

# Сетевые технологии

## Настройка DHCP для IPv4 и IPv6 в GNS3

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## Цель работы

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## Основная цель

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Настройка служб **DHCPv4**, **DHCPv6 Stateless** и **DHCPv6 Stateful** в GNS3  
на маршрутизаторе **VyOS**, с проверкой работы клиентов и анализом трафика в **Wireshark**.

## Ход выполнения

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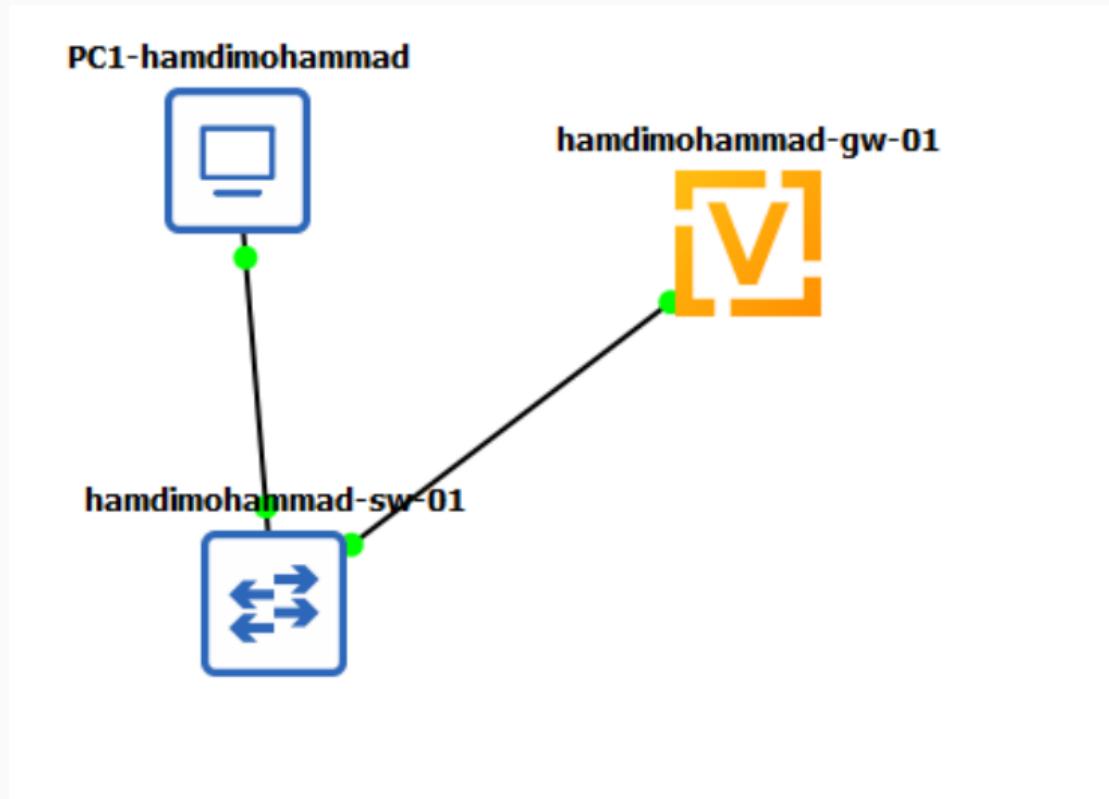
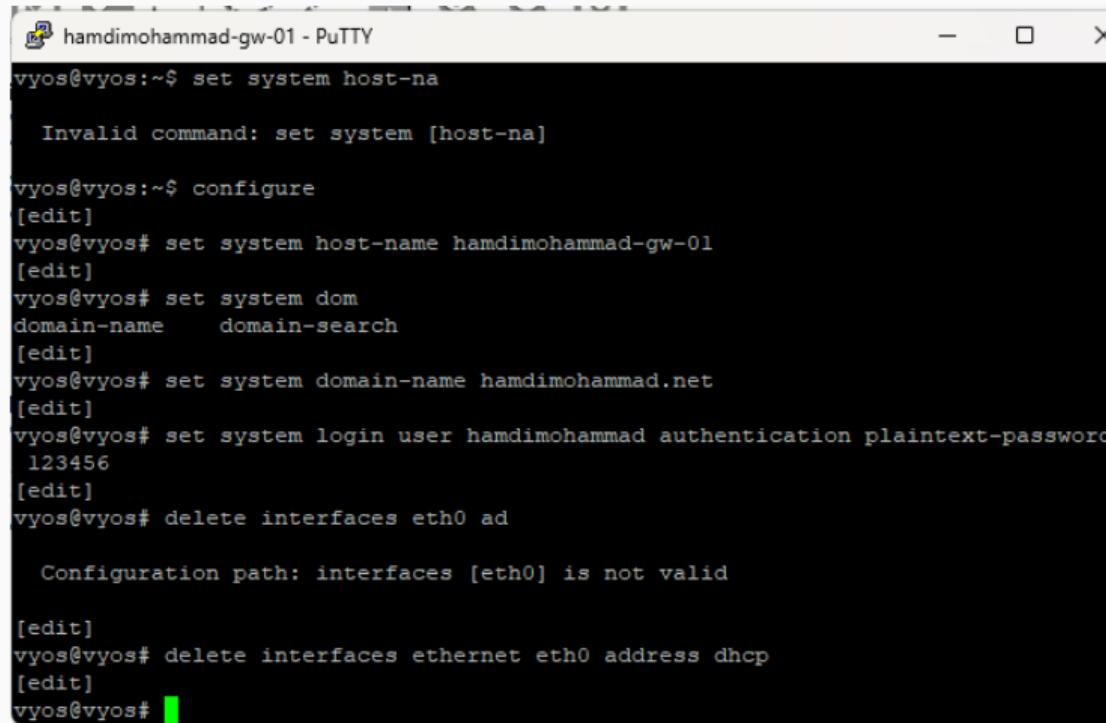


Рис. 1: Топология сети

# Настройка VyOS



```
hamdimohammad-gw-01 - PuTTY

vyos@vyos:~$ set system host-na
      Invalid command: set system [host-na]

vyos@vyos:~$ configure
[edit]
vyos@vyos# set system host-name hamdimohammad-gw-01
[edit]
vyos@vyos# set system dom
domain-name      domain-search
[edit]
vyos@vyos# set system domain-name hamdimohammad.net
[edit]
vyos@vyos# set system login user hamdimohammad authentication plaintext-password
123456
[edit]
vyos@vyos# delete interfaces eth0 ad

      Configuration path: interfaces [eth0] is not valid

[edit]
vyos@vyos# delete interfaces ethernet eth0 address dhcp
[edit]
vyos@vyos#
```

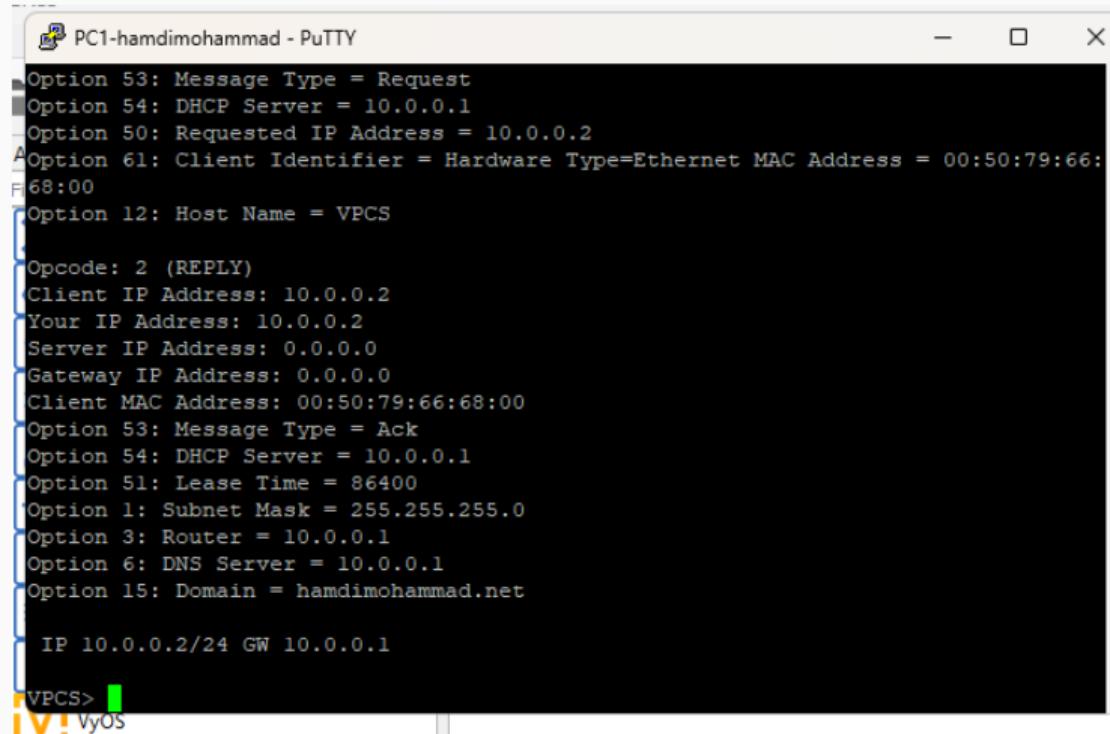
Рис. 2: Системные параметры VyOS

## DHCPv4-сервер

```
hamdimohammad@hamdimohammad-gw-01:~$ configure
[edit]
hamdimohammad@hamdimohammad-gw-01# set interfaces ethernet eth0 address 10.0.0.1
/24
[edit]
hamdimohammad@hamdimohammad-gw-01# set service dhcp-server shared-network-name h
amdimohammad domain-name hamdimohammad.net
[edit]
hamdimohammad@hamdimohammad-gw-01# set service dhcp-server shared-network-name h
amdimohammad name-server 10.0.0.1
[edit]
hamdimohammad@hamdimohammad-gw-01# set service dhcp-server shared-network-name h
amdimohammad subnet 10.0.0.0/24 default-router 10.0.0.1
[edit]
hamdimohammad@hamdimohammad-gw-01# set service dhcp-server shared-network-name h
amdimohammad subnet 10.0.0.0/24 range hosts start 10.0.0.2
[edit]
hamdimohammad@hamdimohammad-gw-01# set service dhcp-server shared-network-name h
amdimohammad subnet 10.0.0.0/24 range hosts stop 10.0.0.253
[edit]
hamdimohammad@hamdimohammad-gw-01# commit
```

Рис. 3: Настройка DHCPv4

## Получение IPv4-адреса



PC1-hamdimohammad - PuTTY

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

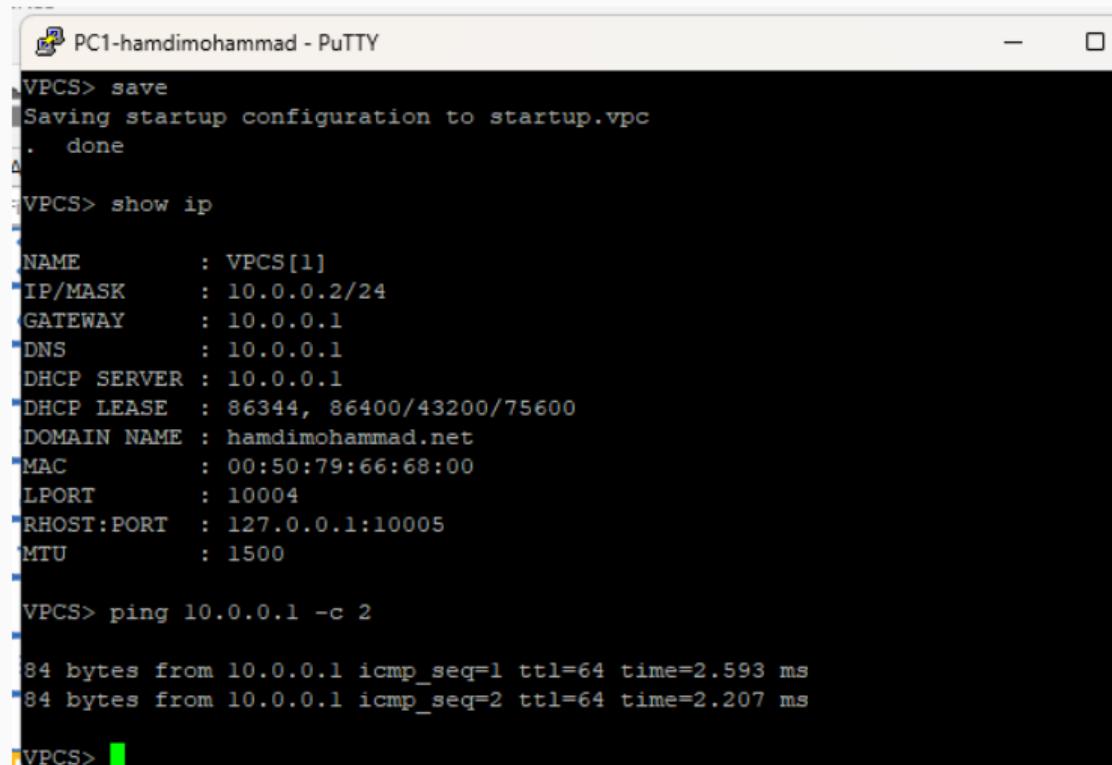
Opcode: 2 (REPLY)
Client IP Address: 10.0.0.2
Your IP Address: 10.0.0.2
Server IP Address: 0.0.0.0
Gateway IP Address: 0.0.0.0
Client MAC Address: 00:50:79:66:68:00
Option 53: Message Type = Ack
Option 54: DHCP Server = 10.0.0.1
Option 51: Lease Time = 86400
Option 1: Subnet Mask = 255.255.255.0
Option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

IP 10.0.0.2/24 GW 10.0.0.1

VPCS> VyOS
```

Рис. 4: Получение адреса по DHCP

## Проверка конфигурации



```
PC1-hamdimohammad - 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  : 86344, 86400/43200/75600
DOMAIN NAME : hamdimohammad.net
MAC        : 00:50:79:66:68:00
LPORT      : 10004
RHOST:PORT : 127.0.0.1:10005
MTU        : 1500

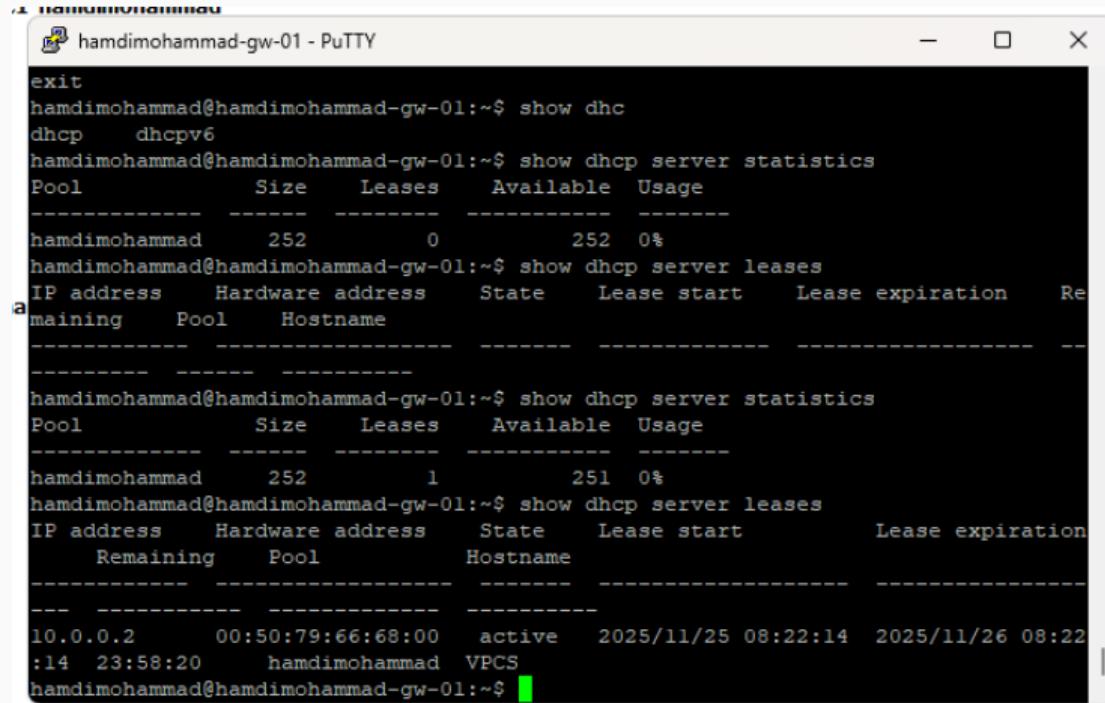
VPCS> ping 10.0.0.1 -c 2

84 bytes from 10.0.0.1 icmp_seq=1 ttl=64 time=2.593 ms
84 bytes from 10.0.0.1 icmp_seq=2 ttl=64 time=2.207 ms

VPCS>
```

Рис. 5: IP-адресация PC1

## DHCPv4 leases и лог



```
hamdimohammad@hamdimohammad-gw-01 - PuTTY
exit
hamdimohammad@hamdimohammad-gw-01:~$ show dhcp
dhcp      dhcpcv6
hamdimohammad@hamdimohammad-gw-01:~$ show dhcp server statistics
Pool          Size     Leases   Available   Usage
-----  -----  -----  -----
hamdimohammad    252       0      252   0%
hamdimohammad@hamdimohammad-gw-01:~$ show dhcp server leases
IP address      Hardware address      State      Lease start      Lease expiration      Re
maining
-----  -----  -----  -----
hamdimohammad@hamdimohammad-gw-01:~$ show dhcp server statistics
Pool          Size     Leases   Available   Usage
-----  -----  -----  -----
hamdimohammad    252       1      251   0%
hamdimohammad@hamdimohammad-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    2025/11/25 08:22:14  2025/11/26 08:22
:14 23:58:20    hamdimohammad VPCS
hamdimohammad@hamdimohammad-gw-01:~$
```

Рис. 6: Журнал и статистика DHCP

# Процесс выдачи адреса

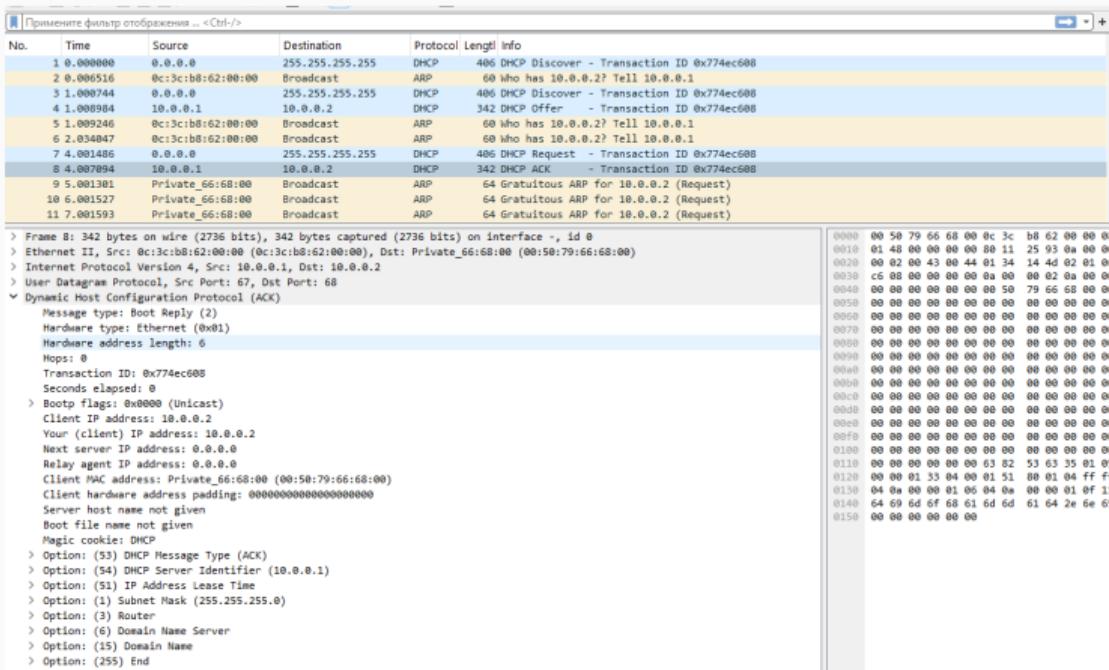


Рис. 7: DHCP трафик

## Топология сети

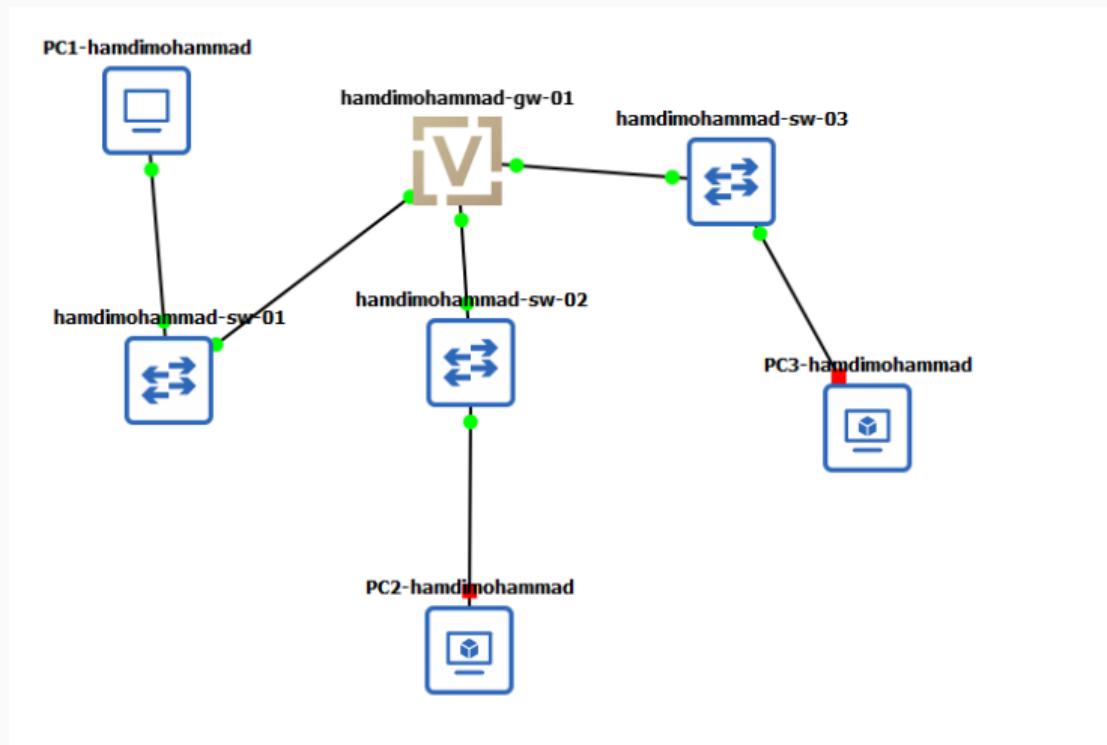


Рис. 8: Топология IPv6

## Настройка интерфейсов IPv6

```
[edit]
hamdimohammad@hamdimohammad-gw-01# set interfaces ethernet eth1 address 2000::1/
64
[edit]
hamdimohammad@hamdimohammad-gw-01# set interfaces ethernet eth2 address 2001::1/
64
[edit]
hamdimohammad@hamdimohammad-gw-01# show interfaces
    ethernet eth0 {
        address 10.0.0.1/24
        hw-id 0c:3c:b8:62:00:00
    }
    ethernet eth1 {
+        address 2000::1/64
        hw-id 0c:3c:b8:62:00:01
    }
    ethernet eth2 {
+        address 2001::1/64
        hw-id 0c:3c:b8:62:00:02
    }
    loopback lo {
    }
[edit]
hamdimohammad@hamdimohammad-gw-01#
```

Рис. 9: IPv6 интерфейсы на VyOS

## RA и общие параметры сети

```
[edit]
hamdimohammad@hamdimohammad-gw-01#
[edit]
hamdimohammad@hamdimohammad-gw-01# set service router-advert interface eth1 prefix 2000::/64
[edit]
hamdimohammad@hamdimohammad-gw-01# set service router-advert interface eth0 eth1 eth2
[edit]
hamdimohammad@hamdimohammad-gw-01# set service router-advert interface eth1 other-config-flag
[edit]
hamdimohammad@hamdimohammad-gw-01# set service srvi
      Configuration path: [srvi] is not valid
[edit]
hamdimohammad@hamdimohammad-gw-01# set service dhcipv6-server shared-network-name hamdimohammad-stateless
[edit]
hamdimohammad@hamdimohammad-gw-01# set service dhcipv6-server shared-network-name hamdimohammad-stateless subnet 2000::0/64
[edit]
hamdimohammad@hamdimohammad-gw-01# set service dhcipv6-server shared-network-name
```

Рис. 10: DHCPv6 Stateless

## SLAAC-адресация клиента PC2

```
└──(root㉿kali)-[~/home/kali]
  └──# ifconfig eth0
    eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
      inet6 fe80::e7ea:94b8:b90b:ba7d prefixlen 64 scopeid 0x20<link>
      inet6 2000::9db1:23b9:39a2:8500 prefixlen 64 scopeid 0x0<global>
        ether 0c:f4:18:03:00:00 txqueuelen 1000 (Ethernet)
          RX packets 4 bytes 431 (431.0 B)
          RX errors 0 dropped 0 overruns 0 frame 0
          TX packets 23 bytes 3332 (3.2 KiB)
          TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

  └──(root㉿kali)-[~/home/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::e3c:b8ff:fe62:1 UG  100  1   0 eth0
    ::1/128                ::                  Un  0   4   0 lo
    2000::9db1:23b9:39a2:8500/128 ::                  Un  0   2   0 eth0
    fe80::e7ea:94b8:b90b:ba7d/128 ::                  Un  0   3   0 eth0
    ff00::/8                ::                  U   256  3   0 eth0
    ::/0                     ::                  In  -1  1   0 lo

  └──(root㉿kali)-[~/home/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=3.33 ms
    64 bytes from 2000::1: icmp_seq=2 ttl=64 time=1.68 ms

    --- 2000::1 ping statistics ---
    2 packets transmitted, 2 received, 0% packet loss, time 1002ms
    rtt min/avg/max/mdev = 1.683/2.504/3.325/0.821 ms

  └──(root㉿kali)-[~/home/kali]
  └──# cat /etc/resolv.conf
    # Generated by NetworkManager
    search hamdimohammad.net
    nameserver 2000::1

  └──(root㉿kali)-[~/home/kali]
```

## DHCPv6 Information-Request

```
(root💀 kali)-[~/home/kali]
# 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\364\030\003\000\000".
PRC: Requesting information (INIT).
XMT: Forming Info-Request, 0 ms elapsed.
XMT: Info-Request on eth0, interval 970ms.
RCV: Reply message on eth0 from fe80::e3c:b8ff:fe62:1.
PRC: Done.

#
```

Рис. 12: DHCPv6 запрос параметров

## Проверка DNS и связности

```
(root㉿kali)-[~/home/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=1.25 ms
64 bytes from 2000::1: icmp_seq=2 ttl=64 time=1.17 ms

--- 2000::1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1002ms
rtt min/avg/max/mdev = 1.172/1.210/1.249/0.038 ms

(root㉿kali)-[~/home/kali]
# cat /etc/resolv.conf
search hamdimohammad.net.
nameserver 2000::1

(root㉿kali)-[~/home/kali]
#
```

Рис. 13: Параметры после DHCPv6

## Логи сервера

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

Рис. 14: DHCPv6 leases (stateless)

# Wireshark-анализ

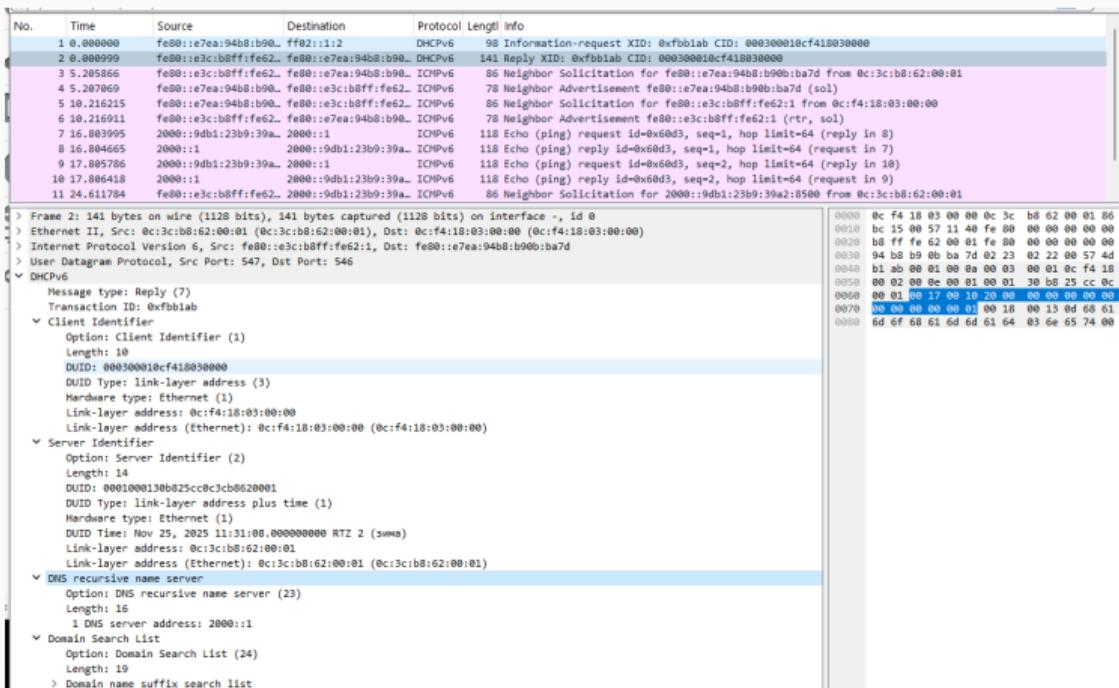


Рис. 15: DHCPv6 Wireshark

## Конфигурация сети на VyOS

```
[edit]
hamdimohammad@hamdimohammad-gw-01# set service dhcpcv6-server shared-network-name
hamdimohammad-stateful
[edit]
hamdimohammad@hamdimohammad-gw-01# set service dhcpcv6-server shared-network-name
hamdimohammad-stateful subnet 2001::0/64
[edit]
hamdimohammad@hamdimohammad-gw-01# set service dhcpcv6-server shared-network-name
hamdimohammad-stateful subnet 2001::0/64 name-server 2001::1
[edit]
hamdimohammad@hamdimohammad-gw-01# set service dhcpcv6-server shared-network-name
hamdimohammad-stateful subnet 2001::0/64 domain-search hamdimohammad.net
[edit]
hamdimohammad@hamdimohammad-gw-01# set service dhcpcv6-server shared-network-name
hamdimohammad-stateful subnet 2001::0/64 address-range start 2001::100 stop 200
1::199
[edit]
hamdimohammad@hamdimohammad-gw-01# commit
[edit]
hamdimohammad@hamdimohammad-gw-01# save
Saving configuration to '/config/config.boot'...
Done
[edit]
hamdimohammad@hamdimohammad-gw-01#
```

Рис. 16: DHCPv6 Stateful настройки

## Начальное состояние интерфейса

```
[root@kali]# ifconfig eth0
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
        inet6 fe80::f49f:d8df:d178:42c9 prefixlen 64 scopeid 0x20<link>
        inet6 2001::199 prefixlen 128 scopeid 0x0<global>
          ether 0c:c9:0e:2d:00:00 txqueuelen 1000 (Ethernet)
            RX packets 5 bytes 636 (636.0 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
```

```
[root@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::e3c:b8ff:fe62:2  UG   100 1   0 eth0
::1/128                ::                  Un   0   4   0 lo
2001::199/128          ::                  Un   0   2   0 eth0
fe80::f49f:d8df:d178:42c9/128  ::                  Un   0   3   0 eth0
ff00::/8                ::                  U    256 3   0 eth0
::/0                    ::                  !n   -1   1   0 lo
```

```
[root@kali]# cat /etc/resolv.conf
# Generated by NetworkManager
search hamdimohammad.net
nameserver 2001::1
```

```
[root@kali]#
```

# Получение адреса по DHCPv6

```
[root@kali:~]# 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\270(u\014\311\016-\000\000".
PRC: Soliciting for leases (INIT).
XMT: Forming Solicit, 0 ms elapsed.
XMT: X-- IA_NA 0e:2d: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::e3c:b8ff:fe62:2.
RCV: X-- IA_NA 0e:2d:00:00
RCV: | X-- starts 1764060150
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:b8:25:cc:0c:3c:b8:62:00:01
RCV: Advertisement recorded.
PRC: Selecting best advertised lease.
PRC: Considering best lease.
PRC: X-- Initial candidate 00:01:00:01:30:b8:25:cc:0c:3c:b8:62:00:01 (s: 10105, p: 0).
XMT: Forming Request, 0 ms elapsed.
XMT: X-- IA_NA 0e:2d: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.
XMT: Request on eth0, interval 1010ms.
RCV: Reply message on eth0 from fe80::e3c:b8ff:fe62:2.
RCV: X-- IA_NA 0e:2d:00:00
RCV: | X-- starts 1764060151
RCV: | X-- t1 - renew +0
RCV: | X-- t2 - rebind +0
```

# Конфигурация интерфейса и DNS

```
(root㉿kali)-[~/home/kali]
└─# ifconfig eth0
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet6 fe80::f49f:d8df:d178:42c9 prefixlen 64 scopeid 0x20<link>
        inet6 2001::198 prefixlen 128 scopeid 0x0<global>
        Floppinet6 2001::199 prefixlen 128 scopeid 0x0<global>
            ether 0c:c9:0e:2d:00:00 txqueuelen 1000 (Ethernet)
            RX packets 9 bytes 1178 (1.1 KiB)
            RX errors 0 dropped 0 overruns 0 frame 0
            TX packets 32 bytes 4850 (4.7 KiB)
            TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

Trash
└─# 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::e3c:b8ff:fe62:2 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::f49f:d8df:d178:42c9/128 ::                  Un  0   3   0 eth0
ff00::/8              ::                  U   256 3   0 eth0
::/0                  ::                  !n  -1  1   0 lo

└─# ping 2001::1 -c 2
PING 2001::1(2001::1) 56 data bytes
64 bytes from 2001::1: icmp_seq=1 ttl=64 time=2.51 ms
64 bytes from 2001::1: icmp_seq=2 ttl=64 time=4.18 ms

--- 2001::1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1002ms
rtt min/avg/max/mdev = 2.505/3.342/4.179/0.837 ms
└─#
```

## Активные leases

```
hamdimohammad@hamdimohammad-gw-01# run show dhcpv6 server leases
IPv6 address      State    Last communication   Lease expiration     Remaining
Type             Pool           IAID_DUID
-----  -----  -----
-----  -----  -----
2001::198        active   2025/11/25 08:42:28   2025/11/25 10:47:28  2:03:10
non-temporary    hamdimohammad-stateful  00:00:2d:0e:00:01:00:01:30:b8:28:75:0c:c
9:0e:2d:00:00
2001::199        active   2025/11/25 08:39:51   2025/11/25 20:39:51  11:55:33
non-temporary    hamdimohammad-stateful  35:67:50:2b:00:04:6e:07:bc:6c:79:6f:e5:8
c:ee:ba:d9:f1:2e:ea:9e:63
[edit]
hamdimohammad@hamdimohammad-gw-01#
```

Рис. 20: DHCPv6 Stateful leases

# Анализ Wireshark

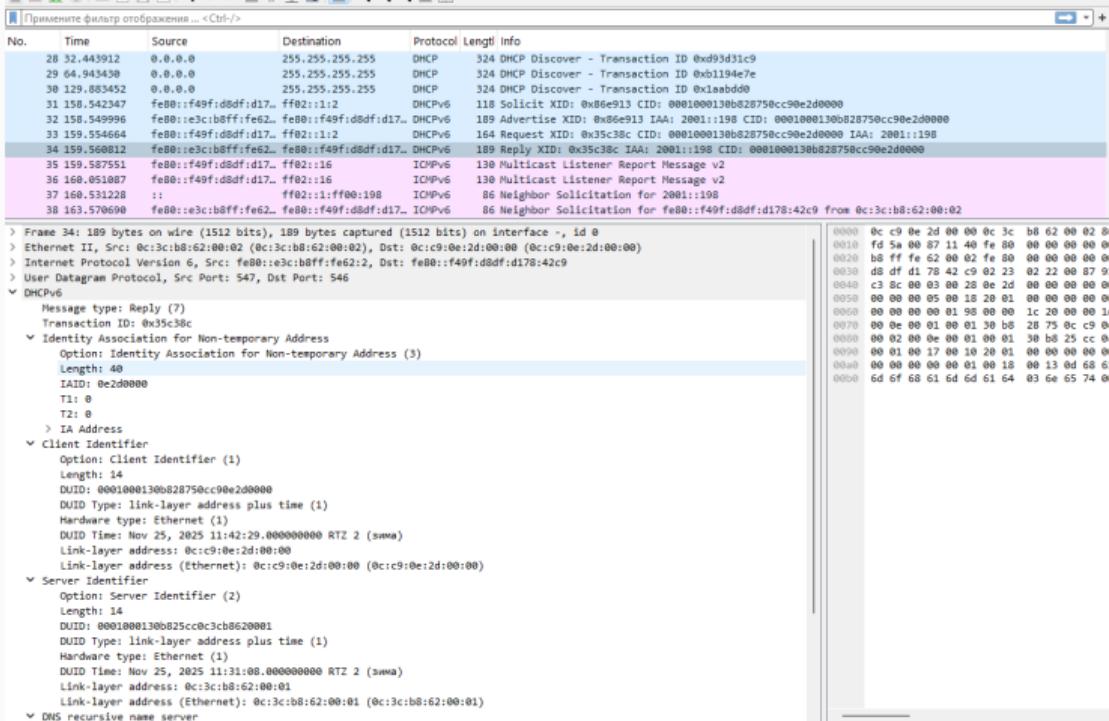


Рис. 21: Анализ Stateful DHCPv6

## Заключение

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## Основные результаты

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- Настроены три механизма автоматической адресации:
  - DHCPv4
  - DHCPv6 Stateless
  - DHCPv6 Stateful
- Реализована работа с RA, SLAAC и DHCPv6-параметрами.
- Клиенты корректно получили IPv4/IPv6-адреса и параметры DNS.
- Трафик DHCP и ICMP был подробно проанализирован в Wireshark.
- Конфигурация сети подтверждена функционирующей связностью.