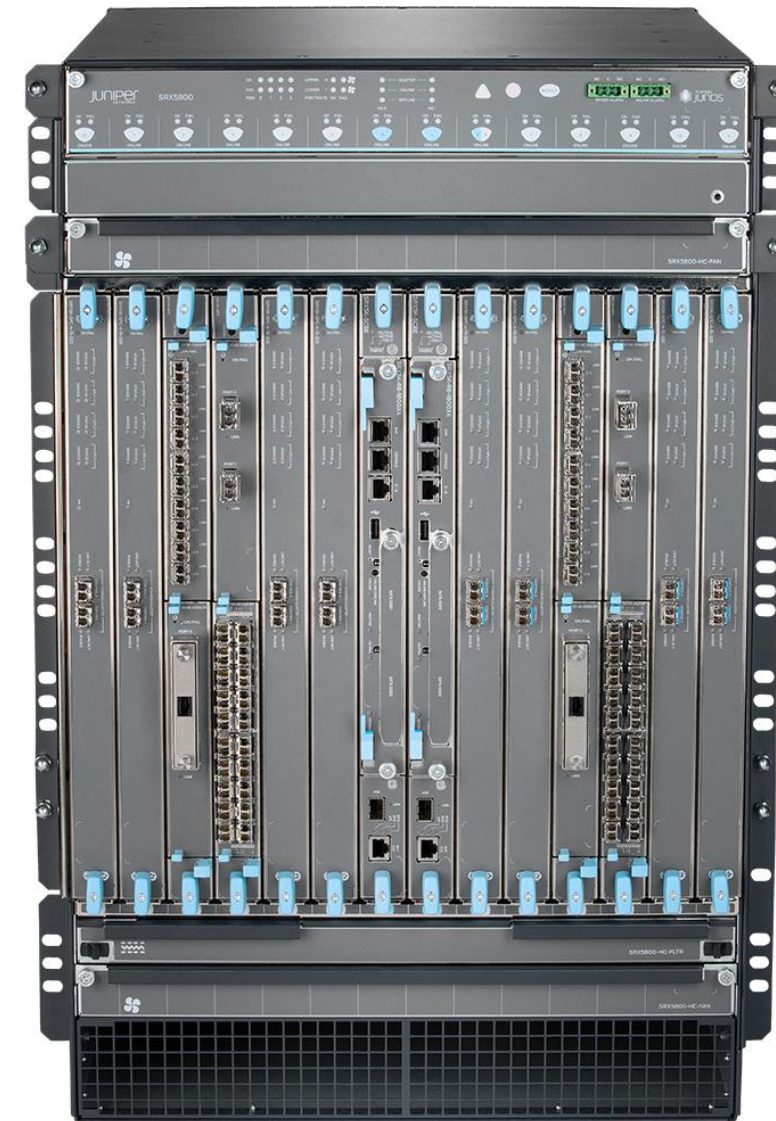
- SRX – modulárne Next-Generation firewally
- Využívané v enterprise



SRX 100



SRX 340



SRX 5800

Firewally rady SSG (Secure Services Gateway)

- SSG – modulárne firewally
 - Operačný systém ScreenOS
 - Nahrádzané radou SRX



SSG 5



SSG 550M



JunOS (Juniper Network Operating System)

Fyzická topológia

- Cisco 2691
 - 12.4(25c) Advanced IP services
- Juniper vMX
 - Model: olive
 - Junos: 15.1F6.9



Logická topológia

192.168.1.0/24
2001:DEAD:BEEF::/64

Juniper vMX-15.1F6.9-1



.1

R1



.2

Loop1: 10.1.1.1/24
2001:ACAD:1:1::1/64

Loop2: 10.1.2.1/24
2001:ACAD:1:2::1/64

Loop3: 10.1.3.1/24
2001:ACAD:1:3::1/64

Loop1: 10.2.1.1/24
2001:ACAD:2:1::1/64

Loop2: 10.2.2.1/24
2001:ACAD:2:2::1/64

Loop3: 10.2.3.1/24
2001:ACAD:2:3::1/64

Po nabootovaní

- Po boote vyžaduje JunOS login
 - Default je root, žiadne heslo

```
...
prefetching /usr/libexec64/rpd
Starting jlaunchhelperd.
/etc/rc: WARNING: run_rc_command: cannot run
Starting cron.

Wed Mar 14 15:15:07 UTC 2018

FreeBSD/amd64 (Amnesiac) (ttyu0)

login: root

--- JUNOS 15.1F6.9 Kernel 64-bit  JNPR-10.1-20160616.329709_builder_stable_10
root@:~ #
```

Po nabootovaní

- Používateľ sa nachádza v klasickom BSD systéme
- Do konfigurácie sa dostane pomocou príkazu **cli**

```

root@:~ # pwd
/root
root@:~ # ls -lha
total 2
drwxr-xr-x  2 root  wheel  512B Mar 15 06:34 .
drwxrwxr-x 22 root  wheel  512B Mar 15 06:34 ..
lrwxr-xr-x  1 root  wheel   36B Mar 15 06:34 .cshrc -> /packages/mnt/os-
runtime/root/.cshrc
lrwxr-xr-x  1 root  wheel   36B Mar 15 06:34 .login -> /packages/mnt/os-
runtime/root/.login
lrwxr-xr-x  1 root  wheel   38B Mar 15 06:34 .profile ->
/packages/mnt/os-runtime/root/.profile
root@:~ # cli
root>

root> ?
Possible completions:
  configure      Manipulate software configuration information
  ping           Ping remote target
  quit           Exit the management session
  request        Make system-level requests
  set            Set CLI properties, date/time, craft interface
message
  show           Show system information
  ssh           Start secure shell on another host
  telnet        Telnet to another host
  traceroute    Trace route to remote host
  ...

```

Pohybovanie sa v režimoch JunOS

- Rovnako ako na Cisco boxoch, funguje otáznik

```
root> ?  
Possible completions:  
clear          Clear information in the system  
configure     Manipulate software configuration information  
file          Perform file operations  
help          Provide help information  
monitor       Show real-time debugging information  
mtrace        Trace multicast path from source to receiver  
op            Invoke an operation script  
ping          Ping remote target  
quit          Exit the management session  
request       Make system-level requests  
...
```


Konfiguračný režim

- Príkaz **configure**
- Pre „vystúpenie“ príkaz **exit**

```
root> configure
Entering configuration mode

[edit]
root#

[edit]
root# exit
Exiting configuration mode

root>
```

Pohyb v podrežimoch

- Príkaz **edit**
- Pre „vystúpenie“ príkaz **exit**

```
[edit]
root# edit interfaces lo0

[edit interfaces lo0]
root# edit unit 0 family inet

[edit interfaces lo0 unit 0 family inet]
root# exit

[edit interfaces lo0]
root# exit

[edit]
root#
```

Aplikovanie zmien

- Pre aplikovanie (a uloženie) konfigurácie je potrebné zadať príkaz **commit**
 - Rôzne možnosti
 - Commit
 - Commit and-quit
 - Commit check
 - Commit confirmed
 - Najskôr je ale potrebné nastaviť heslo pre root-a

```
[edit]
root# commit
[edit]
  'system'
    Missing mandatory statement: 'root-authentication'
error: commit failed: (missing mandatory statements)

[edit]
root#
```

Commit

- Commit
 - Skontroluje logiku príkazov a aplikuje zmeny
- Commit and-quit
 - Skontroluje logiku príkazov a aplikuje zmeny
 - „Vystúpi“ z konfiguračného režimu
- Commit check
 - Skontroluje logiku príkazov
- Commit confirmed
 - Skontroluje logiku príkazov a aplikuje zmeny
 - Čaká definovaný čas na príkaz commit
 - Ak nie je zadáný, vráti zmeny

Nastavenie root hesla

- Možnosť zadania plain-text hesla

```
[edit]  
root# set system root-authentication plain-text-password  
New password:  
error: minimum password length is 6  
error: require change of case, digits or punctuation
```

```
[edit]  
root# set system root-authentication plain-text-password  
New password:  
Retype new password:
```

```
[edit]  
root#
```

Nastavenie root hesla

- Overenie hesla

```
[edit]
root# show | compare
[edit system]
+   root-authentication {
+       encrypted-password "$5$uh4PWIjf$4Z.8NZnq/KjHVU9ZpU4o1yzkKT05gGig4jDqbZwGt45";
## SECRET-DATA
+   }
```

```
[edit]
root# commit
commit complete
```

```
[edit]
root#
```

Zobrazenie konfigurácie

■ Príkaz show

```
root# show
## Last changed: 2018-04-23 15:11:31 UTC
version 15.1F6.9;
system {
    root-authentication {
        encrypted-password "$5$aL4h0RZ5$gP7Ygnvf4aJvD449m.RESuBMLgBbXe3jL0gVy/Z12jB"; ##
SECRET-DATA
    }
    syslog {
        user * {
            any emergency;
        }
        file messages {
            any notice;
            authorization info;
        }
        file interactive-commands {
            interactive-commands any;
        }
    }
}

[edit]
root#
```



IPv4 adresácia

Zobrazenie IPv4 adries na rozhraniach

- Príkaz **show interfaces terse**

```
root> show interfaces terse
Interface          Admin Link Proto  Local          Remote
cbp0               up    up
em0                up    up
em1                up    up
em2                up    up
em3                up    up
esi                up    up
gre                up    up
ipip               up    up
irb                up    up
lo0                up    up
lo0.16384          up    up    inet    127.0.0.1      --> 0/0
lo0.16385          up    up    inet    128.0.0.1      --> 0/0
                  up    up    inet    128.0.0.4      --> 0/0
                  up    up    inet6   fe80::200:f:fc00:0
lsi                up    up
...
```

Nastavenie IPv4 adres na rozhraniach

```
[edit]  
root# set interfaces em0 unit 0 family inet address 192.168.1.1/24
```

```
[edit]  
root# show | compare
```

```
[edit]  
+ interfaces {  
+     em0 {  
+         unit 0 {  
+             family inet {  
+                 address 192.168.1.1/24;  
+             }  
+         }  
+     }  
+ }
```

```
[edit]  
root# commit  
commit complete
```

Overenie IPv4 adries na rozhraniach

```
root> show interfaces terse
Interface          Admin Link Proto  Local          Remote
cbp0               up   up
demux0            up   up
dsc               up   up
em0               up   up
em0.0             up   up   inet   192.168.1.1/24
em1               up   up
em2               up   up
em3               up   up
esi               up   up
gre               up   up
ipip              up   up
...
```

Cisco na druhej strane

- Zobuď rozhranie a zadaj IPv4 adresu

```
R1(config)#interface FastEthernet0/0  
R1(config-if)#no shutdown  
R1(config-if)#ip address 192.168.1.2 255.255.255.0
```

Overenie

```
root> ping 192.168.1.2
PING 192.168.1.2 (192.168.1.2): 56 data bytes
64 bytes from 192.168.1.2: icmp_seq=0 ttl=255 time=5.220 ms
64 bytes from 192.168.1.2: icmp_seq=1 ttl=255 time=8.164 ms
64 bytes from 192.168.1.2: icmp_seq=2 ttl=255 time=8.955 ms
64 bytes from 192.168.1.2: icmp_seq=3 ttl=255 time=3.899 ms
^C
--- 192.168.1.2 ping statistics ---
4 packets transmitted, 4 packets received, 0% packet loss
round-trip min/avg/max/stddev = 3.899/6.559/8.955/2.073 ms

root>
```

```
R1#ping 192.168.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 60/63/68 ms
R1#
```

Smerovacia tabuľka na JunOS

```
root> show route
```

```
inet.0: 2 destinations, 2 routes (2 active, 0 holddown, 0 hidden)
```

```
+ = Active Route, - = Last Active, * = Both
```

```
192.168.1.0/24      *[Direct/0] 00:08:25
```

```
    > via em0.0
```

```
192.168.1.1/32    *[Local/0] 00:08:25
```

```
    Local via em0.0
```

Smerovacia tabuľka na Cisco

```
R1#show ip route
```

```
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
```

```
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
```

```
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
```

```
       E1 - OSPF external type 1, E2 - OSPF external type 2
```

```
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
```

```
       ia - IS-IS inter area, * - candidate default, U - per-user static route
```

```
       o - ODR, P - periodic downloaded static route
```

```
Gateway of last resort is not set
```

```
C      192.168.1.0/24 is directly connected, FastEthernet0/0
```

```
R1#
```




IPv6 adresácia

Nastavenie IPv6 adres na rozhraniach

```
[edit]
root# set interfaces em0 unit 0 family inet6 address FE80::1/64
root# set interfaces em0 unit 0 family inet6 address 2001:DEAD:BEEF::1/64

[edit]
root# show | compare
[edit interfaces em0 unit 0]
+     family inet6 {
+         address 2001:dead:beef::1/64;
+     }

[edit]
root# commit
commit complete
```

Overenie IPv6 adries na rozhraniach

```
root> show interfaces terse
Interface          Admin Link Proto  Local          Remote
cbp0               up   up
demux0            up   up
dsc               up   up
em0               up   up
em0.0             up   up   inet    192.168.1.1/24
                  up   up   inet6   2001:dead:beef::1/64
                  up   up   inet6   fe80::52c9:4aff:fed3:ed00/64
em1               up   up
em2               up   up
em3               up   up
...
```

Cisco na druhej strane

- Zapni IPv6
- Zobuď rozhranie a zadaj IPv4 adresu

```
R1(config)#ipv6 unicast-routing
```

```
R1(config)#ipv6 cef
```

```
R1(config-if)#no shutdown
```

```
R1(config-if)#ipv6 address fe80::2 link-local
```

```
R1(config-if)#ipv6 address 2001:DEAD:BEEF::2/64
```

Overenie

```
root> ping 2001:DEAD:BEEF::2
PING6(56=40+8+8 bytes) 2001:dead:beef::1 --> 2001:dead:beef::2
16 bytes from 2001:dead:beef::2, icmp_seq=0 hlim=64 time=14.228 ms
16 bytes from 2001:dead:beef::2, icmp_seq=1 hlim=64 time=9.163 ms
16 bytes from 2001:dead:beef::2, icmp_seq=2 hlim=64 time=12.788 ms
16 bytes from 2001:dead:beef::2, icmp_seq=3 hlim=64 time=8.585 ms
^C
--- 2001:DEAD:BEEF::2 ping6 statistics ---
4 packets transmitted, 4 packets received, 0% packet loss
round-trip min/avg/max/std-dev = 8.585/11.191/14.228/2.381 ms

root>
```

```
R1#ping 2001:DEAD:BEEF::1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:DEAD:BEEF::1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 324/603/1048 ms
R1#
```

Overenie Link-local adries

```
root> ping 2001:DEAD:BEEF::2
PING6(56=40+8+8 bytes) 2001:dead:beef::1 --> 2001:dead:beef::2
16 bytes from 2001:dead:beef::2, icmp_seq=0 hlim=64 time=14.228 ms
16 bytes from 2001:dead:beef::2, icmp_seq=1 hlim=64 time=9.163 ms
16 bytes from 2001:dead:beef::2, icmp_seq=2 hlim=64 time=12.788 ms
16 bytes from 2001:dead:beef::2, icmp_seq=3 hlim=64 time=8.585 ms
^C
--- 2001:DEAD:BEEF::2 ping6 statistics ---
4 packets transmitted, 4 packets received, 0% packet loss
round-trip min/avg/max/std-dev = 8.585/11.191/14.228/2.381 ms

root>
```

```
R1#ping fe80::1
Output Interface: fastethernet0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to FE80::1, timeout is 2 seconds:
Packet sent with a source address of FE80::2
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 392/516/640 ms
R1#
```

Smerovacia tabuľka na JunOS

```
root> show route
```

```
inet.0: 2 destinations, 2 routes (2 active, 0 holddown, 0 hidden)
```

```
+ = Active Route, - = Last Active, * = Both
```

```
192.168.1.0/24      *[Direct/0] 00:08:25
```

```
> via em0.0
```

```
192.168.1.1/32     *[Local/0] 00:08:25
```

```
Local via em0.0
```

```
inet6.0: 3 destinations, 3 routes (3 active, 0 holddown, 0 hidden)
```

```
+ = Active Route, - = Last Active, * = Both
```

```
2001:dead:beef::/64*[Direct/0] 00:08:25
```

```
> via em0.0
```

```
2001:dead:beef::1/128
```

```
*[Local/0] 00:08:25
```

```
Local via em0.0
```

```
fe80::1/128       *[Local/0] 00:08:14
```

```
Local via em0.0
```


Smerovacia tabuľka na Cisco

```
R1#show ipv6 route
IPv6 Routing Table - 4 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
       U - Per-user Static route
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
       O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
C   2001:DEAD:BEEF::/64 [0/0]
    via ::, FastEthernet0/0
L   2001:DEAD:BEEF::2/128 [0/0]
    via ::, FastEthernet0/0
L   FE80::/10 [0/0]
    via ::, Null0
L   FF00::/8 [0/0]
    via ::, Null0
R1#
```



Pridanie Loopback rozhraní

Pridanie Loopback rozhraní

- Na každom smerovači vytvoríme 3 Loopback rozhrania
- Loopback 0.1:
 - 10.1.1.1/24
 - 2001:ACAD:1:1::1/64
 - FE80::1
- Loopback 0.1 :
 - 10.1.2.1/24
 - 2001:ACAD:1:2::1/64
 - FE80::1
- Loopback 0.1 :
 - 10.1.3.1/24
 - 2001:ACAD:1:3::1/64
 - FE80::1
- Loopback 1:
 - 10.2.1.1/24
 - 2001:ACAD:2:1::1/64
 - FE80::2
- Loopback 2:
 - 10.2.2.1/24
 - 2001:ACAD:2:2::1/64
 - FE80::2
- Loopback 3:
 - 10.2.3.1/24
 - 2001:ACAD:2:3::1/64
 - FE80::2

JunOS a Loopback rozhrania

- JunOS nepodporuje viac Loopback rozhraní na jednom boxe
 - Iba jedno jediné – lo0
- Adresa musí mať masku /32, resp. /128 (to tvrdí dokumentácia)
- Finta: dať adresy na rozhranie lo0.1

```
[edit interfaces lo0 unit 1]
root# set family inet address 10.1.1.1/24
root# set family inet6 address 2001:ACAD:1:1::1/64
root# set family inet6 address FE80::1/64

root# set family inet address 10.1.2.1/24
root# set family inet6 address 2001:ACAD:1:2::1/64
root# set family inet6 address FE80::1/64

root# set family inet address 10.1.3.1/24
root# set family inet6 address 2001:ACAD:1:3::1/64
root# set family inet6 address FE80::1/64
```

Overenie

```
root# show interfaces terse
Interface          Admin Link Proto  Local          Remote
cbp0               up   up
em0               up   up
em0.0             up   up   inet   192.168.1.1/24
                  inet6   2001:dead:beef::1/64
                  fe80::1/64
em1               up   up
...
irb               up   up
lo0              up   up
lo0.1            up   up   inet   10.1.1.1/24
                  10.1.2.1/24
                  10.1.3.1/24
                  inet6   2001:acad:1:1::1/64
                  2001:acad:1:2::1/64
                  2001:acad:1:3::1/64
                  fe80::1/64
lo0.16384         up   up   inet   127.0.0.1      --> 0/0
lo0.16385         up   up   inet   128.0.0.1      --> 0/0
                  128.0.0.4      --> 0/0
                  inet6   fe80::200:f:fc00:0
lsi              up   up
...
```

Overenie na Cisco

```
R1#show ip int br
```

Interface	IP-Address	OK?	Method	Status	Protocol
FastEthernet0/0	192.168.1.2	YES	manual	up	up
Serial0/0	unassigned	YES	unset	administratively down	down
FastEthernet0/1	unassigned	YES	manual	administratively down	down
Serial0/1	unassigned	YES	unset	administratively down	down
Loopback1	10.2.1.1	YES	manual	up	up
Loopback2	10.2.2.1	YES	manual	up	up
Loopback3	10.2.3.1	YES	manual	up	up

```
R1#show ipv6 interface brief
```

```
FastEthernet0/0      [up/up]
  FE80::2
  2001:DEAD:BEEF::2
Loopback1            [up/up]
  FE80::2
  2001:ACAD:2:1::1
Loopback2            [up/up]
  FE80::2
  2001:ACAD:2:2::1
Loopback3            [up/up]
  FE80::2
  2001:ACAD:2:3::1
```

Smerovacia tabuľka JunOS (prvá časť)

```
root> show route
```

```
inet.0: 8 destinations, 8 routes (8 active, 0 holddown, 0 hidden)
```

```
+ = Active Route, - = Last Active, * = Both
```

```
10.1.1.0/24      *[Direct/0] 00:06:26  
                 > via lo0.1
```

```
10.1.1.1/32     *[Local/0] 00:06:26  
                Local via lo0.1
```

```
10.1.2.0/24     *[Direct/0] 00:06:26  
                 > via lo0.1
```

```
10.1.2.1/32     *[Local/0] 00:06:26  
                Local via lo0.1
```

```
10.1.3.0/24     *[Direct/0] 00:06:26  
                 > via lo0.1
```

```
10.1.3.1/32     *[Local/0] 00:06:26  
                Local via lo0.1
```

```
192.168.1.0/24  *[Direct/0] 00:06:26  
                 > via em0.0
```

```
192.168.1.1/32  *[Local/0] 00:06:26  
                Local via em0.0
```


Smerovacia tabuľka JunOS (druhá časť)

```
inet6.0: 9 destinations, 9 routes (9 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both
```

```
2001:acad:1:1::/64 *[Direct/0] 00:06:26
> via lo0.1
```

```
2001:acad:1:1::1/128
*[Local/0] 00:06:26
Local via lo0.1
```

```
2001:acad:1:2::/64 *[Direct/0] 00:06:26
> via lo0.1
```

```
2001:acad:1:2::1/128
*[Local/0] 00:06:26
Local via lo0.1
```

```
2001:acad:1:3::/64 *[Direct/0] 00:06:26
> via lo0.1
```

```
2001:acad:1:3::1/128
*[Local/0] 00:06:26
Local via lo0.1
```

```
2001:dead:beef::/64*[Direct/0] 00:06:26
> via em0.0
```

```
2001:dead:beef::1/128
*[Local/0] 00:06:26
Local via em0.0
```

```
fe80::1/128
*[Local/0] 00:06:26
Local
```

```
root>
```

Smerovacia tabuľka Cisco IOS

```
R1#sh ip route
```

```
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
```

```
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
```

```
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
```

```
       E1 - OSPF external type 1, E2 - OSPF external type 2
```

```
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
```

```
       ia - IS-IS inter area, * - candidate default, U - per-user static route
```

```
       o - ODR, P - periodic downloaded static route
```

```
Gateway of last resort is not set
```

```
    10.0.0.0/24 is subnetted, 3 subnets
```

```
C      10.2.1.0 is directly connected, Loopback1
```

```
C      10.2.2.0 is directly connected, Loopback2
```

```
C      10.2.3.0 is directly connected, Loopback3
```

```
C    192.168.1.0/24 is directly connected, FastEthernet0/0
```

```
R1#
```

Smerovacia tabuľka Cisco IOS

```
R1#show ipv6 route
IPv6 Routing Table - 10 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
       U - Per-user Static route
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
       O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
C 2001:ACAD:2:1::/64 [0/0]
  via ::, Loopback1
L 2001:ACAD:2:1::1/128 [0/0]
  via ::, Loopback1
C 2001:ACAD:2:2::/64 [0/0]
  via ::, Loopback2
L 2001:ACAD:2:2::1/128 [0/0]
  via ::, Loopback2
C 2001:ACAD:2:3::/64 [0/0]
  via ::, Loopback3
L 2001:ACAD:2:3::1/128 [0/0]
  via ::, Loopback3
C 2001:DEAD:BEEF::/64 [0/0]
  via ::, FastEthernet0/0
L 2001:DEAD:BEEF::2/128 [0/0]
  via ::, FastEthernet0/0
L FE80::/10 [0/0]
  via ::, Null0
L FF00::/8 [0/0]
  via ::, Null0
```



Statické smerovanie

Statické smerovanie IPv4

- Definícia pomocou routing-options
- Len cez IP next-hop, rozhranie si priradí sám

```
[edit]  
root# set routing-options static route 0.0.0.0/0 next-hop 10.6.7.1
```

```
root> show route  
  
inet.0: 4 destinations, 4 routes (4 active, 0 holddown, 0 hidden)  
+ = Active Route, - = Last Active, * = Both  
  
0.0.0.0/0          *[Static/5] 00:05:07  
                  > to 10.6.7.1 via em1.0
```

Statické smerovanie IPv6

- Definícia pomocou routing-options, cez **rib inet6.0**
- Len cez IP next-hop, rozhranie si priradí sám

```
[edit]
root# set routing-options rib inet6.0 static route ::/0 next-hop 2001:db8::1
```

```
root> show route

inet6.0: 9 destinations, 9 routes (9 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both

::/0                *[Static/5] 00:27:46
                    > to 2001:db8::1 via em0.0
```



OSPFv2 – single area

Router ID

- Nenastavuje sa v jednotlivých procesoch, ale pre smerovač ako celok
- Pre všetky procesy rovnaké
 - Pre OSPF je možný len jeden proces
 - Konfiguruje sa bez čísla

```
[edit]  
root# set routing-options router-id 1.1.1.1
```

Pridanie rozhrania

- Príkaz „network“ neexistuje
 - Jediná možnosť je pridať celé rozhranie
- Oblasť sa zapisuje ako 4-miestne číslo

```
[edit]  
root# set protocols ospf area 0.0.0.0 interface em0
```

Konfigurácia Cisco IOS

```
R1(config)#router ospf 1
R1(config-router)#router-id 2.2.2.2
R1(config-router)#exit

R1(config)#interface FastEthernet0/0
R1(config-if)#ip ospf 1 area 0
R1(config-if)#
```

Overenie rozhraní

```
root# show ospf interface
```

Interface	State	Area	DR ID	BDR ID	Nbrs
em0.0	DR	0.0.0.0	1.1.1.1	2.2.2.2	1

```
root#
```

```
R1#show ip ospf interface brief
```

Interface	PID	Area	IP Address/Mask	Cost	State	Nbrs	F/C
Fa0/0	1	0	192.168.1.2/24	10	BDR	1/1	

```
R1#
```

Overenie susedov

```
root# show ospf neighbor
Address          Interface          State      ID              Pri  Dead
192.168.1.2     em0.0             Full      2.2.2.2        1   30

root#
```

```
R1#show ip ospf neighbor

Neighbor ID      Pri   State           Dead Time      Address         Interface
1.1.1.1         128   FULL/DR         00:00:34      192.168.1.1    FastEthernet0/0
R1#
```



OSPFv2 – multi area

Pridanie rozhrania

- Do oblasti 1 pridáme loopback rozhrania

```
[edit]  
root# set protocols ospf area 1 interface lo0.1 passive
```

Konfigurácia Cisco IOS

```
R1(config)#interface range loopback 1 - 3
R1(config-if-range)#ip ospf 1 area 1
R1(config-if-range)#exit

R1(config)#router ospf 1
R1(config-router)#passive-interface loopback 1
R1(config-router)#passive-interface loopback 2
R1(config-router)#passive-interface loopback 3
```


Overenie rozhraní

```
root# show ospf interface
```

Interface	State	Area	DR ID	BDR ID	Nbrs
em0.0	DR	0.0.0.0	1.1.1.1	2.2.2.2	1

```
root#
```

```
R1#show ip ospf interface brief
```

Interface	PID	Area	IP Address/Mask	Cost	State	Nbrs	F/C
Fa0/0	1	0	192.168.1.2/24	10	BDR	1/1	
Lo1	1	1	10.2.1.1/24	1	LOOP	0/0	
Lo2	1	1	10.2.2.1/24	1	LOOP	0/0	
Lo3	1	1	10.2.3.1/24	1	LOOP	0/0	

```
R1#
```

Overenie smerovacej tabuľky

```
root> show route protocol ospf
```

```
inet.0: 12 destinations, 12 routes (12 active, 0 holddown, 0 hidden)
```

```
+ = Active Route, - = Last Active, * = Both
```

```
10.2.1.1/32      *[OSPF/10] 00:01:38, metric 2  
                 > to 192.168.1.2 via em0.0
```

```
10.2.2.1/32      *[OSPF/10] 00:01:38, metric 2  
                 > to 192.168.1.2 via em0.0
```

```
10.2.3.1/32      *[OSPF/10] 00:01:38, metric 2  
                 > to 192.168.1.2 via em0.0
```

```
224.0.0.5/32     *[OSPF/10] 00:42:08, metric 1  
                 MultiRecv
```

```
R1#show ip route ospf
```

```
10.0.0.0/8 is variably subnetted, 9 subnets, 2 masks
```

```
0 IA 10.1.3.0/24 [110/10] via 192.168.1.1, 00:00:39, FastEthernet0/0
```

```
0 IA 10.1.2.1/32 [110/10] via 192.168.1.1, 00:00:39, FastEthernet0/0
```

```
0 IA 10.1.3.1/32 [110/10] via 192.168.1.1, 00:00:39, FastEthernet0/0
```

```
0 IA 10.1.2.0/24 [110/10] via 192.168.1.1, 00:00:39, FastEthernet0/0
```

```
0 IA 10.1.1.0/24 [110/10] via 192.168.1.1, 00:00:39, FastEthernet0/0
```

```
0 IA 10.1.1.1/32 [110/10] via 192.168.1.1, 00:00:39, FastEthernet0/0
```

```
R1#
```

Nastavenie typu rozhrania

```
[edit]  
root# set protocols ospf area 1 interface lo0.1 interface-type p2p
```

```
R1(config)#interface range loopback 1 - 3  
R1(config-if-range)#ip ospf network point-to-point
```

Overenie smerovacej tabuľky

```
root> show route protocol ospf
inet.0: 12 destinations, 15 routes (12 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both
```

```
10.2.1.0/24      *[OSPF/10] 00:01:33, metric 2
                 > to 192.168.1.2 via em0.0
10.2.2.0/24      *[OSPF/10] 00:01:33, metric 2
                 > to 192.168.1.2 via em0.0
10.2.3.0/24      *[OSPF/10] 00:01:33, metric 2
                 > to 192.168.1.2 via em0.0
224.0.0.5/32     *[OSPF/10] 00:46:12, metric 1
                 MultiRecv
```

```
R1#show ip route ospf
    10.0.0.0/8 is variably subnetted, 9 subnets, 2 masks
O IA   10.1.3.0/24 [110/10] via 192.168.1.1, 00:00:39, FastEthernet0/0
O IA   10.1.2.0/24 [110/10] via 192.168.1.1, 00:00:39, FastEthernet0/0
O IA   10.1.1.0/24 [110/10] via 192.168.1.1, 00:00:39, FastEthernet0/0
R1#
```



OSPFv2 – databázy

OSPF databáza na JunOS

```
root> show ospf database
```

```
OSPF database, Area 0.0.0.0
```

Type	ID	Adv Rtr	Seq	Age	Opt	Cksum	Len
Router	*1.1.1.1	1.1.1.1	0x80000007	472	0x22	0x89c2	36
Router	2.2.2.2	2.2.2.2	0x80000004	206	0x22	0xf349	36
Network	192.168.1.2	2.2.2.2	0x80000001	473	0x22	0x9b0	32
Summary	*10.1.1.0	1.1.1.1	0x80000003	572	0x22	0xcd5d	28
Summary	*10.1.2.0	1.1.1.1	0x80000003	122	0x22	0xc267	28
Summary	*10.1.3.0	1.1.1.1	0x80000002	472	0x22	0xb970	28
Summary	10.2.1.0	2.2.2.2	0x80000001	219	0x22	0xb175	28
Summary	10.2.2.0	2.2.2.2	0x80000001	219	0x22	0xa67f	28
Summary	10.2.3.0	2.2.2.2	0x80000001	219	0x22	0x9b89	28

```
OSPF database, Area 0.0.0.1
```

Type	ID	Adv Rtr	Seq	Age	Opt	Cksum	Len
Router	*1.1.1.1	1.1.1.1	0x80000006	233	0x22	0x7766	60
Summary	*10.2.1.0	1.1.1.1	0x80000001	218	0x22	0xd950	28
Summary	*10.2.2.0	1.1.1.1	0x80000001	218	0x22	0xce5a	28
Summary	*10.2.3.0	1.1.1.1	0x80000001	218	0x22	0xc364	28
Summary	*192.168.1.0	1.1.1.1	0x80000003	467	0x22	0xb417	28

OSPF databáza na Cisco IOS

```
R1#show ip ospf database
```

```
OSPF Router with ID (2.2.2.2) (Process ID 1)
```

```
Router Link States (Area 0)
```

Link ID	ADV Router	Age	Seq#	Checksum	Link count
1.1.1.1	1.1.1.1	363	0x80000007	0x0089C2	1
2.2.2.2	2.2.2.2	177	0x80000004	0x00F349	1

```
Net Link States (Area 0)
```

Link ID	ADV Router	Age	Seq#	Checksum
192.168.1.2	2.2.2.2	362	0x80000001	0x0009B0

```
Summary Net Link States (Area 0)
```

Link ID	ADV Router	Age	Seq#	Checksum
10.1.1.0	1.1.1.1	431	0x80000003	0x00CD5D
10.1.2.0	1.1.1.1	122	0x80000003	0x00C267
10.1.3.0	1.1.1.1	363	0x80000002	0x00B970
10.2.1.0	2.2.2.2	186	0x80000001	0x00B175
10.2.2.0	2.2.2.2	186	0x80000001	0x00A67F
10.2.3.0	2.2.2.2	186	0x80000001	0x009B89

```
Router Link States (Area 1)
```

Link ID	ADV Router	Age	Seq#	Checksum	Link count
2.2.2.2	2.2.2.2	191	0x80000005	0x00F3DC	3

```
Summary Net Link States (Area 1)
```

Link ID	ADV Router	Age	Seq#	Checksum
10.1.1.0	2.2.2.2	849	0x80000001	0x001807
10.1.2.0	2.2.2.2	849	0x80000001	0x000D11
10.1.3.0	2.2.2.2	359	0x80000001	0x00021B
192.168.1.0	2.2.2.2	849	0x80000001	0x00F4CB



OSPFv3 – single area

Pridanie rozhrania

- Na JunOS Router-ID už máme

```
[edit]  
root# set protocols ospf3 area 0.0.0.0 interface em0
```

```
R1(config)#ipv6 router ospf 1  
R1(config-rtr)#router-id 2.2.2.2  
R1(config-rtr)#exit  
  
R1(config)#interface fastEthernet 0/0  
R1(config-if)#ipv6 ospf 1 area 0
```

Overenie rozhraní

```
root> show ospf3 interface
```

Interface	State	Area	DR ID	BDR ID	Nbrs
em0.0	DR	0.0.0.0	1.1.1.1	2.2.2.2	1

```
root>
```

```
R1#show ipv6 ospf interface brief
```

Interface	PID	Area	Intf ID	Cost	State	Nbrs	F/C
Fa0/0	1	0	4	10	BDR	1/1	

```
R1#
```

Overenie susedov

```
root> show ospf3 neighbor
ID                Interface          State    Pri    Dead
2.2.2.2          em0.0             Full     1      37
  Neighbor-address fe80::2

root>
```

```
R1#show ipv6 ospf neighbor

Neighbor ID      Pri    State           Dead Time    Interface ID  Interface
1.1.1.1         128    FULL/DR         00:00:35    1             FastEthernet0/0
R1#
```



OSPFv2 – multi area

Pridanie rozhrania

- Do oblasti 1 pridáme loopback rozhrania

```
[edit]  
root# set protocols ospf3 area 1 interface lo0.1 passive
```

Konfigurácia Cisco IOS

```
R1(config)#interface range loopback 1 - 3
R1(config-if-range)#ipv6 ospf 1 area 1
R1(config-if-range)#exit

R1(config)#ipv6 router ospf 1
R1(config-router)#passive-interface loopback 1
R1(config-router)#passive-interface loopback 2
R1(config-router)#passive-interface loopback 3
```

Overenie rozhraní

```
root> show ospf3 interface
```

Interface	State	Area	DR ID	BDR ID	Nbrs
em0.0	DR	0.0.0.0	1.1.1.1	2.2.2.2	1
lo0.1	DRother	0.0.0.1	0.0.0.0	0.0.0.0	0

```
root>
```

```
R1#show ipv6 ospf interface brief
```

Interface	PID	Area	Intf ID	Cost	State	Nbrs	F/C
Fa0/0	1	0	4	10	BDR	1/1	
Lo1	1	1	13	1	LOOP	0/0	
Lo2	1	1	14	1	LOOP	0/0	
Lo3	1	1	15	1	LOOP	0/0	

```
R1#
```

Overenie smerovacej tabuľky - JunOS

```
root> show route protocol ospf3

inet.0: 12 destinations, 15 routes (12 active, 0 holddown, 0 hidden)

inet6.0: 13 destinations, 13 routes (13 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both

2001:acad:2:1::1/128
    *[OSPF3/10] 00:03:46, metric 1
    > to fe80::2 via em0.0
2001:acad:2:2::1/128
    *[OSPF3/10] 00:03:46, metric 1
    > to fe80::2 via em0.0
2001:acad:2:3::1/128
    *[OSPF3/10] 00:03:46, metric 1
    > to fe80::2 via em0.0
ff02::5/128
    *[OSPF3/10] 00:11:27, metric 1
    MultiRecv

root>
```


Overenie smerovacej tabuľky – Cisco IOS

```
R1#show ipv6 route ospf
IPv6 Routing Table - 16 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
       U - Per-user Static route
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
       O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
OI 2001:ACAD:1:1::/64 [110/10]
   via FE80::1, FastEthernet0/0
OI 2001:ACAD:1:1::1/128 [110/10]
   via FE80::1, FastEthernet0/0
OI 2001:ACAD:1:2::/64 [110/10]
   via FE80::1, FastEthernet0/0
OI 2001:ACAD:1:2::1/128 [110/10]
   via FE80::1, FastEthernet0/0
OI 2001:ACAD:1:3::/64 [110/10]
   via FE80::1, FastEthernet0/0
OI 2001:ACAD:1:3::1/128 [110/10]
   via FE80::1, FastEthernet0/0
R1#
```

Nastavenie typu rozhrania

```
[edit]  
root# set protocols ospf3 area 1 interface lo0.1 interface-type p2p
```

```
R1(config)#interface range loopback 1 - 3  
R1(config-if-range)#ipv6 ospf network point-to-point
```

Overenie smerovacej tabuľky - JunOS

```
root> show route protocol ospf3
```

```
inet.0: 12 destinations, 15 routes (12 active, 0 holddown, 0 hidden)
```

```
inet6.0: 13 destinations, 16 routes (13 active, 0 holddown, 0 hidden)
```

```
+ = Active Route, - = Last Active, * = Both
```

```
2001:acad:1:1::/64 [OSPF3/10] 00:02:00, metric 0
```

```
> via lo0.1
```

```
2001:acad:1:2::/64 [OSPF3/10] 00:02:00, metric 0
```

```
> via lo0.1
```

```
2001:acad:1:3::/64 [OSPF3/10] 00:02:00, metric 0
```

```
> via lo0.1
```

```
2001:acad:2:1::/64 *[OSPF3/10] 00:01:44, metric 2
```

```
> to fe80::2 via em0.0
```

```
2001:acad:2:2::/64 *[OSPF3/10] 00:01:44, metric 2
```

```
> to fe80::2 via em0.0
```

```
2001:acad:2:3::/64 *[OSPF3/10] 00:01:44, metric 2
```

```
> to fe80::2 via em0.0
```

```
ff02::5/128 *[OSPF3/10] 00:14:49, metric 1
```

```
MultiRecv
```

```
root>
```

Overenie smerovacej tabuľky – Cisco IOS

```
R1#show ipv6 route ospf
IPv6 Routing Table - 13 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
       U - Per-user Static route
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
       O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
OI 2001:ACAD:1:1::/64 [110/10]
    via FE80::1, FastEthernet0/0
OI 2001:ACAD:1:2::/64 [110/10]
    via FE80::1, FastEthernet0/0
OI 2001:ACAD:1:3::/64 [110/10]
    via FE80::1, FastEthernet0/0
R1#
```



Access list

Schéma ACL

```
firewall {
  family family-name {          # any, inet, inet6, ...
    filter filter-name {
      term term-name {
        from {
          match-conditions;
        }
        then {
          actions;
        }
      }
      term term-name {
        from {
          match-conditions;
        }
        then {
          actions;
        }
      }
      ...
    }
  }
}
```

Príklad IPv4 ACL

```
firewall {  
  family inet {  
    filter Povol-len-UNIZA {  
      term Povol-UNIZA {  
        from {  
          address 158.193.0.0/16  
        }  
        then {  
          accept;  
        }  
      }  
      term Zakaz-ostatne {  
        then {  
          reject;  
        }  
      }  
    }  
  }  
}
```

Pridanie rozhrania

- Rovnako ako na Cisco zariadeniach
 - 1 ACL per
 - Port
 - Smer
 - Adresovú rodinu

```
set interfaces em1 unit 0 family inet filter output Povol-len-UNIZA
```




UNIVERSITY OF ŽILINA
Faculty of Management Science
and Informatics

Ďakujem za pozornosť.



■ Vytvorené v rámci projektu KEGA 026TUKE-4/2021