MINISTERSTVO ŠKOLSTVA, VEDY, VÝSKUMU A ŠPORTU SLOVENSKEJ REPUBLIKY

Mikrotik

Katedra informačných sietí
Fakulta riadenia a informatiky, ŽU

Agenda

- Predstavenie spoločnosti Mikrotik
- Zoznámenie sa s hardvérom
- Predstavenie RouterOS
- CLI na RouterOS

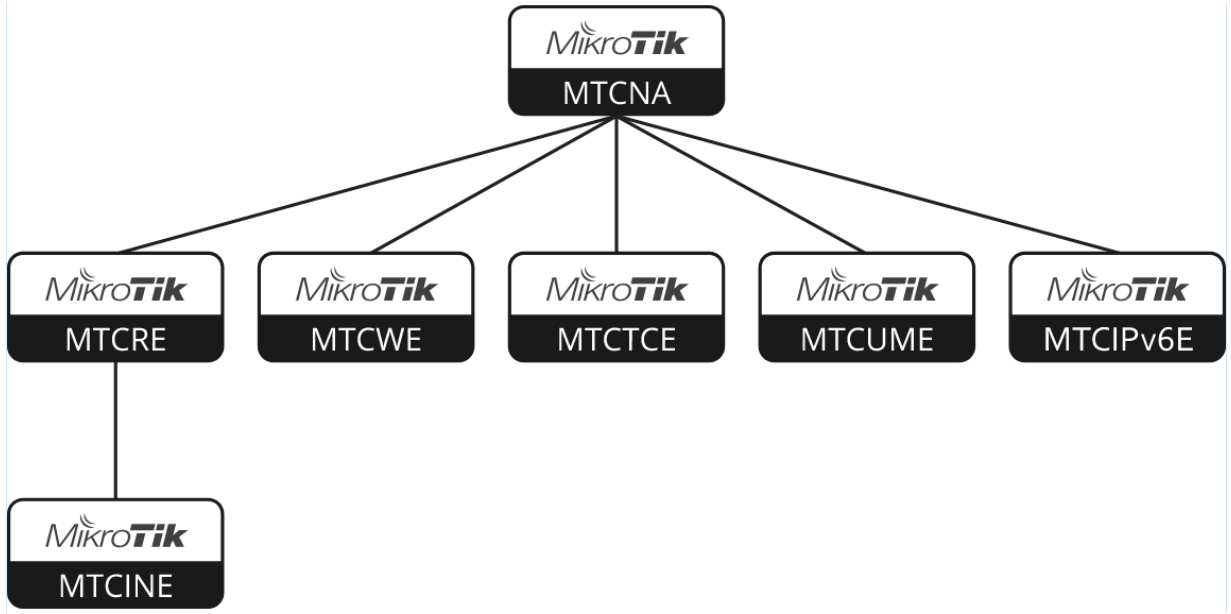
Mikrotik

História

- Založenie v 1996
- Sídlo: Riga, Litva
- Riešenia pre bezdrôtových ISP
- 1997
  - RouterOS pre routre postavené na Intel (PC) platforme
- 2002
  - vlastné hardvérové riešenia s názvom RouterBOARD

Mikrotik akadémia

- Podobné ako Cisco Netacad
- Certifikácie rozdelené do úrovní
- MTCNA
  - Zamerané na základné sieťové technológie
  - Routing, Bridge, DHCP, Firewall, NAT, WiFi, QoS, Tunnel(PPPoE), monitoring
  - Prezentované na RouterOS
  - Nie tak do detailov ako CCNA
- Mikrotik akadémia na Uniza
  - Elektrotechnická fakulta

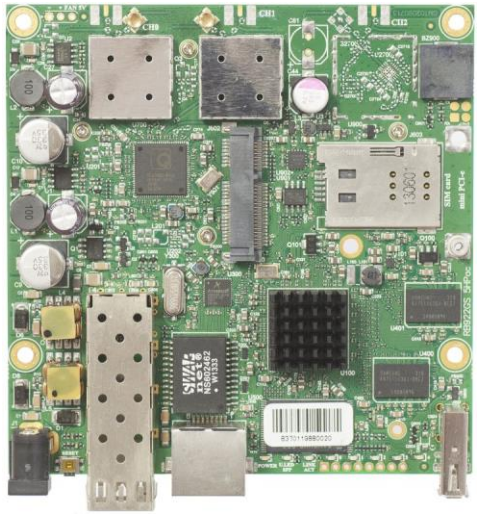


Bezdrôtové zariadenia pre ISP

- Spoje bod-bod
- AP a viacerí klienti
- Samostatné dosky bez obalu
  - RouterBOARD

- Nelicencované pásmo
  - 2,4GHz, 5GHz, 60GHz
- Licencované pásmo

- Využívané lokálnymi ISP:
  - Bluenet, WCOM...



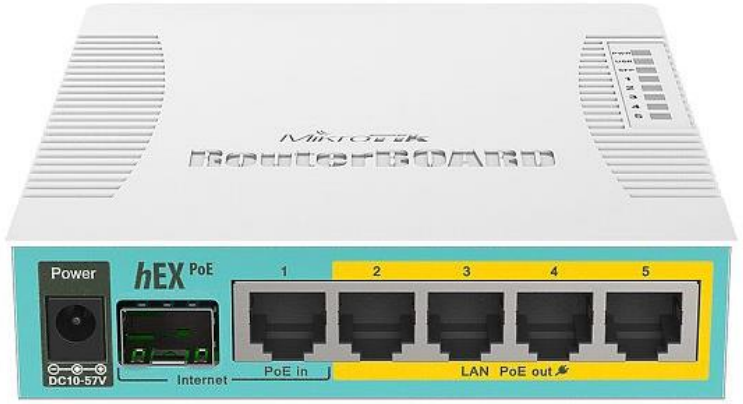
Kombinované zariadenia pre domácnosti

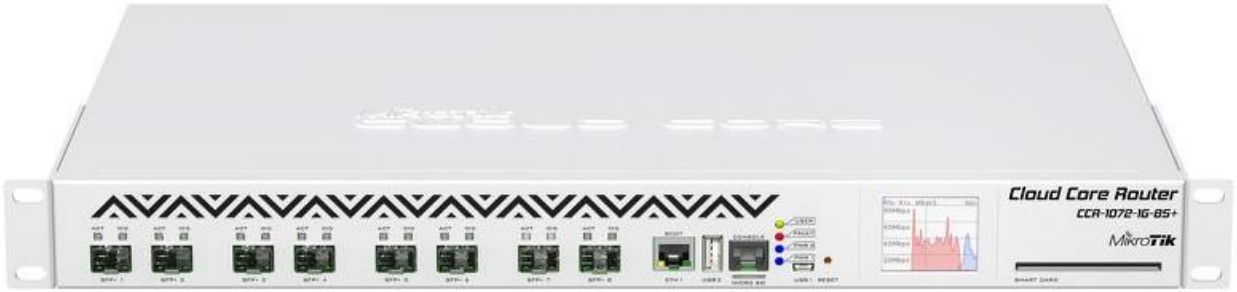
- Domáci bezdrôtový router (router+switch+WiFi)
- 100M/1G porty
- 2,4 alebo 5GHz WiFi
- WiFi AC štandard
- SFP

- Samostatné WiFi access pointy
  - Vnútorné aj vonkajšie

Routre

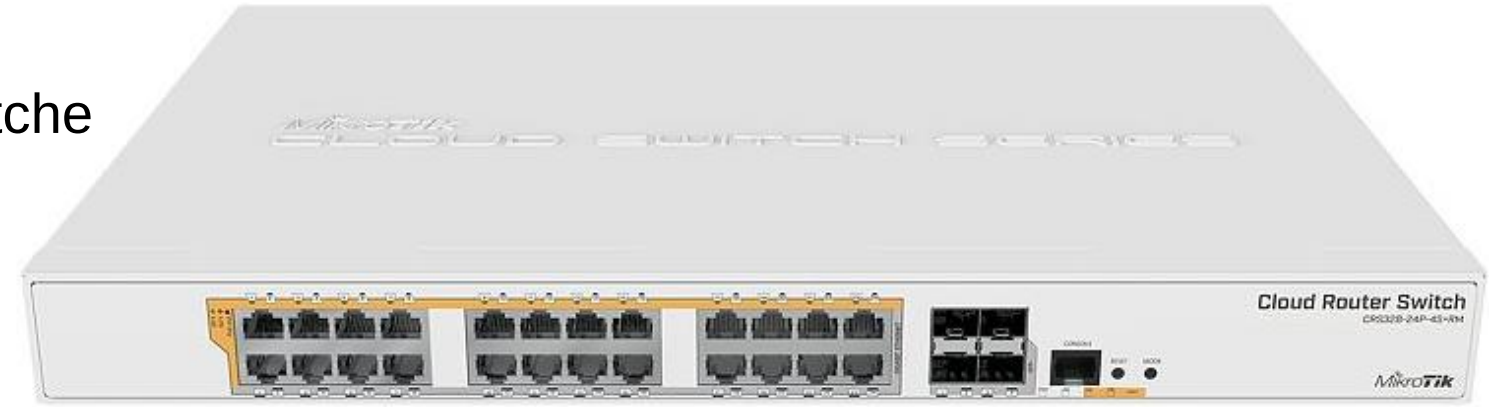
- 5 portové (100M/1G) routre aj s PoE pre domácnosti a malé firmy
- Rack modely 1G s SFP
- Core routre pre stredné firmy s 10G portami





Switche

- SwOS aj RouterOS
- 5 portové (100M/1G) routre aj s PoE pre domácnosti a malé firmy
- 24 portové 1G rack modely s 10GE uplinkmi
- 16 portové 10GE distribučné switche



RouterOS

RouterOS

- Uzavretý OS pre sieťové zariadenia
- Linux kernel v3.3.5
- Podpora množstva architektúr:
  - x86, MIPS, TILE, ARM, PPC
- Minimum 32MB RAM
- L2 funkcionalita a šifrovanie (IPSec) akcelerované hardwarom
- L3 a vyššie len CPU
- Licencia súčasťou hardware alebo samostatne (x86)
- Licenčné úrovne
  - Level 3 – WiFi klient (nevie AP)
  - Level 4,5,6 – počty VPN tunelov, Hotspot klientov spravovaných AP

- Aktualizácie dostupné počas celej životnosti zariadenia priamo na stránke výrobcu

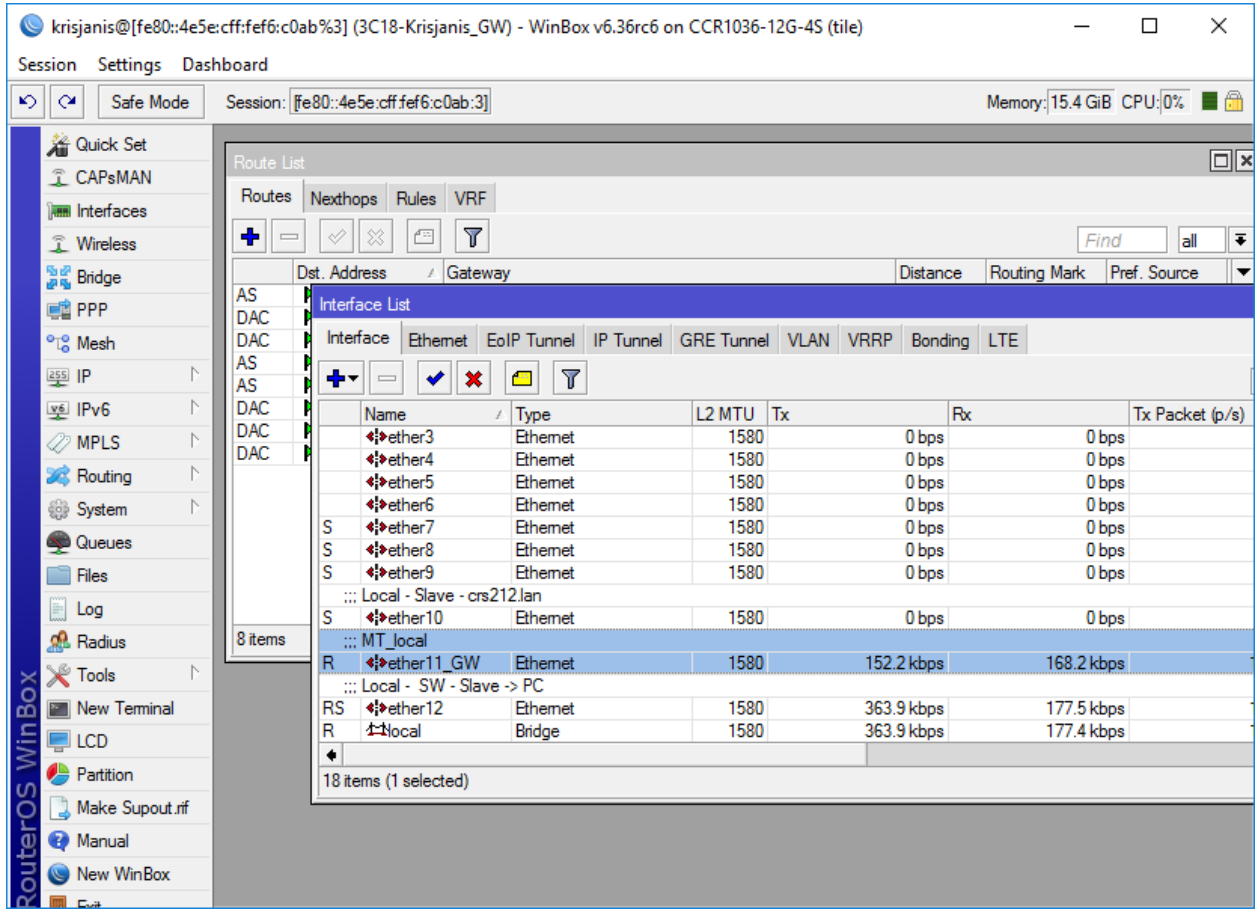
- Cloud Hosted Router (CHR)
  - RouterOS pre virtuálne stroje
  - VirtualBox, KVM, VMWare, Hyper-V, Xen
  - 64bit CPU, 128MB RAM, 128MB HDD
  - Bezplatná verzia obmedzená 1Mbps/interface
  - Všetky funkcie ako klasický RouterOS

Funkcionalita

- Firewall
  - Stavový firewall, NAT, L7 filtering
- Routing
  - Statický, RIPv1/v2, RIPng, OSPFv2/v3, BGP
  - VRF
- DHCP klient aj server
- QoS, VRRP, NTP, Dynamic DNS, OpenFlow, SNMP, RADIUS
- VPN
  - IPSec, OpenVPN, PPTP, L2TP, 6in4, 6to4
  - MPLS L3VPN, VPLS
- MPLS
- Wireless
  - WiFi 802.11 a/b/g/n/ac
  - proprietárne protokoly Nstreme, NV2
- CDP, SSH, Telnet, ping...

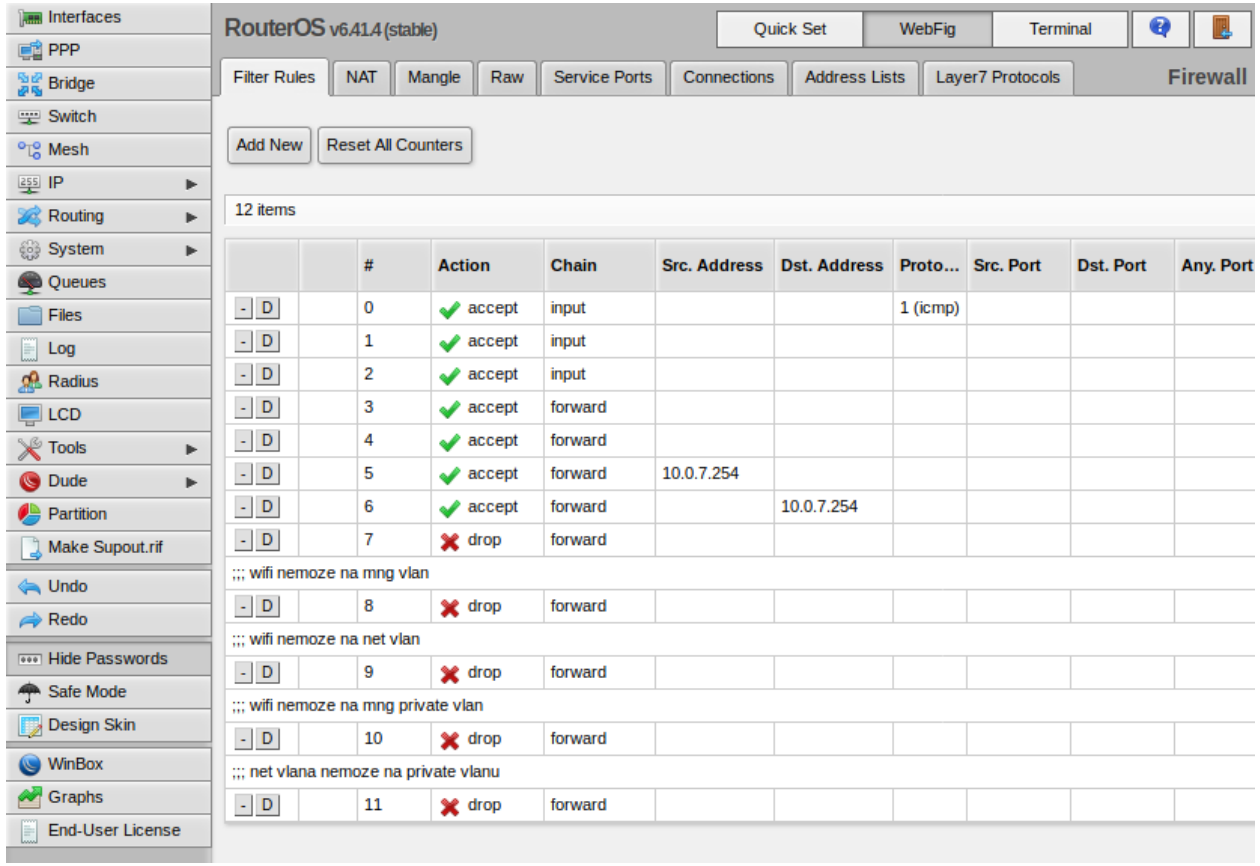
WinBox

- Windows GUI utilita na konfiguráciu
- Funguje na Linuxe pod Wine
- GUI rozčlenené logicky podľa CLI príkazov
- Vhodné na oboznámenie sa s RouterOS
- Nie všetky pokročilé funkcie dostupné
- Štandardne na porte 8291
- Podporuje pripojenie na L2



Webfig

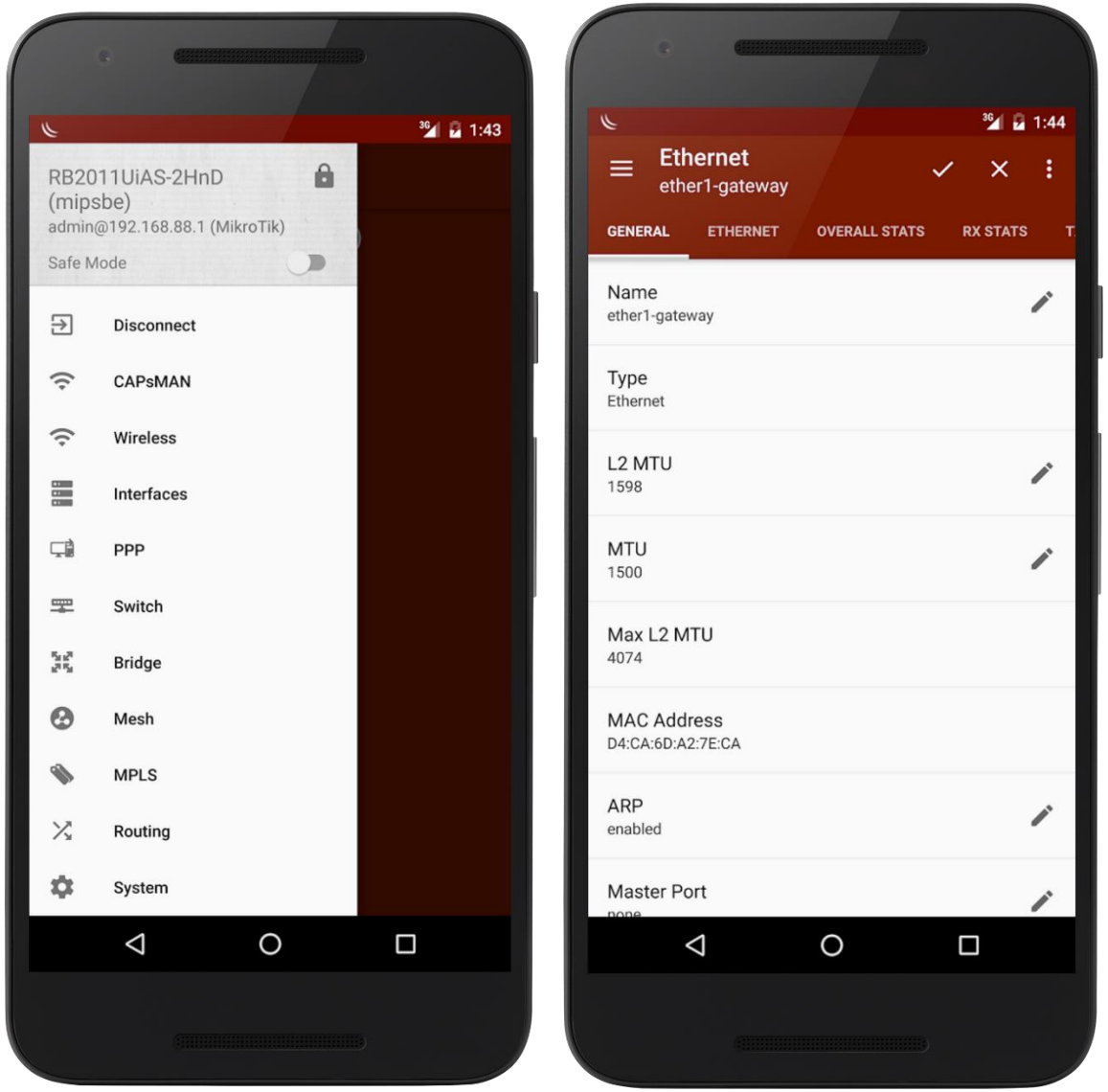
- Web utilita dostupné priamo po pripojení na port 80/443 na zariadenie
- Alternatíva ku WinBox
- Nie je potrebné nič inštalovať
- Funkcionalita oproti CLI obmedzená



TikApp a API

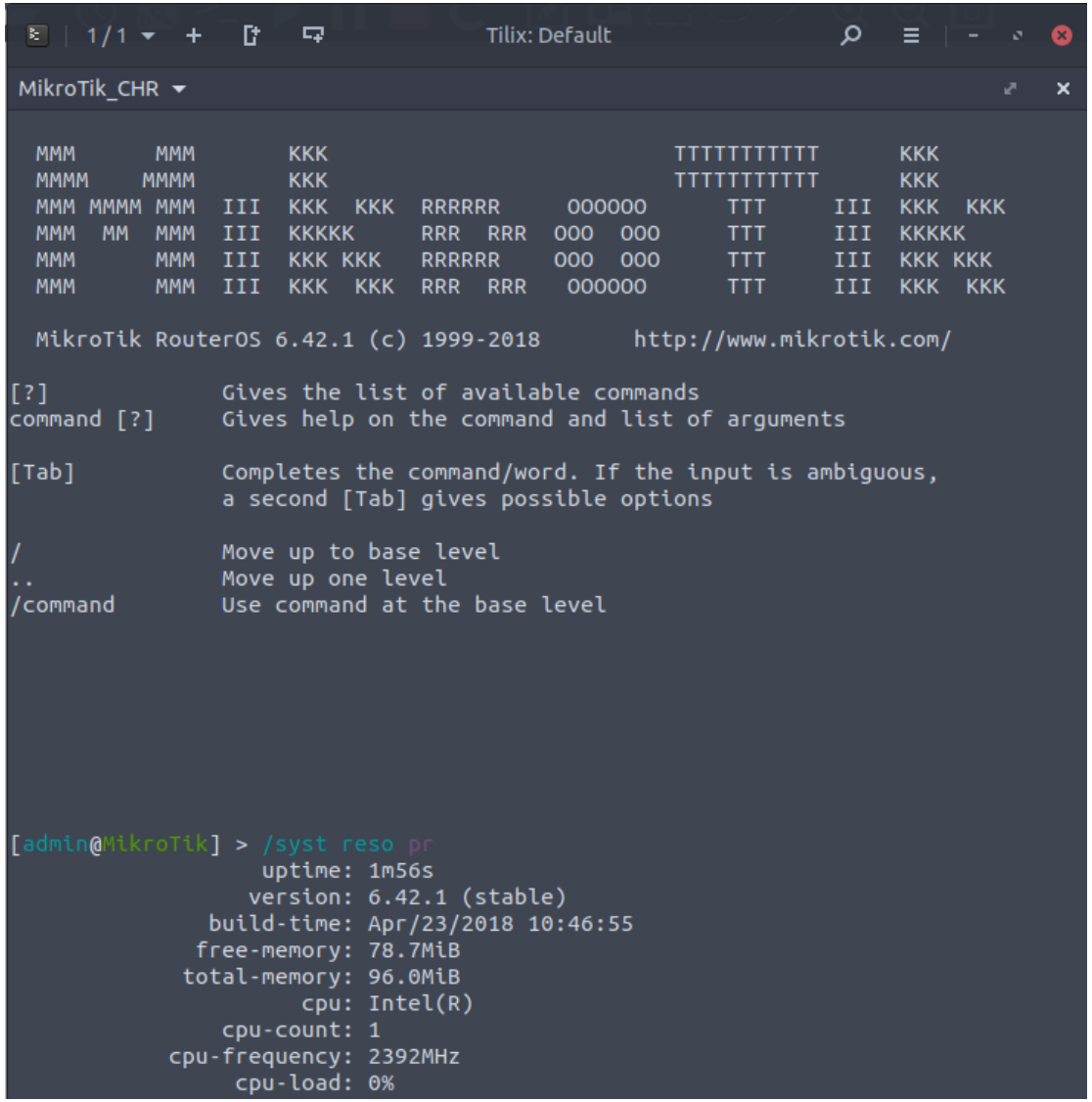
- TikApp
  - Konfiguračný nástroj pre Android
  - Stále v alpha verzii
  - Voľby rozčlenené podobne ako vo WinBox a WebFig

- API
  - Štandardne na portoch 8728 a 8729 (SSL)
  - Dostupné knižnice pre množstvo jazykov
  - Java, Python, Go, PHP...



CLI

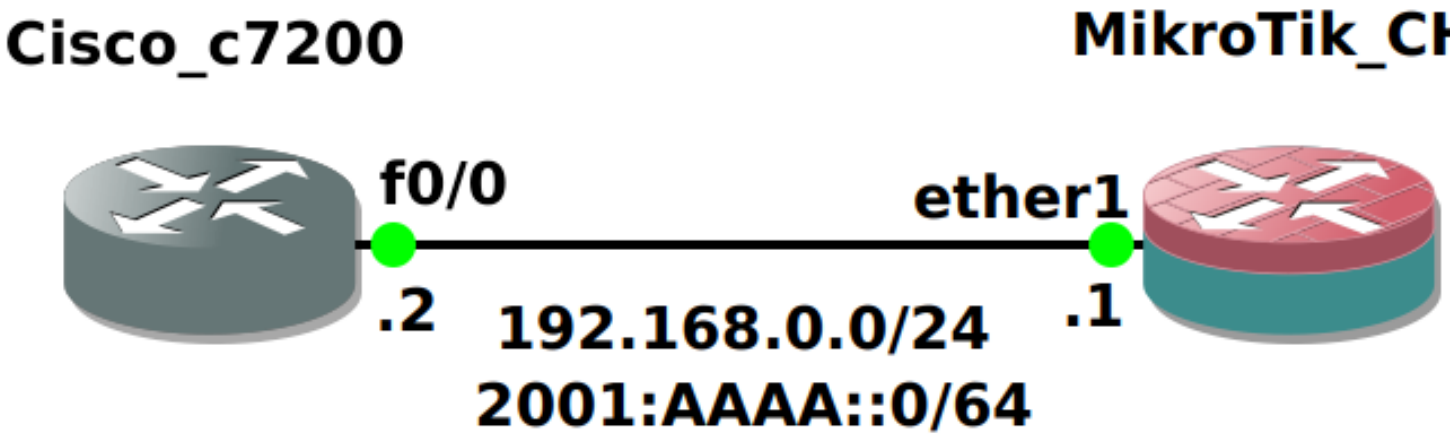
- Dostupná cez SSH, Telnet, WinBox
- Na vyšších modeloch aj RJ45 sériová konzola
- Odporúčané používať namiesto GUI utilít
- Oficiálna dokumentácia sa odkazuje len na CLI



RouterOS – základná konfigurácia

Topológia

- Cisco Catalyst 7200
  - IOS 15.2(4)M11
- Mikrotik CHR
  - RouterOS 6.42.1



lo0: 192.168.20.2/24
2001:ACAD:20::2/64
lo1: 192.168.21.2/24
2001:ACAD:21::2/64

lo0: 192.168.10.1/24
2001:ABBA:10::1/64
lo1: 192.168.11.1/24
2001:ABBA:11::1/64

Prvé pripojenie

- Pri prvom pripojení je potrebné sa prihlásiť
  - Default je admin, žiadne heslo

```
...
MikroTik 6.42.1 (stable)
MikroTik Login: admin
Password:

  MMMM    MMMM       KKK                          TTTTTTTTTTT      KKK
  MMM MMMM MMM  III  KKK  KKK  RRRRRR     OOOOOO      TTT     III  KKK  KKK
  MMM  MM  MMM  III  KKKKK     RRR  RRR  OOO  OOO     TTT     III  KKKKK
  MMM      MMM  III  KKK KKK   RRRRRR    OOO  OOO     TTT     III  KKK KKK
  MMM      MMM  III  KKK  KKK  RRR  RRR   OOOOOO      TTT     III  KKK  KKK

  MikroTik RouterOS 6.42.1 (c) 1999-2018       http://www.mikrotik.com/

[?]             Gives the list of available commands
command [?]     Gives help on the command and list of arguments

[Tab]           Completes the command/word. If the input is ambiguous,
                a second [Tab] gives possible options

/               Move up to base level
..              Move up one level
/command        Use command at the base level

[admin@MikroTik] >
```

CLI

- Na rozdiel od Cisco IOS
  - CLI nie je rozdelené do režimov
  - organizované ako stromová štruktúra
  - Nemá running a startup konfig
  - Zadané príkazy sú okamžite uložené

- /
  - interface
    - bonding
    - bridge
    - ethernet
  - ip
    - address
    - dhcp-server
    - route
    - firewall
      - nat
  - ipv6
  - log
  - routing
  - system
    - package
    - reboot

Pohyb v stromovej štruktúre

- <tab> - dopĺňa príkazy / zobrazuje možné kľúčové slová
- <enter> - vstúpi do úrovne štruktúry / spustenie príkazu
- ? – zobrazí popis príkazu
- .. – o úroveň vyššie
- / - späť do koreňa

```
[admin@MikroTik] > /ip address <tab>
add  comment  disable  edit  enable  export  find  print  remove  set
...
[admin@MikroTik] > /ip ?
.. -- go up to root
address -- Address management
dhcp-client -- DHCP client settings
dhcp-server -- DHCP server settings
firewall -- Firewall management
route -- Route management
...
[admin@MikroTik] > /ip address <enter>
[admin@MikroTik] /ip address> ..
[admin@MikroTik] /ip > ..
[admin@MikroTik] /ip address> /
[admin@MikroTik] >
```

Farby v CLI

- červená – príkaz zle zadaný
- tyrkysová – príkaz správne zadaný/menu stromu
- zelená – parametre príkazu (povinné prarametre označené tučným písmom)
- fialová – príkazy v každej úrovni stromu (add, set, enable, export...)

```
[admin@MikroTik] > /ip adress
...
[admin@MikroTik] > /ip add
...
[admin@MikroTik] > /ip address add address=192.168.10.1/24 interface=ether1
...
[admin@MikroTik] > /ip address add <tab>
broadcast  comment  copy-from  disabled  netmask  network  address  interface
...
[admin@MikroTik] > /interface <tab>
6to4              ipip          ppp-client    vlan       export
bonding           ipipv6        ppp-server    vpls       find
bridge            l2tp-client   pppoe-client  vrrp       monitor-traffic
detect-internet   l2tp-server   pppoe-server  wireless   print
eoip              list          pptp-client   blink      reset-counters
eoipv6            lte           pptp-server   comment    set
ethernet          mesh          sstp-client   disable
gre               ovpn-client   sstp-server   edit
gre6              ovpn-server   traffic-eng   enable
```

Zobrazenie konfigurácie

- `/export` – kompletná konfigurácia
- príkaz `export` v konkrétnej časti stromu – konfigurácia iba časti stromu

```
[admin@MikroTik] > /export
# may/02/2018 12:46:47 by RouterOS 6.42.1
#
/interface bridge
add name=lo0
/interface ethernet
set [ find default-name=ether2 ] name=ether1
set [ find default-name=ether1 ] name=ether2
/ip address
add address=192.168.20.1/24 interface=lo0 network=192.168.20.0
/ip dhcp-client
add disabled=no interface=ether2
/ipv6 address
add address=fd00::1 interface=lo0
...
[admin@MikroTik] > /ip address export
# may/02/2018 12:51:07 by RouterOS 6.42.1
#
/ip address
add address=192.168.20.1/24 interface=lo0 network=192.168.20.0
```

Zobrazenie používateľov a zmena hesla

- `/user print` – zobrazenie používateľov
- `/user set <meno> password=<heslo>` – zmena hesla
- už nastavené heslo nie je možné zobraziť

```
[admin@MikroTik] > /user print
Flags: X - disabled
 #   NAME              GROUP             ADDRESS           LAST-LOGGED-IN
 0   ;;; system default user
     admin             full                                may/02/2018 11:02:46
[admin@MikroTik] >

...

[admin@MikroTik] > /user set admin password=tazkeheslo
```

Zmena hostname

- `/system identity set name=<hostname>` – zmena hostname

```
[admin@MikroTik] > /system identity print
  name: MikroTik

...

[admin@MikroTik] > /system identity set name=RouterMikrotik

...

[admin@RouterMikrotik] > /system identity print
  name: RouterMikrotik
```

Zakázanie telnetu + zmena SSH portu

- `/ip service print` – ktoré služby bežia na akých portoch

```
[admin@MikroTik] > /ip service print
Flags: X - disabled, I - invalid
 #   NAME       PORT ADDRESS                                 CERTIFICATE
 0   telnet       23
 3   ssh          22
...
[admin@MikroTik] > /ip service disable telnet
[admin@MikroTik] > /ip service set ssh port=2222
...

[admin@MikroTik] > /ip service print
Flags: X - disabled, I - invalid
 #   NAME       PORT ADDRESS                                 CERTIFICATE
 0 XI telnet      23
 1   ftp          21
 2   www          80
 3   ssh        2222
```

Práca s rozhraniami

Zobrazenie zapnutie a vypnutie rozhraní

- `/interface print` – zobrazenie rozhraní
- `/interface enable <nazov>` – zapnutie rozhrania
- `/interface disable numbers=0,1` – vypnutie rozhraní s indexom 0 a 1

```
[admin@MikroTik] > /interface print
Flags: D - dynamic, X - disabled, R - running, S - slave
 #     NAME                                TYPE       ACTUAL-MTU L2MTU
 0  R  ether1                              ether            1500
 1  R  ether2                              ether            1500
...
[admin@MikroTik] > /interface disable ether1
[admin@MikroTik] > /interface disable numbers=0,1
[admin@MikroTik] > /interface enable ether2
...
[admin@MikroTik] > /interface print
Flags: D - dynamic, X - disabled, R - running, S - slave
 #     NAME                                TYPE       ACTUAL-MTU L2MTU
 0  X  ether1                              ether            1500
 1  R  ether2                              ether            1500
```

Loopback rozhranie

- RouterOS nemá samostatné loopback rozhrania
- emulácia funkcionality pridaním bridge rozhrania bez asociovania bridge portov
- `/interface bridge add name=lo0` – vytvorí bridge rozhranie s názvom lo0

```
[admin@MikroTik] > /interface bridge add name=lo0
...
[admin@MikroTik] > /interface print
Flags: D - dynamic, X - disabled, R - running, S - slave
 #     NAME                                TYPE       ACTUAL-MTU L2MTU
 0  X  ether1                              ether            1500
 1  R  ether2                              ether            1500
 2  R  lo0                                 bridge           1500 65535
...
[admin@MikroTik] > interface bridge print brief
Flags: X - disabled, R - running
 #   NAME                                              MTU ACTUAL-MTU L2MTU
 0 R lo0                                             auto       1500 65535
```

Softvérový prepínač

- na niektorých zariadeniach akcelerovaný hardvérom
- `/interface bridge add name=switch1`– vytvorí switch
- `/interface bridge port add bridge=switch1 interface=ether1` – pridá rozhranie ako port switchu

```
[admin@MikroTik] > /interface bridge add name=switch1
[admin@MikroTik] > /interface bridge port add bridge=switch1 interface=ether1
[admin@MikroTik] > /interface bridge port add bridge=switch1 interface=ether2
...
[admin@MikroTik] > /interface print
Flags: D - dynamic, X - disabled, R - running, S - slave
 #     NAME                                TYPE       ACTUAL-MTU L2MTU
 0  RS ether1                              ether            1500
 1  RS ether2                              ether            1500
 3  R  switch1                             bridge           1500 65535
```

Softvérový prepínač - VLANy

- ether1 – trunk port (native VLAN 1)
- ether2 – access port VLAN 20

```
[admin@MikroTik] > /interface bridge add name=switch1 vlan-filtering=yes
[admin@MikroTik] > /interface bridge port add bridge=switch1 interface=ether1
[admin@MikroTik] > /interface bridge port add bridge=switch1 interface=ether2 pvid=20
[admin@MikroTik] > /interface bridge vlan add bridge=switch1 tagged=ether1
untagged=ether2 vlan-ids=20
...
[admin@MikroTik] > /interface bridge vlan print
Flags: X - disabled, D - dynamic
 #   BRIDGE           VLAN-IDS  CURRENT-TAGGED         CURRENT-UNTAGGED
 0 D switch1          1                                switch1
                                                       ether1
 1   switch1          20        ether1                 ether2
```

VLAN rozhrania

- `interface fa0/1.<VLAN ID>` – na Cisco zariadení (router)
- `interface vlan <VLAN ID>` – na Cisco zariadení (switch)
- `/interface vlan add interface=<rozhranie> vlan-id=<id>` – vytvorí vlan rozhranie na rozhraní “rozhranie” s VLAN ID “id”

```
[admin@MikroTik] > /interface vlan add interface=ether1 vlan-id=10 name=ether1.10
[admin@MikroTik] > /interface vlan add interface=switch1 vlan-id=20 name=vlan20
...

[admin@MikroTik] > /interface vlan print
Flags: X - disabled, R - running, S - slave
 #    NAME                MTU ARP             VLAN-ID INTERFACE
 0 R  ether1.10          1500 enabled              10 ether1
 1 R  vlan20             1500 enabled              20 switch1
```

Etherchannel

- `/interface bonding add name=bond0 slaves=ether1,ether2 mode=802.3ad`
  - vytvorí Etherchannel rozhranie s názvom „bond0“
  - zlúči rozhrania „ether1“ a „ether2“
  - režim Etherchannelu je „802.3ad“ (LACP)

```
[admin@MikroTik] > /interface bonding add name=bond0 slaves=ether1,ether2
mode=802.3ad

...

[admin@MikroTik] > /interface bonding print
Flags: X - disabled, R - running
 0  R name="bond0" mtu=1500 mac-address=08:00:27:11:79:8A arp=enabled
      arp-timeout=auto slaves=ether1,ether2 mode=802.3ad primary=none
      link-monitoring=mii arp-interval=100ms arp-ip-targets=""
      mii-interval=100ms down-delay=0ms up-delay=0ms lacp-rate=30secs
      transmit-hash-policy=layer-2 min-links=0
```

CDP

```
[admin@MikroTik] > /ip neighbor print detail
 0 interface=ether1 address=192.168.0.2 address4=192.168.0.2
   mac-address=CA:01:23:EF:00:00 identity="Cisco_c7200"
   platform="Cisco 7206VXR"
   version="Cisco IOS Software, 7200 Software (C7200-ADVENTERPRISEK9-M),
        Version 15.2(4)M11, RELEASE SOFTWARE (fc2)\nTechnical Support:
        http://www.cisco.com/techsupport\nCopyright (c) 1986-2016 by Cisco
        Systems, Inc.\nCompiled Sun 16-Oct-16 07:53 by prod_rel_team"
   unpack=none age=27s interface-name="FastEthernet0/0" system-caps=""
   system-caps-enabled=""
```

```
Cisco_c7200#show cdp neighbors detail
-------------------------
Device ID: MikroTik
Entry address(es):
  IP address: 192.168.0.1
Platform: MikroTik,  Capabilities: Router
Interface: FastEthernet0/0,  Port ID (outgoing port): ether1
Holdtime : 112 sec

Version :
6.42.1 (stable)

advertisement version: 1
```

IPv4 adresácia

Pridanie, odobranie a zobrazenie IPv4 adries na rozhraniach

- `/ip address add address=192.168.11.1/24 interface=lo1` – pridá IP na rozhranie
- `/ip address remove numbers=2` – odobratie položky s indexom 2 s položiek IP adries

```
[admin@MikroTik] > /ip address add address=192.168.11.1/24 interface=lo1
...
[admin@MikroTik] > /ip address print
Flags: X - disabled, I - invalid, D - dynamic
 #   ADDRESS            NETWORK         INTERFACE
 0   192.168.0.1/24     192.168.0.0     ether1
 1   192.168.10.1/24    192.168.10.0    lo0
 2   192.168.11.1/24    192.168.11.0    lo1
...
[admin@MikroTik] > /ip address remove numbers=2
[admin@MikroTik] > /ip address remove [find interface=lo0]
...
[admin@MikroTik] > /ip address print
Flags: X - disabled, I - invalid, D - dynamic
 #   ADDRESS            NETWORK         INTERFACE
 0   192.168.10.1/24    192.168.10.0    lo0
 1   192.168.0.1/24     192.168.0.0     ether1
```

Cisco na druhej strane

- Zapnutie rozhrania a nastavenie IPv4 adresy

```
Cisco_c7200(config)#interface FastEthernet0/0
Cisco_c7200(config-if)#no shutdown
Cisco_c7200(config-if)#ip address 192.168.0.2 255.255.255.0
```

Overenie

```
[admin@MikroTik] > ping 192.168.0.2 count=4
  SEQ HOST                                     SIZE TTL TIME  STATUS
    0 192.168.0.2                                56 255 21ms
    1 192.168.0.2                                56 255 9ms
    2 192.168.0.2                                56 255 7ms
    3 192.168.0.2                                56 255 6ms
    sent=4 received=4 packet-loss=0% min-rtt=6ms avg-rtt=10ms max-rtt=21ms
```

```
Cisco_c7200#ping 192.168.0.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 60/63/68 ms
R1#
```

Smerovacia tabuľka RouterOS

```
[admin@MikroTik] > /ip route print
Flags: X - disabled, A - active, D - dynamic,
C - connect, S - static, r - rip, b - bgp, o - ospf, m - mme,
B - blackhole, U - unreachable, P - prohibit
 #      DST-ADDRESS        PREF-SRC        GATEWAY            DISTANCE
 0 ADC  192.168.0.0/24     192.168.0.1     ether1                    0
 1 ADC  192.168.10.0/24    192.168.10.1    lo0                       0
 2 ADC  192.168.11.0/24    192.168.11.1    lo1                       0
```

Smerovacia tabuľka Cisco

```
Cisco_c7200#show ip route
Codes: L - local, 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, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

      192.168.0.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.0.0/24 is directly connected, FastEthernet0/0
L        192.168.0.2/32 is directly connected, FastEthernet0/0
      192.168.20.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.20.0/24 is directly connected, Loopback0
L        192.168.20.2/32 is directly connected, Loopback0
      192.168.21.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.21.0/24 is directly connected, Loopback1
L        192.168.21.2/32 is directly connected, Loopback1
```

IPv6 adresácia

Povolenie IPv6

- IPv6 funkcionalita je štandardne vypnutá
- je potrebné povoliť softvérový balíček ipv6 a reštartovať zariadenie
- `/system package print` – vypíše dostupné balíčky
- `/system package enable ipv6` – povolí IPv6 balíček
- `/system reboot` – reštartuje zariadenie

```
[admin@MikroTik] > /system package print
Flags: X - disabled
 #   NAME                  VERSION                  SCHEDULED
 0   routeros-x86          6.42.1
 1   system                6.42.1
 2 X ipv6                  6.42.1
...
[admin@MikroTik] > /system package enable ipv6
...
[admin@MikroTik] > /system package print
Flags: X - disabled
 #   NAME                  VERSION                  SCHEDULED
 2 X ipv6                  6.42.1                   scheduled for enable
...
[admin@MikroTik] > /system reboot
Reboot, yes? [y/N]:
y
system will reboot shortly
```

Nastavenie a overenie IPv6 adries na rozhraniach

```
[admin@MikroTik] > /ipv6 address add address=2001:AAAA::1/64 interface=ether1
[admin@MikroTik] > /ipv6 address add address=2001:ABBA:10::1/64 interface=lo0
[admin@MikroTik] > /ipv6 address add address=2001:ABBA:11::1/64 interface=lo1

...

[admin@MikroTik] > /ipv6 address print
Flags: X - disabled, I - invalid, D - dynamic, G - global, L - link-local
 #    ADDRESS                                     FROM-...  INTERFACE        ADV
 0 DL fe80::8450:c9ff:fef0:2edc/64                          lo1              no
 1 DL fe80::50b2:b8ff:febe:429a/64                          lo0              no
 2 DL fe80::a00:27ff:fe11:798a/64                           ether1           no
 3  G 2001:aaaa::1/64                                       ether1           yes
 4  G 2001:abba:10::1/64                                    lo0              yes
 5  G 2001:abba:11::1/64                                    lo1              yes
```

Cisco na druhej strane

```
Cisco_c7200(config)#ipv6 unicast-routing
Cisco_c7200(config)#ipv6 cef
...
Cisco_c7200(config-if)#interface fastEthernet 0/0
Cisco_c7200(config-if)#ipv6 address 2001:aaaa::2/64
...
Cisco_c7200(config-if)#int loopback 0
Cisco_c7200(config-if)#ipv6 address 2001:acad:20::2/64
...
Cisco_c7200(config-if)#int loopback 1
Cisco_c7200(config-if)#ipv6 address 2001:acad:21::2/64
```

Overenie

```
[admin@MikroTik] > ping 2001:aaaa::2
  SEQ HOST                                     SIZE TTL TIME  STATUS
    0 2001:aaaa::2                               56  64 8ms   echo reply
    1 2001:aaaa::2                               56  64 7ms   echo reply
    2 2001:aaaa::2                               56  64 10ms  echo reply
    3 2001:aaaa::2                               56  64 9ms   echo reply
    4 2001:aaaa::2                               56  64 10ms  echo reply
    5 2001:aaaa::2                               56  64 9ms   echo reply
    6 2001:aaaa::2                               56  64 9ms   echo reply
    7 2001:aaaa::2                               56  64 10ms  echo reply
    8 2001:aaaa::2                               56  64 9ms   echo reply
    9 2001:aaaa::2                               56  64 8ms   echo reply
    sent=10 received=10 packet-loss=0% min-rtt=7ms avg-rtt=8ms max-rtt=10ms
```

```
Cisco_c7200#ping 2001:aaaa::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:AAAA::1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/6/8 ms
```

Smerovacia tabuľka IPv6

```
[admin@MikroTik] > /ipv6 route print
Flags: X - disabled, A - active, D - dynamic,
C - connect, S - static, r - rip, o - ospf, b - bgp, U - unreachable
 #      DST-ADDRESS                GATEWAY                    DISTANCE
 0 ADC  2001:aaaa::/64             ether1                            0
 1 ADC  2001:abba:10::/64          lo0                               0
 2 ADC  2001:abba:11::/64          lo1                               0
```

Smerovacia tabuľka na Cisco

```
Cisco_c7200#show ipv6 route
IPv6 Routing Table - default - 7 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
       H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea
       IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, l - LISP
C   2001:AAAA::/64 [0/0]
     via FastEthernet0/0, directly connected
L   2001:AAAA::2/128 [0/0]
     via FastEthernet0/0, receive
C   2001:ACAD:20::/64 [0/0]
     via Loopback0, directly connected
L   2001:ACAD:20::2/128 [0/0]
     via Loopback0, receive
C   2001:ACAD:21::/64 [0/0]
     via Loopback1, directly connected
L   2001:ACAD:21::2/128 [0/0]
     via Loopback1, receive
L   FF00::/8 [0/0]
     via Null0, receive
```

DHCP

DHCP server

- vytvorenie poolu, z ktorého sa budú IP prideľovať
- nastavenie gateway a dns servera sieti
- zapnutie dhcp servera

```
[admin@MikroTik] > /ip pool add name=dhcp1 ranges=192.168.0.10-192.168.0.20
[admin@MikroTik] > /ip dhcp-server network add address=192.168.0.0/24 gateway=19
2.168.0.1 dns-server=8.8.8.8
[admin@MikroTik] > /ip dhcp-server add name=dhcp-server1 address-pool=dhcp1
interface=ether1 disabled=no
...
[admin@MikroTik] > /ip dhcp-server print
Flags: D - dynamic, X - disabled, I - invalid
 #    NAME       INTERFACE    RELAY           ADDRESS-POOL    LEASE-TIME ADD-ARP
 0    dhcp-s...  ether1                       dhcp1           10m
[admin@MikroTik] > /ip dhcp-server network print
Flags: D - dynamic
 #   ADDRESS            GATEWAY         DNS-SERVER          WINS-SERVER     DOM
 0   192.168.0.0/24     192.168.0.1     8.8.8.8
```

DHCP server - overenie

```
[admin@MikroTik] > /ip dhcp-server lease print detail
Flags: X - disabled, R - radius, D - dynamic, B - blocked
 0 D address=192.168.0.20 mac-address=CA:01:23:EF:00:00
     client-id="cisco-ca01.23ef.0000-Fa0/0" address-lists=""
     server=dhcp-server1 dhcp-option="" status=bound expires-after=9m22s
     last-seen=38s active-address=192.168.0.20
     active-mac-address=CA:01:23:EF:00:00
     active-client-id="cisco-ca01.23ef.0000-Fa0/0" active-server=dhcp-server1
     host-name="Cisco_c7200"
```

```
*May  2 21:45:39.951: %DHCP-6-ADDRESS_ASSIGN: Interface FastEthernet0/0 assigned DHCP
address 192.168.0.20, mask 255.255.255.0, hostname Cisco_c7200

Cisco_c7200#show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
FastEthernet0/0            192.168.0.20    YES DHCP   up                    up
Loopback0                  192.168.20.2    YES manual up                    up
Loopback1                  192.168.21.2    YES manual up                    up
```

DHCP klient + overenie

```
[admin@MikroTik] > /ip dhcp-client add interface=ether1 disabled=no
...
[admin@MikroTik] > /ip dhcp-client print
Flags: X - disabled, I - invalid, D - dynamic
 #   INTERFACE           USE ADD-DEFAULT-ROUTE STATUS        ADDRESS
 0   ether1              yes yes               searching...
```

```
[admin@MikroTik] > /ip dhcp-client print
Flags: X - disabled, I - invalid, D - dynamic
 #   INTERFACE           USE ADD-DEFAULT-ROUTE STATUS        ADDRESS
 0   ether1              yes yes               bound         192.168.0.1/24
...
[admin@MikroTik] > /ip address print
Flags: X - disabled, I - invalid, D - dynamic
 #   ADDRESS             NETWORK         INTERFACE
 0   192.168.10.1/24     192.168.10.0    lo0
 1   192.168.11.1/24     192.168.11.0    lo1
 2 D 192.168.0.1/24      192.168.0.0     ether1
```

NAT

Statický NAT (preklad 1:1)

- vonkajší interface, IP – `ether1, fastEthernet0/0, 158.193.152.100`
- vnútorný interface, IP – `ether2, fastEthernet0/1, 192.168.10.254`
- na rozdiel od Cisca, musí byť IP pridaná na vonkajšom rozhraní

```
[admin@MikroTik] > /ip address add address=158.193.152.100/28 interface=ether1
[admin@MikroTik] > /ip firewall nat add chain=srcnat src-address=192.168.10.254
action=src-nat to-addresses=158.193.152.100
[admin@MikroTik] > /ip firewall nat add chain=dstnat dst-address=158.193.152.100
action=dst-nat to-addresses=192.168.10.254
```

```
Cisco_c7200(config)# interface fastEthernet0/0
Cisco_c7200(config-if)# ip nat outside
Cisco_c7200(config)# interface fastEthernet0/1
Cisco_c7200(config-if)# ip nat inside

Cisco_c7200(config)# ip nat inside source static 192.168.10.254 158.193.152.100
```

PNAT overload

- vonkajší interface – `ether1, fastEthernet0/0`
- vnútorný interface – `ether2, fastEthernet0/1`
- vnútorná sieť – 192.168.10.0/24

```
[admin@MikroTik] > /ip firewall nat add chain=srcnat src-address=192.168.10.0/24
action=masquerade out-interface=ether1
```

```
Cisco_c7200(config)# interface fastEthernet0/0
Cisco_c7200(config-if)# ip nat outside
Cisco_c7200(config)# interface fastEthernet0/1
Cisco_c7200(config-if)# ip nat inside

Cisco_c7200(config)# access-list 1 permit ip 192.168.10.0 0.0.0.255 any

Cisco_c7200(config)# ip nat inside source list 1 interface fastEthernet0/0 overload
```

Port forwarding

- vonkajší interface – `ether1, fastEthernet0/0`
- vnútorný interface – `ether2, fastEthernet0/1`
- HTTPS server IP – 192.168.10.254/24

```
[admin@MikroTik] > /ip firewall nat add chain=dstnat in-interface=ether1 dst-port=443
protocol=tcp action=dst-nat to-addresses=192.168.10.254 to-ports=443
```

```
Cisco_c7200(config)# interface fastEthernet0/0
Cisco_c7200(config-if)# ip nat outside
Cisco_c7200(config)# interface fastEthernet0/1
Cisco_c7200(config-if)# ip nat inside

Cisco_c7200(config)# ip nat inside source static tcp 192.168.10.254 443 interface
fastEthernet0/0 443
```

PPPoE

PPPoE klient

- vonkajší interface – `ether1, fastEthernet0/0`
- PPPoE interface – `WAN, Dialer1`
- `nezabudnúť pridať požadovanú formu NATu`

```
[admin@MikroTik] > /interface pppoe-client add add-default-route=yes disabled=no
allow=pap,chap interface=ether1 name=WAN password=DSLtazkeHeslo user=MojeMeno
...
[admin@MikroTik] > /ip firewall nat add chain=srcnat src-address=192.168.10.0/24
action=masquerade out-interface=WAN
```

```
Cisco_c7200(config)# interface FastEthernet 0/0
Cisco_c7200(config-if)# no ip address
Cisco_c7200(config-if)# pppoe enable
Cisco_c7200(config-if)# pppoe-client dial-pool-number 1
Cisco_c7200(config-if)# no shut
...
Cisco_c7200(config)# interface Dialer1
Cisco_c7200(config-if)# ip address negotiated
Cisco_c7200(config-if)# ip nat outside
Cisco_c7200(config-if)# encapsulation ppp
Cisco_c7200(config-if)# dialer pool 1
Cisco_c7200(config-if)# ppp authentication chap pap callin
Cisco_c7200(config-if)# ppp pap sent-username MojeMeno password DSLtazkeHeslo
Cisco_c7200(config-if)# ppp chap hostname MojeMeno
Cisco_c7200(config-if)# ppp chap password DSLtazkeHeslo
Cisco_c7200(config-if)# no shut
...
Cisco_c7200(config)# access-list 1 permit ip 192.168.10.0 0.0.0.255 any
Cisco_c7200(config)# ip nat inside source list 1 interface Dialer1 overload
```

Statický routing

Statický routing – IPv4

- dst-address = cieľová sieť
- gateway = next-hop

```
[admin@MikroTik] > /ip route add dst-address=192.168.20.0/24 gateway=192.168.0.2
```

```
[admin@MikroTik] > /ip route print
Flags: X - disabled, A - active, D - dynamic,
C - connect, S - static, r - rip, b - bgp, o - ospf, m - mme,
B - blackhole, U - unreachable, P - prohibit
 #      DST-ADDRESS        PREF-SRC        GATEWAY            DISTANCE
 0 ADC  192.168.0.0/24     192.168.0.1     ether1                    0
 1 ADC  192.168.11.0/24    192.168.11.1    lo1                       0
 2 A S  192.168.20.0/24                    192.168.0.2               1
...
[admin@MikroTik] > ping 192.168.20.2
  SEQ HOST                                     SIZE TTL TIME  STATUS
    0 192.168.20.2                               56 255 7ms
    1 192.168.20.2                               56 255 8ms
    2 192.168.20.2                               56 255 9ms
    3 192.168.20.2                               56 255 9ms
sent=4 received=4 packet-loss=0% min-rtt=7ms avg-rtt=8ms max-rtt=10ms
```

Statický routing – IPv6

- dst-address = cieľová sieť
- gateway = next-hop

```
[admin@MikroTik] > /ipv6 route add dst-address=2001:acad:20::0/64 gateway=2001:aaaa::2
```

```
[admin@MikroTik] > /ipv6 route print
Flags: X - disabled, A - active, D - dynamic,
C - connect, S - static, r - rip, o - ospf, b - bgp, U - unreachable
 #      DST-ADDRESS                GATEWAY                    DISTANCE
 0 ADC  2001:aaaa::/64             ether1                            0
 1 ADC  2001:abba:10::/64          lo0                               0
 2 ADC  2001:abba:11::/64          lo1                               0
 3 A S  2001:acad:20::/64          2001:aaaa::2                      1
...
[admin@MikroTik] > ping 2001:acad:20::2
  SEQ HOST                                     SIZE TTL TIME  STATUS
    0 2001:acad:20::2                            56  64 20ms  echo reply
    1 2001:acad:20::2                            56  64 7ms   echo reply
    2 2001:acad:20::2                            56  64 9ms   echo reply
    sent=3 received=3 packet-loss=0% min-rtt=7ms avg-rtt=12ms max-rtt=20ms
```

OSPFv2 – single area

Pridanie inštancie

- Router ID sa nastavuje pre každú inštanciu zvlášť
- RouterOS obsahuje štandardne vypnutú inštanciu „default“, ktorú nie je možné zmazať
- meno OSPF inštancie je lokálne podobne ako číslo procesu na Cisco routroch

```
[admin@MikroTik] > /routing ospf instance set default router-id=192.168.10.1
disabled=no
```

```
[admin@MikroTik] > /routing ospf instance print
Flags: X - disabled, * - default
 0 X* name="default" router-id=0.0.0.0 distribute-default=never
      redistribute-connected=no redistribute-static=no redistribute-rip=no
      redistribute-bgp=no redistribute-other-ospf=no metric-default=1
      metric-connected=20 metric-static=20 metric-rip=20 metric-bgp=auto
      metric-other-ospf=auto in-filter=ospf-in out-filter=ospf-out
...
[admin@MikroTik] > /routing ospf instance print
Flags: X - disabled, * - default
 0  * name="default" router-id=192.168.10.1 distribute-default=never
      redistribute-connected=no redistribute-static=no redistribute-rip=no
      redistribute-bgp=no redistribute-other-ospf=no metric-default=1
      metric-connected=20 metric-static=20 metric-rip=20 metric-bgp=auto
      metric-other-ospf=auto in-filter=ospf-in out-filter=ospf-out
```

Pridanie rozhrania

- Rozhranie sa pridá do OSPF pomocou príkazu network
- Oblasť sa identifikuje menom, area 0 (0.0.0.0) má štandardne meno backbone

```
[admin@MikroTik] > /routing ospf network add network=192.168.0.0/24 area=backbone
```

```
[admin@MikroTik] > /routing ospf area print
Flags: X - disabled, I - invalid, * - default
 #    NAME                                AREA-ID         TYPE    DEFAULT-COST
 0  * backbone                            0.0.0.0         default
...
[admin@MikroTik] > /routing ospf network print
Flags: X - disabled, I - invalid
 #   NETWORK            AREA
 0   192.168.0.0/24     backbone
```

Konfigurácia Cisco IOS

```
Cisco_c7200(config)#router ospf 1
Cisco_c7200(config-router)#router-id 192.168.20.1
Cisco_c7200(config-router)#exit

Cisco_c7200(config)#interface FastEthernet0/0
Cisco_c7200(config-if)#ip ospf 1 area 0
Cisco_c7200(config-if)#
```

Overenie rozhraní

```
[admin@MikroTik] > /routing ospf interface print
Flags: X - disabled, I - inactive, D - dynamic, P - passive
 #    INTERFACE                 COST PRI NETWORK-TYPE   AUT... AUTHENTICATIO...
 0 D  ether1                      10   1 broadcast      none
 1 D  lo0                         10   1 broadcast      none
```

```
Cisco_c7200#show ip ospf interface brief
Interface    PID   Area            IP Address/Mask    Cost  State Nbrs F/C
Lo0          1     0               192.168.20.2/24    1     LOOP  0/0
Fa0/0        1     0               192.168.0.2/24     1     BDR   1/1
```

Overenie susedov

```
[admin@MikroTik] > /routing ospf neighbor print
 0 instance=default router-id=192.168.20.1 address=192.168.0.2 interface=ether1
   priority=1 dr-address=192.168.0.1 backup-dr-address=192.168.0.2
   state="Full" state-changes=5 ls-retransmits=0 ls-requests=0 db-summaries=0
   adjacency=5m55s
```

```
Cisco_c7200#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.10.1      1   FULL/DR         00:00:31    192.168.0.1     FastEthernet0/0
```

Smerovacie tabuľky

```
[admin@MikroTik] > /ip route print
Flags: X - disabled, A - active, D - dynamic,
C - connect, S - static, r - rip, b - bgp, o - ospf, m - mme,
B - blackhole, U - unreachable, P - prohibit
 #      DST-ADDRESS        PREF-SRC        GATEWAY            DISTANCE
 0 ADC  192.168.0.0/24     192.168.0.1     ether1                    0
 1 ADC  192.168.10.0/24    192.168.10.0    lo0                       0
 2 ADC  192.168.11.0/24    192.168.11.1    lo1                       0
 3 ADo  192.168.20.2/32                    192.168.0.2             110
```

```
Cisco_c7200#show ip route
Codes: L - local, 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, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

      192.168.0.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.0.0/24 is directly connected, FastEthernet0/0
L        192.168.0.2/32 is directly connected, FastEthernet0/0
O     192.168.10.0/24 [110/11] via 192.168.0.1, 00:01:49, FastEthernet0/0
      192.168.20.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.20.0/24 is directly connected, Loopback0
L        192.168.20.2/32 is directly connected, Loopback0
      192.168.21.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.21.0/24 is directly connected, Loopback1
L        192.168.21.2/32 is directly connected, Loopback1
```

OSPFv2 – multi area

Vytvorenie oblasti a pridanie rozhrania

- Vytvoríme oblasť 1
- Do oblasti 1 pridáme lo1 rozhrania

```
[admin@MikroTik] > /routing ospf area add name=area1 area-id=0.0.0.1
...
[admin@MikroTik] > /routing ospf area print
Flags: X - disabled, I - invalid, * - default
 #    NAME                                AREA-ID         TYPE    DEFAULT-COST
 0  * backbone                            0.0.0.0         default
 1    area1                               0.0.0.1         default
```

```
[admin@MikroTik] > /routing ospf network add network=192.168.11.0/24 area=area1
...
[admin@MikroTik] > /routing ospf network print
Flags: X - disabled, I - invalid
 #   NETWORK            AREA
 0   192.168.0.0/24     backbone
 1   192.168.10.0/24    backbone
 2   192.168.11.0/24    area1
```

Overenie rozhraní

```
[admin@MikroTik] > /routing ospf interface print
Flags: X - disabled, I - inactive, D - dynamic, P - passive
 #    INTERFACE                 COST PRI NETWORK-TYPE   AUT... AUTHENTICATIO...
 0 D  ether1                      10   1 broadcast      none
 1 D  lo0                         10   1 broadcast      none
 2 D  lo1                         10   1 broadcast      none
```

```
Cisco_c7200#sh ip ospf interface brief
Interface    PID   Area            IP Address/Mask    Cost  State Nbrs F/C
Lo0          1     0               192.168.20.2/24    1     LOOP  0/0
Fa0/0        1     0               192.168.0.2/24     1     BDR   1/1
Lo1          1     1               192.168.21.2/24    1     LOOP  0/0
```

Overenie smerovacej tabuľky

```
[admin@MikroTik] > /ip route print
Flags: X - disabled, A - active, D - dynamic,
C - connect, S - static, r - rip, b - bgp, o - ospf, m - mme,
B - blackhole, U - unreachable, P - prohibit
 #      DST-ADDRESS        PREF-SRC        GATEWAY            DISTANCE
 0 ADC  192.168.0.0/24     192.168.0.1     ether1                    0
 1 ADC  192.168.10.0/24    192.168.10.0    lo0                       0
 2 ADC  192.168.11.0/24    192.168.11.1    lo1                       0
 3 ADo  192.168.20.2/32                    192.168.0.2             110
 4 ADo  192.168.21.2/32                    192.168.0.2             110
```

```
Cisco_c7200#show ip route
      192.168.0.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.0.0/24 is directly connected, FastEthernet0/0
L        192.168.0.2/32 is directly connected, FastEthernet0/0
O     192.168.10.0/24 [110/11] via 192.168.0.1, 00:00:03, FastEthernet0/0
O IA  192.168.11.0/24 [110/11] via 192.168.0.1, 00:00:03, FastEthernet0/0
      192.168.20.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.20.0/24 is directly connected, Loopback0
L        192.168.20.2/32 is directly connected, Loopback0
      192.168.21.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.21.0/24 is directly connected, Loopback1
L        192.168.21.2/32 is directly connected, Loopback1
```

OSPFv2 – databázy

OSPF databáza na RouterOS

```
[admin@MikroTik] > /routing ospf lsa print
AREA        TYPE          ID              ORIGINATOR     SEQUENCE-NU...        AGE
backbone    router        192.168.10.1    192.168.10.1       0x80000005        320
backbone    router        192.168.20.1    192.168.20.1       0x80000005         82
backbone    network       192.168.0.1     192.168.10.1       0x80000002       1031
backbone    summary-n...  192.168.11.0    192.168.10.1       0x80000002        319
backbone    summary-n...  192.168.21.2    192.168.20.1       0x80000002         82
area1       router        192.168.10.1    192.168.10.1       0x80000002        320
area1       summary-n...  192.168.0.0     192.168.10.1       0x80000002        320
area1       summary-n...  192.168.10.0    192.168.10.1       0x80000002        320
area1       summary-n...  192.168.20.2    192.168.10.1       0x80000002        320
area1       summary-n...  192.168.21.2    192.168.10.1       0x80000002        136
...
[admin@MikroTik] > /routing ospf lsa print detail
 instance=default area=backbone type=router id=192.168.10.1
   originator=192.168.10.1 sequence-number=0x80000005 age=360 checksum=0x2BCE
   options="E" body=
     flags=BORDER
         link-type=Stub id=192.168.10.0 data=255.255.255.0 metric=10
         link-type=Transit id=192.168.0.1 data=192.168.0.1 metric=10
...
```

OSPF databáza na Cisco IOS

```
Cisco_c7200#show ip ospf database

            OSPF Router with ID (192.168.20.1) (Process ID 1)

                    Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
192.168.10.1    192.168.10.1    412         0x80000005 0x002BCE 2
192.168.20.1    192.168.20.1    173         0x80000005 0x006B5F 2

                    Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.0.1     192.168.10.1    1124        0x80000002 0x009DE9

                    Summary Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.11.0    192.168.10.1    411         0x80000002 0x004A1F
192.168.21.2    192.168.20.1    173         0x80000002 0x0045F6

                    Router Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum Link count
192.168.20.1    192.168.20.1    173         0x80000002 0x002191 1

                    Summary Net Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.0.0     192.168.20.1    173         0x80000002 0x004112
192.168.10.0    192.168.20.1    173         0x80000002 0x003708
192.168.11.0    192.168.20.1    173         0x80000002 0x002C12
192.168.20.2    192.168.20.1    173         0x80000002 0x0050EC
...
```

OSPFv3 – single area

Pridanie inštancie a rozhrania

- na rozdiel od OSPFv2 sa rozhrania pridávajú cez príkaz interface

```
[admin@MikroTik] > /routing ospf-v3 instance set default router-id=192.168.10.1
disabled=no
```

```
[admin@MikroTik] > /routing ospf-v3 interface add interface=ether1 area=backbone
```

Overenie rozhraní

```
[admin@MikroTik] > /routing ospf-v3 interface print
Flags: X - disabled, I - inactive, D - dynamic, P - passive
 #    INTERFACE                AREA                  COST PRIORITY NETWORK-TYPE
 0    ether1                   backbone                10        1 default
 1    lo0                      backbone                10        1 default
```

```
Cisco_c7200#show ipv6 ospf interface brief
Interface    PID   Area            Intf ID    Cost  State Nbrs F/C
Lo0          1     0               5          1     LOOP  0/0
Fa0/0        1     0               3          1     BDR   1/1
```

Overenie susedov

```
[admin@MikroTik] > /routing ospf-v3 neighbor print
 0 instance=default router-id=192.168.21.2 address=fe80::c801:23ff:feef:0
   interface=ether1 priority=1 dr=192.168.10.1 backup-dr=192.168.21.2
   state="Full" state-changes=5 ls-retransmits=0 ls-requests=0 db-summaries=0
   adjacency=4m58s
```

```
Cisco_c7200#show ipv6 ospf neighbor

            OSPFv3 Router with ID (192.168.21.2) (Process ID 1)

Neighbor ID     Pri   State           Dead Time   Interface ID    Interface
192.168.10.1      1   FULL/DR         00:00:35    1               FastEthernet0/0
```

OSPFv3 – multi area

Vytvorenie oblasti a pridanie rozhrania

- Vytvoríme oblasť 1
- Do oblasti 1 pridáme lo1 rozhrania
- passive – pasívny interface
- network-type – typ rozhrania (broadcast, point-to-point)

```
[admin@MikroTik] > /routing ospf-v3 area add name=area1 area-id=0.0.0.1
...
[admin@MikroTik] > /routing ospf-v3 area print
Flags: X - disabled, I - invalid, * - default
 #    NAME                                AREA-ID         TYPE    DEFAULT-COST
 0  * backbone                            0.0.0.0         default
 1    area1                               0.0.0.1         default
```

```
[admin@MikroTik] > /routing ospf-v3 interface add interface=lo1 area=area1
...
[admin@MikroTik] > /routing ospf-v3 interface add interface=lo1 area=area1
passive=yes
...
[admin@MikroTik] > /routing ospf-v3 interface add interface=lo1 area=area1 network-
type=point-to-point
```

Overenie rozhraní

```
[admin@MikroTik] > /routing ospf-v3 interface print
Flags: X - disabled, I - inactive, D - dynamic, P - passive
 #    INTERFACE                AREA                  COST PRIORITY NETWORK-TYPE
 0    ether1                   backbone                10        1 default
 1    lo0                      backbone                10        1 default
 2    lo1                      area1                   10        1 default
```

```
Cisco_c7200#show ipv6 ospf interface brief
Interface    PID   Area            Intf ID    Cost  State Nbrs F/C
Lo0          1     0               5          1     LOOP  0/0
Fa0/0        1     0               3          1     BDR   1/1
```

Overenie smerovacej tabuľky

```
[admin@MikroTik] > /ipv6 route print
Flags: X - disabled, A - active, D - dynamic,
C - connect, S - static, r - rip, o - ospf, b - bgp, U - unreachable
 #      DST-ADDRESS                GATEWAY                     DISTANCE
 0 ADC  2001:aaaa::/64             ether1                             0
 1 ADC  2001:abba:10::/64          lo0                                0
 2 ADC  2001:abba:11::/64          lo1                                0
 3 ADo  2001:acad:21::2/128        fe80::c801:23ff:feef:...         110
```

```
Cisco_c7200#show ipv6 route
C   2001:AAAA::/64 [0/0]
     via FastEthernet0/0, directly connected
L   2001:AAAA::2/128 [0/0]
     via FastEthernet0/0, receive
O   2001:ABBA:10::/64 [110/11]
     via FE80::A00:27FF:FE11:798A, FastEthernet0/0
C   2001:ACAD:20::/64 [0/0]
     via Loopback0, directly connected
L   2001:ACAD:20::2/128 [0/0]
     via Loopback0, receive
C   2001:ACAD:21::/64 [0/0]
     via Loopback1, directly connected
L   2001:ACAD:21::2/128 [0/0]
     via Loopback1, receive
L   FF00::/8 [0/0]
     via Null0, receive
```

Ďakujem za pozornosť!

Ohodnoť našu CNA na google:

- https://goo.gl/maps/BAnFvQKYCBpffcEX7

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