



UNIVERSITY OF ŽILINA  
Faculty of Management Science  
and Informatics

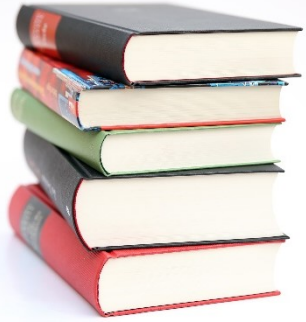
# DHCPv4, DHCPv6

## Počítačové siete 1

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# Čo nás dnes čaká

- **Dokončenie z predošlej prednášky:**
  - IPv6 ACLs
- **DHCPv4**
  - Komponenty, činnosť, správy
  - Konfigurácia
- **Multicastové IPv6 adresy (pripomienka)**
- **DHCPv6**
  - Dynamické pridelovanie IPv6 adries
    - SLAAC
    - Stateless DHCPv6
    - Statefull DHCPv6
  - Konfigurácia

(RSE\_08 DHCP)



## Reakcia na otázku v ankete k predošlej prednáške - ACL

„Aký je rozdiel medzi ACL a firewall-om ?“

## Definovanie objektov na Cisco ASA (KIS sieť)

### **object network KIS-VLAN-110-IPv4**

```
subnet 192.168.110.0 255.255.255.0
```

```
description KIS WIFI VLAN 192.168.110.0/24
```

### **object network NAT-POOL-NEW**

```
range 158.193.152.81 158.193.152.94
```

```
description KIS OUTSIDE NAT POOL 158.193.152.80/28
```

### **object network KIS-VLAN-30-IPv4**

```
subnet 192.168.30.0 255.255.255.0
```

```
description KIS ECDL VLAN 192.168.30.0/24
```

## Definovanie ACL na Cisco ASA (KIS sieť)

```
access-list vlan10_multicast standard permit host 233.10.47.10
access-list VLAN10-IN extended permit ip object-group WIFI-APS object
KIS-WLC-Int
access-list VLAN10-IN extended deny ip object KIS-VLAN-10-IPv4 object
KIS-VLAN-255-IPv4
access-list VLAN10-IN extended permit ip object KIS-VLAN-10-IPv4 any
access-list VLAN255-IN extended permit ip any any
access-list VPN-DISABLED-NAT extended permit ip object KIS-VLAN-10-IPv4
object KIS-VPN-NET
access-list VPN-DISABLED-NAT extended permit ip object KIS-VLAN-255-IPv4
object KIS-VPN-NET
access-list VPN-ALLOWED-NETWORKS standard permit 192.168.10.0
255.255.255.0
access-list VPN-ALLOWED-NETWORKS standard permit 192.168.255.0
255.255.255.0
```

## Aký je rozdiel medzi ACL a firewall-om

# Web GUI na Cisco ASA (KIS siet')

The screenshot displays the Cisco ASDM 7.6(1) for ASA - 192.168.10.1 interface. The main window shows the 'Configuration > Firewall > Access Rules' page. The left sidebar contains a tree view with 'Access Rules' selected. The main area shows a table of access rules with columns for #, Enabled, Source Criteria, Destination Criteria, Service, Action, Hits, and Logging. The table lists 16 rules, including a deny rule for SSH (rule 2) and several permit rules for various services like SSH, WEB, and CAPWAP. The right sidebar shows the 'Addresses' section with a list of network objects.

#	Enabled	Source Criteria:	Destination Criteria:	Service	Action	Hits	Logging
1		any	Any less secure ne...				
mgmt (0 implicit incoming rules)							
outside (36 incoming rules)							
1	<input checked="" type="checkbox"/>	block_address	any				
2	<input checked="" type="checkbox"/>	any	SSH-PRISTUP-64	IP ip	Deny	7701	disa..
3	<input checked="" type="checkbox"/>	any	WEB-PRISTUP-64	SSH	Permit	TOP 10 29...	
4	<input checked="" type="checkbox"/>	any	158.193.138.32	WEB	Permit	TOP 10 11...	
5	<input type="checkbox"/>	any	CLOUD-PUBLIC-NET	SERV_ASA	Permit	0	
6	<input checked="" type="checkbox"/>	any	CASTOR-64	IP ip	Permit	0	
7	<input type="checkbox"/>	any	NLAB-64	SERV_CASTOR	Permit	TOP 10 36...	
8	<input checked="" type="checkbox"/>	KIS-LWAPs-Ext	KIS-WLC-Ext	SERV_NLAB	Permit	0	
9	<input checked="" type="checkbox"/>	KIS-LWAPs-Ext	KIS-WLC-Int	CAPWAP	Permit	0	
10	<input checked="" type="checkbox"/>	158.193.139.100	192.168.255.9	CAPWAP	Permit	19	
11	<input checked="" type="checkbox"/>	158.193.139.100	158.193.152.9	IP ip	Permit	0	
12	<input checked="" type="checkbox"/>	KIS-AP5	158.193.152.9	IP ip	Permit	0	
13	<input checked="" type="checkbox"/>	KIS-AP5	192.168.255.9	UDP 12222-12223	Permit	0	
14	<input checked="" type="checkbox"/>	Laboratoria-4	158.193.152.2	UDP 12222-12223	Permit	0	
15	<input checked="" type="checkbox"/>	Laboratoria-4	158.193.152.2	UDP 445	Permit	0	
16	<input checked="" type="checkbox"/>	Uniza	SUCH-SERVER	UDP 445	Permit	11	

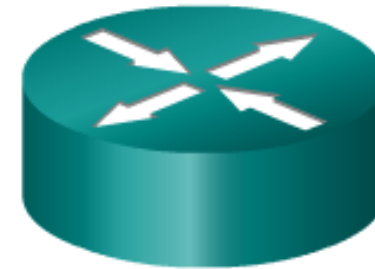


# IPv6 ACL

# Porovnanie IPv4 a IPv6 ACLs

Sú podobné, ale tieto 3 veci sú v IPv6 inak:

- Aplikovanie IPv6 ACL príkazom:
  - **ipv6 traffic-filter**
- Nepoužíva wildcard masky
  - Používa sa **prefix-length**
- Má niektoré podmienky navyše
  - permit icmp any any **nd-na**
  - permit icmp any any **nd-ns**



## IPv4 ACLs

- Standard
  - Numbered
  - Named
- Extended
  - Numbered
  - Named

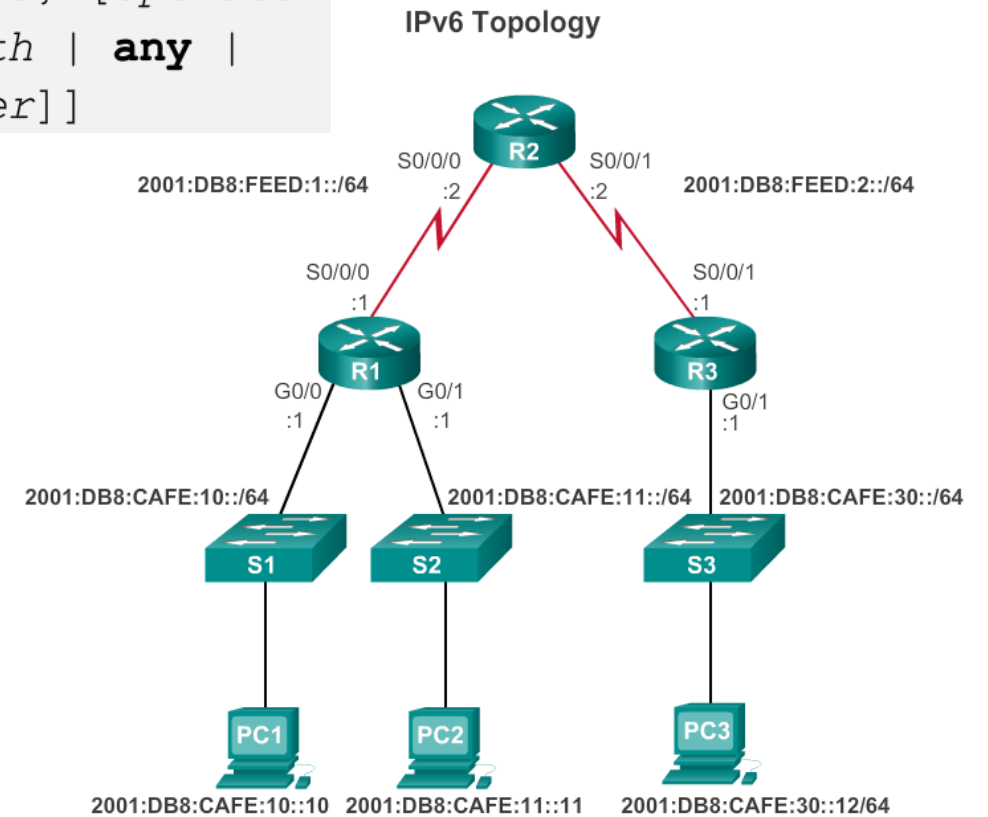
## IPv6 ACLs

- Named only
- Similar in functionality to IPv4 Extended ACL



# Konfigurácia IPv6 ACLs

```
R1(config)# ipv6 access-list access-list-name  
R1(config-ipv6-acl)# deny | permit protocol {source-ipv6-  
prefix/prefix-length | any | host source-ipv6-address} [operator  
[port-number]] {destination-ipv6-prefix/prefix-length | any |  
host destination-ipv6-address} [operator [port-number]]
```



```
R1(config)# interface s0/0/0  
R1(config-if)# ipv6 traffic-filter NO-R3-LAN-ACCESS in
```

# IPv6 ACL příklady

```
R1 (config) # ipv6 access-list NO-R3-LAN-ACCESS  
R1 (config-ipv6-acl) # deny ipv6 2001:db8:cafe:30::/64 any  
R1 (config-ipv6-acl) # permit ipv6 any any
```

```
R1 (config) # interface s0/0/0  
R1 (config-if) # ipv6 traffic-filter NO-R3-LAN-ACCESS in
```

```
R1 (config) # ipv6 access-list NO-FTP-TO-11  
R1 (config-ipv6-acl) # deny tcp any 2001:db8:cafe:11::/64 eq ftp  
R1 (config-ipv6-acl) # deny tcp any 2001:db8:cafe:11::/64 eq ftp-data  
R1 (config-ipv6-acl) # permit ipv6 any any  
R1 (config-ipv6-acl) # exit  
R1 (config) # interface g0/0  
R1 (config-if) # ipv6 traffic-filter NO-FTP-TO-11 in
```

# IPv6 ACL příklady

```
ipv6 access-list RESTRICTED-ACCESS
pv6-acl) # remark Permit access only HTTP and HTTPS to Network 10
pv6-acl) # permit tcp any host 2001:db8:cafe:10::10 eq 80
pv6-acl) # permit tcp any host 2001:db8:cafe:10::10 eq 443 ] 1
pv6-acl) # remark Deny all other traffic to Network 10
pv6-acl) # deny ipv6 any 2001:db8:cafe:10::/64 2
pv6-acl) # remark Permit PC3 telnet access to PC2
pv6-acl) # permit tcp host 2001:DB8:CAFE:30::12 host 2001:DB8:CAFE:11::11 eq 23
pv6-acl) # remark Deny telnet access to PC2 for all other devices
pv6-acl) # deny tcp any host 2001:db8:cafe:11::11 eq 23 4
pv6-acl) # remark Permit access to everything else
pv6-acl) # permit ipv6 any any 5
pv6-acl) # exit
interface g0/0
f) # ipv6 traffic-filter RESTRICTED-ACCESS in 6
a) #
```

# Overenie IPv6 ACLs

```
R3#show ipv6 interface g0/0
GigabitEthernet0/0 is up, line protocol is up
  Global unicast address(es):
    2001:DB8:CAFE:30::1, subnet is 2001:DB8:CAFE:30::/64
  Input features: Access List
  Inbound access list RESTRICTED-ACCESS
<some output omitted for brevity>
```

```
R3#show access-lists
IPv6 access list RESTRICTED-ACCESS
  permit tcp any host 2001:DB8:CAFE:10::10 eq www sequence 20
  permit tcp any host 2001:DB8:CAFE:10::10 eq 443 sequence 30
  deny ipv6 any 2001:DB8:CAFE:10::/64 sequence 50
  permit tcp host 2001:DB8:CAFE:30::12 host 2001:DB8:CAFE:11::11 eq
telnet sequence 70
  deny tcp any host 2001:DB8:CAFE:11::11 eq telnet sequence 90
  permit ipv6 any any sequence 110
R3#
```



# Dynamic Host Configuration Protocol DHCPv4

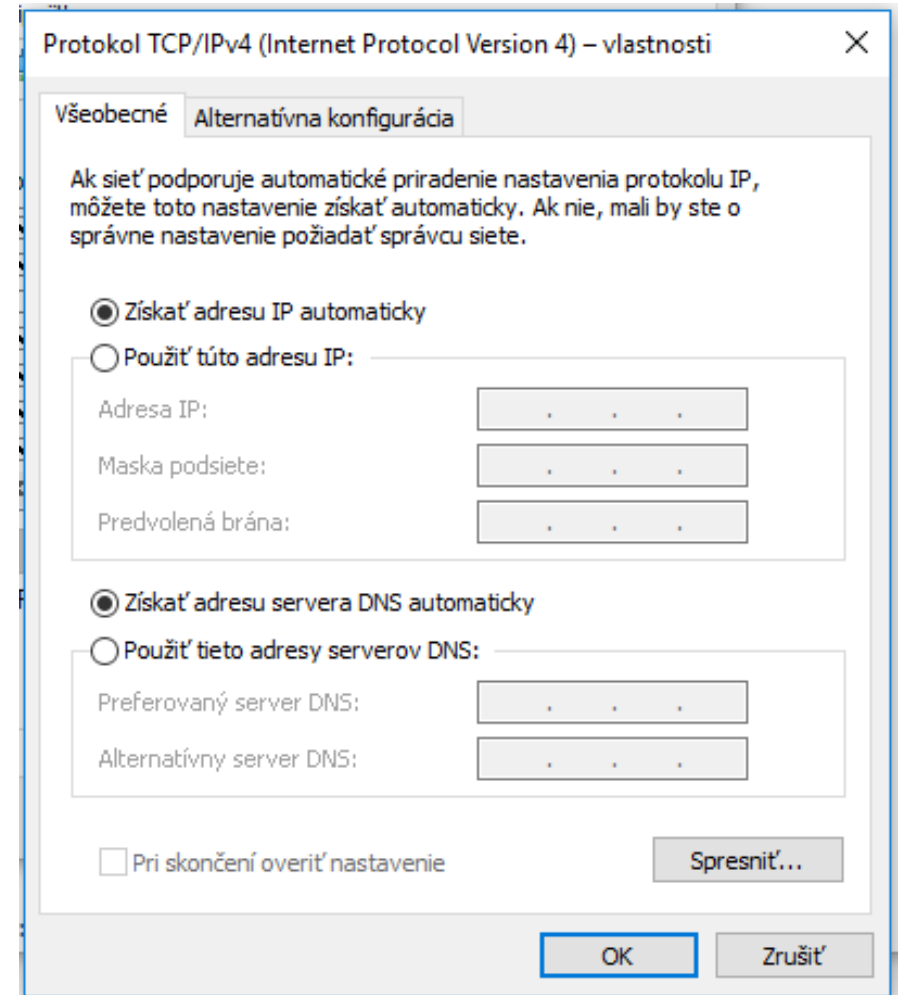
**RFC 2131**

# Dynamická konfigurácia hostov

- Pomocou doplnkovej sieťovej služby
  - Musí byť v sieti nainštalovaná, nakonfigurovaná a spustená
- Historický vývoj:
  - A) Reverse Address Resolution Protocol (**RARP**):
    - Klient/Server dotazovanie, získa len vlastnú adresu; treba nakonfigurovať RARP table
  - B) BOOTstrap Protocol (**BOOTP**):
    - K/S, stanica získa okrem svojej IP adresy aj adresu smerovača, servera
    - Obmedzený počet konfig. parametrov (vendor extensions)
    - Používa 2-fázový konfig. proces
    - klient nerobi rebind/renew konfiguráciu so serverom, okrem restartu
  - C) Dynamic Host Configuration protocol (**DHCP**):
    - K/S, stanici pridelená adresa len kým komunikuje, pri novom prihlásení nová adresa
    - Používa 1-fázový konfig. proces (negociácia IP aj všetkého ostatného info)
    - Široká množina konfig. Parametrov (options)
    - neptorebuje restart, rebind/renew sa deje automaticky, po istom časovom intervale

# Dynamic Host Configuration Protocol

- Klient / Server protokol
- Umožňuje klientom (koncovým staniciam) vyžiadať od DHCP servera konfiguračné parametre
  - Servery a smerovače by mali mať statické IP adresy
    - Vieme prečo?
- Najpoužívanejšie parametre
  - IP adresa, sieťová maska, IP adresa default gateway, IP adresa DNS servera
- **DHCP komponenty**
  - DHCP klient
    - Má ho väčšina moderných OS
  - DHCP Server
  - Relay Agent
    - Prechod DHCP žiadosti cez smerovač



# DHCP komponenty

## ▪ DHCP klient

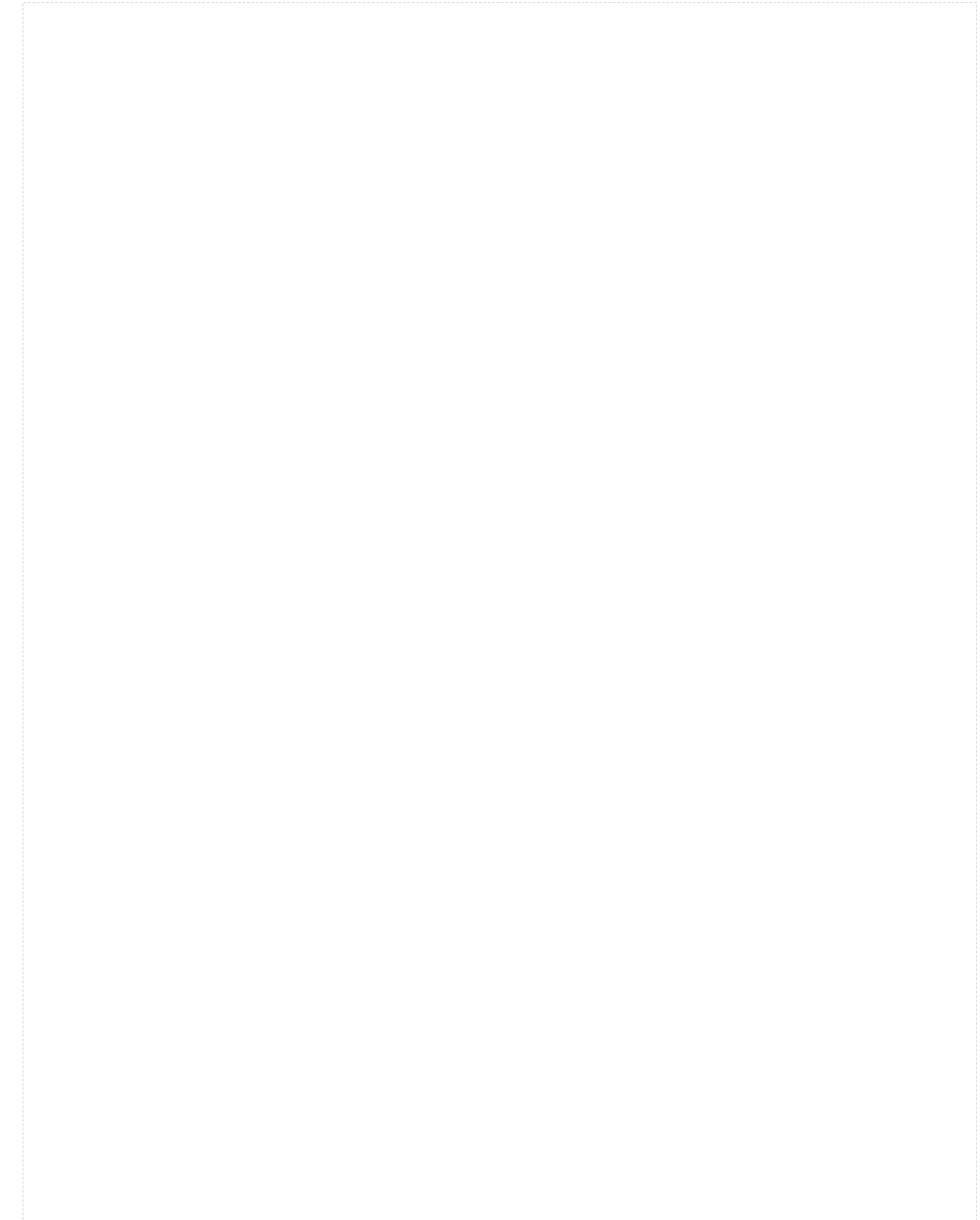
- Žiada o konfiguračné parametre DHCP server
  - L2 Broadcast
- OS Windows:
  - Môžeme riadiť príkazom ipconfig

## ▪ DHCP Server

- Serverovská entita
  - Proces môže byť spustený na smerovači alebo na dedikovanom serveri
- Spravuje IP adresnú množinu
  - a iné konfiguračné parametre
- Prideluje ich na požiadanie DHCP klientom

## ▪ Relay agent

- Umožňuje prechod DHCP žiadostí cez L3 zariadenie





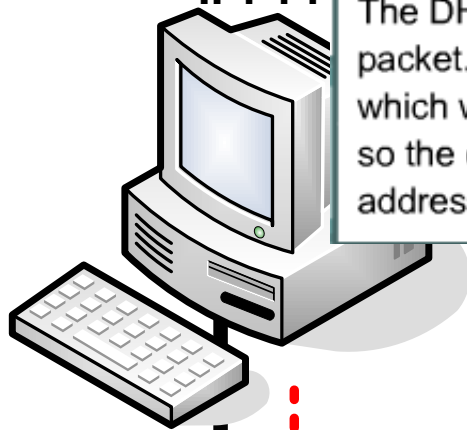
# Alokácia IP adresy cez DHCP

- **Dynamická** Alokácia
  - Pridelí IP adresu žiadajúcej stanici na špecifikované časové obdobie (lease - limited)
  - Potom nastáva uvoľnenie adresy alebo obnovenie prenájmu
- **Automatická** Alokácia
  - DHCP server priradí automaticky stanici permanentnú statickú adresu z rozsahu (lease - unlimited)
- **Manuálna** Alokácia
  - Vyžaduje konfiguráciu DHCP servera
  - Pridelí žiadajúcej stanici vždy rovnakú IP adresu (MAC-IP), ktorú klient nevracia



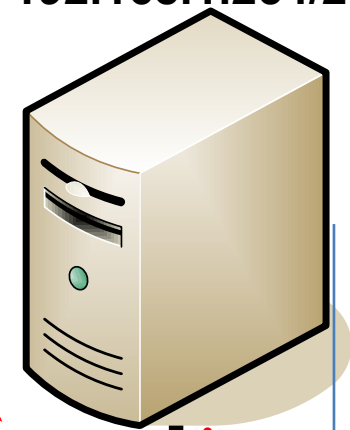
# Client A

IP: ??



The DHCP Client sends a directed IP broadcast, with a DHCP request packet. In the simplest case, there is a DHCP server on the same segment, which will pick up this request. The server notes the GIADDR field is blank, so the client is on the same segment. The server also notes the hardware address of the client in the request packet.

# Server 192.168.1.254/24



# DHCP činnost

Ethernet II Frame

IP

UDP

DHCP Discover

SRC MAC: MAC A	SRC IP: ?	UDP	CIADR: ?	GIADDR: ?
DST MAC: FF:FF:FF:FF:FF:FF	DST IP: 255.255.255.255	67	Mask: ?	CHADDR: MAC A

DHCP Offer

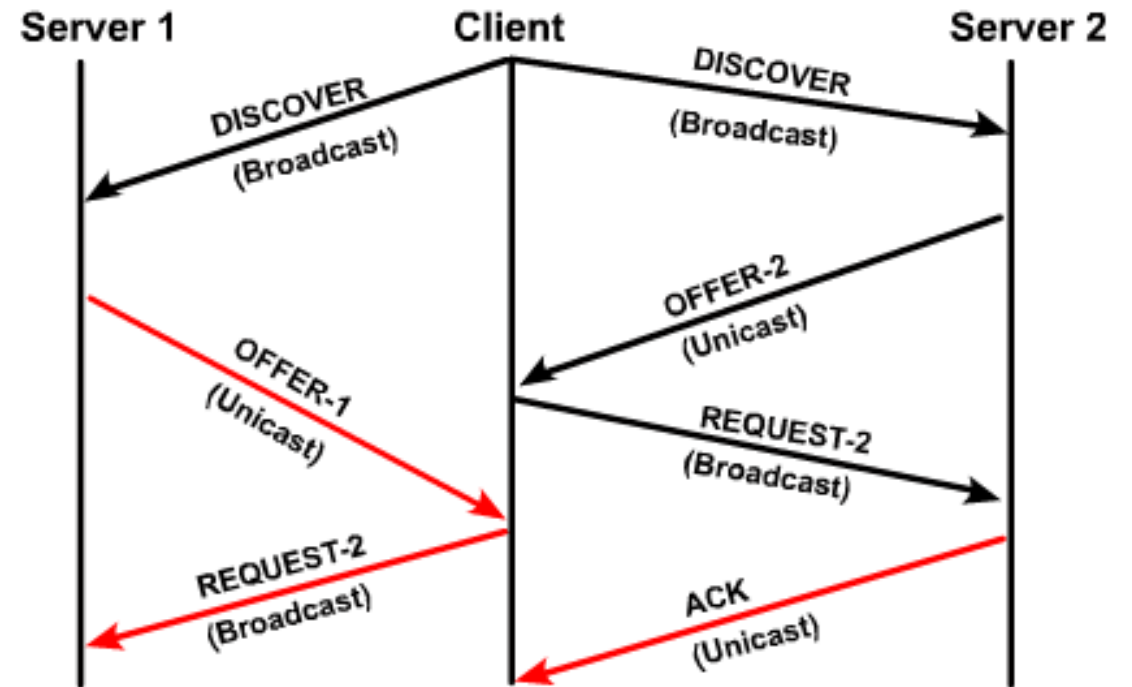
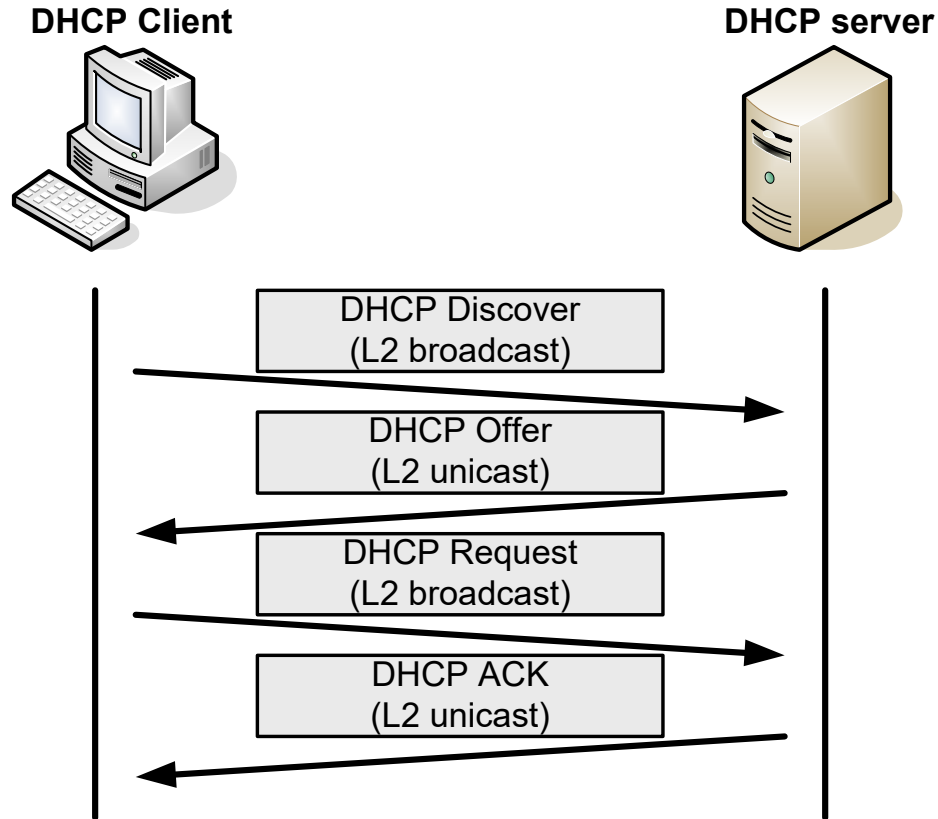
SRC MAC: MAC DHCP Serv	SRC IP: 192.168.1.254	UDP	CIADR: 192.168.1.10	GIADDR: 192.168.1.1
DST MAC: MAC A	DST IP: 192.168.1.10	68	Mask: 255.255.255.0	CHADDR: MAC A

MAC: Media Access Control Address  
 CIADDR: Client IP Address  
 GIADDR: Gateway IP Address  
 CHADDR: Client Hardware Address

The DHCP server picks an IP address from the available pool for that segment, as well as the other segment and global parameters. It puts them into the appropriate fields of the DHCP packet. It then uses the hardware address of A (in CHADDR) to construct an appropriate frame to send back to the client.

# DHCP činnosť - DORA

- Môže klient dostať viac ponúk?

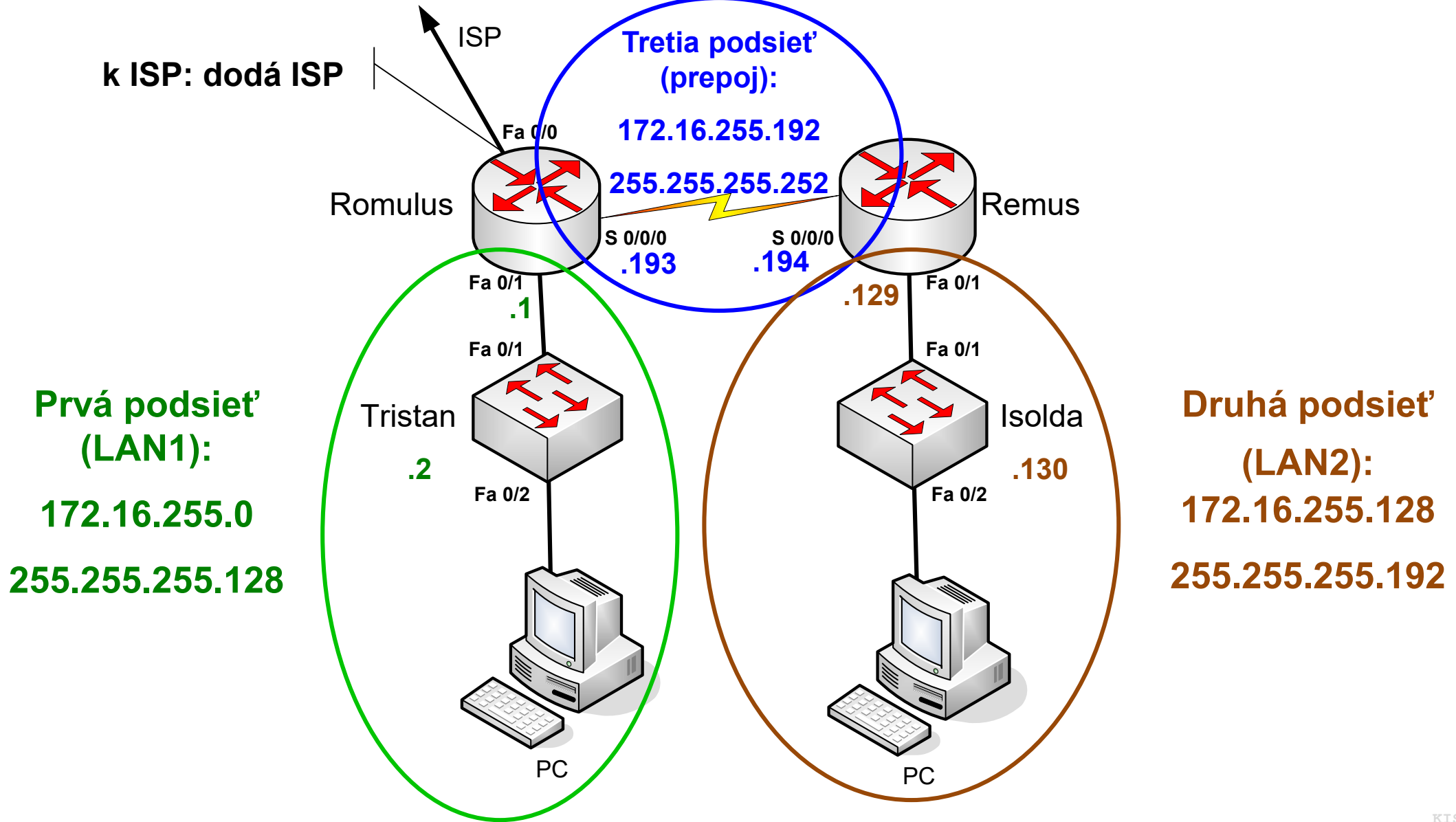


- Discover – niekedy už môže byť s návrhom IP adresy – **uvažujeme kedy asi?**
- Request – **uvažujeme prečo broadcastom?**
- ACK – iba výnimočne server pošle NACK - **uvažujeme kedy asi?**

# Konfigurácia DHCP servera na smerovači Cisco

- Konfigurácia DHCP servera sa vykonáva **v GKR**
- Pozostáva z viacerých krokov:
  - **Spustenie** služby a **pomenovanie** konfigurácie
    - Na jednom smerovači môže byť spravovaných viac DHCP rozsahov
  - Nastavenie **parametrov** DHCP služby
    - IP rozsah, z ktorého sa budú prideľovať adresy a sieťové masky
    - Adresa defaultného gateway-a
    - Adresa DNS servera
    - Iných parametrov
      - DHCP parametrov je až okolo 50

# Príklad: Nakonfiguruj DHCP server pre LAN1



# Konfigurácia DHCP servera na smerovači Cisco

```
Romulus (config) #ip dhcp pool MOJ_DHCP
```

- Spustenie DHCP služby a pomenovanie adresného rozsahu („pool“)
  - Zmenil sa prompt
  - Som v submóde konfigurácie DHCP služby

```
Romulus (dhcp-config) #network 172.16.255.0 255.255.255.128  
Romulus (dhcp-config) #default-router 172.16.255.1  
Romulus (dhcp-config) #dns-server 195.146.132.59  
Romulus (dhcp-config) #exit
```

- Nastavenie adresného rozsahu, ktorý bude DHCP služba riadiť pri pridelovaní IP adries
- Nastavenie defaultného gateway-a pre klientov

# Zoznam iných parametrov

```
Romulus (dhcp-config) #?
```

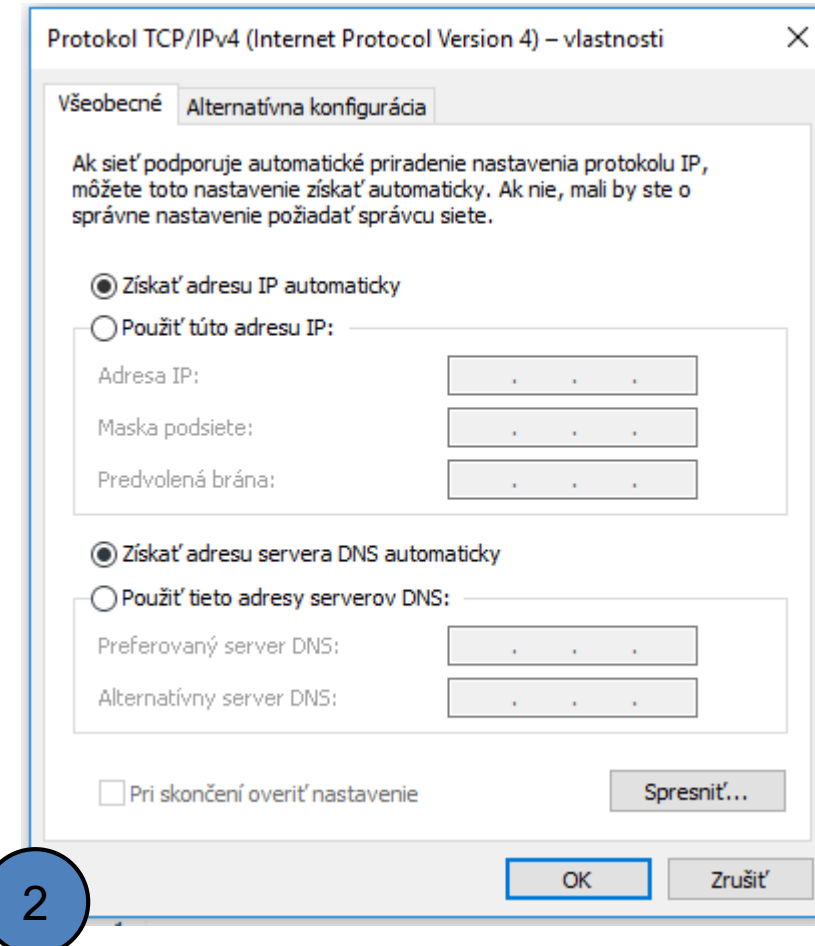
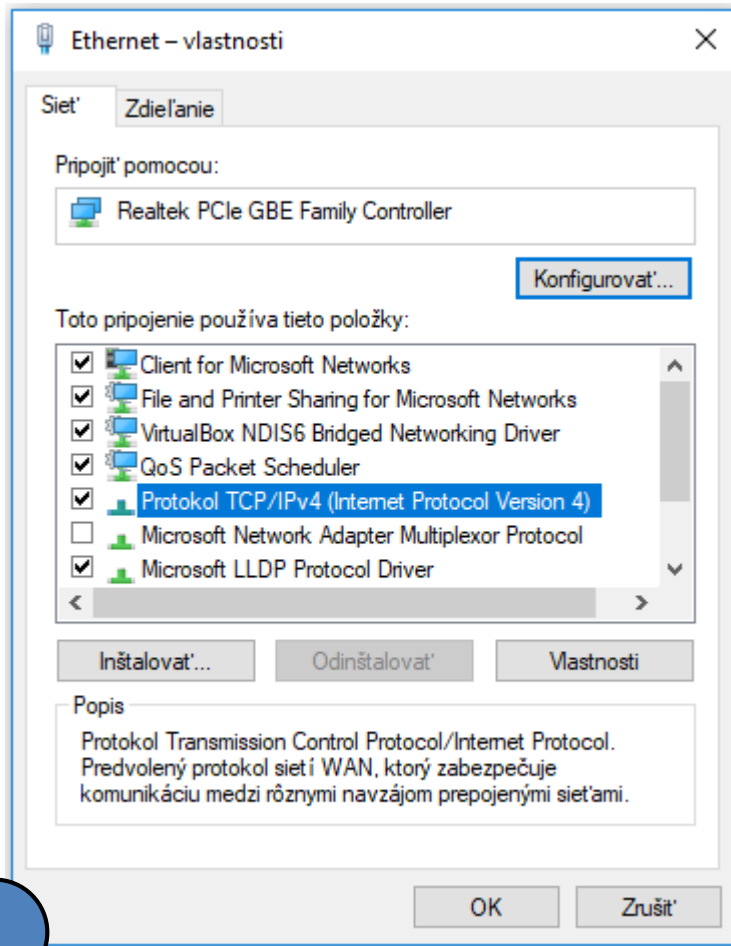
```
DHCP pool configuration commands:
```

```
accounting      Send Accounting Start/Stop messages
bootfile        Boot file name
class           Specify a DHCP class
client-identifier Client identifier
client-name     Client name
default-router  Default routers
dns-server      DNS servers
domain-name     Domain name
exit            Exit from DHCP pool configuration mode
hardware-address Client hardware address
host            Client IP address and mask
import          Programatically importing DHCP option parameters
lease           Address lease time
netbios-name-server NetBIOS (WINS) name servers
netbios-node-type NetBIOS node type
network         Network number and mask
next-server     Next server in boot process
no              Negate a command or set its defaults
option          Raw DHCP options
origin          Configure the origin of the pool
relay          Function as a DHCP relay
--More--
```

## DHCPv4

# Nastavenie DHCP klienta v OS Windows 10

- Start → Control Panel → Network connections → right click on an interface → Choose properties





# ipconfig

```
C:\Users\janau>ipconfig /?
```

```
USAGE:
```

```
ipconfig [/allcompartments] [/? | /all |  
/renew [adapter] | /release [adapter] |  
/renew6 [adapter] | /release6 [adapter] |  
/flushdns | /displaydns | /registerdns |  
/showclassid adapter |  
/setclassid adapter [classid] |  
/showclassid6 adapter |  
/setclassid6 adapter [classid] ]
```

```
where
```

```
adapter          Connection name  
(wildcard characters * and ? allowed, see examples)
```

```
Options:
```

```
/?              Display this help message  
/all           Display full configuration information.  
/release       Release the IPv4 address for the specified adapter.  
/release6      Release the IPv6 address for the specified adapter.  
/renew         Renew the IPv4 address for the specified adapter.  
/renew6        Renew the IPv6 address for the specified adapter.  
/flushdns      Purges the DNS Resolver cache.  
/registerdns   Refreshes all DHCP leases and re-registers DNS names  
/displaydns    Display the contents of the DNS Resolver Cache.  
/showclassid   Displays all the dhcp class IDs allowed for adapter.  
/setclassid    Modifies the dhcp class id.  
/showclassid6 Displays all the IPv6 DHCP class IDs allowed for adapter.  
/setclassid6   Modifies the IPv6 DHCP class id.
```

The default is to display only the IP address, subnet mask and default gateway for each adapter bound to TCP/IP.

For Release and Renew, if no adapter name is specified, then the IP address leases for all adapters bound to TCP/IP will be released or renewed.

```
C:\Users\janau>ipconfig /all
```

## Overenie získanej IP adresy **ipconfig**

### Windows IP Configuration

Wireless LAN adapter Wi-Fi:

```
Connection-specific DNS Suffix . . . :  
Description . . . . . : Intel(R) Dual Band Wireless-AC 3160  
Physical Address. . . . . : D0-7E-35-E7-0E-37  
DHCP Enabled. . . . . : Yes  
Autoconfiguration Enabled . . . . . : Yes  
IPv6 Address. . . . . : 2001:acad::acad:1(Preferred)  
Link-local IPv6 Address . . . . . : fe80::6ce4:4b68:db81:65ec%8(Preferred)  
IPv4 Address. . . . . : 192.168.100.6(Preferred)  
Subnet Mask . . . . . : 255.255.255.0  
Lease Obtained. . . . . : Friday, November 10, 2017 8:47:38 AM  
Lease Expires . . . . . : Friday, November 17, 2017 3:16:53 AM  
Default Gateway . . . . . : fe80::1%8  
                               192.168.100.1  
DHCP Server . . . . . : 192.168.100.1  
DHCPv6 IAID . . . . . : 147881525  
DHCPv6 Client DUID. . . . . : 00-01-00-01-1C-8D-36-AF-F0-76-1C-6C-8A-66  
DNS Servers . . . . . : 192.168.100.1  
NetBIOS over Tcpi . . . . . : Enabled
```

# Overenie nastavenia DHCP na smerovači

```
Romulus#sh run
Building configuration...

Current configuration : 859 bytes
!
version 12.4
!
Output omitted
!
!
ip dhcp pool Moj_DHCP
  network 172.16.255.0 255.255.255.128
  default-router 172.16.255.1
  dns-server 195.146.132.59
!
!
Output omitted
!
```

# Overenie činnosti DHCP na smerovači

- Výpis zoznamu pridelených IP adries

```
Romulus#show ip dhcp binding
```

```
Bindings from all pools not associated with VRF:
```

IP address	Client-ID/ Hardware address/ User name	Lease expiration	Type
172.16.255.2	0100.1c23.203a.28	Nov 15 2018 09:23 AM	Automatic

# Vymazanie DHCP štatistík

```
Romulus# show ip dhcp binding
```

```
Bindings from all pools not associated with VRF:
```

IP address	Client-ID/ Hardware address/ User name	Lease expiration	Type
172.16.255.2	0100.1c23.203a.28	Jan 10 2008 09:23 AM	Automatic

```
Romulus# clear ip dhcp binding
```

```
% Incomplete command.
```

```
Romulus# clear ip dhcp binding *
```

```
Romulus# show ip dhcp binding
```

```
Bindings from all pools not associated with VRF:
```

IP address	Client-ID/ Hardware address/ User name	Lease expiration	Type
------------	--	------------------	------

# Vyňatie určitého rozsahu IP adries z DHCP rozsahu

- Konfiguruje sa v GKR móde
- Využitie ak chcem vyčleniť z adresného priestoru DHCP servera časť adries ktoré sa nebudú dynamicky prideľovať
  - Napr. prvých 50 adries

```
Romulus#configure terminal  
Romulus (config)#ip dhcp excluded-address 172.16.255.1 172.16.255.50  
Romulus (config)#
```

Od: Dolná  
IP adressa

Do: Horná  
IP adressa

# Uvoľnenie (release) a vyžiadanie novej IP adresy

```
C:\Users\janau>ipconfig /release
```

```
Windows IP Configuration
```

```
Wireless LAN adapter Wi-Fi:
```

```
Connection-specific DNS Suffix . :  
Link-local IPv6 Address . . . . . : fe80::dc70:91f4:262f:5e94%4  
Default Gateway . . . . . : fe80::1%4
```

```
C:\Users\Janka>ipconfig /renew
```

```
Windows IP Configuration
```

```
Wireless LAN adapter Wi-Fi:
```

```
Connection-specific DNS Suffix . :  
Link-local IPv6 Address . . . . . : fe80::dc70:91f4:262f:5e94%4  
IPv4 Address. . . . . : 192.168.100.15  
Subnet Mask . . . . . : 255.255.255.0  
Default Gateway . . . . . : fe80::1%4  
192.168.100.1
```

# Diagnostika DHCP

```
Romulus# debug ip dhcp server events
```

```
Romulus#
```

```
*Jan 9 10:02:16.063: DHCPD: Sending notification of DISCOVER:  
*Jan 9 10:02:16.063: DHCPD: htype 1 chaddr 001c.2320.3a28  
*Jan 9 10:02:16.063: DHCPD: remote id 020a0000ac10ff0101000000  
*Jan 9 10:02:16.063: DHCPD: circuit id 00000000  
*Jan 9 10:02:16.063: DHCPD: Seeing if there is an internally  
specified pool class:  
*Jan 9 10:02:16.063: DHCPD: htype 1 chaddr 001c.2320.3a28  
*Jan 9 10:02:16.063: DHCPD: remote id 020a0000ac10ff0101000000  
*Jan 9 10:02:16.063: DHCPD: circuit id 00000000  
*Jan 9 10:02:18.063: DHCPD: client requests 172.16.255.51.  
*Jan 9 10:02:18.063: DHCPD: Adding binding to radix tree  
(172.16.255.51)  
*Jan 9 10:02:18.063: DHCPD: Adding binding to hash tree  
*Jan 9 10:02:18.063: DHCPD: assigned IP address 172.16.255.51 to  
client 0100.1c23.203a.28.
```

```
...  
Output omitted
```



# Štatistiky

```
Remulus# sh ip dhcp server statistics
```

```
Memory usage          23340
Address pools         1
Database agents       0
Automatic bindings    1
Manual bindings       0
Expired bindings      0
Malformed messages   0
Secure arp entries    0
```

```
Message                Received
BOOTREQUEST            0
DHCPDISCOVER           1
DHCPREQUEST            2
DHCPDECLINE            0
DHCPRELEASE            0
DHCPINFORM             0
```

```
Message                Sent
BOOTREPLY              0
DHCPOFFER              1
DHCPACK                2
DHCPNAK                0
```

# Stav adresného rozsahu

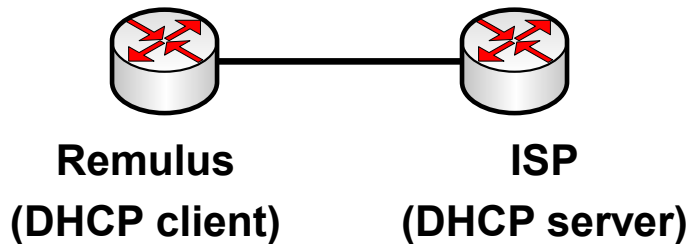
```
Remulus# sh ip dhcp pool
```

```
Pool Moj DHCP :
```

```
Utilization mark (high/low)      : 100 / 0  
Subnet size (first/next)          : 0 / 0  
Total addresses                   : 126  
Leased addresses                  : 1  
Pending event                     : none  
1 subnet is currently in the pool :
```

Current index	IP address range	Leased addresses
172.16.255.3	172.16.255.1 - 172.16.255.126	1

# Konfigurácia dynamickej adresy na smerovači

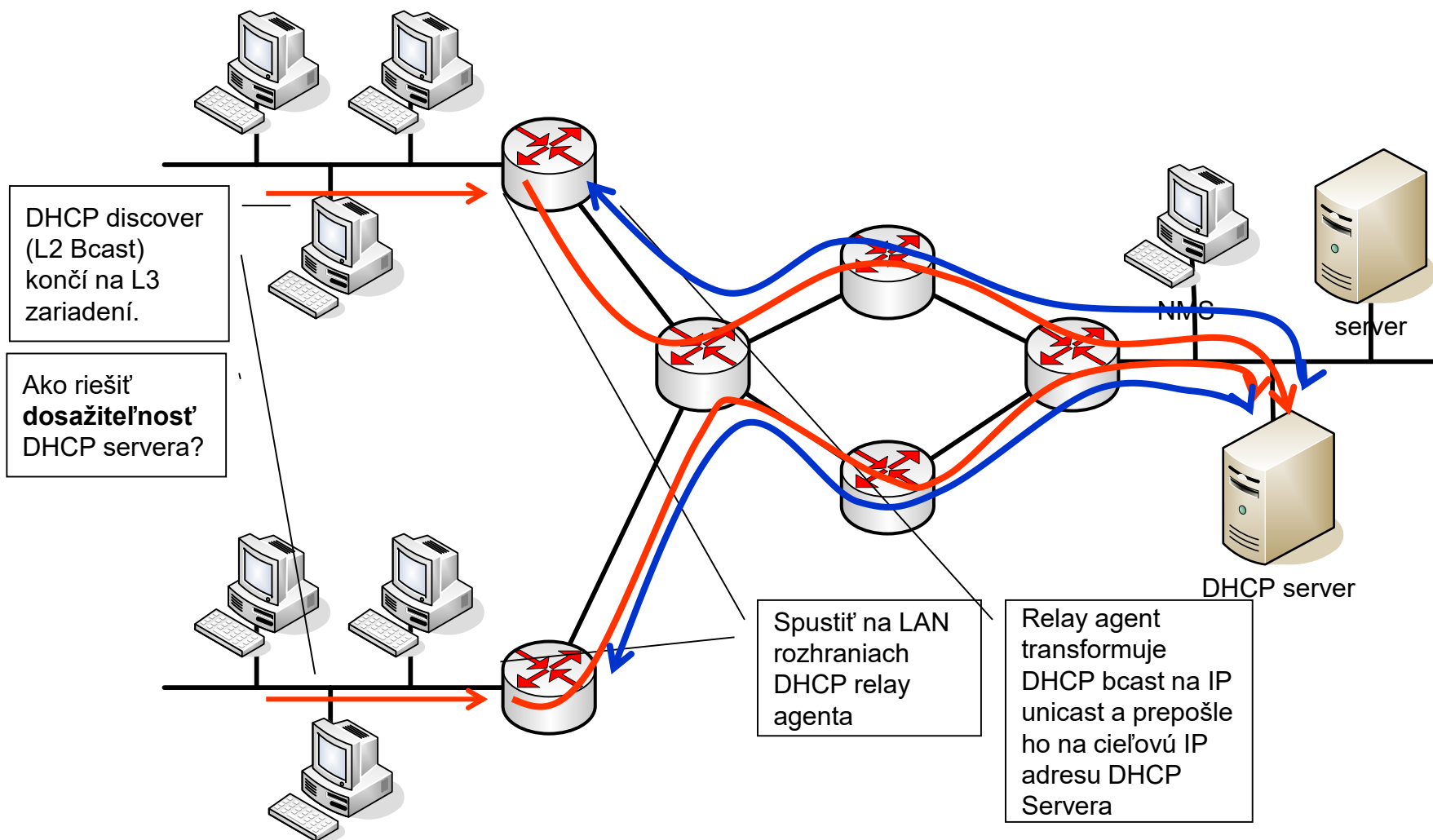


```
ISP#sh run
...
ip dhcp pool DHCP_client
  network 192.168.10.0 /24
  default-router 192.168.10.1
```

```
Remulus(config)#int fa 0/0
Remulus(config-if)#ip address dhcp
Remulus(config-if)#^Z
Remulus#
*Mar  1 00:06:46.927: %SYS-5-CONFIG_I: Configured from console by console
*Mar  1 00:06:57.379: %DHCP-6-ADDRESS_ASSIGN: Interface FastEthernet0/0 assigned
DHCP address 192.168.10.2, mask 255.255.255.0, hostname Remulus
```

```
Remulus#sh ip int fa 0/0
FastEthernet0/0 is up, line protocol is up
  Internet address is 192.168.10.2/24
  Broadcast address is 255.255.255.255
  Address determined by DHCP
```

# Relay Agent



# Spustenie DHCP relay

```
Remulus (config-if) # ip helper-address IP_ADRESA
```

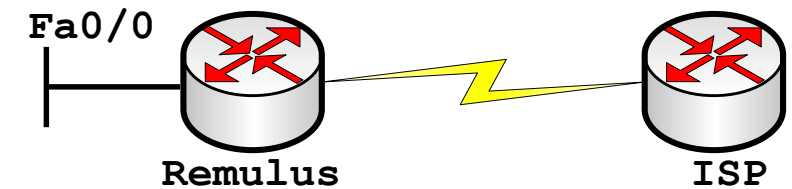
- Preposiela nasledujúce UDP služby:
  - Port 37: Time
  - Port 49: TACACS
  - Port 53: DNS
  - Port 67: DHCP/BOOTP server
  - Port 68: DHCP/BOOTP client
  - Port 69: TFTP
  - Port 137: NetBIOS name service
  - Port 138: NetBIOS datagram service
- Špecifikácia ďalších cez:
  - ip forward-protocol



# Konfigurácia IP DHCP relay

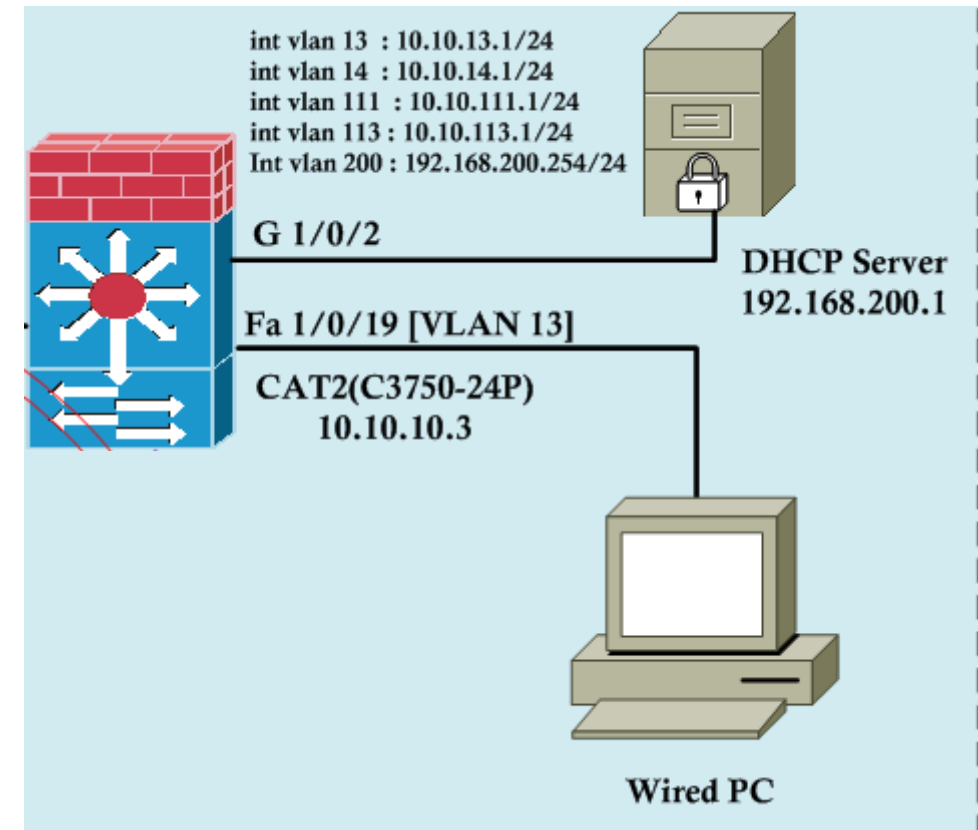
```
ISP#sh run
...
ip dhcp pool LAN_Remus
network 172.16.255.0 255.255.255.0
default-router 172.16.255.1
...
```

```
Remulus(config)#int fa 0/0
Remulus(config-if)# ip helper-address 192.168.1.1
Remulus#sh run int fa 0/0
!
interface FastEthernet0/0
 ip address 172.16.255.1 255.255.255.0
 ip helper-address 192.168.1.1
 duplex auto
 speed auto
```



```
Remulus#show ip dhcp binding
Bindings from all pools not associated with VRF:
IP address          Client-ID/
                   Hardware address/
                   User name
172.16.255.2        0102.004c.4f4f.50
                   Mar 02 2002 12:07 AM
                   Automatic
```

# DORA – pohľad na proces z Wiresharku (Relay agent)



No.	Time	Source	Destination	Protocol	Length	RSSI	Info
89	10:13:16.529797	192.168.200.254	224.0.0.252	LLMNR	67		Standard query ANF 0DWF2Q1
90	10:13:16.530908	0.0.0.0	255.255.255.255	DHCP	342		DHCP Discover - Transaction ID 0x9f2f9e60
91	10:13:16.535700	10.10.13.3	255.255.255.255	DHCP	342		DHCP Offer - Transaction ID 0x9f2f9e60
92	10:13:16.536504	0.0.0.0	255.255.255.255	DHCP	363		DHCP Request - Transaction ID 0x9f2f9e60
93	10:13:16.540109	10.10.13.3	255.255.255.255	DHCP	342		DHCP ACK - Transaction ID 0x9f2f9e60
94	10:13:16.612576	De11_65:8f:37	Broadcast	ARP	42		who has 10.10.13.1? Tell 10.10.13.11
95	10:13:16.617046	All-MSRP-router:De11_65:8f:37		ARP	60		10.10.13.1 is at 00:00:0c:07:ac:01

# Wireshark: DHCP Discover

```
⊕ Frame 19: 342 bytes on wire (2736 bits), 342 bytes captured (2736 bits)
⊖ Ethernet II, Src: Dell_65:8f:37 (5c:26:0a:65:8f:37), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
  ⊕ Destination: Broadcast (ff:ff:ff:ff:ff:ff)
  ⊕ Source: Dell_65:8f:37 (5c:26:0a:65:8f:37)
    Type: IP (0x0800)
⊕ Internet Protocol Version 4, Src: 0.0.0.0 (0.0.0.0), Dst: 255.255.255.255 (255.255.255.255)
⊖ User Datagram Protocol, Src Port: bootpc (68), Dst Port: bootps (67)
  Source port: bootpc (68)
  Destination port: bootps (67)
  Length: 308
  ⊕ Checksum: 0x0145 [validation disabled]
⊖ Bootstrap Protocol
  Message type: Boot Request (1)
  Hardware type: Ethernet
  Hardware address length: 6
  Hops: 0
  Transaction ID: 0x08c0659a
  Seconds elapsed: 0
  ⊕ Bootp flags: 0x8000 (Broadcast)
  Client IP address: 0.0.0.0 (0.0.0.0)
  Your (client) IP address: 0.0.0.0 (0.0.0.0)
  Next server IP address: 0.0.0.0 (0.0.0.0)
  Relay agent IP address: 0.0.0.0 (0.0.0.0)
  Client MAC address: Dell_65:8f:37 (5c:26:0a:65:8f:37)
  Client hardware address padding: 00000000000000000000
  Server host name not given
  Boot file name not given
  Magic cookie: DHCP
  ⊕ Option: (t=53,l=1) DHCP Message Type = DHCP Discover
  ⊕ Option: (t=61,l=7) Client identifier
  ⊕ Option: (t=12,l=7) Host Name = "8DWP2Q1"
  ⊕ Option: (t=60,l=8) vendor class identifier = "MSFT 5.0"
  ⊕ Option: (t=55,l=12) Parameter Request List
```



# Wireshark: DHCP Offer

```
⊕ Frame 20: 342 bytes on wire (2736 bits), 342 bytes captured (2736 bits)
⊖ Ethernet II, Src: Cisco_a7:ff:48 (00:1a:e3:a7:ff:48), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
  ⊕ Destination: Broadcast (ff:ff:ff:ff:ff:ff)
  ⊕ Source: Cisco_a7:ff:48 (00:1a:e3:a7:ff:48)
  Type: IP (0x0800)
⊕ Internet Protocol Version 4, Src: 10.10.13.3 (10.10.13.3), Dst: 255.255.255.255 (255.255.255.255)
⊖ User Datagram Protocol, Src Port: bootps (67), Dst Port: bootpc (68)
  Source port: bootps (67)
  Destination port: bootpc (68)
  Length: 308
  ⊕ Checksum: 0x2a36 [validation disabled]
⊖ Bootstrap Protocol
  Message type: Boot Reply (2)
  Hardware type: Ethernet
  Hardware address length: 6
  Hops: 0
  Transaction ID: 0x08c0659a
  Seconds elapsed: 0
  ⊕ Bootp flags: 0x8000 (Broadcast)
  Client IP address: 0.0.0.0 (0.0.0.0)
  Your (client) IP address: 10.10.13.10 (10.10.13.10)
  Next server IP address: 192.168.200.1 (192.168.200.1)
  Relay agent IP address: 10.10.13.3 (10.10.13.3)
  Client MAC address: Dell_65:8f:37 (5c:26:0a:65:8f:37)
  Client hardware address padding: 00000000000000000000
  Server host name not given
  Boot file name not given
  Magic cookie: DHCP
  ⊕ Option: (t=53,l=1) DHCP Message Type = DHCP Offer
  ⊕ Option: (t=1,l=4) Subnet Mask = 255.255.255.0
  ⊕ Option: (t=58,l=4) Renewal Time Value = 12 hours
  ⊕ Option: (t=59,l=4) Rebinding Time Value = 21 hours
  ⊕ Option: (t=51,l=4) IP Address Lease Time = 1 day
  ⊕ Option: (t=54,l=4) DHCP Server Identifier = 192.168.200.1
  ⊕ Option: (t=15,l=8) Domain Name = "mrn.com"
  ⊕ Option: (t=3,l=4) Router = 10.10.13.1
  ⊕ Option: (t=6,l=4) Domain Name Server = 192.168.200.1
```

# Wireshark: DHCP Request

```
⊕ Frame 21: 363 bytes on wire (2904 bits), 363 bytes captured (2904 bits)
⊖ Ethernet II, Src: Dell_65:8f:37 (5c:26:0a:65:8f:37), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
  ⊕ Destination: Broadcast (ff:ff:ff:ff:ff:ff)
  ⊕ Source: Dell_65:8f:37 (5c:26:0a:65:8f:37)
    Type: IP (0x0800)
⊕ Internet Protocol Version 4, Src: 0.0.0.0 (0.0.0.0), Dst: 255.255.255.255 (255.255.255.255)
⊖ User Datagram Protocol, Src Port: bootpc (68), Dst Port: bootps (67)
  Source port: bootpc (68)
  Destination port: bootps (67)
  Length: 329
  ⊕ Checksum: 0x015a [validation disabled]
⊖ Bootstrap Protocol
  Message type: Boot Request (1)
  Hardware type: Ethernet
  Hardware address length: 6
  Hops: 0
  Transaction ID: 0x08c0659a
  Seconds elapsed: 0
  ⊕ Bootp flags: 0x8000 (Broadcast)
  Client IP address: 0.0.0.0 (0.0.0.0)
  Your (client) IP address: 0.0.0.0 (0.0.0.0)
  Next server IP address: 0.0.0.0 (0.0.0.0)
  Relay agent IP address: 0.0.0.0 (0.0.0.0)
  Client MAC address: Dell_65:8f:37 (5c:26:0a:65:8f:37)
  Client hardware address padding: 00000000000000000000
  Server host name not given
  Boot file name not given
  Magic cookie: DHCP
  ⊕ Option: (t=53,l=1) DHCP Message Type = DHCP Request
  ⊕ Option: (t=61,l=7) Client identifier
  ⊕ Option: (t=50,l=4) Requested IP Address = 10.10.13.10
  ⊕ Option: (t=54,l=4) DHCP Server Identifier = 192.168.200.1
  ⊕ Option: (t=12,l=7) Host Name = "8DWP2Q1"
  ⊕ Option: (t=81,l=21) Client Fully Qualified Domain Name
  ⊕ Option: (t=60,l=8) Vendor class identifier = "MSFT 5.0"
  ⊕ Option: (t=55,l=12) Parameter Request List
```

# Wireshark: DHCP Ack

- ⊕ Frame 22: 342 bytes on wire (2736 bits), 342 bytes captured (2736 bits)
- ⊖ Ethernet II, Src: Cisco\_a7:ff:48 (00:1a:e3:a7:ff:48), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
  - ⊕ Destination: Broadcast (ff:ff:ff:ff:ff:ff)
  - ⊕ Source: Cisco\_a7:ff:48 (00:1a:e3:a7:ff:48)
  - Type: IP (0x0800)
- ⊕ Internet Protocol Version 4, Src: 10.10.13.3 (10.10.13.3), Dst: 255.255.255.255 (255.255.255.255)
- ⊖ User Datagram Protocol, Src Port: bootps (67), Dst Port: bootpc (68)
  - Source port: bootps (67)
  - Destination port: bootpc (68)
  - Length: 308
  - ⊕ Checksum: 0xafe0 [validation disabled]
- ⊖ Bootstrap Protocol
  - Message type: Boot Reply (2)
  - Hardware type: Ethernet
  - Hardware address length: 6
  - Hops: 0
  - Transaction ID: 0x08c0659a
  - Seconds elapsed: 0
  - ⊕ Bootp flags: 0x8000 (Broadcast)
  - Client IP address: 0.0.0.0 (0.0.0.0)
  - Your (client) IP address: 10.10.13.10 (10.10.13.10)
  - Next server IP address: 0.0.0.0 (0.0.0.0)
  - Relay agent IP address: 10.10.13.3 (10.10.13.3)
  - Client MAC address: Dell\_65:8f:37 (5c:26:0a:65:8f:37)
  - Client hardware address padding: 000000000000000000000000
  - Server host name not given
  - Boot file name not given
  - Magic cookie: DHCP
  - ⊕ Option: (t=53,l=1) DHCP Message Type = DHCP ACK
  - ⊕ Option: (t=58,l=4) Renewal Time Value = 12 hours
  - ⊕ Option: (t=59,l=4) Rebinding Time Value = 21 hours
  - ⊕ Option: (t=51,l=4) IP Address Lease Time = 1 day
  - ⊕ Option: (t=54,l=4) DHCP Server Identifier = 192.168.200.1
  - ⊕ Option: (t=1,l=4) Subnet Mask = 255.255.255.0
  - ⊕ Option: (t=15,l=8) Domain Name = "mrn.com"
  - ⊕ Option: (t=3,l=4) Router = 10.10.13.1
  - ⊕ Option: (t=6,l=4) Domain Name Server = 192.168.200.1

# Overenie činnosti DHCP

- Zisti či nie je vypnutá DHCP služba
  - Hľadaj v running `no service dhcp`
- Zisti či nie je IP adresný konflikt
  - `sh ip dhcp conflict`
- Overenie fyzickej topológie
  - Či mám priamo dostupný DHCP server
    - Ak je v inej LAN or VLAN: `ip helper-address`
- Testnutie konektivity
  - pridelením statickej adresy a ping
- Zistiť či DHCP prideluje IP adresu zo správneho rozsahu

# Overenie či server prijíma DHCP

```
Remulus#debug ip packet detail
```

```
Remulus#undebug all
```

```
! Dost obsiahle vypisy, ako to sprehladnit?
```

# Overenie či server prijíma DHCP

```
Remulus#debug ip packet detail
Remulus#undebug all
! Dost obsiahle vypisy, ako to sprehladnit?
! Zadefinujeme ACL, ktore bude filtrovat vystup co nas zaujima
Remulus#conf t
Remulus(config)#access-list 100 permit ip host 0.0.0.0 host 255.255.255.255
Remulus(config)#exit
Remulus#debug ip packet detail 100
*Mar 1 00:01:54.623: %SYS-5-CONFIG I: Configured from console by consoleIP packet
debugging is on (detailed) for access list 100
*Mar 1 00:02:47.795: IP: s=0.0.0.0 (FastEthernet0/0), d=255.255.255.255, len 32 8, rcvd 2
*Mar 1 00:02:47.799:      UDP src=68, dst=67
*Mar 1 00:02:49.863: IP: s=0.0.0.0 (FastEthernet0/0), d=255.255.255.255, len 35 3, rcvd 2
*Mar 1 00:02:49.867:      UDP src=68, dst=67
```

# Overenie či server prijíma DHCP

```
Remulus#debug ip dhcp server events
*Mar 1 00:04:22.823: DHCPD: Sending notification of DISCOVER:
*Mar 1 00:04:22.827: DHCPD: htype 1 chaddr 0200.4c4f.4f50
*Mar 1 00:04:22.827: DHCPD: remote id 020a0000ac10ff0100000000
*Mar 1 00:04:22.827: DHCPD: circuit id 00000000
*Mar 1 00:04:22.831: DHCPD: Seeing if there is an internally specified pool class:
*Mar 1 00:04:22.831: DHCPD: htype 1 chaddr 0200.4c4f.4f50
*Mar 1 00:04:22.835: DHCPD: remote id 020a0000ac10ff0100000000
*Mar 1 00:04:22.835: DHCPD: circuit id 00000000
*Mar 1 00:04:24.839: DHCPD: client requests 172.16.255.2.
*Mar 1 00:04:24.839: DHCPD: Adding binding to radix tree (172.16.255.2)
*Mar 1 00:04:24.843: DHCPD: Adding binding to hash tree
*Mar 1 00:04:24.843: DHCPD: assigned IP address 172.16.255.2 to client 0102.004c.4f4f.50.
*Mar 1 00:04:24.863: DHCPD: Sending notification of ASSIGNMENT:
*Mar 1 00:04:24.867: DHCPD: address 172.16.255.2 mask 255.255.255.0
*Mar 1 00:04:24.867: DHCPD: htype 1 chaddr 0200.4c4f.4f50
*Mar 1 00:04:24.871: DHCPD: lease time remaining (secs) = 86400
*Mar 1 00:04:26.907: DHCPD: checking for expired leases.
```



# Dynamic Host Configuration Protocol DHCPv6



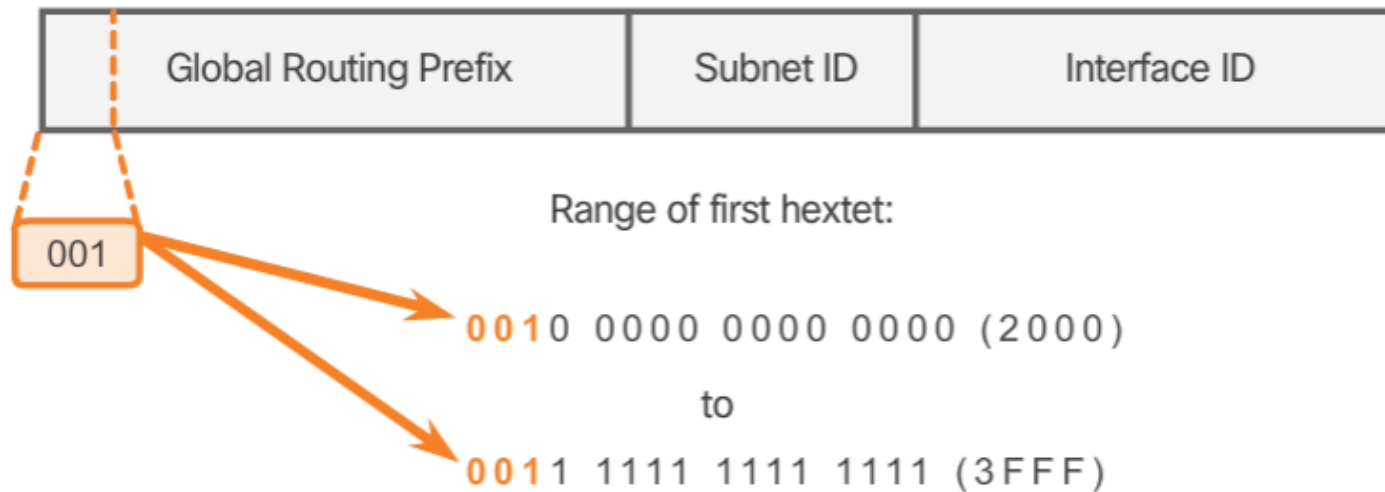


## Vsuvka – na zopakovanie z PIKSu IPv6

Čo už vieme o IPv6 adresách... (mali by sme)

# Unicastové IPv6 adresy

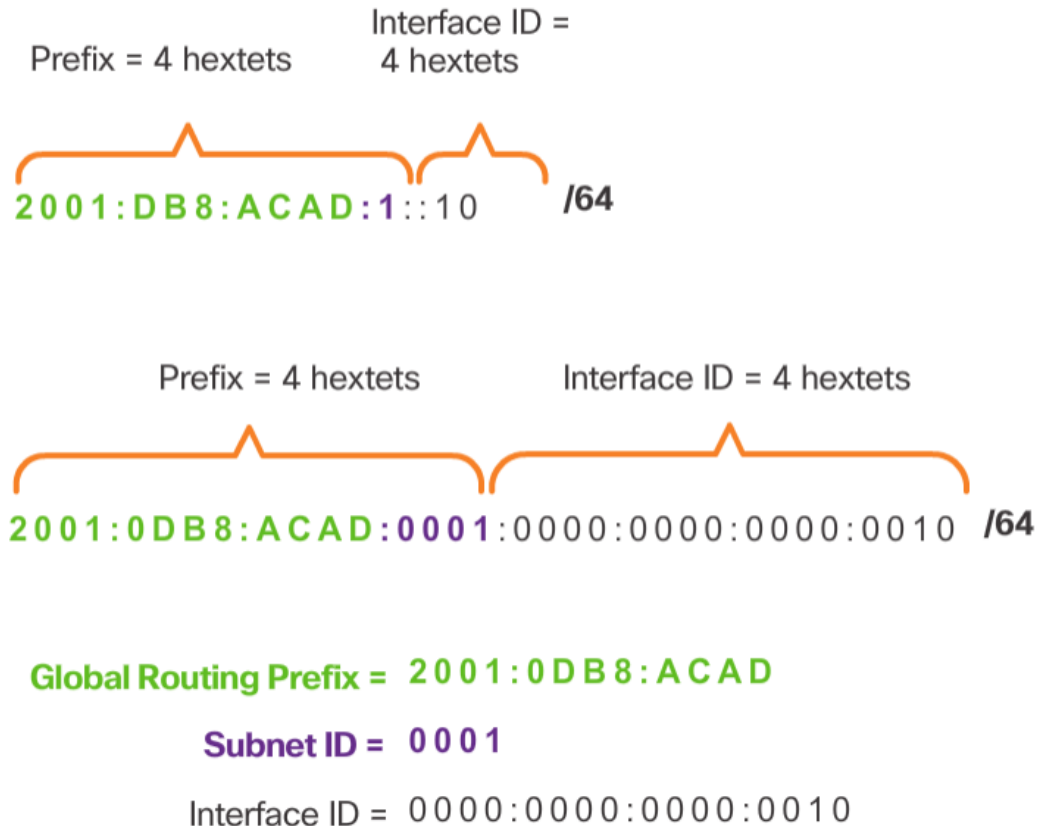
- Musí byť jedinečná v celom Internete (podobne ako verejná adresa v IPv4)
- Je smerovateľná v internete



- Aktuálne sa predeľujú iba rozsahy **2000::/3**
  - t.j. iba 1/8 celého IPv6 priestoru adries
  - na 3 bitoch =  $2^3$  možností, ale prideliuje sa iba 1 možnosť z nich (001), preto:
  - prvý hextet je v rozsahu od 2000 po 3FFF
  - 2001:0DB8::/32 je vyhradená adresa pre dokumentačné účely

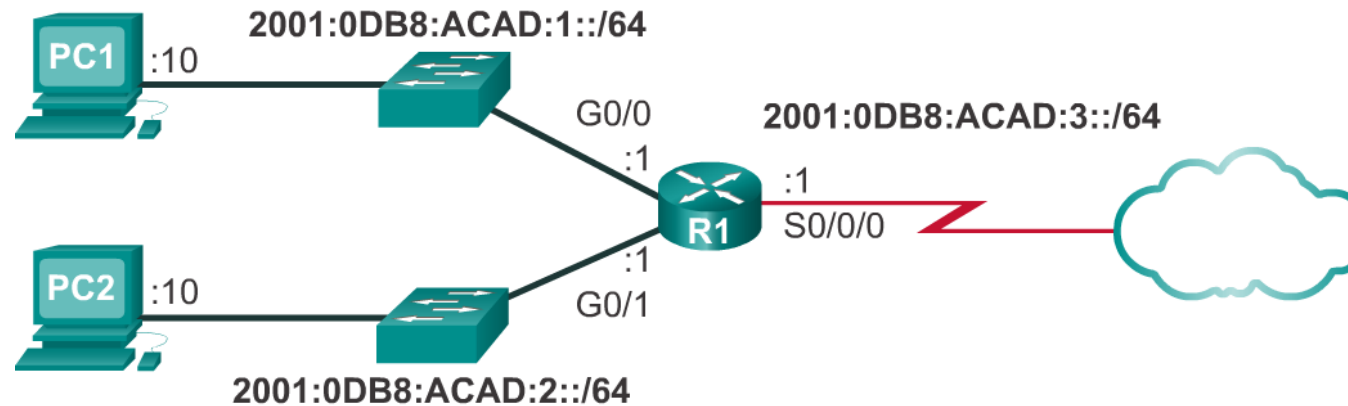
# Ako ju čítať a intepretovať

- **Interface ID** - podobne ako „host portion“ v IPv4, ale volá sa inak, lebo v IPv6 1 host môže mať **viac** IPv6 adries pre každé svoje rozhranie



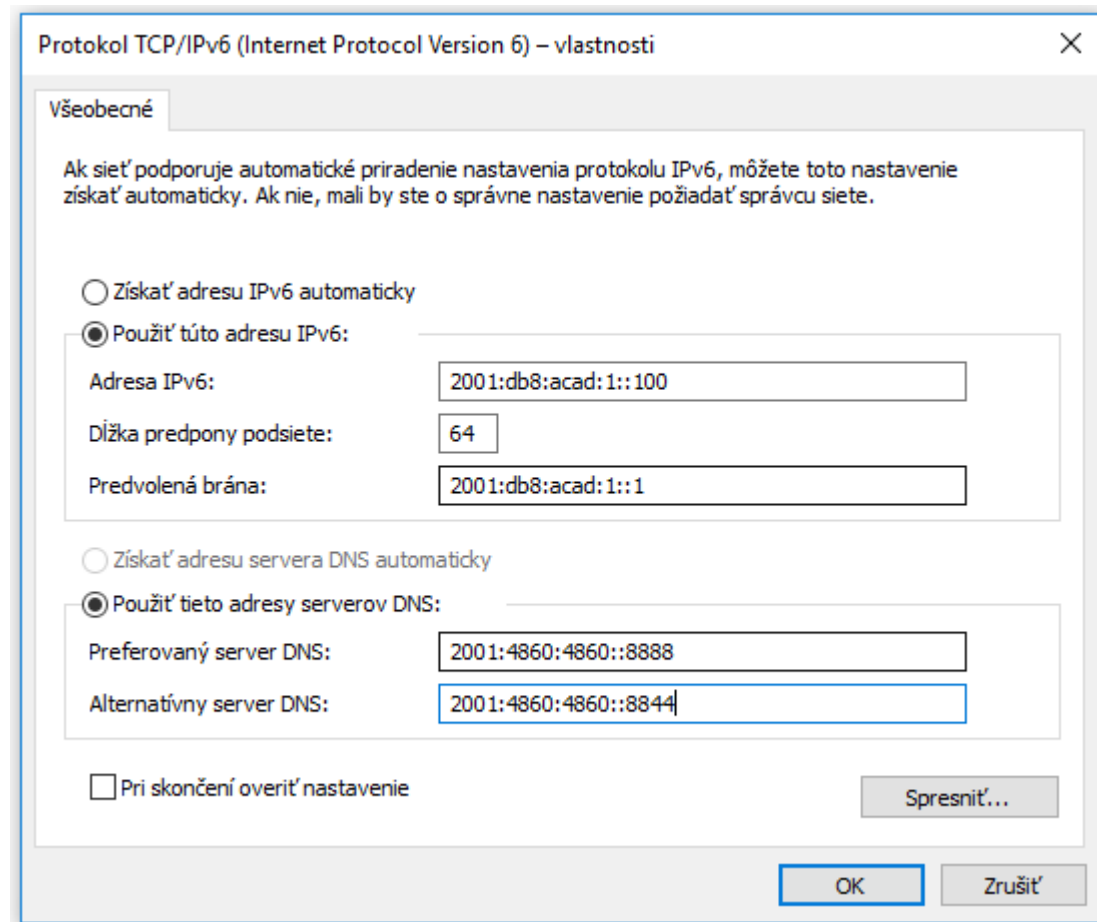
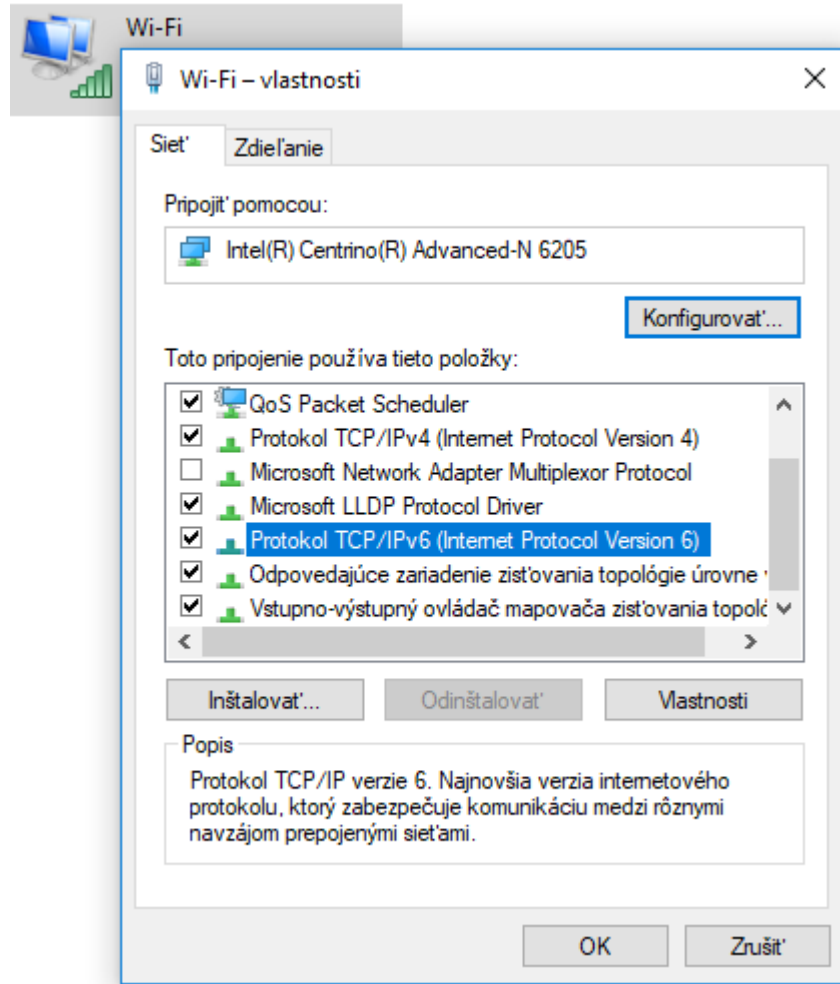
- To čo v IPv4 boli vyhradené adresy vrámci nejakého subnetu (adresa siete a broadcast), už v IPv6 nie sú vyhradené:
- **Samé 1tky** – možno použiť, lebo v IPv6 nemáme broadcast, ale.. vrchných 128 adries je **rezervovaných** pre adresy:  
„Subnet anycast“)
  - 2001:DB8:ACAD:1::  
od FFFF:FFFF:FFFF:FF00  
do FFFF:FFFF:FFFF:FFFF
  - Aktuálne sa využíva iba jedna ....FE, pre Mobile IPv6 Home-Agents anycast
- **Samé 0** – možno použiť, ale... je to **rezervované** pre anycastovú adresu „Subnet-Router“, takže sa prideluje iba smerovačom
  - 2001:DB8:ACAD:1::

# Statická konfigurácia na smerovači



```
R1 (config) #interface gigabitethernet 0/0
R1 (config-if) #ipv6 address 2001:db8:acad:1::1/64
R1 (config-if) #no shutdown
R1 (config-if) #exit
R1 (config) #interface gigabitethernet 0/1
R1 (config-if) #ipv6 address 2001:db8:acad:2::1/64
R1 (config-if) #no shutdown
R1 (config-if) #exit
R1 (config) #interface serial 0/0/0
R1 (config-if) #ipv6 address 2001:db8:acad:3::1/64
R1 (config-if) #clock rate 56000
R1 (config-if) #no shutdown
```

# Statická konfigurácia na počítači



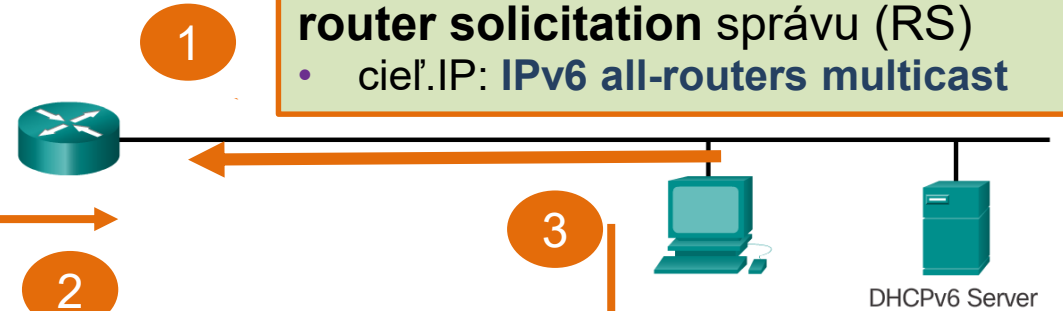
- Rovnako by to fungovalo, keby sme použili link-local adresu pre GW

## Global unicast – pripomienka

# Global Unicast - Dynamická konfigurácia IPv6 adresy

Smerovač posiela rozhraním informácie všetkým IPv6 uzlom na sieti ICMPv6 - tzv. **router advertisement** správy (RA)

- Pravidelne každých 200 s
- Aj ako odpoveď na RS správu
- Aké presne info záleží na danej voľbe v RA (Option 1,2,3)
- cieľ.IP: **IPv6 all-nodes multicast**



Host pošle žiadosť o svoje adresné informácie všetkým IPv6 smerovačom – ICMPv6 tzv. **router solicitation** správu (RS)

- cieľ.IP: **IPv6 all-routers multicast**

Host si pozrie zdrojovú adresu IPv6 paketu, v ktorom prišla zabalená RA správa od routra, a nastaví si na túto (zväčša link-local adresa) ako default gateway vo svojich nastaveniach

Správa router advertisement má tieto možnosti (options):

### 1. **SLAAC** = Stateless address autoconfiguration

- RA: Poskytnem ti všetko čo potrebuješ (Prefix, Prefix-length, DNS)

### 2. **SLAAC + DHCPv6** (stateless)

- RA: Poskytnem ti niečo (Prefix, Prefix-length), ale pre zvyšné info požiadaj DHCPv6 (DNS)

### 3. **DHCPv6** (stateful)

- RA: Nevieť ti pomôcť, požiadaj DHCPv6 server o info

Toto sa deje vždy bez ohľadu na option v RA {1, 2, 3}

# 1. option: SLAAC = Stateless address autoconfiguration

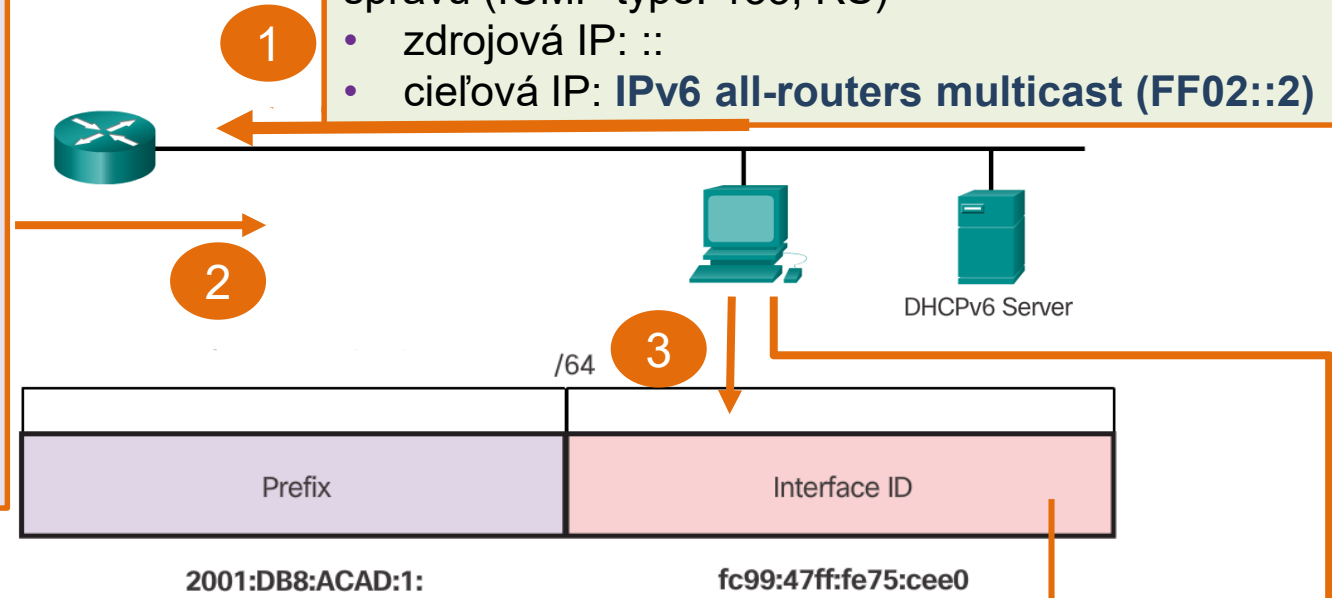
## Dynamická konfigurácia

Smerovač pošle rozhraním informácie v správe **RA s option 1:**

- **Network prefix a prefix length** – do ktorej subsiete patrí host
- **DNS adresy**, doménové meno
- **Default gateway** (IPv6 link-local adresa smerovača) – nie je ako položka v RA, je iba ako zdrojová adresa v hlavičke paketu nesúcom správu RA
- **Lifetime, ...**
- zdroj.IP: R1 link-local adresa
- cieľ.IP: **IPv6 all-nodes multicast (FF02::1)**

Host pošle žiadosť o svoje adresné informácie všetkým IPv6 smerovačom - tzv. **router solicitation** správu (ICMP type: 133, RS)

- zdrojová IP: ::
- cieľová IP: **IPv6 all-routers multicast (FF02::2)**



Host si dokáže sám prideliť adresu tak, že k prefixu siete, ktorý prijal od routra v RA správe, pripojí svoj 64-bitový Interface ID, ktoré môže získať 2 spôsobmi:

- **Modified EUI-64** = modified extended universal identifier (napr. Cisco zariadenia)
- **Náhodné 64bitové číslo** (napr. Windows preferuje tento spôsob RFC 3041)

Výsledok je 128-bitová adresa, ktorá je použiteľná a garantovane globálne unikátna

DAD = duplicate address detection: „Nemá náhodou už niekto túto IPv6 adresu?“

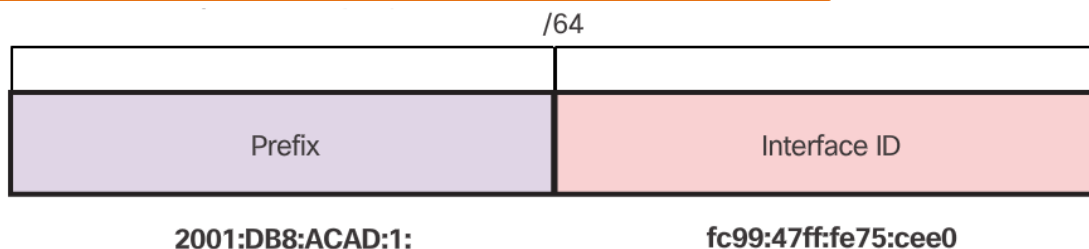
- cieľ.IP: **IPv6 solicited-node multicast**

## 2. option: SLAAC + DHCPv6 - Dynamická konfigurácia

Smerovač pošle rozhraním informácie v správe **RA** s **option 2**:

- **Network prefix a prefix length** – do ktorej subsiete patrí host
- **Default gateway** (IPv6 link-local) – nie je ako položka v RA, je iba ako zdrojová adresa v hlavičke paketu nesúcom správu RA
- Neposiela DNS (treba požiadať DHCPv6 server)

Host pošle žiadosť o svoje adresné informácie všetkým IPv6 smerovačom - tzv. **router solicitation** správu (RS)



Host požiada DHCPv6 server o zvyšné info (DNS, doménové mená) – tzv. **DHCPv6 solicitation** správa s **option 2**

Host si sám prideli adresu (prefix z RA od smerovača + interface ID), interface ID môže získať:

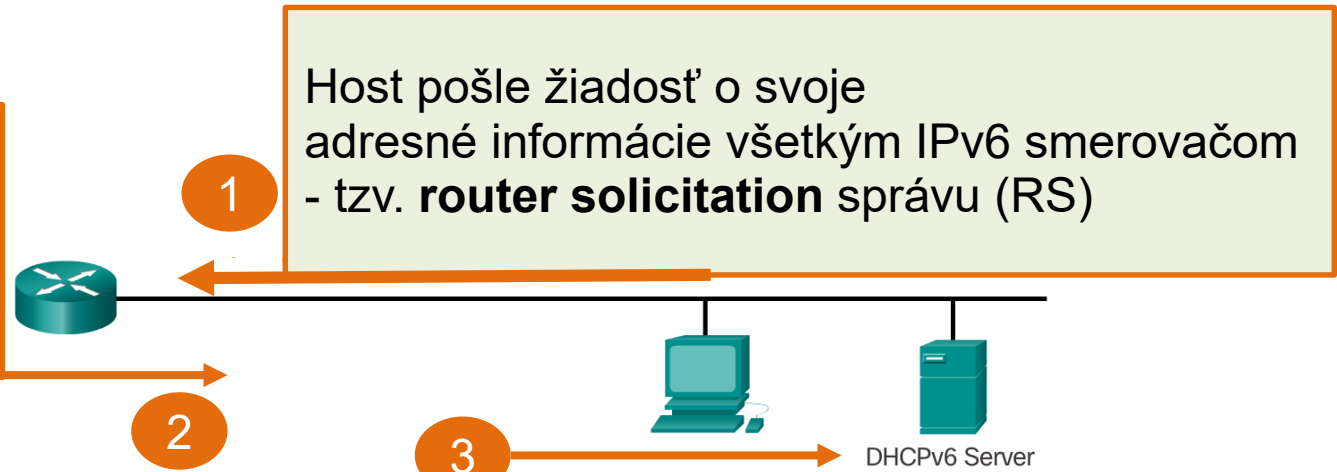
- **Modified EUI-64** = modified extended universal identifier (napr. Cisco zariadenia)
- **Náhodné 64bitové číslo** (napr. Windows preferuje tento spôsob) RFC 3041

Výsledok je 128-bitová adresa, ktorá je použiteľná a garantovane globálne unikátna



### 3. option: DHCPv6 - Dynamická konfigurácia

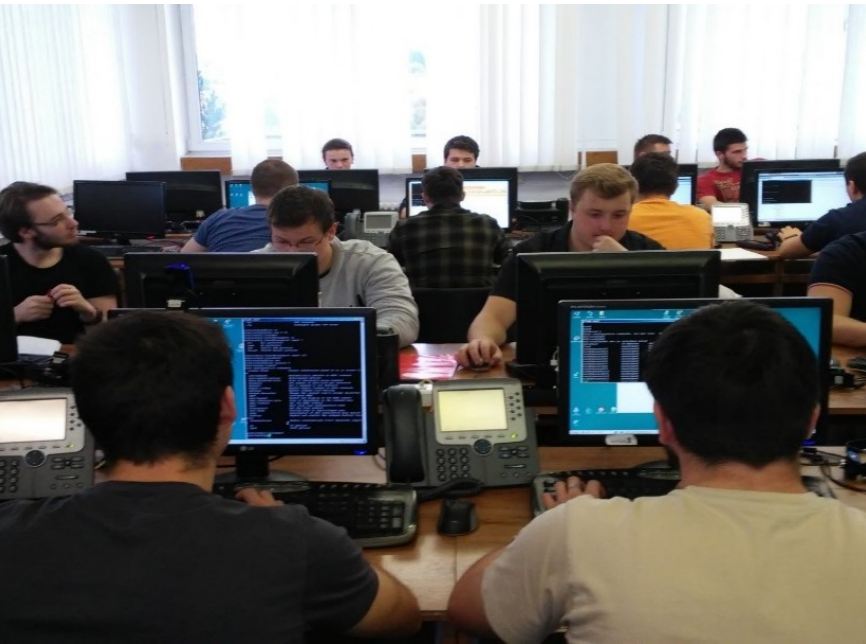
Smerovač nepošle rozhraním žiadne užitočné info v správe **RA** s **option 3**, iba odkáže hosta na DHCPv6.



Host požiadava DHCPv6 server o adresné info – tzv. **DHCPv6 solicitation** správa s option 3

Host si nastaví **default GW** podľa zdrojovej adresy z IPv6 paketu, ktorý mu prišiel od smerovača, a ktorý niesol ICMPv6 RA správu s option 3.

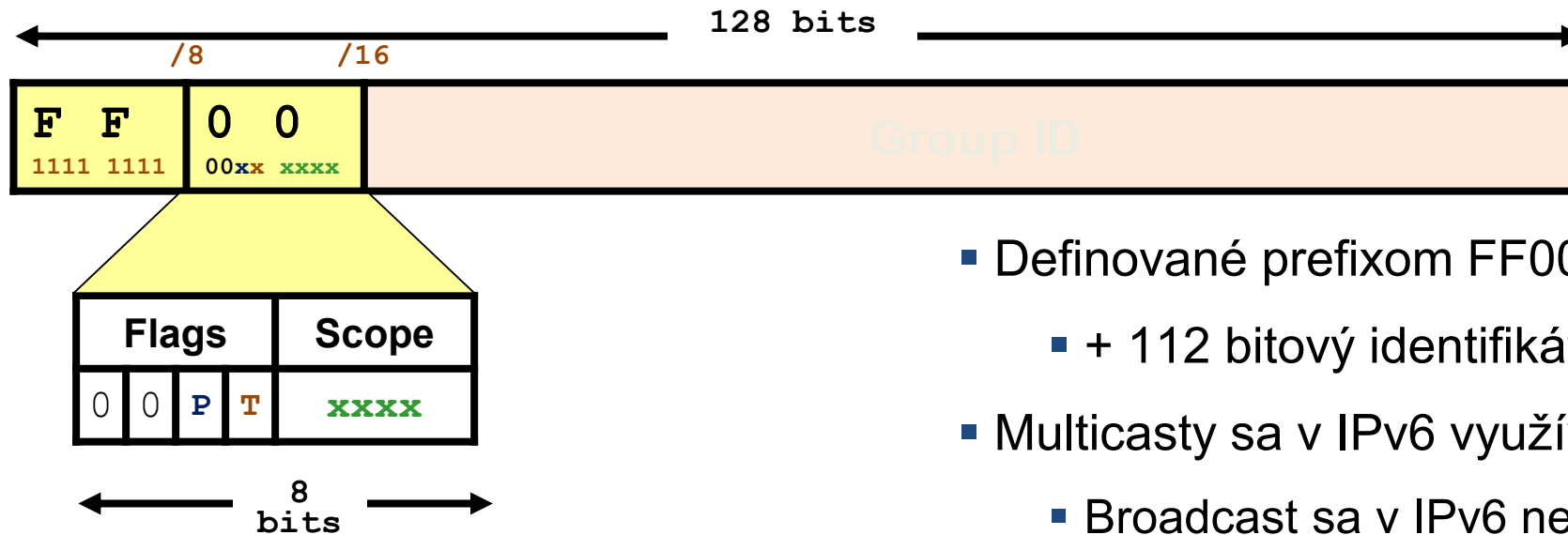
Toto sa deje vždy bez ohľadu na option v RA {1, 2, 3}



## Krátká vsuvka o IPv6 multicast adresách

Využívané aj v DHCPv6

# IPv6 multicastové adresy



## Flags:

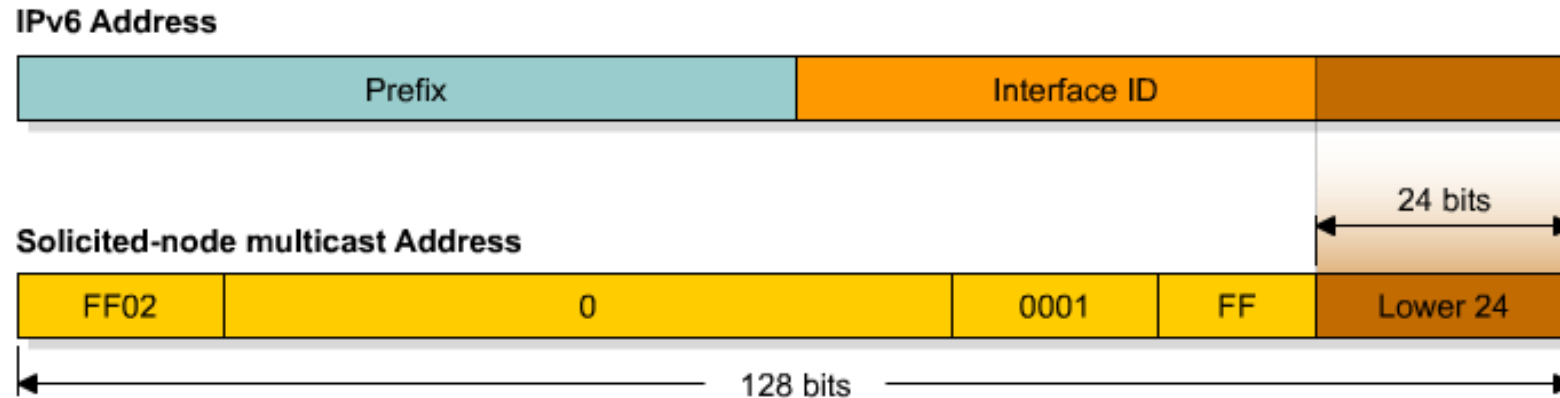
- **P** = Prefix for unicast-based assignments
- **T** = **0** if permanent, **1** if temporary

## Scope:

- 1 (**0001**) = Node (interface local)
- 2 (**0010**) = Link local
- 5 (**0101**) = Site local
- 8 (**1000**) = Organization
- E (**1110**) = Global

- Definované prefixom FF00::/8
  - + 112 bitový identifikátor mcast skupiny
- Multicasty sa v IPv6 využívajú veľmi často
  - Broadcast sa v IPv6 nepoužíva
- Prvý oktet: FF
- Druhý oktet obsahuje:
  - Prefix, platnosť a rozšírenie
  - Adresy FF00:: to FF0F:: sú rezervované, napr:
    - **FF02::/16** – všeobecne známe, link local
      - **FF02::1** (IPv6 all-nodes multicast, cieľ.IP v RA)
      - **FF02::2** (IPv6 all-routers multicast, cieľ.IP v RS)

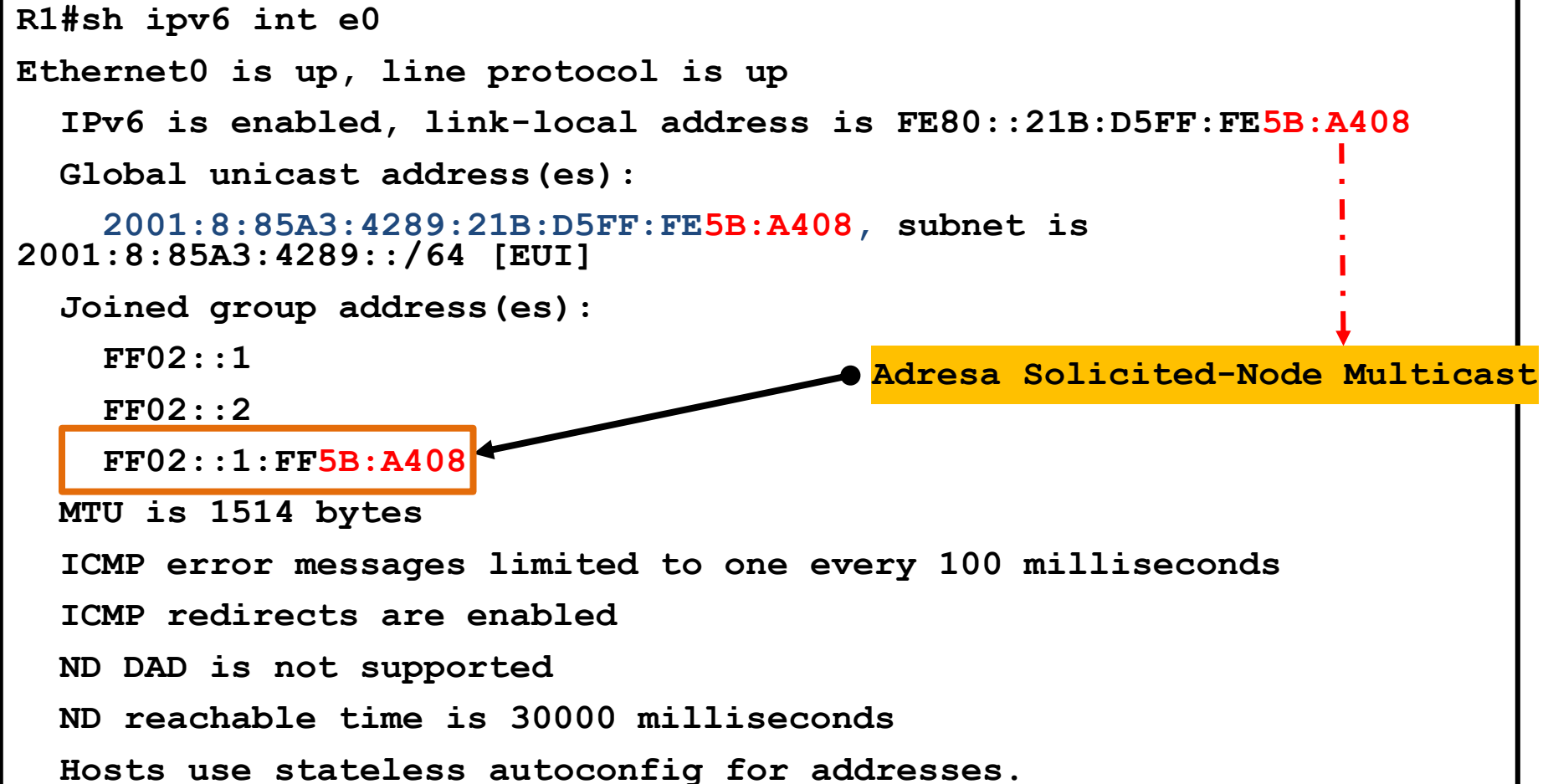
# Multicastové adresy Solicited-Node



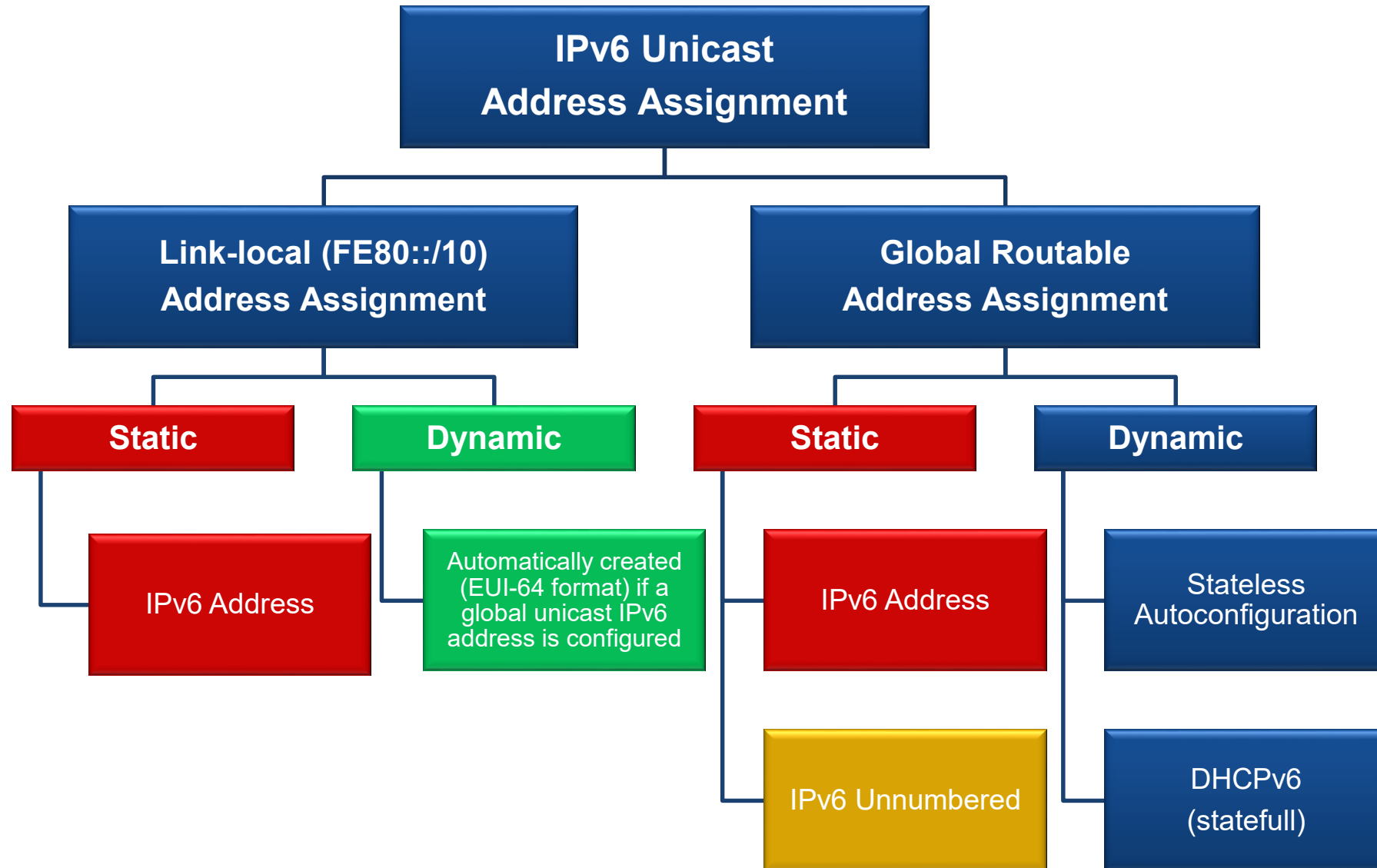
- Solicited-node multicast adresa pozostáva z prefixu **FF02::1:FF: /104**
  - Adresa má rozsah link-local
  - Má ju každý IPv6 host (ukážka na ďalšom slajde)
- Nasadenie
  - Neighbor discovery (ND)
    - Zistenie link-local adresy suseda, zistenie default route, zistenie smerovača na linke
  - Bezstavová autokonfigurácia, DAD
- Typické použitie je v ICMPv6, ktoré nahrádza ARP (viem susedovu IPv6 adr. a zisťujem jeho MAC)
  - Spodných 24 bitov IPv6 adresy je 24 bitov z IPv6 adresy hľadaného suseda
  - ICMPv6 je vo vnútri IPv6 paketu, takže paket musí mať adresu príjemcu, v tomto prípade práve Solicited-Node multicast

## Ukážka na rozhraní smerovača

```
R1#sh ipv6 int e0
Ethernet0 is up, line protocol is up
  IPv6 is enabled, link-local address is FE80::21B:D5FF:FE5B:A408
  Global unicast address(es):
    2001:8:85A3:4289:21B:D5FF:FE5B:A408, subnet is
2001:8:85A3:4289::/64 [EUI]
  Joined group address(es):
    FF02::1
    FF02::2
    FF02::1:FF5B:A408
  MTU is 1514 bytes
  ICMP error messages limited to one every 100 milliseconds
  ICMP redirects are enabled
  ND DAD is not supported
  ND reachable time is 30000 milliseconds
  Hosts use stateless autoconfig for addresses.
```



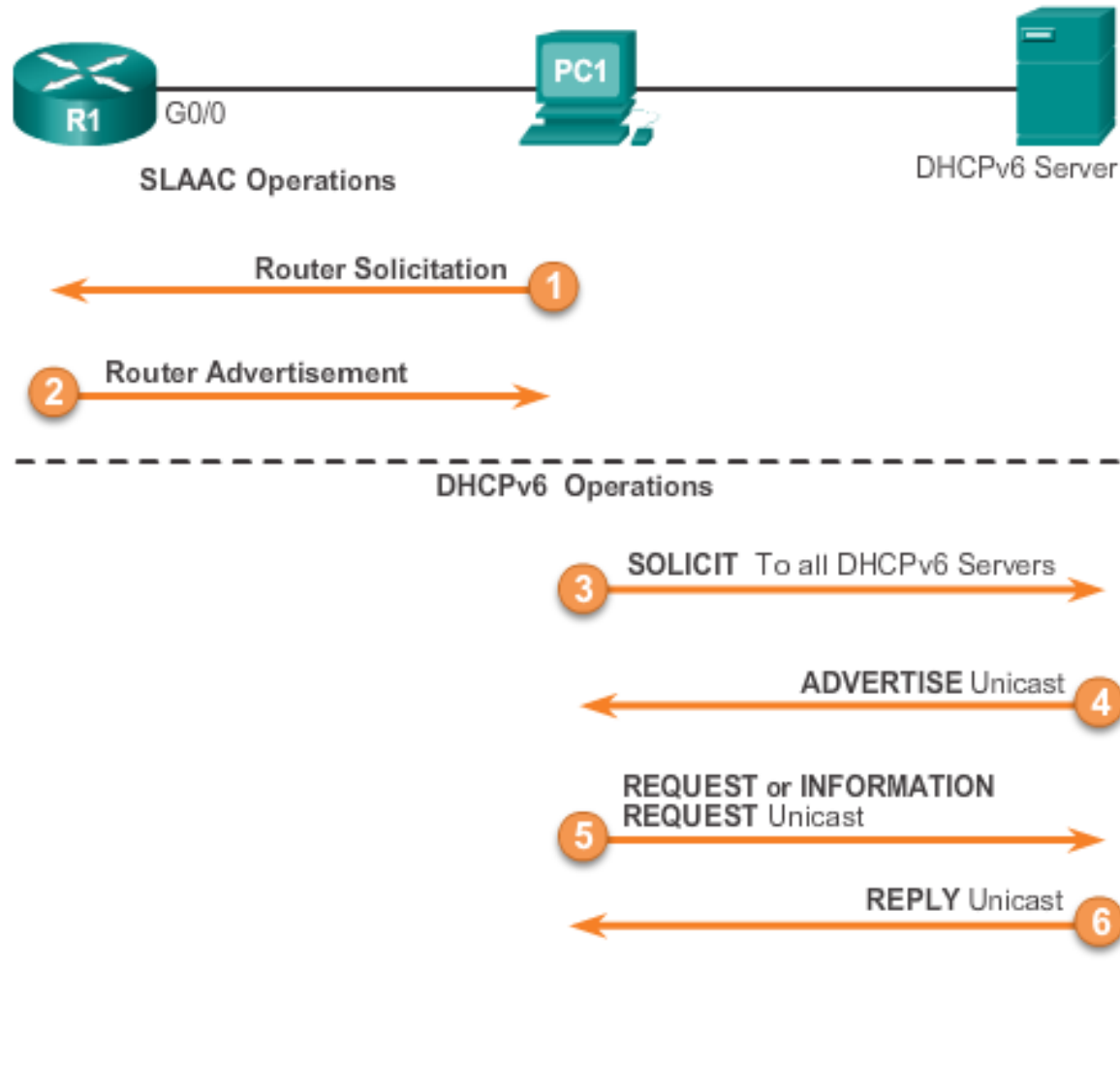
# Možnosti konfigurácie unicast IPv6 adres





# Konfigurácia DHCPv6

# Fungovanie DHCPv6

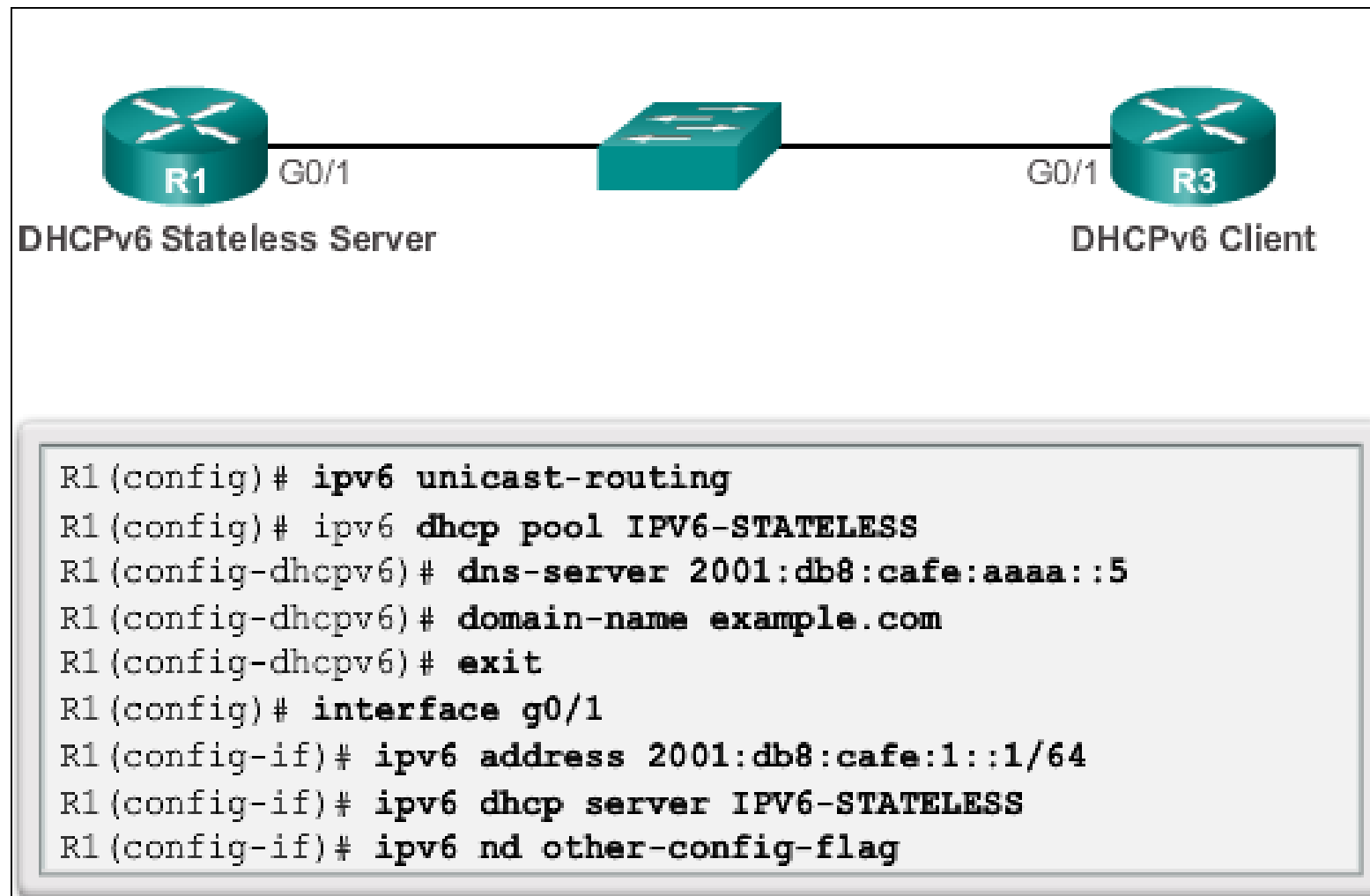


- Smerovač (default GW) má v správe RA (Router Advertisement) dve konfigurovateľné bity (ktoré rozhodujú o Option: 1,2,3) :
  - **'M' bit** - "Managed address configuration" flag.
    - 1 = klientovi povie, aby požiadal DHCPv6 pre získanie IPv6 adresy a ostatných info.
  - **'O' bit** - "**Other** configuration" flag
    - 1 = klientovi povie, aby o **ostatné** informácie (okrem prefixu a default GW) požiadal DHCPv6 server (DNS, ..)
  - Možné kombinácie:
    - MO=00 (SLAAC)
    - MO=01 (stateless DHCPv6)
    - MO=10 (statefull DHCPv6)

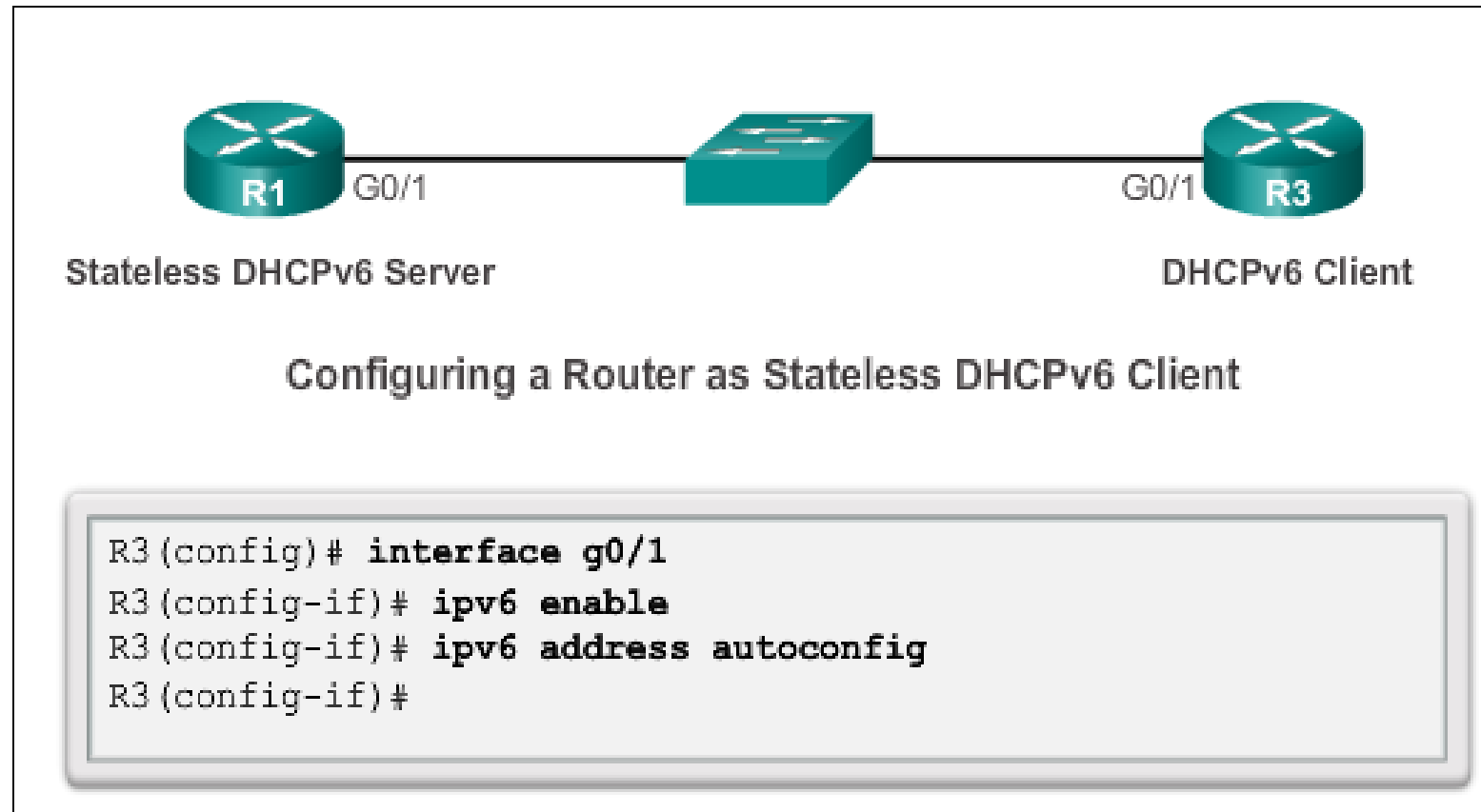


## Konfigurácia smerovača ako Stateless DHCPv6 servera

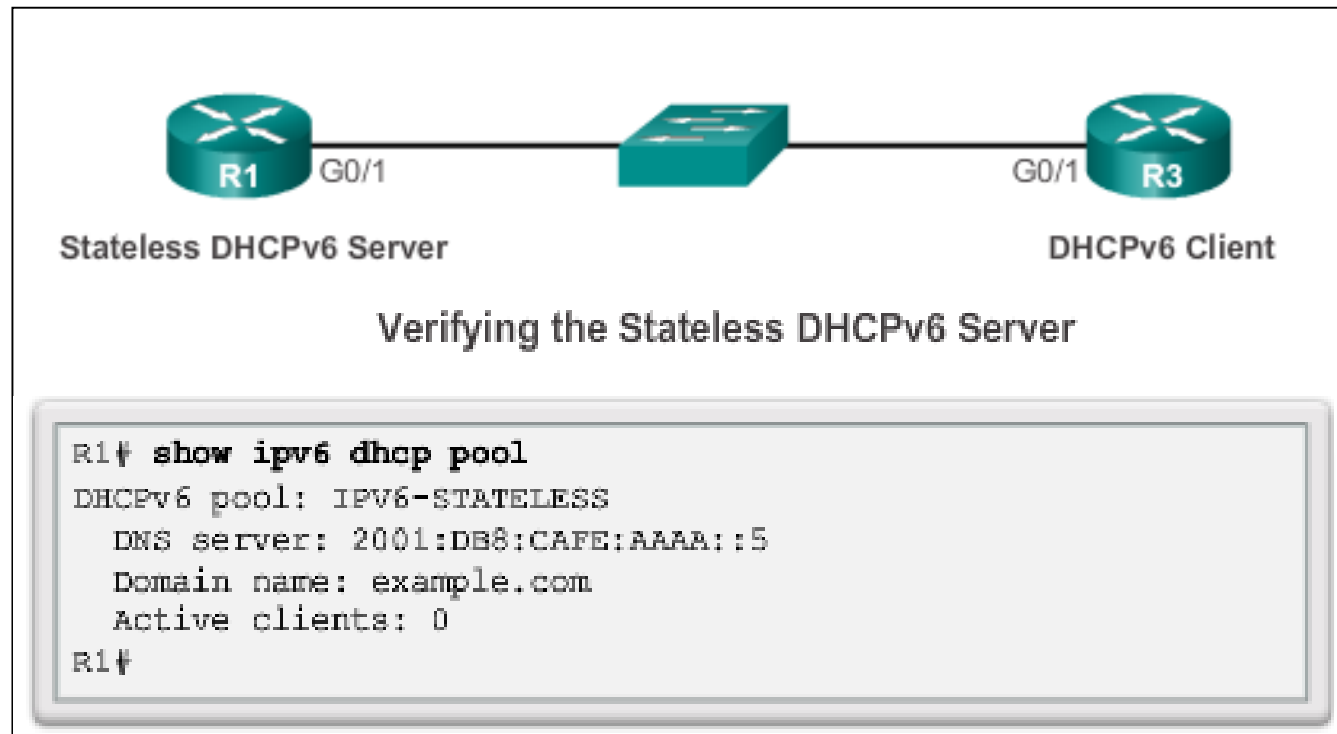
- $M = 0$ 
  - Klient získa stateless adresu z RA správy od smerovača
- $O = 1$ 
  - DHCPv6 server dodá klientovi iba ostatné info (DNS, ..)



# Stateless DHCPv6 klienta



# Diagnostika Stateless DHCPv6

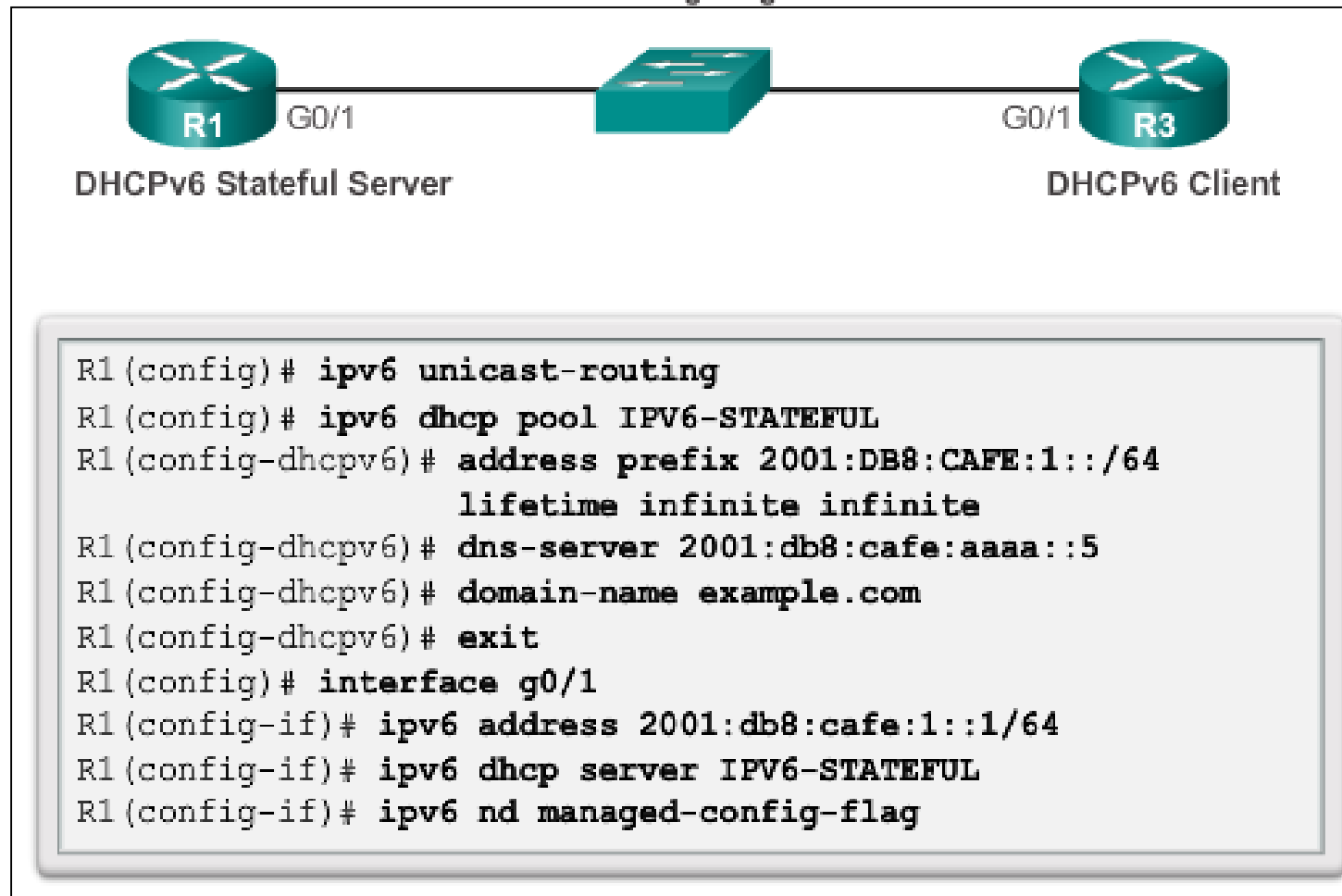


- **show IPv6 interface**
- **debug ipv6 dhcp detail**

# Konfigurácia smerovača ako Statefull DHCPv6 servera

- $M = 1$ 
  - DHCPv6 dodá klientovi IPv6 adresu
- $O = 0$ 
  - Hodnotu tohto flagu je v tomto variante nepodstatná

Configuring a Router as a Stateful DHCPv6 Server



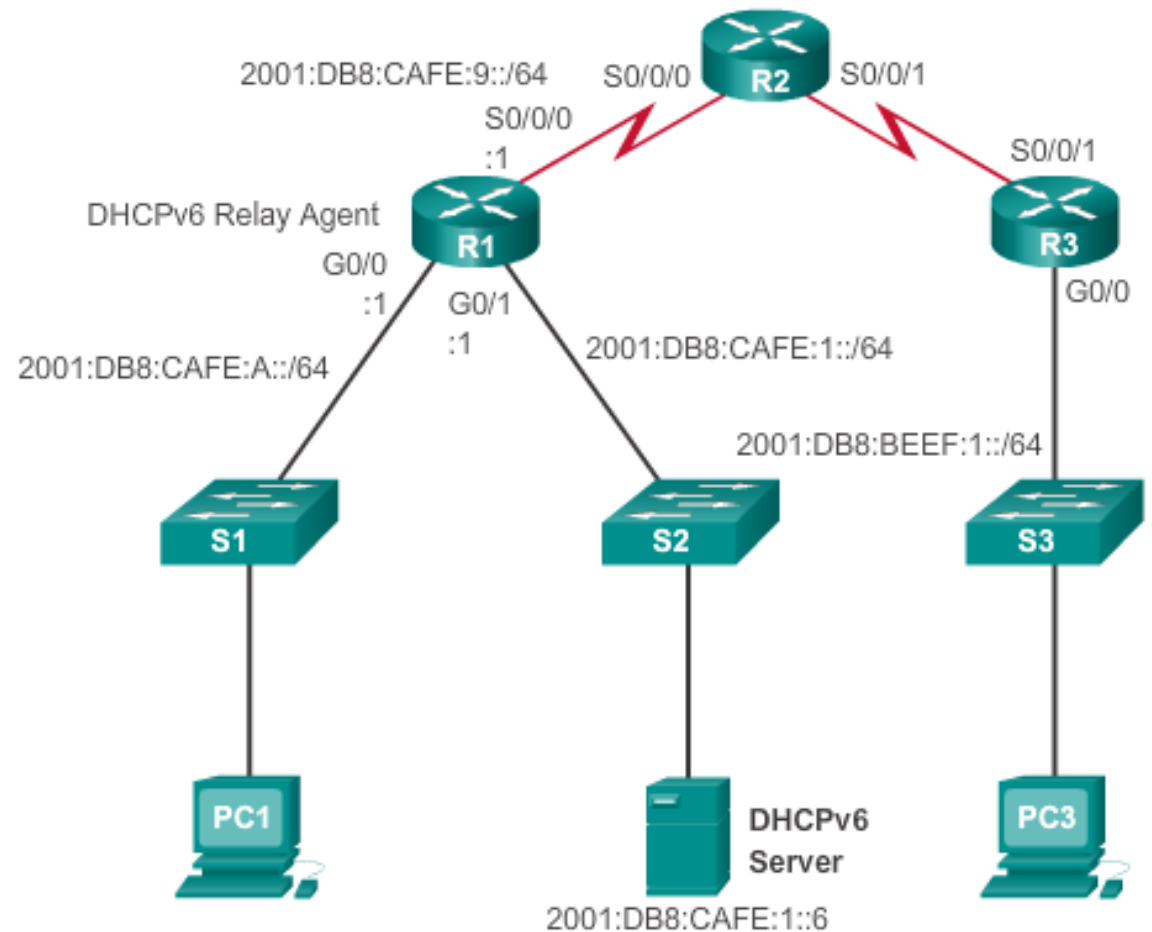
# Diagnostika Stateful DHCPv6

- Diagnostika pre stateful DHCPv6 server:
  - show ipv6 dhcp pool
  - show ipv6 dhcp binding
- Diagnostika pre stateful DHCPv6 klienta:
  - show ipv6 interface

```
R3# show ipv6 interface g0/1
GigabitEthernet0/1 is up, line protocol is up
  IPv6 is enabled, link-local address is
  FE80::32F7:DFE:FE25:2DE1
  No virtual link-local address(es):
  Global unicast address(es):
    2001:DB8:CAFE:1:5844:47B2:2603:C171, subnet is
    2001:DB8:CAFE:1:5844:47B2:2603:C171/128
  Joined group address(es):
    FF02::1
    FF02::1:FF03:C171
    FF02::1:FF25:2DE1
  MTU is 1500 bytes
  ICMP error messages limited to one every 100 milliseconds
  ICMP redirects are enabled
  ICMP unreachables are sent
  ND DAD is enabled, number of DAD attempts: 1
  ND reachable time is 30000 milliseconds (using 30000)
  ND NS retransmit interval is 1000 milliseconds
  Default router is FE80::D68C:B5FF:FECE:A0C1 on
```

Konfigurácia smerovača ako

## Stateful DHCPv6 Relay Agent



```
R1(config)# interface g0/0
R1(config-if)# ipv6 dhcp relay destination 2001:db8:cafe:1::6
R1(config-if)# end
R1# show ipv6 dhcp interface g0/0
GigabitEthernet0/0 is in relay mode
Relay destinations:
  2001:DB8:CAFE:1::6
```

# Kroky v diagnostike

Troubleshooting Task 1:	Resolve conflicts.
Troubleshooting Task 2:	Verify allocation method.
Troubleshooting Task 3:	Test with a static IPv6 address.
Troubleshooting Task 4:	Verify switch port configuration.
Troubleshooting Task 5:	Test from the same subnet or VLAN.

# DHCPv6 konfigurácia na smerovači – stateless / statefull

### Statefull DHCPv6 Services

```
R1(config)# ipv6 unicast-routing
R1(config)# ipv6 dhcp pool IPV6-STATEFUL
R1(config-dhcpv6)# address prefix 2001:DB8:CAFE:1::/64 lifetime
infinite infinite
R1(config-dhcpv6)# dns-server 2001:db8:cafe:aaaa::5
R1(config-dhcpv6)# domain-name example.com
R1(config-dhcpv6)# exit
R1(config)# interface g0/1
R1(config-if)# ipv6 address 2001:db8:cafe:1::1/64
R1(config-if)# ipv6 dhcp server IPV6-STATEFUL
R1(config-if)# ipv6 nd managed-config-flag
```

### Stateless DHCPv6 Services

```
R1(config)# ipv6 unicast-routing
R1(config)# ipv6 dhcp pool IPV6-STATELESS
R1(config-dhcpv6)# dns-server 2001:db8:cafe:aaaa::5
R1(config-dhcpv6)# domain-name example.com
R1(config-dhcpv6)# exit
R1(config)# interface g0/1
R1(config-if)# ipv6 address 2001:db8:cafe:1::1/64
R1(config-if)# ipv6 dhcp server IPV6-STATELESS
R1(config-if)# ipv6 nd other-config-flag
```



# Debugging DHCPv6

```
R1# debug ipv6 dhcp detail
    IPv6 DHCP debugging is on (detailed)
R1#
*Feb  3 21:27:41.123:  IPV6 DHCP: Received SOLICIT from
FE80::32F7:DFE:FE25:2DE1 on GigabitEthernet0/1
*Feb  3 21:27:41.123:  IPV6 DHCP: detailed packet contents
*Feb  3 21:27:41.123:    src FE80::32F7:DFE:FE25:2DE1
(GigabitEthernet0/1)
*Feb  3 21:27:41.127:    dst FF02::1:2
*Feb  3 21:27:41.127:    type SOLICIT(1), kid 13190645
*Feb  3 21:27:41.127:    option ELAPSED-TIME(8), len 2
*Feb  3 21:27:41.127:      elapsed-time 0
*Feb  3 21:27:41.127:    option CLIENTID(1), len 10
*Feb  3 21:27:41.127:      000
*Feb  3 21:27:41.127:  IPV6 DHCP: Using interface pool IPV6-
STATEFUL
*Feb  3 21:27:41.127:  IPV6 DHCP: Creating binding for
FE80::32F7:DFE:FE25:2DE1 in pool IPV6-STATEFUL
<Output omitted>
```



UNIVERSITY OF ŽILINA  
Faculty of Management Science  
and Informatics

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SLOVENSKEJ REPUBLIKY

# Ďakujem za pozornosť.

Obsahom bola **kapitola 8 (DHCP)** z kurzu **CCNA 2 RSE**.  
Otestujte sa cvičným testom na Netacadie z RSE\_08, aj odložené testy z minula z RSE\_07 a CN\_04 (ACLs).  
Vyjadrite svoj názor na [prednášku](#) tohto týždňa (alebo cvičenie).