



**MREŽA ZNANJA**

Ljubljana, 11.–13. oktober 2022

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# Osnove IPv6 naslavljanja

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# VSEBINA

- Nekaterne osnovne značilnosti IPv6 protokola
- Oblika IPv6 naslova, zapis, krajšanje
- Tipi IPv6 naslovov in obseg delovanja
- Naslavljanje naprav v IPv6 omrežju
- Preverjanje nastavitev IPv6 na napravah



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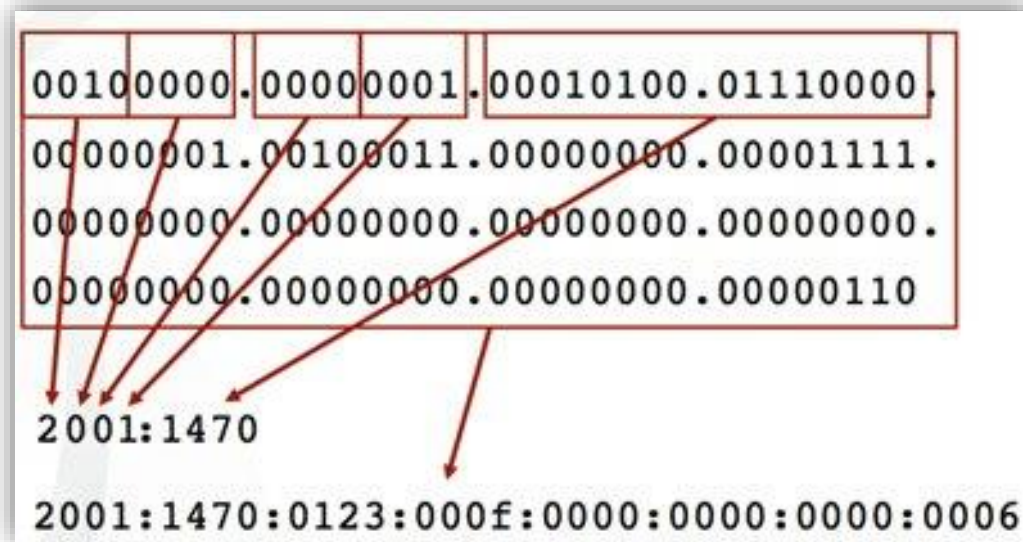
# IPv6

- Veliko večji naslovni prostor (IPv6 = 128bit, IPv4=32bitov)
- Komunikacija end-to-end (ni več NAT-a)
- Poenostavljena samodejna nastavitvev naslovov
- Nova oblika glave paketov (hitrejše usmerjanje paketov)
- NI kompatibilen z IPv4 (IPv4 in IPv6 lahko sobivata LAN)
- Tranzicijski mehanizmi



## OBLIKA IPv6 NASLOVA

- Dolg 128 bitov
- Razdeljen na 16 bitne bloke
- Šestnajstiški zapis
- Ločilo med bloki „:“

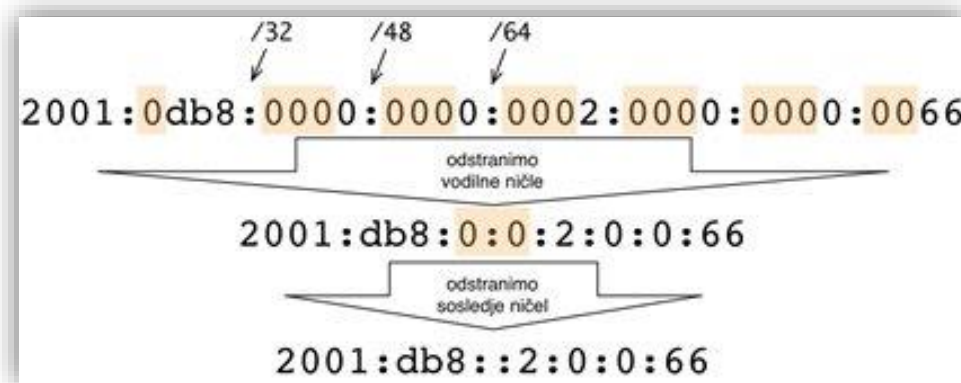


Vir: <https://ipv6.si>



# KRAJŠANJE IPv6 NASLOVA

- Odstranimo vse vodilne 0.
- S štiripičjem (::) nadomestimo več zaporednih blokov z vrednostjo 0.
- Štiripičje lahko uporabimo samo 1 krat v naslovu.
- Če je več možnosti za krajšanje, krajšamo iz leve proti desni.
- Naslov zapišemo v [ ], da lahko dodamo številko vrat.

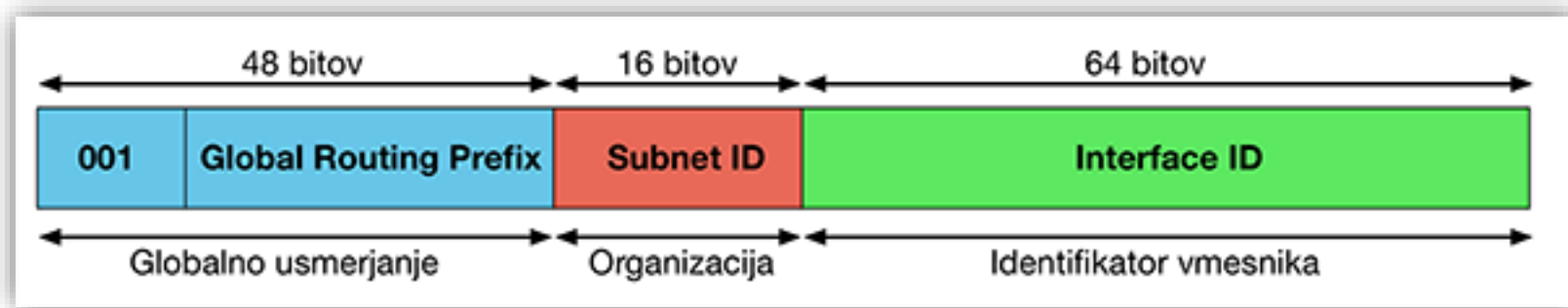


Vir: <https://ipv6.si>



## SESTAVA IPv6 NASLOVA

- Predpona (prefix)
- Identifikator vmesnika (interface ID)
- Predpona iz več delov



Vir: <https://ipv6.si>



# TIPI IPv6 NASLOVOV IN OBSEG DELOVANJA

- **Globalni naslovi**

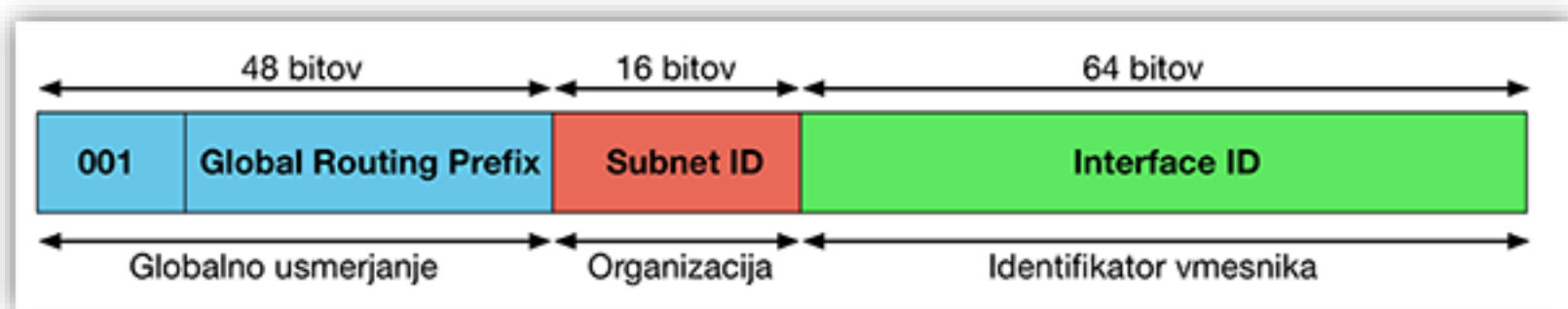
primer: [2001:1470:8000::66]

- **Link-local naslovi**

primer: [fe80::20c:29ff:fe83:59b5]

- **Loopback naslov**

primer: [::1/128]





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# NASLAVLJANJE NAPRAV V OMREŽJU

- Ročna nastavitvev
- Avtomatska nastavitvev z uporabo SLAAC
- Avtomatska nastavitvev z uporabo DHCPv6
- Samodejna nastavitvev Link-local naslovov



# ROČNA NASTAVITEV WINDOWS SISTEMOV

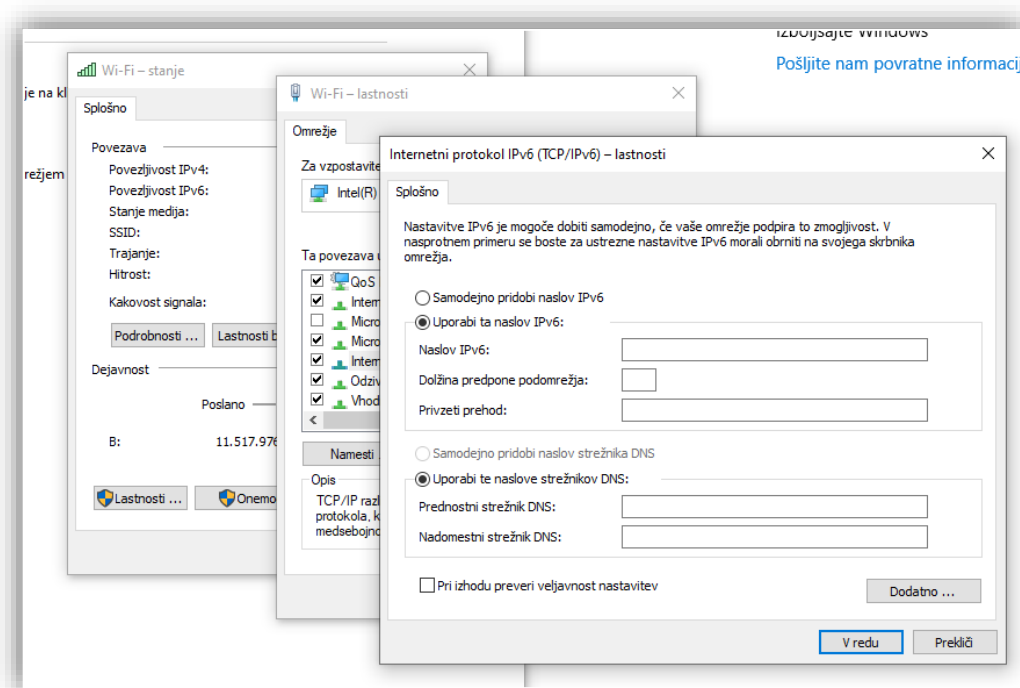
- Z grafičnim uporabniškim vmesnikom

- Netsh (se opušča)

- ▶ netsh interface ipv6 add address
- ▶ netsh interface ipv6 add route
- ▶ netsh interface ipv6 add dnsserver

- Powershell

- ▶ Get-NetAdapter
- ▶ New-NetIPAddress
- ▶ Set-DnsClientServerAddress





# ROČNA NASTAVITEV LINUX SISTEMOV

- Ubuntu
- CentOS

```
~$ cat /etc/network/interfaces
# This file describes the network interfaces available on your system
# and how to activate them. For more information, see interfaces(5).

source /etc/network/interfaces.d/*

# The loopback network interface
auto lo
iface lo inet loopback

# The primary network interface
auto ens3
iface ens3 inet dhcp

# IPv6
iface ens3 inet6 static
address 2001:1470: : :49
netmask 64
gateway 2001:1470: : :1
~$
```

```
[root@ ~]# cat /etc/sysconfig/network-scripts/ifcfg-eth0
DEVICE=eth0
BOOTPROTO=none
DNS1=193.2.1.66
HWADDR=
NM_CONTROLLED=yes
ONBOOT=yes
TYPE=Ethernet
IPV6INIT=yes
IPV6ADDR="2001:1470: : :e:248/64"
USERCTL=no
IPADDR=
NETMASK=255.255.255.128
GATEWAY=
[root@ ~]#
```



# ROČNA NASTAVITEV TISKALNIKOV - Kyocera

Nastavitve IPv6 (žično omrežje)

\*IPv6 :  Vkllop  Izklop

\*Naslov IP :

\*Dolžina predpone :

\*RA (brez stanja) :  Vkllop  Izklop

\*DHCPv6 (s stanjem) :  Vkllop  Izklop

\*Ime domene :

Nastavitve IPv6 (splošno)

\*Privzeta vrata :

\*Strežnik DNS :  Uporabi strežnik DNS iz protokola DHCP  
 Uporabi ta strežnik DNS

\*Strežnik DNS (glavni) :

\*Strežnik DNS (pomožni) :

\*Pripona iskanja strežnika DNS  Uporabi pripono iskanja strežnika DNS iz protokola DHCP  
 Uporabi spodnjo pripono iskanja strežnika DNS

\*Pripona iskanja strežnika DNS (glavna) :

\*Pripona iskanja strežnika DNS (pomožna) :



# ROČNA NASTAVITEV TISKALNIKOV - Canon

025 /

Settings/Registration: Preferences: Network Settings > IPv6 Settings > Edit IPv6 Settings

### Edit IPv6 Settings

Change the following settings.  
The following changes will be effective after the main power is turned OFF and ON.  
· IP Address Settings,DHCP Option Settings,DNS Settings

#### IP Address Settings

Use IPv6

Link-Local Address:  
Link-Local Address: fe80:0000:0000:0000:86ba:3bff:fe3a:7f13  
Prefix Length: 64

Use Stateless Address

Stateless Address 1:  
Stateless Address 1: 0000:0000:0000:0000:0000:0000:0000:0000  
Prefix Length 1: 0

Stateless Address 2:  
Stateless Address 2: 0000:0000:0000:0000:0000:0000:0000:0000  
Prefix Length 2: 0

Stateless Address 3:  
Stateless Address 3: 0000:0000:0000:0000:0000:0000:0000:0000  
Prefix Length 3: 0

Stateless Address 4:  
Stateless Address 4: 0000:0000:0000:0000:0000:0000:0000:0000  
Prefix Length 4: 0

Stateless Address 5:  
Stateless Address 5: 0000:0000:0000:0000:0000:0000:0000:0000  
Prefix Length 5: 0

Stateless Address 6:  
Stateless Address 6: 0000:0000:0000:0000:0000:0000:0000:0000  
Prefix Length 6: 0

Use Manual Address

IP Address: 2001:1470: :3100  
Prefix Length: 64 (0-128)  
Default Router Address: 2001:1470: :0001

Use DHCPv6

Stateful Address: 0000:0000:0000:0000:0000:0000:0000:0000  
Prefix Length: 0

#### DHCP Option Settings

Acquire DNS Server Address  
 Acquire Domain Name

#### DNS Settings

Primary DNS Server Address: 2001:1470: :0037  
Secondary DNS Server Address: 2001:1470: :0035

Use Same Host Name/Domain Name as IPv4

Host Name: IJC-3025i  
Domain Name:

DNS Dynamic Update

Register Manual Address  
 Register Stateful Address  
 Register Stateless Address

DNS Dynamic Update Interval: 24 hr. (0-48)



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# AVTOMATSKA NASTAVITEV SISTEMOV – SLAAC 1/2

(Stateless Autoconfiguration)

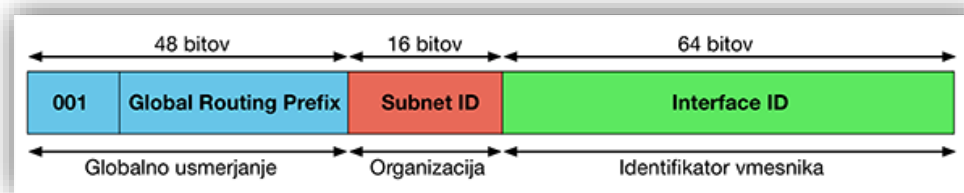
- Pomembno vlogo ima usmerjevalnik
- Sporočila RA (*Router Advertisement*)
- Omrežne predpone IPv6 (ipv6-prefix) in njihova dolžina (prefix-length)
- Čas veljavnosti predpone IPv6
- Podatek o rekurzivnem DNS strežniku



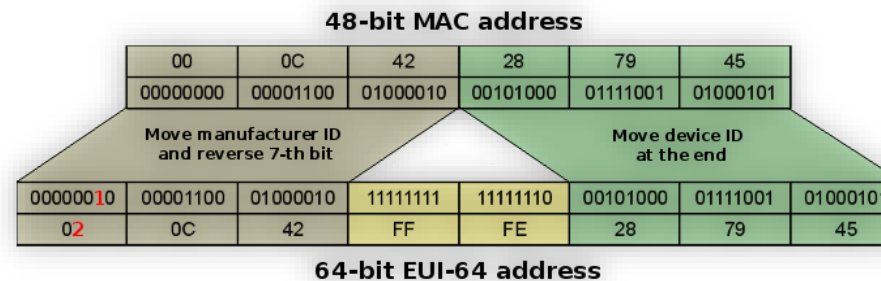
# AVTOMATSKA NASTAVITEV SISTEMOV – SLAAC 2/2

(Stateless Autoconfiguration)

- Metoda EUI-64
- IPv6 Privacy Extension



Vir: <https://ipv6.si>



Vir: <https://wiki.mikrotik.com/wiki/Manual:IPv6>



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## AVTOMATSKA NASTAVITEV SISTEMOV – DHCPv6

- Precej drugačen od DHCPv4 (nastavitve)
- Pomembno vlogo ima usmerjevalnik
- Parametri glede na zastavice v RA (M in O)
- IPv6 naslov
- DNS, NTP ...
- Privzeti prehod določi usmerjevalnik (z uporabo SLAAC)



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# SAMODEJNA NASTAVITEV LINK-LOCAL NASLOVA

- Naprava samodejno nastavi
- fe80::/64
- Link-Local naslov za vsak mrežni vmesnik



# PREVERJANJE NASTAVITEV WINDOWS SISTEMA

- Windows 10
- Ukaz: Ipconfig /all
- SLAAC
- DHCPv6
- Link-local

```
Ethernet adapter Ethernet 3:

Connection-specific DNS Suffix . . . : edsus.si
Description . . . . . : Realtek PCIe GBE Family Controller #2
Physical Address. . . . . : AA-7B
DHCP Enabled. . . . . : Yes
Autoconfiguration Enabled . . . . : Yes
IPv6 Address. . . . . : 2001:1470 :5c89(Preferred)
Lease Obtained. . . . . : torek, 04.
Lease Expires . . . . . : ponedeljek
IPv6 Address. . . . . : 2001:1470 :75cd:1155:e855:a675(Preferred)
Temporary IPv6 Address. . . . . : 2001:1470 :101c:b368:8c88:4ed(Preferred)
Link-local IPv6 Address . . . . . : fe80::75cd:1155:e855:a675%11(Preferred)
IPv4 Address. . . . . : (Preferred)
Subnet Mask . . . . . :
Lease Obtained. . . . . : petek, 31.
Lease Expires . . . . . : sobota, 15.
Default Gateway . . . . . : fe80::662:73ff:fe99:4e7f%11

DHCP Server . . . . . :
DHCPv6 IAID . . . . . : 83026
DHCPv6 Client DUID. . . . . : -81-AA-7B
DNS Servers . . . . . : 2001:1470 :78
                          2001:1470 :76
                          2001:1470:8000::66
                          2001:1470:8000::72

Primary WINS Server . . . . . :
Secondary WINS Server . . . . . :
NetBIOS over Tcpip. . . . . : Enabled
Connection-specific DNS Suffix Search List :
                                          edsus.si
```





# PREVERJANJE NASTAVITEV LINUX SISTEMOV

- CentOS
  - ▶ Ročno
  - ▶ Link-local

```
[root@ ~]# ip addr
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc mq state UP qlen 1000
    link/ether : brd ff:ff:ff:ff:ff:ff
    inet :248/25 brd :255 scope global eth0
    inet6 2001:1470 :e:248/64 scope global
        valid_lft forever preferred_lft forever
    inet6 fe80::211:aff:fe99:9a49/64 scope link
        valid_lft forever preferred_lft forever
3: eth1: <BROADCAST,MULTICAST> mtu 1500 qdisc noop state DOWN qlen 1000
    link/ether : brd ff:ff:ff:ff:ff:ff
[root@ ~]#
```



# PREVERJANJE NASTAVITEV LINUX SISTEMOV

- Ubuntu
  - ▶ Ročno
  - ▶ Link-local

```
~$ ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
2: ens3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default
    link/ether 82:00:20:08:00:02:53 brd ff:ff:ff:ff:ff:ff
    inet 192.168.1.100/24 scope global ens3
        valid_lft forever preferred_lft forever
    inet6 2001:1470:100:100::100/64 scope global
        valid_lft forever preferred_lft forever
    inet6 fe80::21a:53:253/64 scope link
        valid_lft forever preferred_lft forever
~$
```



# PREVERJANJE NASTAVITEV LINUX SISTEMOV

- CentOS

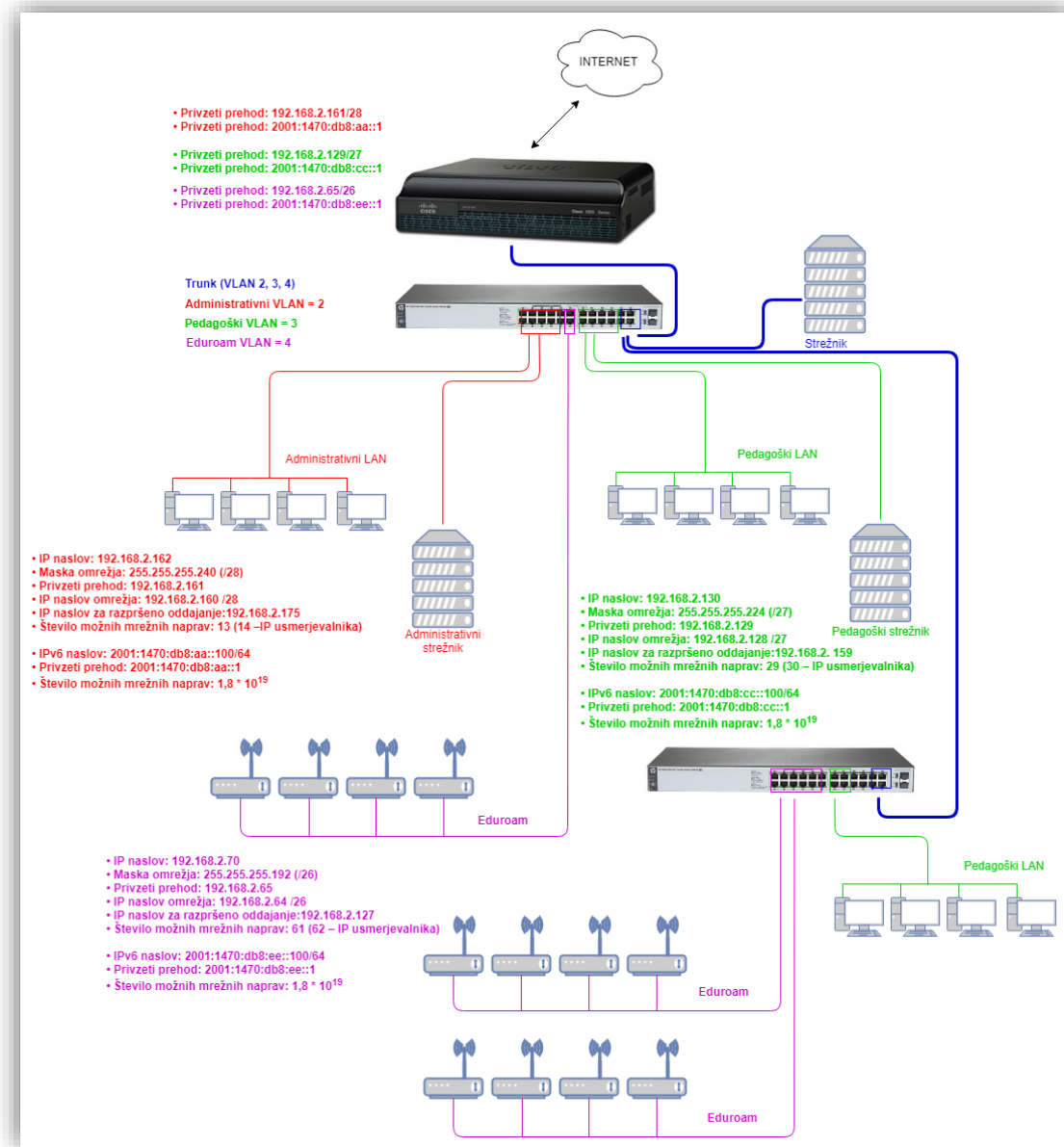
  - ▶ Prehod

```
[root@~]# ip -6 r s
unreachable ::/96 dev lo metric 1024 error -101 mtu 65536 advmss 65476 hoplimit 0
unreachable ::ffff:0.0.0.0/96 dev lo metric 1024 error -101 mtu 65536 advmss 65476 hoplimit 0
2001:1470:::/64 dev eth0 proto kernel metric 256 mtu 1500 advmss 1440 hoplimit 0
unreachable 2002:a00::/24 dev lo metric 1024 error -101 mtu 65536 advmss 65476 hoplimit 0
unreachable 2002:7f00::/24 dev lo metric 1024 error -101 mtu 65536 advmss 65476 hoplimit 0
unreachable 2002:a9fe::/32 dev lo metric 1024 error -101 mtu 65536 advmss 65476 hoplimit 0
unreachable 2002:ac10::/28 dev lo metric 1024 error -101 mtu 65536 advmss 65476 hoplimit 0
unreachable 2002:c0a8::/32 dev lo metric 1024 error -101 mtu 65536 advmss 65476 hoplimit 0
unreachable 2002:e000::/19 dev lo metric 1024 error -101 mtu 65536 advmss 65476 hoplimit 0
unreachable 3ffe:ffff::/32 dev lo metric 1024 error -101 mtu 65536 advmss 65476 hoplimit 0
fe80::/64 dev eth0 proto kernel metric 256 mtu 1500 advmss 1440 hoplimit 0
default via 2001:1470::1 dev eth0 metric 1 mtu 1500 advmss 1440 hoplimit 0
[root@~]#
```

- Ubuntu

  - ▶ Prehod

```
~$ ip -6 route show
2001:1470:::/64 dev ens3 proto kernel metric 256 pref medium
fe80::/64 dev ens3 proto kernel metric 256 pref medium
default via 2001:1470::1 dev ens3 metric 1024 pref medium
~$
```





# KJE NAJDEM PODATKE O NAŠIH NASLOVIH?

- Delni podatki na <https://portal.arnes.si>
- Podrobnejši podatki na <https://automator.arnes.si>

Portal članic - IP registracija

Moje članice

Seznam zahtevkov/omrežij članic, za katere ste upravitelj

Članica

Osnovna šola

Osnovna šola

KONTAKTI

ARNES, p.p., 7, 1001 Ljubljana, Slovenija

indj@arnes.si

(01) 479 88 00

(01) 479 88 01

POMOČ

ip-reg@arnes.si

POVEZAVE

Arnes

Osnovni podatki

Kontakti

Lokacija

RSS

arnes OEANT register.si si-cert

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Automator

Osnovna šola

Uporabniška omrežja

ID	IP	Ime	Status	Akcije
...	...	...	...	...
...	...	...	...	...

Omrežja

Podrobnosti

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# VIRI

- Understanding IPv6, Microsoft Press
- <https://ipv6.si/protokol-ipv6/>
- <https://en.wikipedia.org/wiki/IPv6>
- [https://en.wikipedia.org/wiki/IPv6\\_address](https://en.wikipedia.org/wiki/IPv6_address)
- <https://wiki.mikrotik.com/wiki/Manual:IPv6/Address>
- <https://www.ripe.net/about-us/press-centre/understanding-ip-addressing>