Reprezentácia YANG modelov v kontexte konfigurácie smerovačov v rozsahu CCNAv7 tém

Reprezentácia rôznych spôsobov konfigurácie CCNAv7 tém

CLI (text) vs. RESTCONF (JSON, XML) vs. NETCONF (XML)

Obsahom tohto dokumentu sú názorné ukážky a porovnania prístupov, ktoré je možné využívať na konfiguráciu smerovačov – konkrétne konfiguráciu tém, ktorým sa venujú kurzy CCNAv7. Pri vyučovaní tejto problematiky je v súčasnosti primárne rozšírený tradičný prístup, využitím príkazového riadku. Postupom času dochádza k automatizácii aj v odvetví počítačových sietí. Manuálna konfigurácia cez CLI, pokiaľ sa jedná o spravovanie veľkého množstva zariadení, začína byť zdĺhavá a náchylná na chybovosť. Rovnako môže byť problémom práca so zariadeniami od rôznych výrobcov, keďže každý výrobca má definované iné CLI príkazy. Konkrétny administrátor, ktorý topológiu spravuje, by ich teda musel všetky ovládať. Je zrejmé, že aj v prípade použitia dokumentácie, sa správa rôznorodej PC siete značne komplikuje.

Vyššie spomenuté problémy je možné riešiť vytvorením rôznych automatizačných nástrojov, kde topológiu spravuje „kód“. Z pojmu automatizácia vyplýva, že primárna interakcia nebude medzi človekom a strojom, ale medzi systémami navzájom. Na zjednodušenie a sprostredkovanie takejto interakcie sa populárnym riešením stala implementácia API (aplikačných rozhraní). API je možné nájsť priamo na sieťových zariadeniach a rôznych ďalších kontrolných systémoch.

K API sieťových zariadení, ako je napr. smerovač CSR1000v môžeme pristupovať využitím protokolov RESTCONF (HTTPS) a NETCONF (SSH 830). Druhou otázkou, ktorú bolo potrebné vyriešiť sa stalo popísanie zdrojov a služieb sieťových zariadení formou, ktorá by bola zrozumiteľná pre počítače. CLI je síce zrozumiteľná pre ľudí, no v prípade potreby automatizácie nám CLI poskytuje neštruktúrované dáta, s ktorými sa ťažko pracuje. Preto vznikol koncept popisu zdrojov a služieb využitím modelov (YANG). Každý komponent alebo služba sa skladá z rovnakých atribútov, či je implementovaná na Cisco, Juniper, MikroTik alebo akomkoľvek inom zariadení. Každý výrobca používa vlastnú sadu CLI príkazov, no YANG model ostáva rovnaký.

V dokumente bude znázornená konfigurácia tradičným spôsobom cez CLI a ukážka danej konfigurácie po transformovaní do RESTCONF a NETCONF reprezentácie. Ku každej téme bude ukázaná sada CLI príkazov a odpovedajúca reprezentácia v RESTCONF (JSON) a NETCONF (XML) protokoloch.

CCNA1 – Introduction to Networks

1. Hostname

CLI:

```
#hostname Router_Name
```

RESTCONF: https://192.168.2.6:443/restconf/data/native/hostname

```
{
   "Cisco-IOS-XE-native:hostname": "Router_Name"
}
```

NETCONF:

```
<hostname>Router_Name</hostname>
```

2. Heslá do privilegovaného režimu

CLI:

```
#enable password slabeHeslo
#enable secret silneHeslo
```

RESTCONF: https://192.168.2.6:443/restconf/data/native/enable

```
{
   "Cisco-IOS-XE-native:enable":
      "password": {
         "secret": "slabeHeslo"
      },
      "secret": {
         "type": "5",
      "secret": "$1$mERr$2Z8TGAkG8cdGKPYorGsbe/"
      }
   }
}
```

NETCONF:

```
<enable>
   <password>
      <type>7</type>
      <secret>0832404F0B1C2D12010703</secret>
   </password>
   <secret>
      <type>5</type>
      <secret>$1$mERr$2Z8TGAkG8cdGKPYorGsbe/</secret>
   </secret>
</enable>
```

3. Konfigurácia liniek – konzola a VTY

CLI:

```
#line console 0
   #password konzola
   #login
   #exec-timeoute 5
   #logging synchronous
#line vty 0 4
   #login local
#transport input ssh
```

RESTCONF: https://192.168.2.6:443/restconf/data/native/line

```
{
   "Cisco-IOS-XE-native:line": {
      "console": [
         {
            "first": "0",
            "exec-timeout": {
               "minutes": 5
            },
           "logging": {
               "synchronous": {}
            },
            "login": {},
            "password": {
               "secret": "konzola"
            }
         }
      ],
      "vty": [
         {
            "first": 0,
```

```
            "last": 4,
            "login": {
               "local": [
                  null
               ]
            },
            "transport": {
               "input": {
                  "input": [
                     "ssh"
                  ]
               }
            }
         },
      ]
   }
}
```

NETCONF:

```
<vty>
   <first>0</first>
   <last>4</last>
   <login>
      <local/>
   </login>
   <transport>
      <input>
         <input>ssh</input>
      </input>
   </transport>
</vty>
```

4. Konfigurácia šifrovania jednoduchou šifrou

CLI:

```
#service password-encryption
```

RESTCONF: https://192.168.2.6:443/restconf/data/native/

```
"service": {
   "password-encryption": [
      null
    ]
```

NETCONF:

```
<service>
   <password-encryption/>
```

5. Konfigurácia domény

CLI:

```
#ip domain-name cnl.sk
#no ip domain-lookup
```

RESTCONF: https://192.168.2.6:443/restconf/data/native/ip/domain

```
{
   "Cisco-IOS-XE-native:domain": {
      "lookup": false,
      "name": "cnl.sk"
    }
}
```

NETCONF:

```
<domain>
   <lookup>false</lookup>
   <name>cnl.sk</name>
</domain>
```

6. Konfigurácia lokálnej databázy – tvorba používateľov

CLI:

```
#username cisco privilege 15 password cisco123
#username test user secret cisco
```

RESTCONF: https://192.168.2.6:443/restconf/data/native/username

```
{
   "Cisco-IOS-XE-native:username": [
      {
         "name": "cisco",
         "privilege": 15,
         "password": {
            "encryption": "7",
            "password": " 0822455D0A16544541 "
         }
      },
      {
         "name": "test_user",
         "secret": {
            "encryption": "5",
            "secret": "$1$mERr$hx5rVt7rPNoS4wqbXKX7m0"
         }
      }
   ]
}
```

NETCONF:

```
<username>
   <name>cisco</name>
   <privilege>15</privilege>
   <password>
      <encryption>7</encryption>
      <password> 0822455D0A16544541</password>
   </password>
</username>
<username>
   <name>test_user</name>
   <secret>
      <encryption>5</encryption>
      <secret>$1$mERr$hx5rVt7rPNoS4wqbXKX7m0</secret>
   </secret>
</username>
```

7. Konfigurácia rozhrania

CLI:

```
#interface GigabitEthernet1
   #description Uplink Gi1
   #ip add 192.168.10.10 255.255.255.0
   #ipv6 address 2001:db8:0:10::1/64
   #ipv6 address fe80::1 link-local
```

RESTCONF: https://192.168.2.6:443/restconf/data/ietf-interfaces:interfaces/interface=GigabitEthernet1

```
{
   "ietf-interfaces:interface": {
      "name": "GigabitEthernet1",
      "description": "Uplink Gi1",
      "type": "iana-if-type:ethernetCsmacd",
      "enable": true,
      "ietf-ip:ipv4": {
         "address": [
            {
            "ip": "192.168.10.10",
            "netmask": "255.255.255.0"
            }
         ]
      },
      "ietf-ip:ipv6": {
         "address": [
            {
            "ip": "2001:db8:0:10::1",
            "prefix-lenght": 64
            }
         ]
      }
   }
}
```

NETCONF:

```
<GigabitEthernet>
   <name>1</name>
   <description>Uplink Gi1</description>
   <ip>
      <address>
         <primary>
            <address>192.168.10.10</address>
            <mask>255.255.255.0</mask>
         </primary>
      </address>
   </ip>
   <ipv6>
      <address>
         <prefix-list>
            <prefix>2001:DB8:0:10::1/64</prefix>
         </prefix-list>
         <link-local-address>
            <address>fe80::1</address>
            <link-local/>
         </link-local-address>
      </address>
   </ipv6>
```

8. Spustenie CDP a LLDP

CLI:

```
#cdp run
#lldp run
```

RESTCONF:

https://192.168.2.6:443/restconf/data/native/cdp

```
{
   "Cisco-IOS-XE-native:cdp": {
      "Cisco-IOS-XE-cdp:run": [
         null
      ]
   }
}
```

https://192.168.2.6:443/restconf/data/native/lldp

```
{
   "Cisco-IOS-XE-lldp:lldp": {
      "run": [
         null
      ]
   }
}
```

NETCONF:

```
<cdp>
   <run
        xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-cdp"/>
</cdp>
```

```
<lldp
      xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-lldp">
      <run/>
</lldp>
```

CCNA2 – Switching, Routing, and Wireless Essentials

1. Konfigurácia Router-on-a-Stick

CLI:

```
#interface GigabitEthernet1.10
   #encapsulation dot1q 10
   #ip add 10.0.0.1 255.255.255.0
#interface GigabitEthernet1.20
   #encapsulation dot1q 20
   #ip add 21.0.0.1 255.255.255.0
```

RESTCONF: https://192.168.2.6:443/restconf/data/ietf-interfaces:interfaces/

```
{
   "Cisco-IOS-XE-native:interface": {
      "GigabitEthernet": [
         {
            "name": "1.10",
            "encapsulation": {
               "dot1Q": {
               "vlan-id": 10
               }
            },
            "ip": {
               "address": {
                  "primary": {
                     "address": "10.0.0.1",
                     "mask": "255.255.255.0"
                  }
               }
            }
      },
      {
         "name": "1.20",
            "encapsulation": {
               "dot1Q": {
                  "vlan-id": 20
               }
            },

            "ip": {
               "address": {
                  "primary": {
                     "address": "21.0.0.1",
                     "mask": "255.255.255.0"
                  }
               }
            }
         }
      ]
   }
}
```

NETCONF:

```
<GigabitEthernet>
   <name>1.10</name>
   <encapsulation>
      <dot1Q>
         <vlan-id>10</vlan-id>
      </dot1Q>
   </encapsulation>
   <ip>
      <address>
         <primary>
            <address>10.0.0.1</address>
            <mask>255.255.255.0</mask>
         </primary>
      </address>
   </ip>
</GigabitEthernet>
<GigabitEthernet>
   <name>1.20</name>
   <encapsulation>
      <dot1Q>
         <vlan-id>20</vlan-id>
      </dot1Q>
   </encapsulation>
   <ip>
      <address>
         <primary>
            <address>21.0.0.1</address>
            <mask>255.255.255.0</mask>
         </primary>
      </address>
   </ip>
</GigabitEthernet>
```

2. Konfigurácia protokolu DHCPv4

CLI:

```
#ip dhcp excluded-address 10.0.0.0 10.0.0.10
#ip dhcp pool L10
   #domain-name cnl.sk
   #dns-server 8.8.8.8
   #default-router 10.0.0.1
   #network 10.0.0.0 255.255.255.0
```

RESTCONF: https://192.168.2.6:443/restconf/data/native/ip/dhcp

```
{
   "Cisco-IOS-XE-native:dhcp": {
      "Cisco-IOS-XE-dhcp:excluded-address": {
         "low-high-address-list": [
            {
               "low-address": "10.0.0.0",
               "high-address": "10.0.0.10"
            }
         ]
      },
      "Cisco-IOS-XE-dhcp:pool": [
         {
            "id": "L10",
            "default-router": [
               "10.0.0.1"
            ],
            "dns-server": [
               "8.8.8.8"
            ],
            "domain-name": "cnl.sk",
            "network": {
```

```
                "number": "10.0.0.0",
                "mask": "255.255.255.0"
            }
        }
    ]
  }
}
```

NETCONF:

```
<dhcp>
   <excluded-address
      xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-dhcp">
      <low-high-address-list>
         <low-address>10.0.0.0</low-address>
         <high-address>10.0.0.10</high-address>
      </low-high-address-list>
   </excluded-address>
   <pool
      xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-dhcp">
      <id>L10</id>
      <default-router>10.0.0.1</default-router>
      <dns-server>8.8.8.8</dns-server>
      <domain-name>cnl.sk</domain-name>
      <network>
         <number>10.0.0.0</number>
         <mask>255.255.255.0</mask>
      </network>
   </pool>
</dhcp>
```

3. Konfigurácia protokolu DHCPv6

CLI:

```
#ipv6 dhcp pool IPV6-stateless
   #dns-server 2001:db8:0:1::1
   #domain-name cnl.sk
#ipv6 dhcp pool IPV6-stateful
   #dns-server 2001:db8:0:1::1
   #domain-name netacad.com
   #address prefix 2001:db8:0:1::/64 lifetime infinite infinite
#interface GigabitEthernet1
   #ipv6 dhcp server IPv6-stateless
```

RESTCONF: https://192.168.2.6:443/restconf/data/native/ipv6/dhcp

```
{
   "Cisco-IOS-XE-native:dhcp": {
      "Cisco-IOS-XE-dhcp:pool": [
         {
            "name": "IPv6-stateful",
            "address": {
               "prefix": [
                  {
                     "ipv6-address": "2001:db8:0:10::/64",
                     "lifetime": {
                        "valid-lifetime": "infinite",
                        "preferred-lifetime": "infinite"
                     }
                  }
               ]
            },
            "dns-server": [
               "2001:DB8:0:10::1"
            ],
            "domain-name": "netacad.com"
         },
         {
            "name": "IPv6-stateless",
```

```
            "dns-server": [
               "2001:DB8:0:10::1"
            ],
            "domain-name": "cnl.sk"
         }
      ]
   }
}
```

https://192.168.2.6:443/restconf/data/native/interface

```
{
   "Cisco-IOS-XE-native:interface": {
      "GigabitEthernet": [
         {
            "name": "1",
            "description": "Uplink Gi1",
            "ip": {
               "no-address": {
                  "address": false
               }
            },
            "ipv6": {
               "dhcp": {
                  "Cisco-IOS-XE-dhcp:server": [
                     {
                        "word": "IPv6-stateless"
                     }
                  ]
               }
            }
         }
      ]
   }
}
```

NETCONF:

```
<dhcp>
   <pool
      xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-dhcp">
      <name>IPv6-stateful</name>
      <address>
         <prefix>
            <ipv6-address>2001:DB8:0:10::/64</ipv6-address>
            <lifetime>
               <valid-lifetime>infinite</valid-lifetime>
               <preferred-lifetime>infinite</preferred-lifetime>
            </lifetime>
         </prefix>
      </address>
      <dns-server>2001:DB8:0:10::1</dns-server>
      <domain-name>netacad.com</domain-name>
   </pool>
   <pool
      xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-dhcp">
      <name>IPv6-stateless</name>
      <dns-server>2001:DB8:0:10::1</dns-server>
      <domain-name>cnl.sk</domain-name>
   </pool>
</dhcp>
```

4. Konfigurácia protokolu HSRP

CLI:

```
#interface GigabitEthernet1.10
   #standby 10 ip 10.0.0.100
   #standby 10 preempt
   #standby 10 priority 101
```

RESTCONF: https://192.168.2.6:443/restconf/data/native/interface

#pod konkrétnym rozhraním

```
"standby": {
   "standby-list": [
      {
         "group-number": 10,
         "ip": {
            "address": "10.0.0.100"
         },
         "preempt": {},
         "priority ": 101
      }
   ]
}
```

NETCONF:

#pod konkrétnym rozhraním:

```
<standby>
   <standby-list>
      <group-number>10</group-number>
      <ip>
         <address>10.0.0.10</address>
      </ip>
      <preempt></preempt>
      <priority>101</priority>
   </standby-list>
</standby>
```

5. Konfigurácia statických ciest

CLI:

```
#ip route 11.99.8.0 255.255.255.0 GigabitEthernet1
#ip route 22.2.22.0 255.255.255.0 8.8.8.1
#ipv6 route 2001:db8:0:9999::/64 2001:db8:0:12::2
#ipv6 route 2001:db8:0:2222::/64 GigabitEthernet 1 fe80::2
```

RESTCONF:

https://192.168.2.6:443/restconf/data/native/ip/route

```
{
   "Cisco-IOS-XE-native:route": {
      "ip-route-interface-forwarding-list": [
         {
            "prefix": "11.99.8.0",
            "mask": "255.255.255.0",
            "fwd-list": [
               {
                  "fwd": "GigabitEthernet1"
               }
            ]
         },
         {
            "prefix": "22.2.22.0",
            "mask": "255.255.255.0",
            "fwd-list": [
               {
                  "fwd": "8.8.8.1"
               }
            ]
         }
      ]
   }
}
```

https://192.168.2.6:443/restconf/data/native/ipv6/route

```
{
   "Cisco-IOS-XE-native:route": {
      "ipv6-route-list": [
         {
            "prefix": "2001:DB8:0:9999::/64",
            "ipv6-fwd-list": [
               {
                  "fwd": "2001:db8:0:12::2"
               }
            ]
         },
         {
            "prefix": "2001:db8:0:2222::/64"
            "ipv6-fwd-list": [
               {
                  "fwd": "GigabitEthernet1"
                  "next-hop": "fe80::2"
               }
            ]
         }
      ]
   }
}
```

NETCONF:

```
<route>
   <ip-route-interface-forwarding-list>
      <prefix>11.99.8.0</prefix>
      <mask>255.255.255.0</mask>
      <fwd-list>
         <fwd>GigabitEthernet1</fwd>
      </fwd-list>
   </ip-route-interface-forwarding-list>
   <ip-route-interface-forwarding-list>
      <prefix>22.2.22.0</prefix>
      <mask>255.255.255.0</mask>
      <fwd-list>
         <fwd>8.8.8.1</fwd>
      </fwd-list>
   </ip-route-interface-forwarding-list>
</route>
```

```
<route>
   <ipv6-route-list>
      <prefix>2001:DB8:0:2222::/64</prefix>
      <ipv6-fwd-list>
         <fwd>GigabitEthernet1</fwd>
         <next-hop>fe80::2</next-hop>
      </ipv6-fwd-list>
   </ip-route-list>
   <ipv6-route-list>
      <prefix>2001:DB8:0:9999::/64</prefix>
      <ipv6-fwd-list>
         <fwd>2001:db8:0:12::2</fwd>
      </ipv6-fwd-list>
   </ip-route-list>
</route>
```

CCNA3 – Enterprise Networking, Security, and Automation

1. Konfigurácia protokolu OSPFv2

CLI:

```
#router ospf 1
   #router-id 1.1.1.1
   #network 172.16.10.0 0.0.0.127 area 1
   #network 192.168.10.1 0.0.0.0 area 0.0.0.5
   #network 10.0.0.0 0.0.0.3 area 0
   #passive-interface GigabitEthernet 1
   #default-information originate always
#interface GigabitEthernet 1
  #ip ospf priority 15
  #ip ospf cost 15
  #ip ospf hello-interval 8
  #ip ospf dead-interval 22
```

RESTCONF:

https://192.168.2.6:443/restconf/data/native/router

```
{
   "Cisco-IOS-XE-native:router": {
      "Cisco-IOS-XE-ospf:ospf": [
         {
            "id": 1,
            "auto-cost": {
               "reference-bandwidth": 10
            },
            "passive-interface": {
               "interface": "GigabitEthernet1"
            },
            "router-id": "1.1.1.1",
            "default-information": {
               "originate": {
                  "always": [
                     null
                  ]
               }
            },
            "network": [
               {
                  "ip": "10.0.0.0",
                  "mask": "0.0.0.3",
                  "area": 0
               },
```

https://192.168.2.6:443/restconf/data/native/interface

#pod konkrétnym rozhraním:

```
"Cisco-IOS-XE-ospf:ospf": {
   "cost": 15,
   "dead-interval": {
      "value": 22
   },
   "hello-interval": 8,
   "priority": 15
   }
}
```

```
                {
                   "ip": "172.16.10.0",
                   "mask": "0.0.0.127",
                   "area": 1
                },
                {
                   "ip": "192.168.10.1",
                   "mask": "0.0.0.127",
                   "area": "0.0.0.5"
                }
             ]
          }
       ]
    }
}
```

NETCONF:

```
<ospf
   xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-ospf">
   <id>1</id>
   <auto-cost>
      <reference-bandwidth>10</reference-bandwidth>
   </auto-cost>
   <passive-interface>
      <interface>GigabitEthernet1</interface>
   </passive-interface>
   <router-id>1.1.1.1</router-id>
   <default-information>
      <originate>
         <always/>
      </originate>
   </default-information>
   <network>
      <ip>10.0.0.0</ip>
      <mask>0.0.0.3</mask>
      <area>0</area>
   </network>
   <network>
      <ip>172.16.10.0</ip>
      <mask>0.0.0.127</mask>
      <area>1</area>
   </network>
   </network>
   <network>
      <ip>192.168.10.1</ip>
      <mask>0.0.0.0</mask>
      <area>0.0.0.5</area>
   </network>
</ospf>
```

#pod konkrétnym rozhraním:

```
<ospf
   xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-ospf">
   <cost>15</cost>
   <dead-interval>
      <value>22</value>
   </dead-interval>
   <hello-interval>8</hello-interval>
   <priority>15</priority>
</ospf>
```

2. Konfigurácia prístupových zoznamov

CLI:

```
#access-list 1 permit 1.1.1.1
#access-list 1 permit 10.0.0.0 0.0.0.255
#access-list 100 permit tcp host 1.1.1.1 host 192.168.10.0 eq www
#access-list 100 permit tcp host 2.2.2.2 host 192.168.20.0 eq ftp
#access-list 100 permit ospf host 2.2.2.2 host 1.1.1.1
#access-list 100 permit icmp 172.16.1.0 0.0.0.255 any
#access-list 100 permit ip host 10.0.0.1 host 2.2.2.2 log

#interface GigabitEthernet 1
   #ip access-group 1 in
   #ip access-group 100 out
#line vty 5
   #access-class 1 in
```

RESTCONF: https://192.168.2.6:443/restconf/data/native/ip/access-list


```
{
   "Cisco-IOS-XE-native:access-list": {
      "Cisco-IOS-XE-acl:standard": [
         {
            "name": 1,
            "access-list-seg-rule": [
               {
                  "sequence": 10,
                  "permit": {
                     "std-ace": {
                        "ipv4-prefix": "1.1.1.1"
                     }
                  }
               },
               {
                  "sequence": 20,
                  "permit": {
                     "std-ace": {
                        "ipv4-prefix": "10.0.0.0",
                        "mask": "0.0.0.255"
                     }
                  }
               }
            ]
         }
      ],
      "Cisco-IOS-XE-acl:standard": [
         {
            "name": 100,
            "access-list-seg-rule": [
               {
                  "sequence": 10,
                  "ace-rule": {
                     "action": "permit",
                     "protocol": "tcp",
                     "host": "1.1.1.1",
                     "dst-host": "192.168.10.0",
                     "dst-eq": "www"
                  }
               },
               {
                  "sequence": 20,
                  "ace-rule": {
                     "action": "permit",
                     "protocol": "tcp",
                     "host": "2.2.2.2",
                     "dst-host": "192.168.20.0",
                     "dst-eq": "ftp"
                  }
               },
               {
                  "sequence": 30,
                  "ace-rule": {
                     "action": "permit",
                     "protocol": "ospf",
                     "host": "2.2.2.2",
                     "dst-host": "1.1.1.1"
                  }
               },
               {
                  "sequence": 40,
                  "ace-rule": {
                     "action": "permit",
                     "protocol": "icmp",
                     "ipv4-address": "172.16.1.0",
                     "mask": "0.0.0.255",
                     "dst-any": [
                        null
                     ]
                  }
               },
```

```
                {
                   "sequence": 50,
                   "ace-rule": {
                      "action": "permit",
                      "protocol": "ip",
                      "host": "10.0.0.1",
                      "dst-host": "2.2.2.2",
                      "log": [
                         null
                      ]
                   }
                }
             ]
          }
       ]
    }
}
```

https://192.168.2.6:443/restconf/data/native/interface

#pod konkrétnym rozhraním:

```
"ip": {
   "access-group": {
      "in": {
         "acl": {
            "acl-name": 1,
            "in": [
               null
            ]
         }
      },
      "out": {
         "acl": {
            "acl-name": 100,
            "out": [
               null
            ]
         }
      }
   }
}
```

https://192.168.2.6:443/restconf/data/native/line

#pod konkrétnou linkou:

```
"access-class": {
   "access-list": [
      {
         "direction": "in",
         "access-list": 1
      }
   ]
}
```

NETCONF:

```
<access-list>
   <standard
      xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-acl">
      <name>1</name>
      <access-list-seq-rule>
         <sequence>10</sequence>
         <permit>
            <std-ace>
               <ipv4-prefix>1.1.1.1</ipv4-prefix>
            </std-ace>
         </permit>
      </access-list-seq-rule>
      <access-list-seq-rule>
         <sequence>20</sequence>
         <permit>
            <std-ace>
               <ipv4-prefix>10.0.0.0</ipv4-prefix>
               <mask>0.0.0.255</mask>
            </std-ace>
         </permit>
      </access-list-seq-rule>
   </standard>
   <extended
      xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-acl">
      <name>100</name>
      <access-list-seq-rule>
```

```
        <sequence>10</sequence>
        <ace-rule>
          <action>permit</action>
          <protocol>tcp</protocol>
          <host>1.1.1.1</host>
          <dst-host>192.168.10.0</dst-host>
          <dst-eq>www</dst-eq>
        </ace-rule>
      </access-list-seq-rule>
      <access-list-seq-rule>
        <sequence>20</sequence>
        <ace-rule>
          <action>permit</action>
          <protocol>tcp</protocol>
          <host>2.2.2.2</host>
          <dst-host>192.168.20.0</dst-host>
          <dst-eq>ftp</dst-eq>
        </ace-rule>
      </access-list-seq-rule>
      <access-list-seq-rule>
        <sequence>30</sequence>
        <ace-rule>
          <action>permit</action>
          <protocol>ospf</protocol>
          <host>2.2.2.2</host>
          <dst-host>1.1.1.1<dst-host>
          <dst-eq>ftp</dst-eq>
        </ace-rule>
      </access-list-seq-rule>
      <access-list-seq-rule>
        <sequence>40</sequence>
        <ace-rule>
          <action>permit</action>
          <protocol>icmp</protocol>
          <ipv4-address>172.16.1.0</ipv4-address>
          <mask>0.0.0.255</mask>
          <dst-any/>
        </ace-rule>
      </access-list-seq-rule>
      <access-list-seq-rule>
        <sequence>30</sequence>
        <ace-rule>
          <action>permit</action>
          <protocol>ospf</protocol>
          <host>2.2.2.2</host>
          <dst-host>1.1.1.1<dst-host>
          <dst-eq>ftp</dst-eq>
        </ace-rule>
      </access-list-seq-rule>
      <access-list-seq-rule>
        <sequence>40</sequence>
        <ace-rule>
          <action>permit</action>
          <protocol>icmp</protocol>
          <ipv4-address>172.16.1.0</ipv4-address>
          <mask>0.0.0.255</mask>
          <dst-any/>
        </ace-rule>
      </access-list-seq-rule>
      <access-list-seq-rule>
        <sequence>50</sequence>
        <ace-rule>
          <action>permit</action>
          <protocol>ip</protocol>
          <host>10.0.0.1</host>
          <dst-host>2.2.2.2<dst-host>
          <dst-eq>ftp</dst-eq>
          <log/>
        </ace-rule>
      </access-list-seq-rule>
    </extended>
```

#pod konkrétnym rozhraním:

```
<ip>
   <access-group>
      <in>
         <acl>
            <acl-name>1</acl-name>
            <in/>
         </acl>
      </in>
      <out>
         <acl>
            <acl-name>100</acl-name>
            <out/>
         </acl>
      </out>
   </access-group>
```

#pod konkrétnou linkou:

```
<access-class>
   <access-list>
      <direction>in</direction>
      <access-list>1</access-list>
   </access-list>
</access-class>
```

3. Konfigurácia prekladu sieťových adries NAT

CLI:

```
#ip nat inside source static 192.168.30.194 147.232.22.194
#ip nat pool LAN10 147.232.22.195 147.232.22.205 netmask 255.255.255.240
#ip nat inside source list 1 pool LAN10
#ip nat inside source list 2 interface GigabitEthernet1 overload
#interface GigabitEthernet 1
#ip nat inside
```

RESTCONF: https://192.168.2.6:443/restconf/data/native/ip/nat

```
{
   "Cisco-IOS-XE-nat:nat": {
      "pool": [
         {
            "id": "LAN10",
            "start-address": "147.232.22.195",
            "end-address": "147.232.22.205",
            "netmask": "255.255.255.240"
         }
      ],
      "inside": {
         "source": {
            "list": [
               {
                  "id": 1,
                  "pool": "LAN10"
               },
               {
                  "id": 2,
                  "interface": {
                     "GigabitEthernet ": "1",
                  },
                  "overload": [
                        null
                  ]
               }
            ],
            "static": {
               "nat-static-transport-list": [
                  {
                     "local-ip": "192.168.30.194",
                     "global-ip": "147.232.22.194"
                  }
               ]
            }
         }
      }
   }
}
```

https://192.168.2.6:443/restconf/data/native/interface
#pod konkrétnym rozhraním:

```
"Cisco-IOS-XE-nat:nat": {
   "inside": [
      null
   ]
}
```

NETCONF:
#pod konkrétnym rozhraním:

```
<nat
   xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-nat">
   <inside/>
</nat>
<nat
   xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-nat">
   <pool>
      <id>LAN10</id>
      <start-address>147.232.22.195</start-address>
      <end-address>147.232.22.205</end-address>
      <netmask>255.255.255.240</netmask>
   </pool>
   <inside>
      <source>
         <list>
            <id>1</id>
            <pool>LAN10</pool>
         </list>
         <list>
            <id>2</id>
            <interface>
               <GigabitEthernet>1</GigabitEthernet>
            </interface>
            <overload/>
         </list>
         <static>
            <nat-static-transport-list>
               <local-ip>192.168.30.194</local-ip>
               <global-ip>147.232.22.194</global-ip>
            </nat-static-transport-list>
         </static>
      </source>
   </inside>
</nat>
```

4. Konfigurácia protokolu NTP

CLI:

```
#ntp server 1.2.3.4
```

RESTCONF: https://192.168.2.6:443/restconf/data/native/ntp

```
{
   "Cisco-IOS-XE-native:ntp": {
      "Cisco-IOS-XE-ntp:server": {
         "server-list": [
            {
               "ip-address": "1.2.3.4"
            }
         ]
      }
   }
}
```

NETCONF:

```
<ntp>
   <server
      xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-ntp">
      <server-list>
         <ip-address>1.2.3.4</ip-address>
      </server-list>
   </server>
</ntp>
```

5. Konfigurácia protokolu SNMP

CLI:

```
#snmp-server community cisco RO 1
#snmp-server community xyz123 RW 1
#snmp-server host 10.1.1.50 xyz123
```

RESTCONF: https://192.168.2.6:443/restconf/data/native/snmp-server

```
{
   "Cisco-IOS-XE-native:snmp-server": {
      "Cisco-IOS-XE-snmp:community": [
         {
            "name": "cisco",
            "RO": [
               null
            ],
            "access-list-name": 1
         },
         {
            "name": "xyz123",
            "RW": [
               null
            ],
            "access-list-name": 1
         }
      ],
      "Cisco-IOS-XE-snmp:host": [
         {
            "ip-address": "10.1.1.50",
            "community-string": "xyz123"
         }
      ]
   }
}
```

NETCONF:

```
<snmp-server>
   <community
      xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-snmp">
      <name>cisco</name>
      <RO/>
      <access-list-name>1</access-list-name>
   </community>
   <community
      xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-snmp">
      <name>xyz123</name>
      <RW/>
      <access-list-name>1</access-list-name>
   </community>
   <host
      xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-snmp">
      <ip-address>10.1.1.50</ip-address>
```

```
      <community-string>xyz123</community-string>
   </host>
</snmp-server>
```

6. Konfigurácia logovania – SYSLOG + Buffer

CLI:

```
#logging 10.0.0.1
#logging trap notifications
#logging buffered 5000
```

RESTCONF: https://192.168.2.6:443/restconf/data/native/logging

```
{
   "Cisco-IOS-XE-native:logging": {
      "buffered": {
         "size": {
            "size-value": 5000
         }
      },
      "host": {
         "ipv4-host-list": [
            {
               "ipv4-host": "1.2.3.4"
            }
         ]
      },
      "trap": {
         "severity": "notifications"
      },
      "hostip": "10.0.0.1"
   }
}
```

NETCONF:

```
<logging>
   <buffered>
      <size>
         <size-value>5000</size-value>
      </size>
   </buffered>
   <host>
      <ipv4-host-list>
         <ipv4-host>1.2.3.4</ipv4-host>
      </ipv4-host-list>
   </host>
   <trap>
      <severity>notifications</severity>
   </trap>
   <hostip>10.0.0.1</hostip>
</logging>
```