Сетевые технологии

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

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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

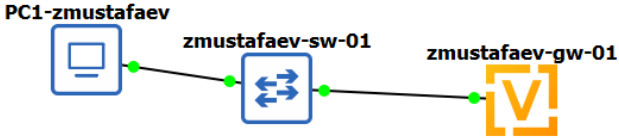
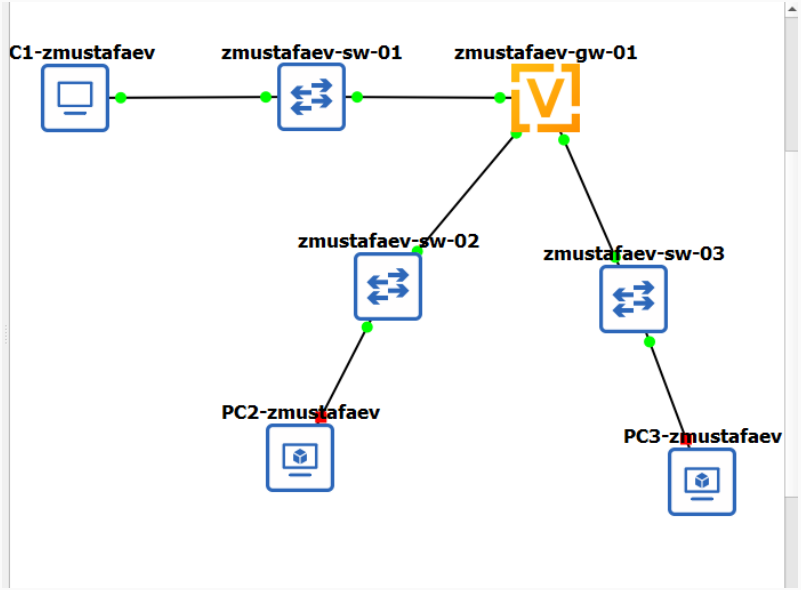


Рис. 1: Топология IPv4

Расширенная IPv6-топология



Начальная конфигурация маршрутизатора

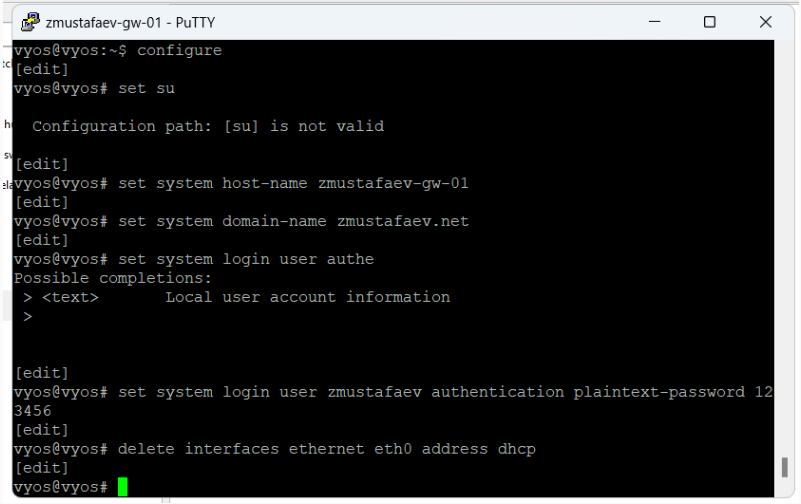


Рис. 3: Настройка VyOS

Настройка IPv4 и DHCP-сервера

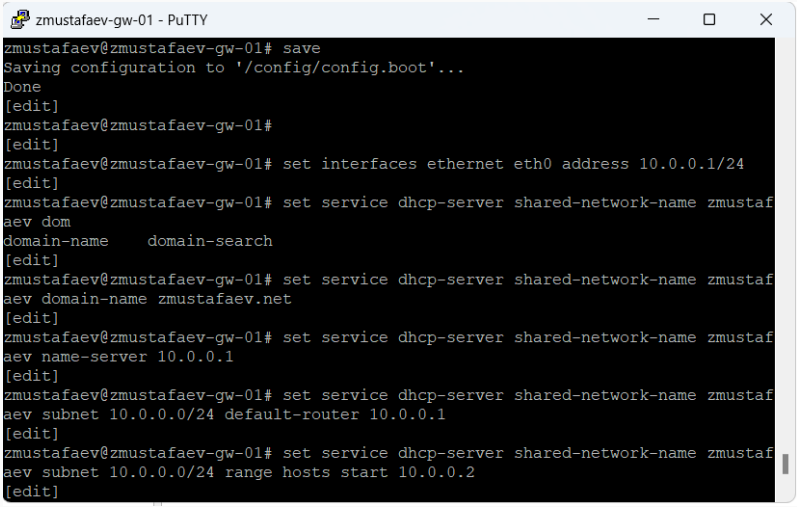


Рис. 4: DHCPv4 конфигурация

Получение адреса клиентом PC1

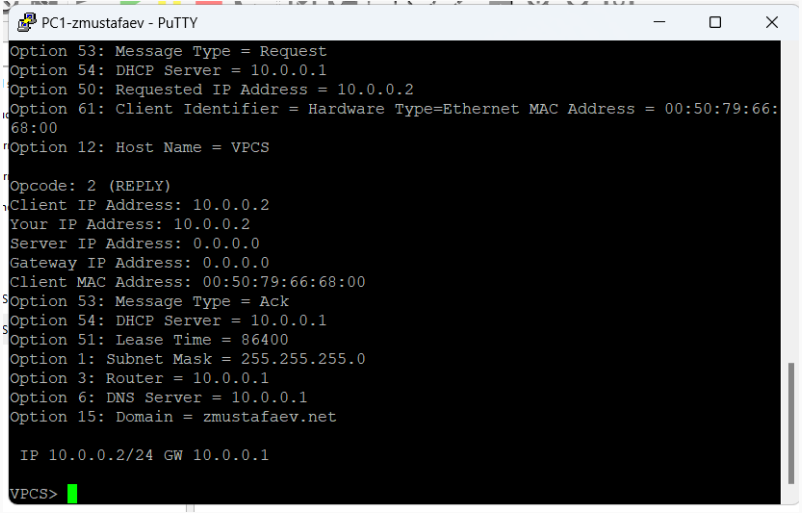
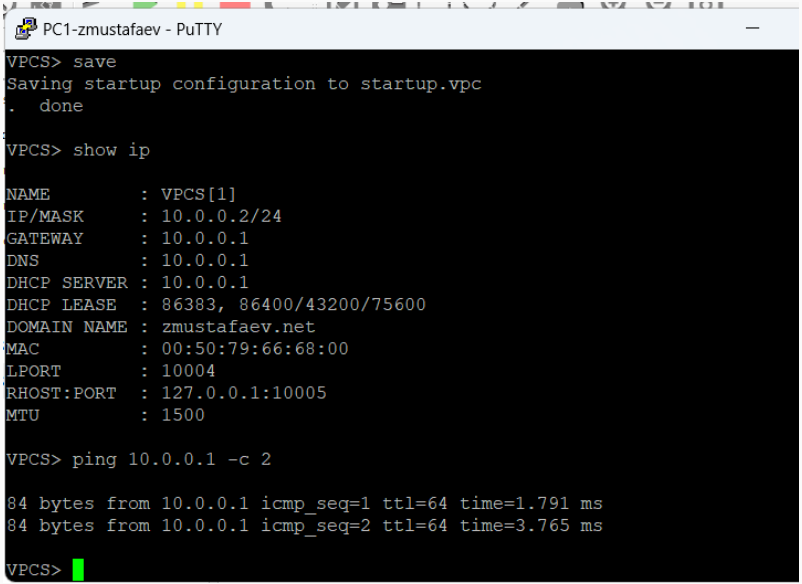


Рис. 5: DHCPv4 клиент

Проверка параметров и связности



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

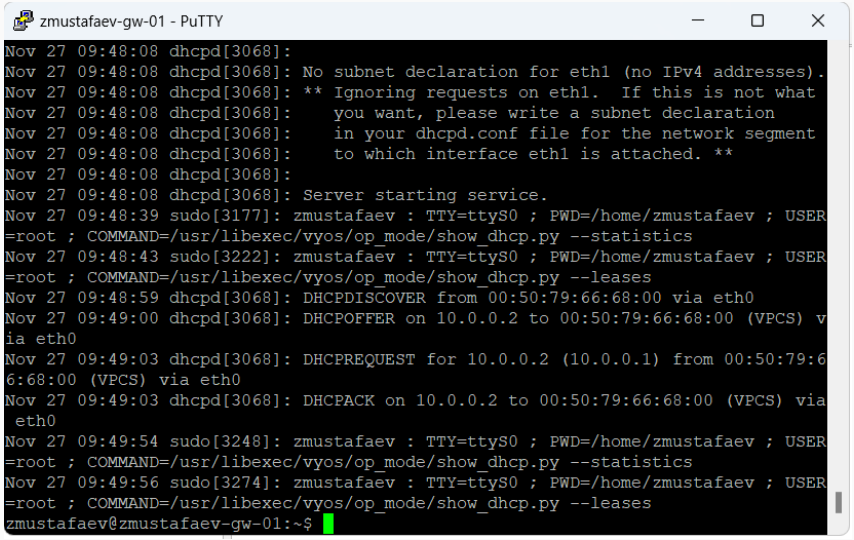
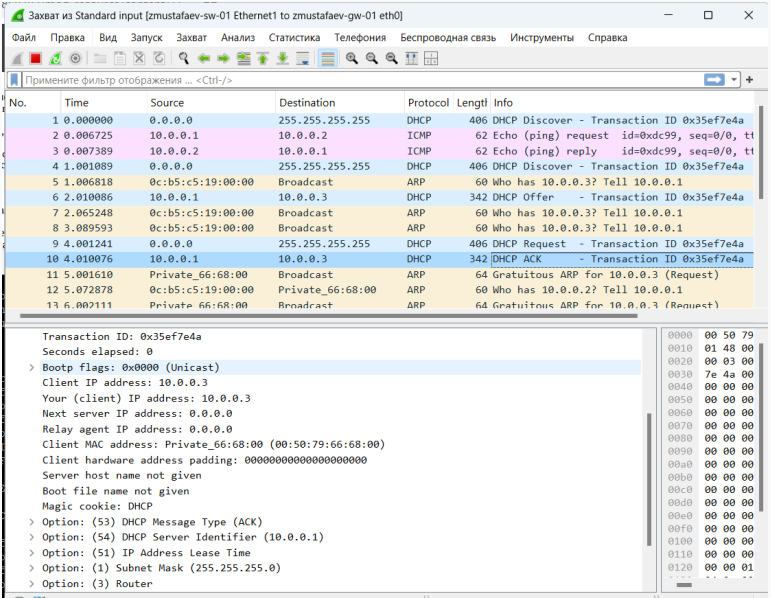


Рис. 8: DHCPv4 log

Журнал DHCP и трафик в Wireshark



Настройка RA и DHCPv6 Stateless

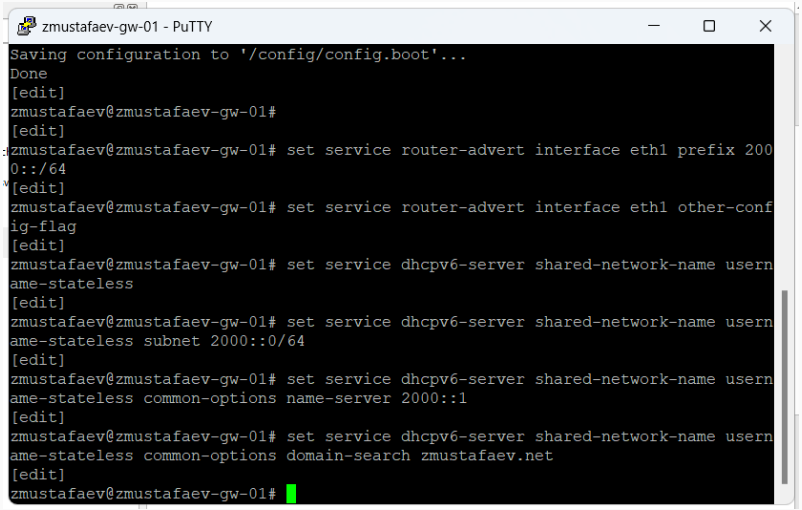


Рис. 10: Настройка Stateless

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 0×0<global>
        inet6 fe80::d00b:1b60:ff5f:5535  prefixlen 64  scopeid 0×20<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

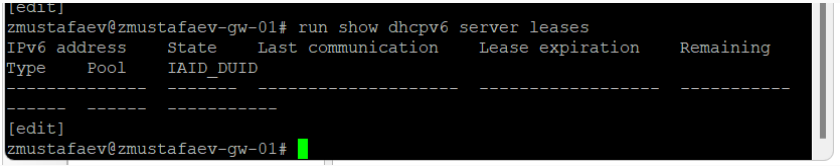
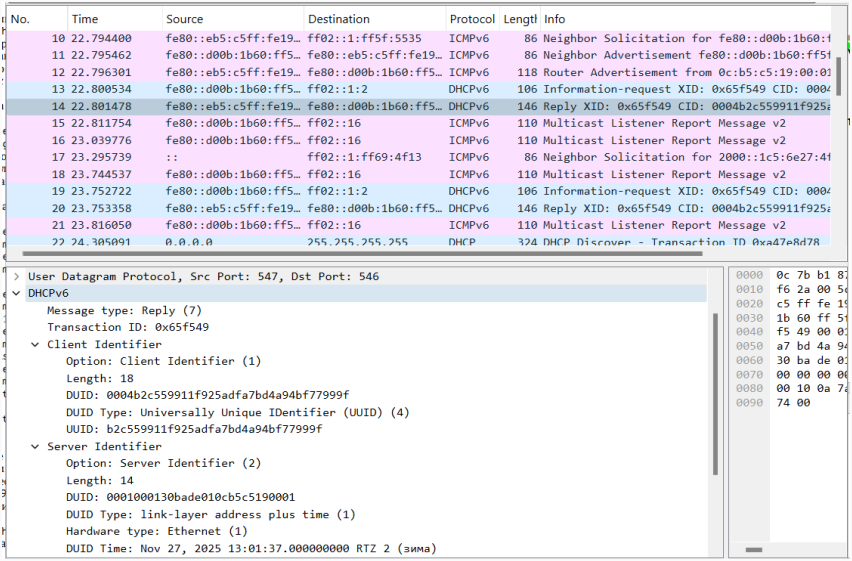


Рис. 13: DHCPv6 Stateless вывод

Wireshark DHCPv6 Stateless

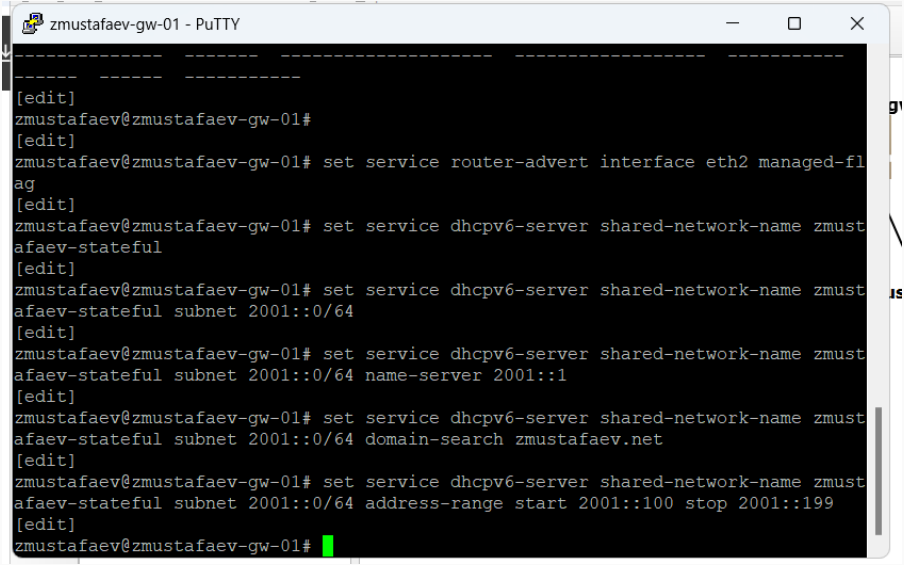


No.	Time	Source	Destination	Protocol	Lengtl	Info
10	22.794400	fe80::eb5:c5ff:fe19…	ff02::1:ff5f:5535	ICMPv6	86	Neighbor Solicitation for fe80::d00b:1b60:f
11	22.795462	fe80::d00b:1b60:ff5…	fe80::eb5:c5ff:fe19…	ICMPv6	86	Neighbor Advertisement fe80::d00b:1b60:ff5f
12	22.796301	fe80::eb5:c5ff:fe19…	fe80::d00b:1b60:ff5…	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::1c5:6e27:41
18	23.744537	fe80::d00b:1b60:ff5…	ff02::16	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
v DHCPv6
    Message type: Reply (7)
    Transaction ID: 0x65f549
  v Client Identifier
      Option: Client Identifier (1)
      Length: 18
      DUID: 0004b2c559911f925adfa7bd4a94bf77999f
      DUID Type: Universally Unique IDentifier (UUID) (4)
      UUID: b2c559911f925adfa7bd4a94bf77999f
  v 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 87
0010  f6 2a 00 5c
0020  c5 ff fe 19
0030  1b 60 ff 5f
0040  f5 49 00 01
0050  a7 bd 4a 94
0060  30 ba de 01
0070  00 00 00 00
0080  00 10 0a 7a
0090  74 00
```

Настройка DHCPv6 Stateful



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 0×20<link>
        inet6 2001::199  prefixlen 128  scopeid 0×0<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[illegible]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
```

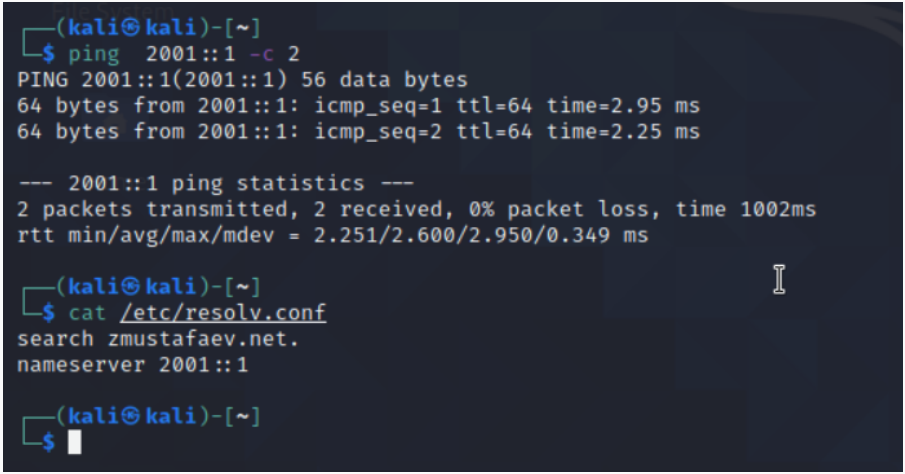


Рис. 19: Проверка связности

Аренды DHCPv6 Stateful

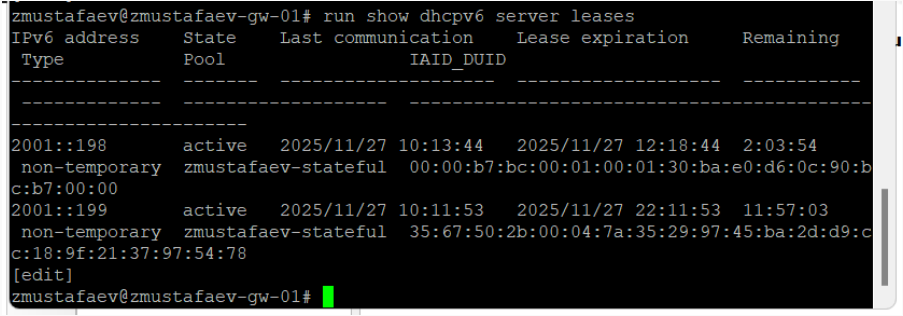
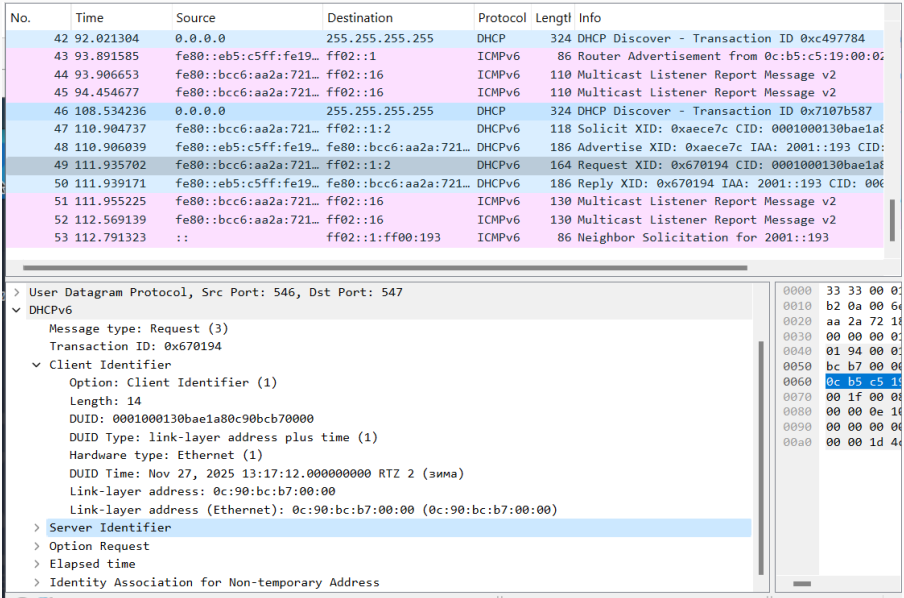


Рис. 20: DHCPv6 аренды

Пакеты Solicit / Advertise / Request / Reply



Выводы

Итоги

- 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.