

Сетевые технологии

DHCP для IPv4 и IPv6 в GNS3 (Лабораторная работа №7)

Заур Мустафаев

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Российский университет дружбы народов, Москва, Россия

Цель лабораторной работы

Цель

Получить практические навыки настройки DHCP для:

- IPv4
- IPv6 (Stateless и Stateful)

с использованием маршрутизатора **VyOS** и среды моделирования **GNS3**.

Выполнение работы

Исходная IPv4-топология

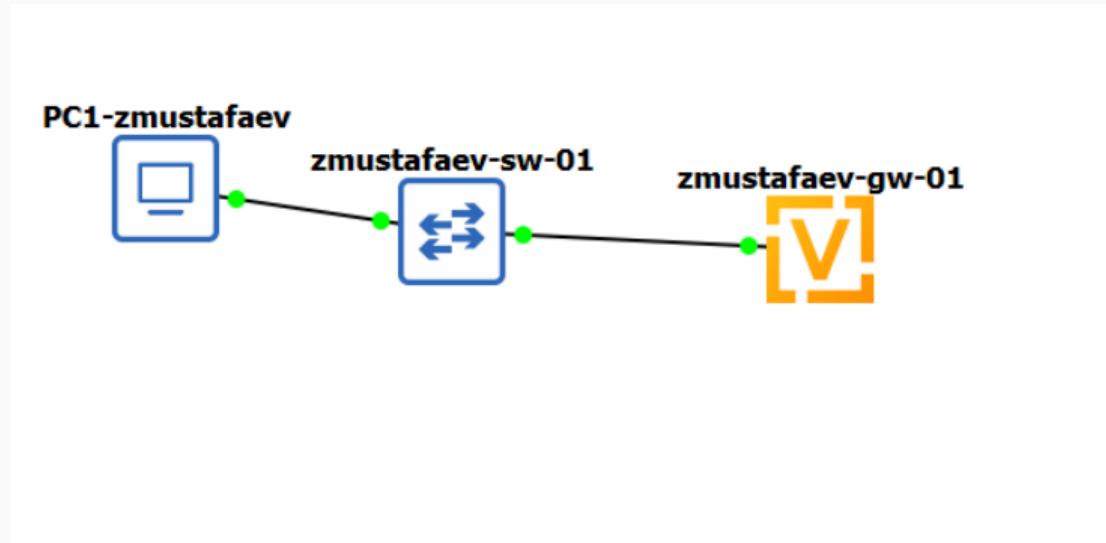
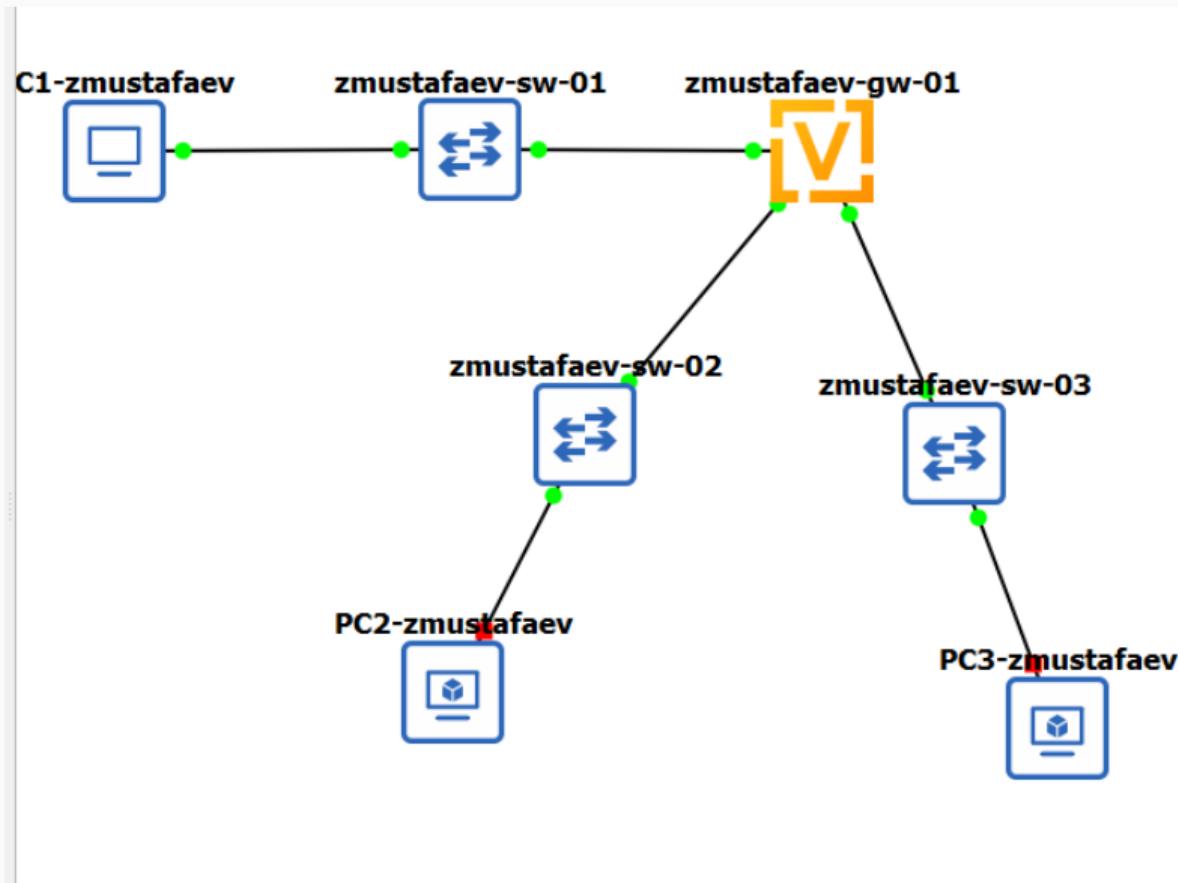
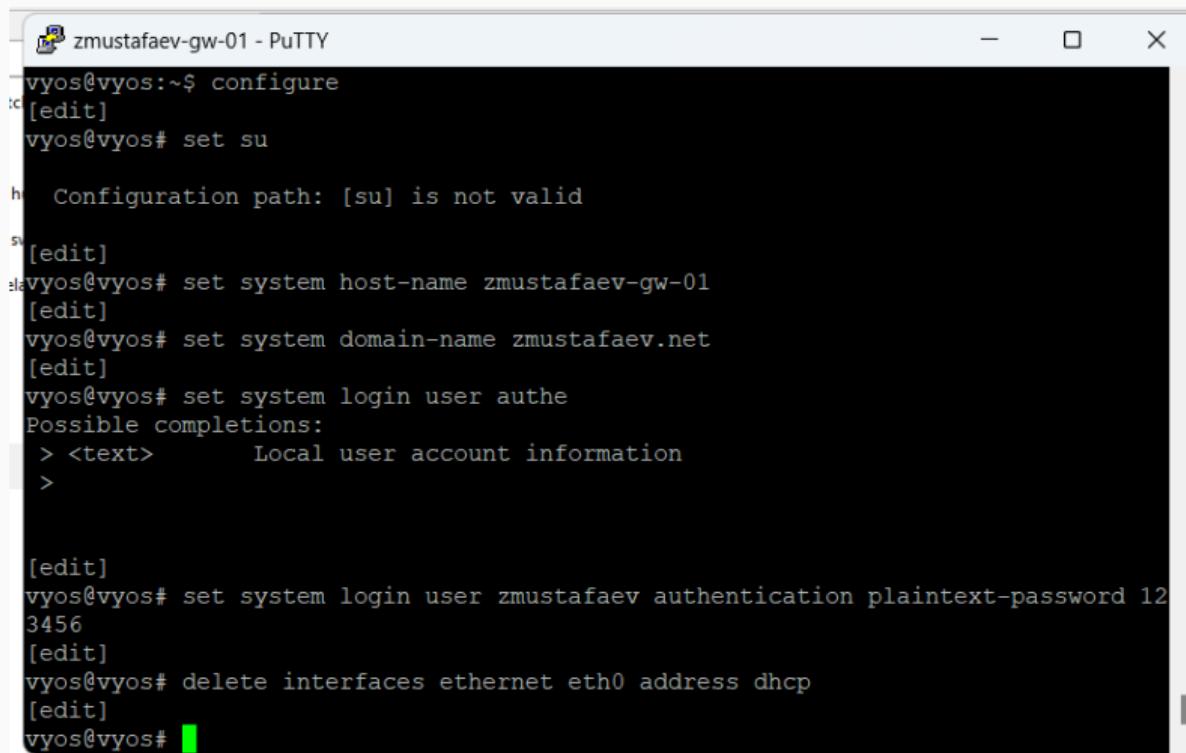


Рис. 1: Топология IPv4

Расширенная IPv6-топология



Начальная конфигурация маршрутизатора



```
zmustafaev-gw-01 - PuTTY
vyos@vyos:~$ configure
[edit]
vyos@vyos# set su

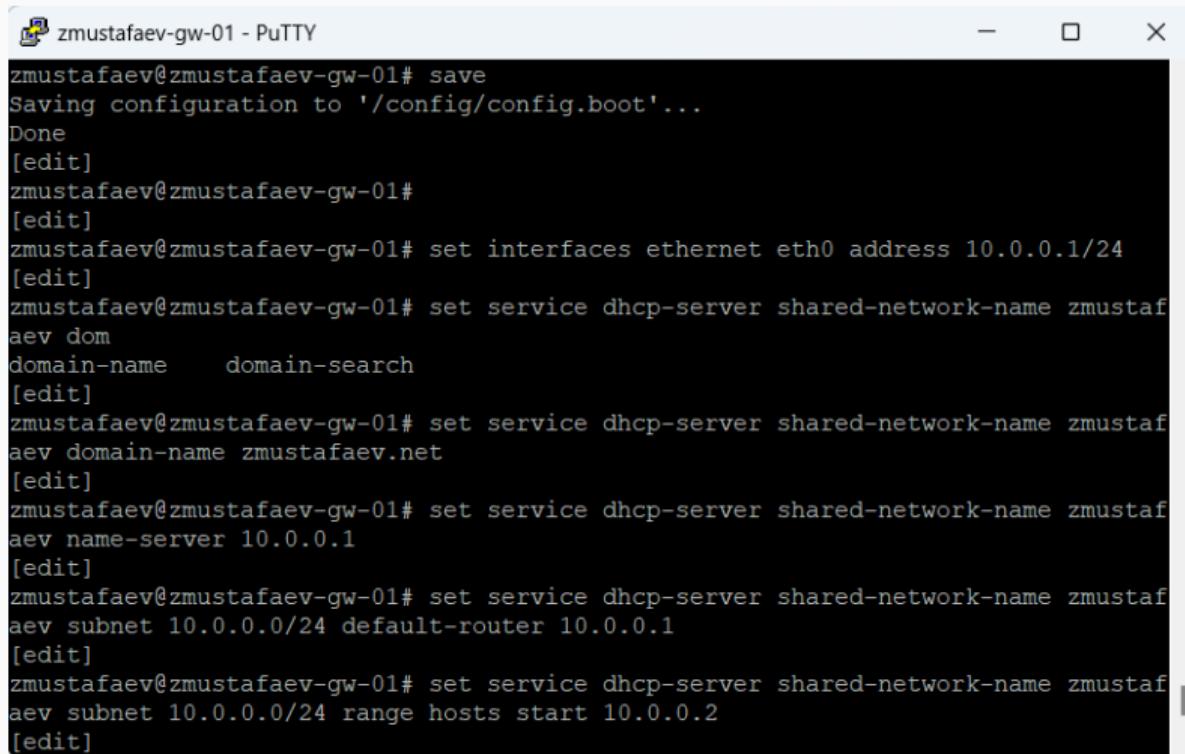
h Configuration path: [su] is not valid

[edit]
vyos@vyos# set system host-name zmustafaev-gw-01
[edit]
vyos@vyos# set system domain-name zmustafaev.net
[edit]
vyos@vyos# set system login user authe
Possible completions:
> <text>      Local user account information
>

[edit]
vyos@vyos# set system login user zmustafaev authentication plaintext-password 12
3456
[edit]
vyos@vyos# delete interfaces ethernet eth0 address dhcp
[edit]
vyos@vyos#
```

Рис. 3: Настройка VyOS

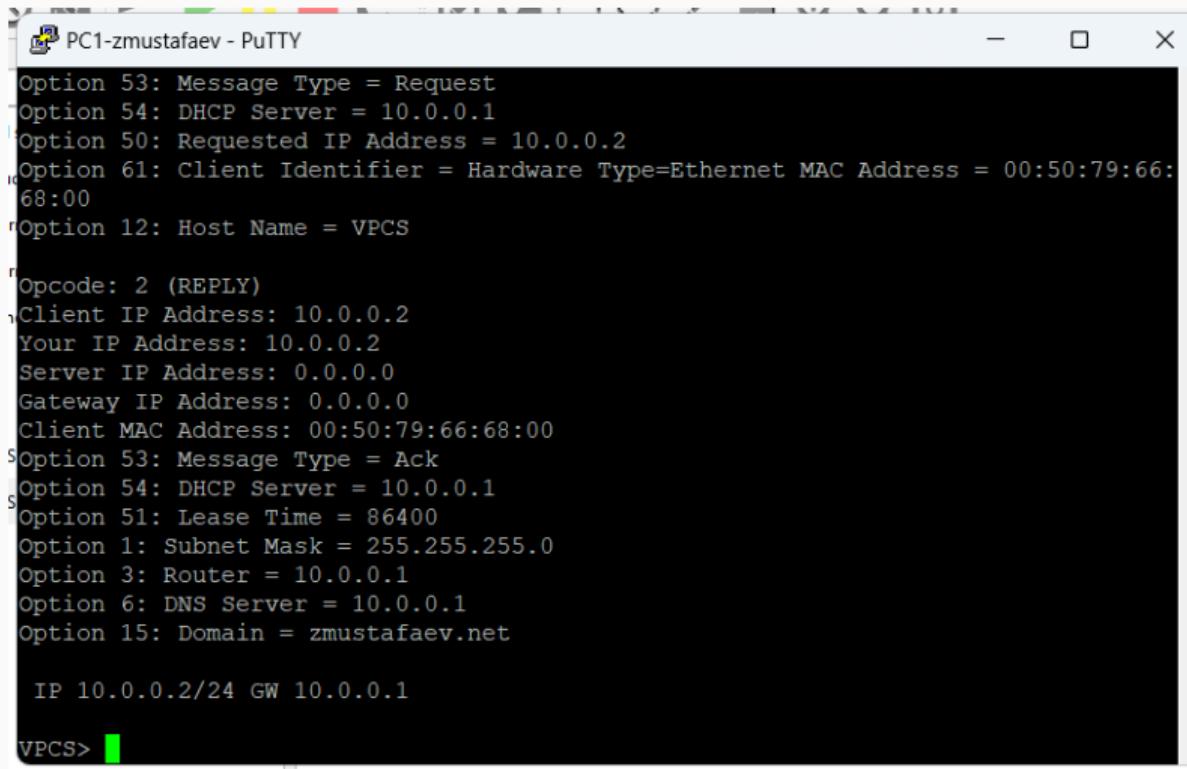
Настройка IPv4 и DHCP-сервера



```
zmustafaev@zmustafaev-gw-01# save
Saving configuration to '/config/config.boot'...
Done
[edit]
zmustafaev@zmustafaev-gw-01#
[edit]
zmustafaev@zmustafaev-gw-01# set interfaces ethernet eth0 address 10.0.0.1/24
[edit]
zmustafaev@zmustafaev-gw-01# set service dhcp-server shared-network-name zmustaf
aev dom
domain-name      domain-search
[edit]
zmustafaev@zmustafaev-gw-01# set service dhcp-server shared-network-name zmustaf
aev domain-name zmustafaev.net
[edit]
zmustafaev@zmustafaev-gw-01# set service dhcp-server shared-network-name zmustaf
aev name-server 10.0.0.1
[edit]
zmustafaev@zmustafaev-gw-01# set service dhcp-server shared-network-name zmustaf
aev subnet 10.0.0.0/24 default-router 10.0.0.1
[edit]
zmustafaev@zmustafaev-gw-01# set service dhcp-server shared-network-name zmustaf
aev subnet 10.0.0.0/24 range hosts start 10.0.0.2
[edit]
```

Рис. 4: DHCPv4 конфигурация

Получение адреса клиентом PC1



```
option 53: Message Type = Request
option 54: DHCP Server = 10.0.0.1
option 50: Requested IP Address = 10.0.0.2
option 61: Client Identifier = Hardware Type=Ethernet MAC Address = 00:50:79:66:68:00
option 12: Host Name = VPCS

opcode: 2 (REPLY)
client IP Address: 10.0.0.2
Your IP Address: 10.0.0.2
Server IP Address: 0.0.0.0
Gateway IP Address: 0.0.0.0
Client MAC Address: 00:50:79:66:68:00
Soption 53: Message Type = Ack
Soption 54: DHCP Server = 10.0.0.1
Soption 51: Lease Time = 86400
option 1: Subnet Mask = 255.255.255.0
option 3: Router = 10.0.0.1
option 6: DNS Server = 10.0.0.1
option 15: Domain = zmustafaev.net

IP 10.0.0.2/24 GW 10.0.0.1

VPCS>
```

Рис. 5: DHCPv4 клиент

Проверка параметров и связности

```
PC1-zmustafaev - PuTTY
VPCS> save
Saving startup configuration to startup.vpc
. done

VPCS> show ip

NAME      : VPCS[1]
IP/MASK   : 10.0.0.2/24
GATEWAY   : 10.0.0.1
DNS       : 10.0.0.1
DHCP SERVER : 10.0.0.1
DHCP LEASE  : 86383, 86400/43200/75600
DOMAIN NAME : zmustafaev.net
MAC        : 00:50:79:66:68:00
LPORT      : 10004
RHOST:PORT : 127.0.0.1:10005
MTU        : 1500

VPCS> ping 10.0.0.1 -c 2

84 bytes from 10.0.0.1 icmp_seq=1 ttl=64 time=1.791 ms
84 bytes from 10.0.0.1 icmp_seq=2 ttl=64 time=3.765 ms

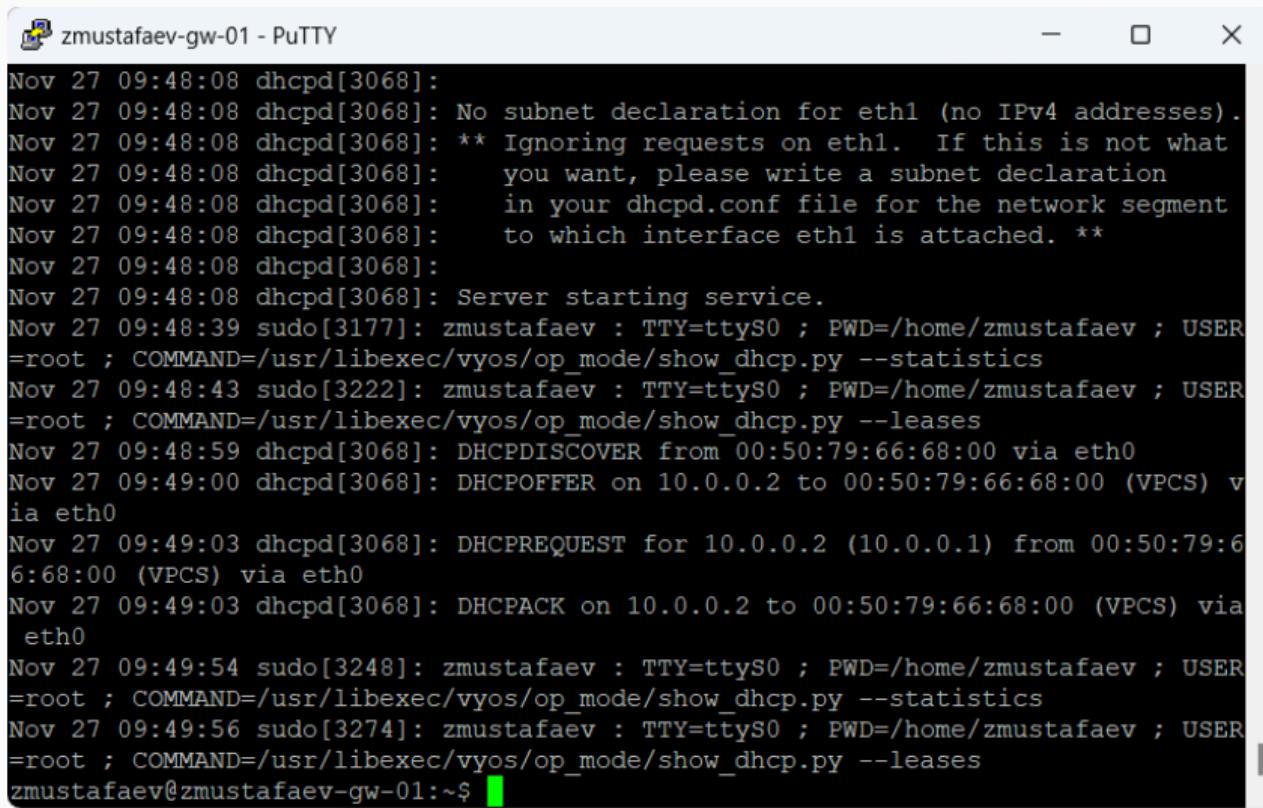
VPCS>
```

DHCPv4 статистика сервера

```
zmustafaev@zmustafaev-gw-01:~$ show dhcp server statistics
Pool          Size     Leases   Available Usage
-----  -----
zmustafaev    252        1      251  0%
zmustafaev@zmustafaev-gw-01:~$ show dhcp server leases
IP address    Hardware address   State      Lease start      Lease expiration
      Remaining      Pool       Hostname
-----  -----
10.0.0.2      00:50:79:66:68:00  active    2025/11/27 09:49:03  2025/11/28 09:49
:03 23:59:06  zmustafaev  VPCS
zmustafaev@zmustafaev-gw-01:~$
```

Рис. 7: Статистика DHCPv4

Журнал DHCP и трафик в Wireshark



zmustafaev-gw-01 - PuTTY

```
Nov 27 09:48:08 dhcpcd[3068]: 
Nov 27 09:48:08 dhcpcd[3068]: No subnet declaration for eth1 (no IPv4 addresses).
Nov 27 09:48:08 dhcpcd[3068]: ** Ignoring requests on eth1. If this is not what
Nov 27 09:48:08 dhcpcd[3068]:     you want, please write a subnet declaration
Nov 27 09:48:08 dhcpcd[3068]:     in your dhcpcd.conf file for the network segment
Nov 27 09:48:08 dhcpcd[3068]:     to which interface eth1 is attached. **
Nov 27 09:48:08 dhcpcd[3068]: 
Nov 27 09:48:08 dhcpcd[3068]: Server starting service.
Nov 27 09:48:39 sudo[3177]: zmustafaev : TTY=ttyS0 ; PWD=/home/zmustafaev ; USER=root ; COMMAND=/usr/libexec/vyos/op_mode/show_dhcp.py --statistics
Nov 27 09:48:43 sudo[3222]: zmustafaev : TTY=ttyS0 ; PWD=/home/zmustafaev ; USER=root ; COMMAND=/usr/libexec/vyos/op_mode/show_dhcp.py --leases
Nov 27 09:48:59 dhcpcd[3068]: DHCPDISCOVER from 00:50:79:66:68:00 via eth0
Nov 27 09:49:00 dhcpcd[3068]: DHCPOFFER on 10.0.0.2 to 00:50:79:66:68:00 (VPCS) via eth0
Nov 27 09:49:03 dhcpcd[3068]: DHCPREQUEST for 10.0.0.2 (10.0.0.1) from 00:50:79:66:68:00 (VPCS) via eth0
Nov 27 09:49:03 dhcpcd[3068]: DHCPACK on 10.0.0.2 to 00:50:79:66:68:00 (VPCS) via eth0
Nov 27 09:49:54 sudo[3248]: zmustafaev : TTY=ttyS0 ; PWD=/home/zmustafaev ; USER=root ; COMMAND=/usr/libexec/vyos/op_mode/show_dhcp.py --statistics
Nov 27 09:49:56 sudo[3274]: zmustafaev : TTY=ttyS0 ; PWD=/home/zmustafaev ; USER=root ; COMMAND=/usr/libexec/vyos/op_mode/show_dhcp.py --leases
zmustafaev@zmustafaev-gw-01:~$
```

Рис. 8: DHCPv4 log

Журнал DHCP и трафик в Wireshark

Захват из Standard input [zmustafaev-sw-01 Ethernet1 to zmustafaev-gw-01 eth0]

Файл Правка Вид Запуск Захват Анализ Статистика Телефония Беспроводная связь Инструменты Справка

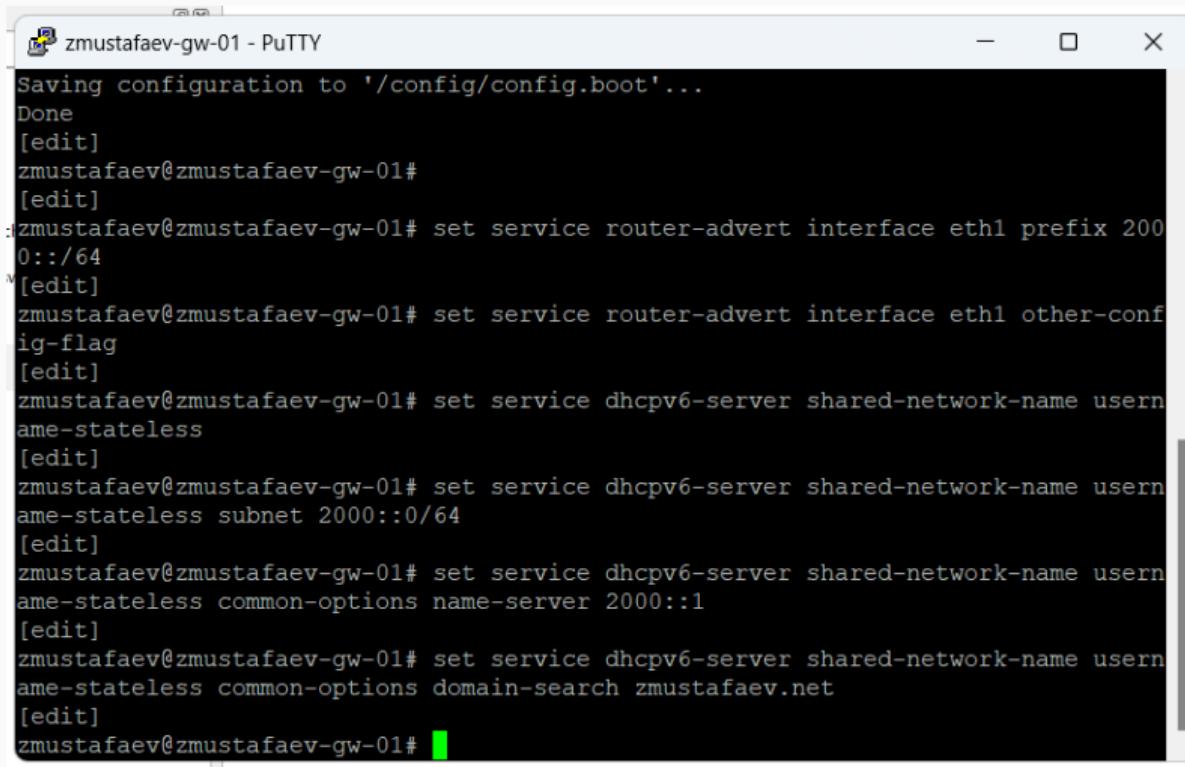
Примените фильтр отображения ... <Ctrl-/>

| No. | Time | Source | Destination | Protocol | Length | Info |
|-----|----------|-------------------|------------------|----------|--------|--|
| 1 | 0.000000 | 0.0.0.0 | 255.255.255.255 | DHCP | 406 | DHCP Discover - Transaction ID 0x35ef7e4a |
| 2 | 0.006725 | 10.0.0.1 | 10.0.0.2 | ICMP | 62 | Echo (ping) request id=0xdc99, seq=0/0, ttl=64 |
| 3 | 0.007389 | 10.0.0.2 | 10.0.0.1 | ICMP | 62 | Echo (ping) reply id=0xdc99, seq=0/0, ttl=64 |
| 4 | 1.001089 | 0.0.0.0 | 255.255.255.255 | DHCP | 406 | DHCP Discover - Transaction ID 0x35ef7e4a |
| 5 | 1.006818 | 0c:b5:c5:19:00:00 | Broadcast | ARP | 60 | Who has 10.0.0.3? Tell 10.0.0.1 |
| 6 | 2.010086 | 10.0.0.1 | 10.0.0.3 | DHCP | 342 | DHCP Offer - Transaction ID 0x35ef7e4a |
| 7 | 2.065248 | 0c:b5:c5:19:00:00 | Broadcast | ARP | 60 | Who has 10.0.0.3? Tell 10.0.0.1 |
| 8 | 3.089593 | 0c:b5:c5:19:00:00 | Broadcast | ARP | 60 | Who has 10.0.0.3? Tell 10.0.0.1 |
| 9 | 4.001241 | 0.0.0.0 | 255.255.255.255 | DHCP | 406 | DHCP Request - Transaction ID 0x35ef7e4a |
| 10 | 4.010076 | 10.0.0.1 | 10.0.0.3 | DHCP | 342 | DHCP ACK - Transaction ID 0x35ef7e4a |
| 11 | 5.001610 | Private_66:68:00 | Broadcast | ARP | 64 | Gratuitous ARP for 10.0.0.3 (Request) |
| 12 | 5.072878 | 0c:b5:c5:19:00:00 | Private_66:68:00 | ARP | 60 | Who has 10.0.0.2? Tell 10.0.0.1 |
| 13 | 6.002111 | Private_66:68:00 | Broadcast | ARP | 64 | Gratuitous ARP for 10.0.0.3 (Request) |

Transaction ID: 0x35ef7e4a
Seconds elapsed: 0
Bootp flags: 0x0000 (Unicast)
Client IP address: 10.0.0.3
Your (client) IP address: 10.0.0.3
Next server IP address: 0.0.0.0
Relay agent IP address: 0.0.0.0
Client MAC address: Private_66:68:00 (00:50:79:66:68:00)
Client hardware address padding: 000000000000000000000000
Server host name not given
Boot file name not given
Magic cookie: DHCP
Option: (53) DHCP Message Type (ACK)
Option: (54) DHCP Server Identifier (10.0.0.1)
Option: (51) IP Address Lease Time
Option: (1) Subnet Mask (255.255.255.0)
Option: (3) Router

| | |
|------|----------|
| 0000 | 00 50 79 |
| 0010 | 01 48 00 |
| 0020 | 00 03 00 |
| 0030 | 7e 4a 00 |
| 0040 | 00 00 00 |
| 0050 | 00 00 00 |
| 0060 | 00 00 00 |
| 0070 | 00 00 00 |
| 0080 | 00 00 00 |
| 0090 | 00 00 00 |
| 00a0 | 00 00 00 |
| 00b0 | 00 00 00 |
| 00c0 | 00 00 00 |
| 00d0 | 00 00 00 |
| 00e0 | 00 00 00 |
| 00f0 | 00 00 00 |
| 0100 | 00 00 00 |
| 0110 | 00 00 00 |
| 0120 | 00 00 01 |

Настройка RA и DHCPv6 Stateless



```
Saving configuration to '/config/config.boot'...
Done
[edit]
zmustafaev@zmustafaev-gw-01#
[edit]
:zmustafaev@zmustafaev-gw-01# set service router-advert interface eth1 prefix 200
0::/64
[edit]
zmustafaev@zmustafaev-gw-01# set service router-advert interface eth1 other-conf
ig-flag
[edit]
zmustafaev@zmustafaev-gw-01# set service dhcipv6-server shared-network-name usern
ame-stateless
[edit]
zmustafaev@zmustafaev-gw-01# set service dhcipv6-server shared-network-name usern
ame-stateless subnet 2000::0/64
[edit]
zmustafaev@zmustafaev-gw-01# set service dhcipv6-server shared-network-name usern
ame-stateless common-options name-server 2000::1
[edit]
zmustafaev@zmustafaev-gw-01# set service dhcipv6-server shared-network-name usern
ame-stateless common-options domain-search zmustafaev.net
[edit]
zmustafaev@zmustafaev-gw-01#
```

Рис. 10: Настройка Stateless

Проверка работы Stateless на PC2

```
[(kali㉿kali)-~]
└$ ifconfig eth0
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
      inet6 2000::1c5:6e27:4f69:4f13 prefixlen 64 scopeid 0x0<global>
      inet6 fe80::d00b:1b60:ff5f:5535 prefixlen 64 scopeid 0x20<link>
        ether 0c:7b:b1:87:00:00 txqueuelen 1000 (Ethernet)
          RX packets 5 bytes 574 (574.0 B)
          RX errors 0 dropped 0 overruns 0 frame 0
          TX packets 23 bytes 3348 (3.2 KiB)
          TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

[(kali㉿kali)-~]
└$ route -n -A inet6
Kernel IPv6 routing table
Destination           Next Hop            Flag Met Ref Use If
::1/128              ::                  U   256 2    0 lo
2000 ::/64             ::                  U   100 1    0 eth0
fe80 ::/64             ::                  U   100 1    0 eth0
::/0                   fe80::eb5:c5ff:fe19:1   UG  100 1    0 eth0
::1/128              ::                  Un  0    4    0 lo
2000 ::1c5:6e27:4f69:4f13/128 ::                  Un  0    2    0 eth0
fe80::d00b:1b60:ff5f:5535/128 ::                  Un  0    3    0 eth0
ff00 ::/8              ::                  U   256 3    0 eth0
::/0                   ::                  !n  -1  1    0 lo

[(kali㉿kali)-~]
└$ ping 2000::1 -c 2
PING 2000::1(2000::1) 56 data bytes
64 bytes from 2000::1: icmp_seq=1 ttl=64 time=4.24 ms
64 bytes from 2000::1: icmp_seq=2 ttl=64 time=1.65 ms

--- 2000::1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1002ms
rtt min/avg/max/mdev = 1.652/2.944/4.237/1.292 ms

[(kali㉿kali)-~]
└$ cat /etc/resolv.conf
# Generated by NetworkManager
search zmustafaev.net
nameserver 2000 ::1
```

Получение параметров DHCPv6 (Stateless)

```
(kali㉿kali)-[~]
└─$ sudo dhclient -6 -S -v eth0
Internet Systems Consortium DHCP Client 4.4.1
Copyright 2004-2018 Internet Systems Consortium.
All rights reserved.
For info, please visit https://www.isc.org/software/dhcp/

Listening on Socket/eth0
Sending on Socket/eth0
Created duid "\000\003\000\001\014{\261\207\000\000".
PRC: Requesting information (INIT).
XMT: Forming Info-Request, 0 ms elapsed.
XMT: Info-Request on eth0, interval 1030ms.
RCV: Reply message on eth0 from fe80::eb5:c5ff:fe19:1.
PRC: Done.

(kali㉿kali)-[~]
└─$ ping 2000::1 -c 2
PING 2000::1(2000::1) 56 data bytes
64 bytes from 2000::1: icmp_seq=1 ttl=64 time=1.66 ms
64 bytes from 2000::1: icmp_seq=2 ttl=64 time=3.10 ms

--- 2000::1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1002ms
rtt min/avg/max/mdev = 1.658/2.378/3.098/0.720 ms

(kali㉿kali)-[~]
└─$ cat /etc/resolv.conf
search zmustafaev.net.
nameserver 2000::1

(kali㉿kali)-[~]
└─$
```

Статистика DHCPv6 Stateless

```
[edit]
zmustafaev@zmustafaev-gw-01# run show dhcpv6 server leases
IPv6 address      State      Last communication      Lease expiration      Remaining
Type    Pool      IAID_DUID
-----  -----  -----
[edit]
zmustafaev@zmustafaev-gw-01#
```

Рис. 13: DHCPv6 Stateless вывод

Wireshark DHCPv6 Stateless

| No. | Time | Source | Destination | Protocol | Length | Info |
|-----|-----------|------------------------|------------------------|----------|--------|--|
| 10 | 22.794400 | fe80::eb5:c5ff:fe19... | ff02::1:ff5f:5535 | ICMPv6 | 86 | Neighbor Solicitation for fe80::d00b:1b60:ff51 |
| 11 | 22.795462 | fe80::d00b:1b60:ff5... | fe80::eb5:c5ff:fe19... | ICMPv6 | 86 | Neighbor Advertisement fe80::d00b:1b60:ff51 |
| 12 | 22.796301 | fe80::eb5:c5ff:fe19... | fe80::d00b:1b60:ff5... | ICMPv6 | 118 | Router Advertisement from 0c:b5:c5:19:00:01 |
| 13 | 22.800534 | fe80::d00b:1b60:ff5... | ff02::1:2 | DHCPv6 | 106 | Information-request XID: 0x65f549 CID: 0004 |
| 14 | 22.801478 | fe80::eb5:c5ff:fe19... | fe80::d00b:1b60:ff5... | DHCPv6 | 146 | Reply XID: 0x65f549 CID: 0004b2c559911f925a |
| 15 | 22.811754 | fe80::d00b:1b60:ff5... | ff02::16 | ICMPv6 | 110 | Multicast Listener Report Message v2 |
| 16 | 23.039776 | fe80::d00b:1b60:ff5... | ff02::16 | ICMPv6 | 110 | Multicast Listener Report Message v2 |
| 17 | 23.295739 | :: | ff02::1:ff69:4f13 | ICMPv6 | 86 | Neighbor Solicitation for 2000::1c5:6e27:4f13 |
| 18 | 23.744537 | fe80::d00b:1b60:ff5... | ff02::1:6 | ICMPv6 | 110 | Multicast Listener Report Message v2 |
| 19 | 23.752722 | fe80::d00b:1b60:ff5... | ff02::1:2 | DHCPv6 | 106 | Information-request XID: 0x65f549 CID: 0004 |
| 20 | 23.753358 | fe80::eb5:c5ff:fe19... | fe80::d00b:1b60:ff5... | DHCPv6 | 146 | Reply XID: 0x65f549 CID: 0004b2c559911f925a |
| 21 | 23.816050 | fe80::d00b:1b60:ff5... | ff02::16 | ICMPv6 | 110 | Multicast Listener Report Message v2 |
| 22 | 24.305091 | 0.0.0.0 | 255.255.255.255 | DHCP | 324 | DHCP Discover - Transaction ID 0xa47e8d78 |

> User Datagram Protocol, Src Port: 547, Dst Port: 546

 DHCPv6

 Message type: Reply (7)

 Transaction ID: 0x65f549

 Client Identifier

 Option: Client Identifier (1)

 Length: 18

 DUID: 0004b2c559911f925adfa7bd4a94bf77999f

 DUID Type: Universally Unique Identifier (UUID) (4)

 UUID: b2c559911f925adfa7bd4a94bf77999f

 Server Identifier

 Option: Server Identifier (2)

 Length: 14

 DUID: 0001000130bade010cb5c5190001

 DUID Type: link-layer address plus time (1)

 Hardware type: Ethernet (1)

 DUID Time: Nov 27, 2025 13:01:37.000000000 RTZ 2 (зима)

 0000 0c 7b b1 82
 0010 f6 2a 00 5c
 0020 c5 ff fe 19
 0030 1b 60 ff 51
 0040 f5 49 00 00
 0050 a7 bd 4a 94
 0060 30 ba de 00
 0070 00 00 00 00
 0080 00 10 0a 7a
 0090 74 00

Настройка DHCPv6 Stateful

```
zmustafaev-gw-01 - PuTTY
-----
[edit]
zmustafaev@zmustafaev-gw-01#
[edit]
zmustafaev@zmustafaev-gw-01# set service router-advert interface eth2 managed-flag
[edit]
zmustafaev@zmustafaev-gw-01# set service dhcpcv6-server shared-network-name zmustafaev-stateful
[edit]
zmustafaev@zmustafaev-gw-01# set service dhcpcv6-server shared-network-name zmustafaev-stateful subnet 2001::0/64
[edit]
zmustafaev@zmustafaev-gw-01# set service dhcpcv6-server shared-network-name zmustafaev-stateful subnet 2001::0/64 name-server 2001::1
[edit]
zmustafaev@zmustafaev-gw-01# set service dhcpcv6-server shared-network-name zmustafaev-stateful subnet 2001::0/64 domain-search zmustafaev.net
[edit]
zmustafaev@zmustafaev-gw-01# set service dhcpcv6-server shared-network-name zmustafaev-stateful subnet 2001::0/64 address-range start 2001::100 stop 2001::199
[edit]
zmustafaev@zmustafaev-gw-01#
```

Работа DHCPv6 Stateful на PC3

Параметры сети до получения адреса

```
(kali㉿kali)-[~]
└─$ ifconfig eth0
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
      inet6 fe80::eaae:1970:d25d:c060  prefixlen 64  scopeid 0x20<link>
          inet6 2001::199  prefixlen 128  scopeid 0x0<global>
            ether 0c:90:bc:b7:00:00  txqueuelen 1000  (Ethernet)
              RX packets 5  bytes 630 (630.0 B)
              RX errors 0  dropped 0  overruns 0  frame 0
              TX packets 24  bytes 3734 (3.6 KiB)
              TX errors 0  dropped 0  overruns 0  carrier 0  collisions 0
```

```
(kali㉿kali)-[~]
└─$ route -n -A inet6
Kernel IPv6 routing table
Destination           Next Hop        Flag Met Ref Use If
:: 1/128             ::                  U    256 2   0 lo
2001:: 199/128        ::                  U    100 1   0 eth0
fe80:: /64            ::                  U    100 1   0 eth0
:: /0                 fe80::eb5:c5ff:fe19:2  UG   100 1   0 eth0
:: 1/128             ::                  Un   0   4   0 lo
2001:: 199/128        ::                  Un   0   2   0 eth0
fe80:: eaae:1970:d25d:c060/128  ::                  Un   0   3   0 eth0
ff00:: /8              ::                  U    256 3   0 eth0
:: /0                 ::                  !n  -1   1   0 lo
```

```
(kali㉿kali)-[~]
└─$ cat /etc/resolv.conf
# Generated by NetworkManager
search zmustafaev.net
nameserver 2001::1
```

```
(kali㉿kali)-[~]
└─$
```

Получение IPv6-адреса (Stateful)

```
(kali㉿kali)-[~]
$ sudo dhclient -6 -v eth0
Internet Systems Consortium DHCP Client 4.4.1
Copyright 2004-2018 Internet Systems Consortium.
All rights reserved.
For info, please visit https://www.isc.org/software/dhcp/

Listening on Socket/eth0
Sending on  Socket/eth0
Created duid "\000\001\000\0010\272\340\326\014\220\274\267\000\000".
PRC: Soliciting for leases (INIT).
XMT: Forming Solicit, 0 ms elapsed.
XMT: X-- IA_NA bc:b7:00:00
XMT: | X-- Request renew in +3600
XMT: | X-- Request rebind in +5400
XMT: Solicit on eth0, interval 1010ms.
RCV: Advertise message on eth0 from fe80::eb5:c5ff:fe19:2.
RCV: X-- IA_NA bc:b7:00:00
RCV: | X-- starts 1764238423
RCV: | X-- t1 - renew +0
RCV: | X-- t2 - rebind +0
RCV: | X-- [Options]
RCV: | | X-- IAADDR 2001::198
RCV: | | X-- Preferred lifetime 27000.
RCV: | | X-- Max lifetime 43200.
RCV: | X-- Server ID: 00:01:00:01:30:ba:de:01:0c:b5:c5:19:00:01
RCV: Advertisement recorded.
PRC: Selecting best advertised lease.
PRC: Considering best lease.
PRC: X-- Initial candidate 00:01:00:01:30:ba:de:01:0c:b5:c5:19:00:01 (s: 10105, p: 0).
XMT: Forming Request, 0 ms elapsed.
XMT: X-- IA_NA bc:b7:00:00
XMT: | X-- Requested renew +3600
XMT: | X-- Requested rebind +5400
XMT: | | X-- IAADDR 2001::198
XMT: | | X-- Preferred lifetime +7200
XMT: | | X-- Max lifetime +7500
XMT: V IA_NA appended.
```

Параметры сети после получения адреса

```
(kali㉿kali)-[~]
$ ifconfig eth0
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
      inet6 2001::198  prefixlen 128  scopeid 0x0<global>
      inet6 fe80::eaae:1970:d25d:c060  prefixlen 64  scopeid 0x20<link>
      inet6 2001::199  prefixlen 128  scopeid 0x0<global>
      ether 0c:90:bc:b7:00:00  txqueuelen 1000  (Ethernet)
      RX packets 9  bytes 1166 (1.1 KiB)
      RX errors 0  dropped 0  overruns 0  frame 0
      TX packets 31  bytes 4526 (4.4 KiB)
      TX errors 0  dropped 0  overruns 0  carrier 0  collisions 0
```

```
(kali㉿kali)-[~]
$ route -n -A inet6
Kernel IPv6 routing table
Destination          Next Hop          Flag Met Ref Use If
::1/128              ::                  U    256 2   0   lo
2001::198/128        ::                  U    256 1   0   eth0
2001::199/128        ::                  U    100 2   0   eth0
fe80::/64             ::                  U    100 1   0   eth0
::/0                  fe80::e[REDACTED]5:c5ff:fe19:2  UG   100 1   0   eth0
::1/128              ::                  Un   0   4   0   lo
2001::198/128        ::                  Un   0   2   0   eth0
2001::199/128        ::                  Un   0   3   0   eth0
fe80::eaae:1970:d25d:c060/128 ::                  Un   0   3   0   eth0
ff00::/8               ::                  U    256 3   0   eth0
::/0                  ::                  !n  -1   1   0   lo
```

Параметры сети после получения адреса

```
(kali㉿kali)-[~]
└─$ ping 2001::1 -c 2
PING 2001::1(2001::1) 56 data bytes
64 bytes from 2001::1: icmp_seq=1 ttl=64 time=2.95 ms
64 bytes from 2001::1: icmp_seq=2 ttl=64 time=2.25 ms

--- 2001::1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1002ms
rtt min/avg/max/mdev = 2.251/2.600/2.950/0.349 ms
```

```
(kali㉿kali)-[~]
└─$ cat /etc/resolv.conf
search zmustafaev.net.
nameserver 2001::1
```

```
(kali㉿kali)-[~]
└─$ █
```

Рис. 19: Проверка связности

Аренды DHCPv6 Stateful

```
zmustafaev@zmustafaev-gw-01# run show dhcipv6 server leases
IPv6 address      State    Last communication   Lease expiration   Remaining
Type             Pool           IAID_DUID
-----
-----
2001::198        active   2025/11/27 10:13:44   2025/11/27 12:18:44  2:03:54
non-temporary    zmustafaev-stateful  00:00:b7:bc:00:01:00:01:30:ba:e0:d6:0c:90:b
c:b7:00:00
2001::199        active   2025/11/27 10:11:53   2025/11/27 22:11:53  11:57:03
non-temporary    zmustafaev-stateful  35:67:50:2b:00:04:7a:35:29:97:45:ba:2d:d9:c
c:18:9f:21:37:97:54:78
[edit]
zmustafaev@zmustafaev-gw-01#
```

Рис. 20: DHCPv6 аренды

Пакеты Solicit / Advertise / Request / Reply

| No. | Time | Source | Destination | Protocol | Length | Info |
|-----|------------|--|------------------|----------|--------|--|
| 42 | 92.021304 | 0.0.0.0 | 255.255.255.255 | DHCP | 324 | DHCP Discover - Transaction ID 0xc497784 |
| 43 | 93.891585 | fe80::eb5:c5ff:fe19::ff02::1 | | ICMPv6 | 86 | Router Advertisement from 0c:b5:c5:19:00:02 |
| 44 | 93.906653 | fe80::bcc6:aa2a:721::ff02::16 | | ICMPv6 | 110 | Multicast Listener Report Message v2 |
| 45 | 94.454677 | fe80::bcc6:aa2a:721::ff02::16 | | ICMPv6 | 110 | Multicast Listener Report Message v2 |
| 46 | 108.534236 | 0.0.0.0 | 255.255.255.255 | DHCP | 324 | DHCP Discover - Transaction ID 0x7107b587 |
| 47 | 110.904737 | fe80::bcc6:aa2a:721::ff02::1:2 | | DHCPv6 | 118 | Solicit XID: 0xaece7c CID: 0001000130bae1a8 |
| 48 | 110.906039 | fe80::eb5:c5ff:fe19::fe80::bcc6:aa2a:721:: | | DHCPv6 | 186 | Advertise XID: 0xaece7c IAA: 2001::193 CID: 0001000130bae1a8 |
| 49 | 111.935702 | fe80::bcc6:aa2a:721::ff02::1:2 | | DHCPv6 | 164 | Request XID: 0x670194 CID: 0001000130bae1a8 |
| 50 | 111.939171 | fe80::eb5:c5ff:fe19::fe80::bcc6:aa2a:721:: | | DHCPv6 | 186 | Reply XID: 0x670194 IAA: 2001::193 CID: 0001000130bae1a8 |
| 51 | 111.955225 | fe80::bcc6:aa2a:721::ff02::16 | | ICMPv6 | 130 | Multicast Listener Report Message v2 |
| 52 | 112.569139 | fe80::bcc6:aa2a:721::ff02::16 | | ICMPv6 | 130 | Multicast Listener Report Message v2 |
| 53 | 112.791323 | :: | ff02::1:ff00:193 | ICMPv6 | 86 | Neighbor Solicitation for 2001::193 |

| | |
|--|------------------|
| > User Datagram Protocol, Src Port: 546, Dst Port: 547 | 0000 33 33 00 00 |
| ` DHCPv6 | 0010 b2 0a 00 6e |
| Message type: Request (3) | 0020 aa 2a 72 18 |
| Transaction ID: 0x670194 | 0030 00 00 00 00 |
| ` Client Identifier | 0040 01 94 00 00 |
| Option: Client Identifier (1) | 0050 bc b7 00 00 |
| Length: 14 | 0060 0c b5 c5 19 |
| DUID: 0001000130bae1a80c90bcb70000 | 0070 00 1f 00 00 |
| DUID Type: link-layer address plus time (1) | 0080 00 00 0e 10 |
| Hardware type: Ethernet (1) | 0090 00 00 00 00 |
| DUID Time: Nov 27, 2025 13:17:12.000000000 RTZ 2 (зима) | 00a0 00 00 1d 4e |
| Link-layer address: 0c:90:bc:b7:00:00 | |
| Link-layer address (Ethernet): 0c:90:bc:b7:00:00 (0c:90:bc:b7:00:00) | |
| ` Server Identifier | |
| ` Option Request | |
| ` Elapsed time | |
| ` Identity Association for Non-temporary Address | |

Выводы

- Настроены и протестированы DHCPv4, DHCPv6 Stateless и DHCPv6 Stateful
- IPv4-клиенты получают полный набор настроек автоматически
- Для IPv6 успешно реализованы оба режима конфигурации
- Проанализирован сетевой трафик DHCPv4 и DHCPv6 в Wireshark
- Подтверждена корректность работы адресации и сетевой инфраструктуры

Работа выполнена успешно.