

Лабораторная работа №6

Сетевые технологии

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Цель работы

Изучение принципов распределения и настройки адресного пространства на устройствах сети.

Выполнение лабораторной работы

Таблица 1: Характеристика сети

Характеристика	Значение
Адрес сети	172.16.20.0/24
Префикс маски	/24
Маска	255.255.255.0
Broadcast-адрес	172.16.20.255
Адрес сети в двоичной форме	10101100.00010000.00010100.00000000
Маска в двоичной форме	11111111.11111111.11111111.00000000
Число возможных подсетей	$2^8=256$
Диапазон адресов узлов	172.16.20.1 - 172.16.20.254

Диапазон адресов для данной подсети: 172.16.20.1 - 172.16.20.126. Диапазон адресов для второй подсети: 172.16.20.129 - 172.16.20.190. Диапазон адресов для третьей подсети: 172.16.20.193 - 172.16.20.254.

Таблица 2: Характеристика сети

Характеристика	Значение
Адрес сети	10.10.1.64/26
Префикс маски	/26
Маска	255.255.255.192
Broadcast-адрес	10.10.1.127
Адрес сети в двоичной форме	00001010.00001010.00000001.01000000
Маска в двоичной форме	11111111.11111111.11111111.11000000
Число возможных подсетей	$2^6=64$
Диапазон адресов узлов	10.10.1.65 - 10.10.1.126

Диапазон адресов: 10.10.1.65 - 10.10.1.94. Адрес подсети: 10.10.1.64. Broadcast: 10.10.1.95.

Таблица 3: Характеристика сети

Характеристика	Значение
Адрес сети	10.10.1.0/26
Префикс маски	/26
Маска	255.255.255.192
Broadcast-адрес	10.10.1.63
Адрес сети в двоичной форме	00001010.00001010.00000001.00000000
Маска в двоичной форме	11111111.11111111.11111111.11000000
Число возможных подсетей	$2^6=64$
Диапазон адресов узлов	10.10.1.1 - 10.10.1.62

Диапазон адресов: **10.10.1.1** - **10.10.1.14**. Адрес подсети: **10.10.1.0**. Broadcast: **10.10.1.15**.

Таблица 4: Характеристика сети

Характеристика	Значение
Адрес сети	2001:db8:c0de::/48
Длина префикса	48
Префикс	2001:db8:c0de::
Маска	ffff:ffff:ffff:0:0:0:0:0
Диапазон адресов узлов	2001:db8:c0de:0:0:0:0 - 2001:db8:c0de:ffff:ffff:ffff:ffff

Разбиение сети на 2 подсети с использованием идентификатора подсети.

2001:db8:c0de:0003::/64

2001:db8:c0de:0004::/64

Разбиение сети на 2 подсети с использованием идентификатора интерфейса.

2001:db8:c0de:0000:1000/68

2001:db8:c0de:0000:5000/68

Таблица 5: Характеристика сети

Характеристика	Значение
Адрес сети	2a02:6b8::/64
Длина префикса	64
Префикс	2a02:6b8:0000:0000
Маска	ffff:ffff:ffff:ffff:0:0:0:0
Диапазон адресов узлов	2a02:6b8:: - 2a02:6b8:0:0:ffff:ffff:ffff:ffff

Разбиение сети на 2 подсети с использованием идентификатора интерфейса

2a02:6b8:0000:0000:1000::/68

2a02:6b8:0000:0000:2000::/68

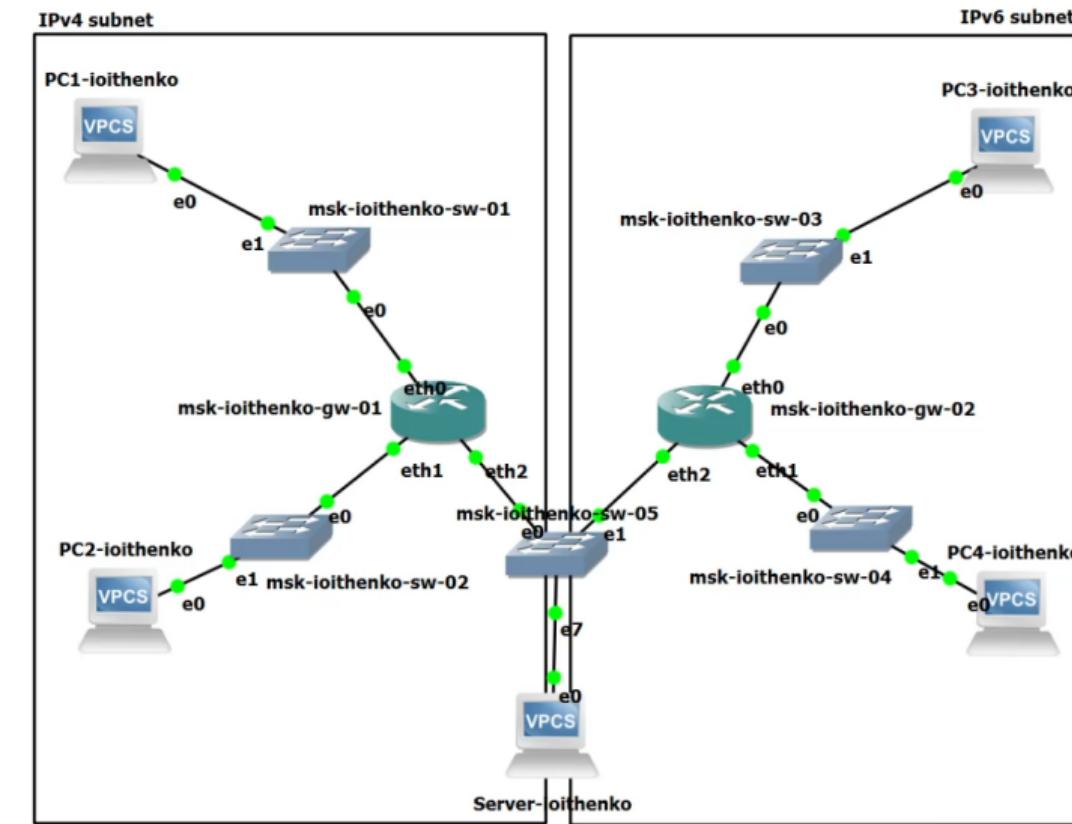
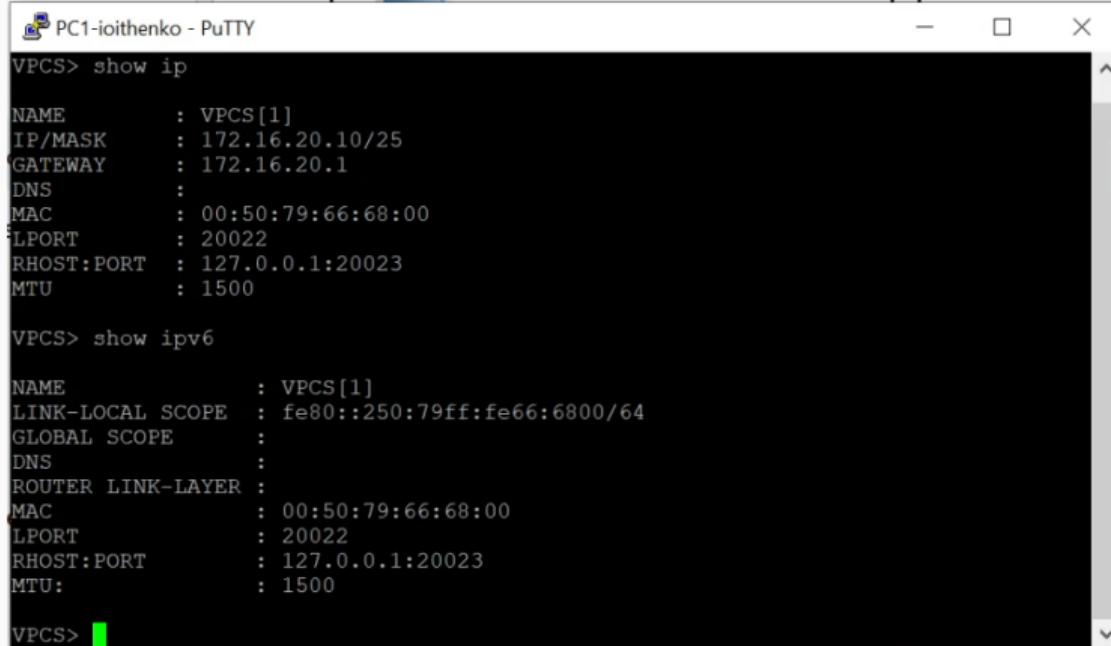


Рис. 1: Топология сети с двумя локальными подсетями в GNS3



PC1-ioithenko - PuTTY

```
VPCS> show ip

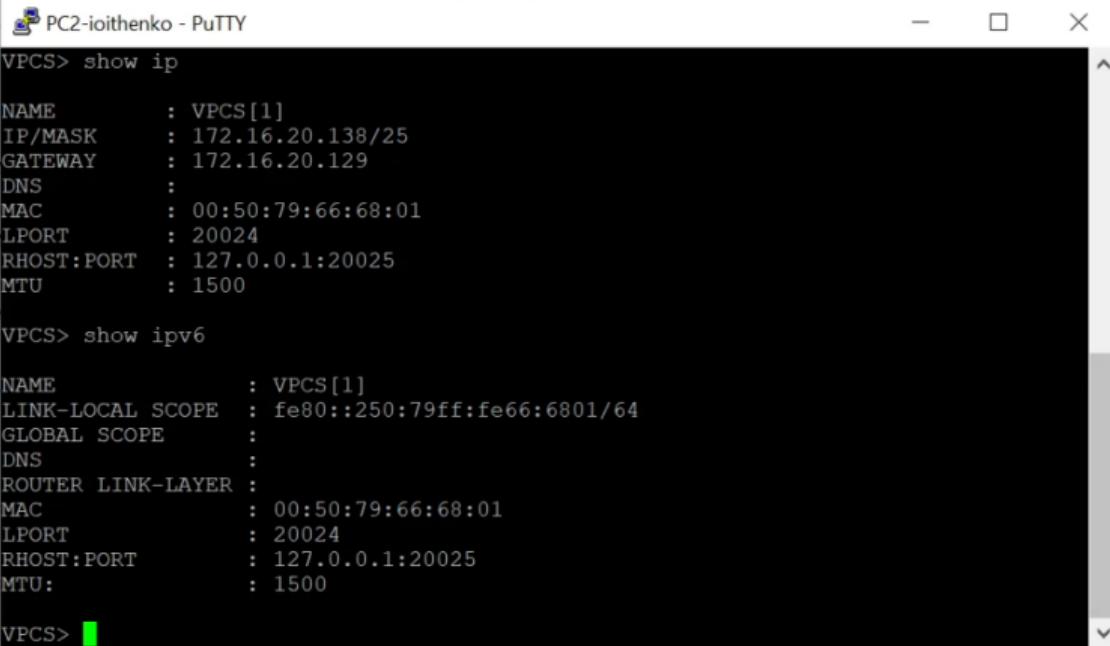
NAME      : VPCS[1]
IP/MASK   : 172.16.20.10/25
GATEWAY   : 172.16.20.1
DNS       :
MAC       : 00:50:79:66:68:00
LPORT     : 20022
RHOST:PORT : 127.0.0.1:20023
MTU       : 1500

VPCS> show ipv6

NAME      : VPCS[1]
LINK-LOCAL SCOPE : fe80::250:79ff:fe66:6800/64
GLOBAL SCOPE   :
DNS       :
ROUTER LINK-LAYER :
MAC       : 00:50:79:66:68:00
LPORT     : 20022
RHOST:PORT   : 127.0.0.1:20023
MTU:        : 1500

VPCS>
```

Рис. 2: Настройка IPv4-адресации на PC-1 и PC-2



PC2-ioithenko - PuTTY

```
VPCS> show ip

NAME      : VPCS[1]
IP/MASK   : 172.16.20.138/25
GATEWAY   : 172.16.20.129
DNS       :
MAC       : 00:50:79:66:68:01
LPORT     : 20024
RHOST:PORT : 127.0.0.1:20025
MTU       : 1500

VPCS> show ipv6

NAME      : VPCS[1]
LINK-LOCAL SCOPE : fe80::250:79ff:fe66:6801/64
GLOBAL SCOPE   :
DNS       :
ROUTER LINK-LAYER :
MAC       : 00:50:79:66:68:01
LPORT     : 20024
RHOST:PORT   : 127.0.0.1:20025
MTU:        : 1500

VPCS>
```

Рис. 3: Настройка IPv4-адресации на PC-2

Dedicated to Daling.
Build time: Sep 9 2023 11:15:00
Copyright (c) 2007-2015, Paul Meng (mirnshi@gmail.com)
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VPCS is free software, distributed under the terms of the "BSD" licence.
Source code and license can be found at vpcs.sf.net.
For more information, please visit wiki.freecode.com.cn.

Press '?' to get help.

Executing the startup file

Hostname is too long. (Maximum 12 characters)

VPCS> ip 64.100.1.10/24 64.100.1.1
Checking for duplicate address...
VPCS : 64.100.1.10 255.255.255.0 gateway 64.100.1.1

VPCS> save
Saving startup configuration to startup.vpc
. done

VPCS>

Рис. 4: Настройка IPv4-адресации на сервере

```
msk-ioithenko-gw-01 - PuTTY
Password:
Welcome to VyOS!

Check out project news at https://blog.vyos.io
and feel free to report bugs at https://vyos.dev

You can change this banner using "set system login banner post-login" command.

VyOS is a free software distribution that includes multiple components,
you can check individual component licenses under /usr/share/doc/*copyright
vyos@msk-ioithenko-gw-01:~$ configure
[edit]
vyos@msk-ioithenko-gw-01# set interfaces ethernet eth0 address 172.16.20.1/25
[edit]
vyos@msk-ioithenko-gw-01# set interfaces ethernet eth1 address 172.16.20.129/25
[edit]
vyos@msk-ioithenko-gw-01# set interfaces ethernet eth2 address 64.100.1.1/24
[edit]
vyos@msk-ioithenko-gw-01# compare
[edit interfaces ethernet eth0]
+address 172.16.20.1/25
[edit interfaces ethernet eth1]
+address 172.16.20.129/25
[edit interfaces ethernet eth2]
+address 64.100.1.1/24
[edit]
vyos@msk-ioithenko-gw-01# commit

Can't configure both static IPv4 and DHCP address on the same interface
[[interfaces ethernet eth0]] failed
sCommit failed
edit]
vyos@msk-ioithenko-gw-01# delete interfaces ethernet eth0 address dhcp
[edit]
vyos@msk-ioithenko-gw-01# compare
[edit interfaces ethernet eth0]
+address dhcp
+address 172.16.20.1/25
[edit]
vyos@msk-ioithenko-gw-01# commit
[edit]
vyos@msk-ioithenko-gw-01# save
Saving configuration to '/config/config.boot'...
Done
[edit]
vyos@msk-ioithenko-gw-01# show interfaces
ethernet eth0 {
    address 172.16.20.1/25
    hw-id 0c:24:e1:09:00:00
}
ethernet eth1 {
    address 172.16.20.129/25
    hw-id 0c:24:e1:09:00:01
}
ethernet eth2 {
    address 64.100.1.1/24
    hw-id 0c:24:e1:09:00:02
}
loopback lo {
}
[edit]
vyos@msk-ioithenko-gw-01#
```

Рис. 5: Настройка IPv4-адресации для интерфейсов маршрутизатора VyOS

PC1-ioithenko - PuTTY

```
VPCS> ping 172.16.20.138/25
84 bytes from 172.16.20.138 icmp_seq=1 ttl=63 time=1.917 ms
84 bytes from 172.16.20.138 icmp_seq=2 ttl=63 time=2.884 ms
84 bytes from 172.16.20.138 icmp_seq=3 ttl=63 time=1.047 ms
84 bytes from 172.16.20.138 icmp_seq=4 ttl=63 time=1.915 ms
84 bytes from 172.16.20.138 icmp_seq=5 ttl=63 time=2.028 ms

VPCS> trace 172.16.20.138/25
trace to 172.16.20.138, 25 hops max, press Ctrl+C to stop
1 172.16.20.1 0.889 ms 0.377 ms 0.472 ms
2 *172.16.20.138 0.893 ms (ICMP type:3, code:3, Destination port unreachable)

VPCS> trace 172.16.20.138/25
trace to 172.16.20.138, 25 hops max, press Ctrl+C to stop
1 172.16.20.1 1.338 ms 0.709 ms 0.781 ms
2 *172.16.20.138 0.968 ms (ICMP type:3, code:3, Destination port unreachable)

VPCS> ping 64.100.1.10/24
84 bytes from 64.100.1.10 icmp_seq=1 ttl=63 time=4.042 ms
84 bytes from 64.100.1.10 icmp_seq=2 ttl=63 time=2.952 ms
84 bytes from 64.100.1.10 icmp_seq=3 ttl=63 time=1.060 ms
84 bytes from 64.100.1.10 icmp_seq=4 ttl=63 time=1.540 ms
84 bytes from 64.100.1.10 icmp_seq=5 ttl=63 time=1.713 ms

VPCS> trace 64.100.1.10/24
trace to 64.100.1.10, 24 hops max, press Ctrl+C to stop
1 172.16.20.1 1.699 ms 1.243 ms 0.415 ms
2 *64.100.1.10 0.981 ms (ICMP type:3, code:3, Destination port unreachable)

VPCS> [redacted]
```

Рис. 6: Проверка подключения с PC-1

PC2-ioithenko - Putty

```
GLOBAL SCOPE      : 
DNS               : 
ROUTER LINK-LAYER: 
MAC              : 00:50:79:66:68:01
LPORT             : 20024
RHOST:PORT       : 127.0.0.1:20025
MTU:              : 1500

VPCS> ping 172.16.20.10/25

84 bytes from 172.16.20.10 icmp_seq=1 ttl=63 time=1.070 ms
84 bytes from 172.16.20.10 icmp_seq=2 ttl=63 time=1.279 ms
84 bytes from 172.16.20.10 icmp_seq=3 ttl=63 time=2.078 ms
84 bytes from 172.16.20.10 icmp_seq=4 ttl=63 time=2.015 ms
84 bytes from 172.16.20.10 icmp_seq=5 ttl=63 time=2.347 ms

VPCS> trace 172.16.20.10/25
trace to 172.16.20.10, 25 hops max, press Ctrl+C to stop
 1  172.16.20.129    2.400 ms  0.503 ms  0.570 ms
 2  *172.16.20.10    0.642 ms (ICMP type:3, code:3, Destination port unreachable)
)

VPCS> ping 64.100.1.10/24

84 bytes from 64.100.1.10 icmp_seq=1 ttl=63 time=2.267 ms
84 bytes from 64.100.1.10 icmp_seq=2 ttl=63 time=1.271 ms
84 bytes from 64.100.1.10 icmp_seq=3 ttl=63 time=1.365 ms
84 bytes from 64.100.1.10 icmp_seq=4 ttl=63 time=1.418 ms
84 bytes from 64.100.1.10 icmp_seq=5 ttl=63 time=1.926 ms

VPCS> trace 64.100.1.10/24
trace to 64.100.1.10, 24 hops max, press Ctrl+C to stop
 1  172.16.20.129    1.670 ms  0.592 ms  0.419 ms
 2  *64.100.1.10     1.452 ms (ICMP type:3, code:3, Destination port unreachable)

VPCS>
```

Рис. 7: Проверка подключения с PC-2

PC3-ioithenko - PuTTY

Press '?' to get help.

Executing the startup file

Hostname is too long. (Maximum 12 characters)

VPCS> ip 2001:db8:c0de:12::a/64
PC1 : 2001:db8:c0de:12::a/64

VPCS> save
Saving startup configuration to startup.vpc
. done

VPCS> show ipv6

NAME	:	VPCS[1]
LINK-LOCAL SCOPE	:	fe80::250:79ff:fe66:6802/64
GLOBAL SCOPE	:	2001:db8:c0de:12::a/64
DNS	:	
ROUTER LINK-LAYER	:	
MAC	:	00:50:79:66:68:02
LPORT	:	20026
RHOST:PORT	:	127.0.0.1:20027
MTU:	:	1500

VPCS> show ip

NAME	:	VPCS[1]
IP/MASK	:	0.0.0.0/0
GATEWAY	:	0.0.0.0
DNS	:	
MAC	:	00:50:79:66:68:02
LPORT	:	20026
RHOST:PORT	:	127.0.0.1:20027
MTU	:	1500

VPCS>

Рис. 8: Настройка IPv6-адресации на PC-3

```
PC4-ioithenko - PuTTY

Press '?' to get help.

Executing the startup file

Hostname is too long. (Maximum 12 characters)

VPCS> ip 2001:db8:c0de:13::a/64
PC1 : 2001:db8:c0de:13::a/64

VPCS> save
Saving startup configuration to startup.vpc
· done

VPCS> show ipv6

NAME          : VPCS[1]
LINK-LOCAL SCOPE   : fe80::250:79ff:fe66:6803/64
GLOBAL SCOPE     : 2001:db8:c0de:13::a/64
DNS           :
ROUTER LINK-LAYER :
MAC            : 00:50:79:66:68:03
LPORT          : 20028
RHOST:PORT      : 127.0.0.1:20029
MTU            : 1500

VPCS> show ip

NAME          : VPCS[1]
IP/MASK       : 0.0.0.0/0
GATEWAY       : 0.0.0.0
DNS           :
MAC            : 00:50:79:66:68:03
LPORT          : 20028
RHOST:PORT      : 127.0.0.1:20029
MTU            : 1500

VPCS>
```

Рис. 9: Настройка IPv6-адресации на PC-4

Server-ioithenko - PuTTY

```
VPCS> save
Saving startup configuration to startup.vpc
. done

VPCS> ip 2001:db8:c0de:11::a/64
PC1 : 2001:db8:c0de:11::a/64

VPCS> save
Saving startup configuration to startup.vpc
. done

VPCS> show ip

NAME      : VPCS[1]
IP/MASK   : 64.100.1.10/24
GATEWAY   : 64.100.1.1
DNS       :
MAC       : 00:50:79:66:68:04
LPORT     : 20030
RHOST:PORT : 127.0.0.1:20031
MTU       : 1500

VPCS> show ipv6

NAME      : VPCS[1]
LINK-LOCAL SCOPE : fe80::250:79ff:fe66:6804/64
GLOBAL SCOPE    : 2001:db8:c0de:11::a/64
DNS       :
ROUTER LINK-LAYER :
MAC       : 00:50:79:66:68:04
LPORT     : 20030
RHOST:PORT : 127.0.0.1:20031
MTU       : 1500
```

Рис. 10: Настройка IPv6-адресации на сервере

```
msk@msk-oiithenko-gw-02 - PuTTY
vyos@msk-oiithenko-gw-02# exit discard
exit
vyos@msk-oiithenko-gw-02:~$ configure
[edit]
:1:/64msk-oiithenko-gw-02# set interfaces ethernet eth0 address 2001:db8:c0de:12::
[edit]
b8:c0de:12::/64nko-
[edit]
:1:/64msk-oiithenko-gw-02# set interfaces ethernet eth1 address 2001:db8:c0de:13::
[edit]
b8:c0de:13::/64nko-gw-02# set service router-advert interface eth1 prefix 2001:d
[edit]
:1:/64msk-oiithenko-gw-02# set interfaces ethernet eth2 address 2001:db8:c0de:11::
[edit]
b8:c0de:11::/64nko-gw-02# set service router-advert interface eth2 prefix 2001:d
[edit]
vyos@msk-oiithenko-gw-02# compare
[edit interfaces ethernet eth0]
+address 2001:db8:c0de:12::1/64
[edit interfaces ethernet eth1]
+address 2001:db8:c0de:13::1/64
[edit interfaces ethernet eth2]
+address 2001:db8:c0de:11::1/64
[edit service]
+router-advert {
+    interface eth0 {
+        prefix 2001:db8:c0de:12::/64 {
+        }
+    }
+    interface eth1 {
+        prefix 2001:db8:c0de:13::/64 {
+        }
+    }
+    interface eth2 {
+        prefix 2001:db8:c0de:11::/64 {
+        }
+    }
+}
[edit]
vyos@msk-oiithenko-gw-02# commit
[edit]
vyos@msk-oiithenko-gw-02# save
Saving configuration to '/config/config.boot'...
Done
[edit]
vyos@msk-oiithenko-gw-02# show interfaces
ethernet eth0 {
    address dhcp
    address 2001:db8:c0de:12::1/64
    hw-id 0c:d1:eb:d6:00:00
}
ethernet eth1 {
    address 2001:db8:c0de:13::1/64
    hw-id 0c:d1:eb:d6:00:01
}
ethernet eth2 {
    address 2001:db8:c0de:11::1/64
    hw-id 0c:d1:eb:d6:00:02
}
```

Рис. 11: Настройка IPv6-адресации для интерфейсов маршрутизатора VyOS

PC3-ioithenko - PuTTY

```
ROUTER LINK-LAYER :  
MAC : 00:50:79:66:68:02  
LPORT : 20026  
RHOST:PORT : 127.0.0.1:20027  
MTU : 1500  
  
VPCS> show ip  
  
NAME : VPCS[1]  
IP/MASK : 0.0.0.0/0  
GATEWAY : 0.0.0.0  
DNS :  
MAC : 00:50:79:66:68:02  
LPORT : 20026  
RHOST:PORT : 127.0.0.1:20027  
MTU : 1500  
  
VPCS> ping 2001:db8:c0de:13::a/64  
  
2001:db8:c0de:13::a icmp6_seq=1 ttl=62 time=934.308 ms  
2001:db8:c0de:13::a icmp6_seq=2 ttl=62 time=1.344 ms  
2001:db8:c0de:13::a icmp6_seq=3 ttl=62 time=2.104 ms  
2001:db8:c0de:13::a icmp6_seq=4 ttl=62 time=514.450 ms  
2001:db8:c0de:13::a icmp6_seq=5 ttl=62 time=1.669 ms  
  
VPCS> ping 2001:db8:c0de:11::a/64  
  
2001:db8:c0de:11::a icmp6_seq=1 ttl=62 time=793.196 ms  
2001:db8:c0de:11::a icmp6_seq=2 ttl=62 time=1.826 ms  
2001:db8:c0de:11::a icmp6_seq=3 ttl=62 time=2.740 ms  
2001:db8:c0de:11::a icmp6_seq=4 ttl=62 time=495.406 ms  
2001:db8:c0de:11::a icmp6_seq=5 ttl=62 time=1.913 ms  
  
VPCS> trace 2001:db8:c0de:13::a/64  
  
trace to 2001:db8:c0de:13::a, 64 hops max  
1 2001:db8:c0de:12::1 1.381 ms 0.565 ms 0.565 ms  
2 2001:db8:c0de:13::a 0.933 ms 0.608 ms 0.652 ms  
  
VPCS> trace 2001:db8:c0de:11::a/64  
  
trace to 2001:db8:c0de:11::a, 64 hops max  
1 2001:db8:c0de:12::1 0.555 ms 0.576 ms 0.645 ms  
2 2001:db8:c0de:11::a 2.550 ms 1.603 ms 1.188 ms
```

Рис. 12: Проверка подключения с PC-3

```
PC4-ioithenko - PuTTY
Saving startup configuration to startup.vpc
. done

VPCS> show ipv6

NAME      : VPCS[1]
LINK-LOCAL SCOPE : fe80::250:79ff:fe66:6803/64
GLOBAL SCOPE    : 2001:db8:c0de:13::a/64
DNS       :
ROUTER LINK-LAYER :
MAC       : 00:50:79:66:68:03
LPORT     : 20028
RHOST:PORT  : 127.0.0.1:20029
MTU        : 1500

VPCS> show ip

NAME      : VPCS[1]
IP/MASK   : 0.0.0.0/0
GATEWAY   : 0.0.0.0
DNS       :
MAC       : 00:50:79:66:68:03
LPORT     : 20028
RHOST:PORT  : 127.0.0.1:20029
MTU        : 1500

VPCS> ping 2001:db8:c0de:12::a/64

2001:db8:c0de:12::a icmp6_seq1 ttl=62 time=2.367 ms
2001:db8:c0de:12::a icmp6_seq2 ttl=62 time=2.419 ms
2001:db8:c0de:12::a icmp6_seq3 ttl=62 time=2.085 ms
2001:db8:c0de:12::a icmp6_seq4 ttl=62 time=293.970 ms
2001:db8:c0de:12::a icmp6_seq5 ttl=62 time=1.598 ms

VPCS> trace 2001:db8:c0de:12::a/64

trace to 2001:db8:c0de:12::a, 64 hops max
1 2001:db8:c0de:13::1  0.602 ms  0.376 ms  0.413 ms
2 2001:db8:c0de:12::a  1.201 ms  1.142 ms  1.111 ms

VPCS> ping 2001:db8:c0de:11::a/64

2001:db8:c0de:11::a icmp6_seq1 ttl=62 time=2.075 ms
2001:db8:c0de:11::a icmp6_seq2 ttl=62 time=1.999 ms
2001:db8:c0de:11::a icmp6_seq3 ttl=62 time=2.040 ms
2001:db8:c0de:11::a icmp6_seq4 ttl=62 time=1.574 ms
2001:db8:c0de:11::a icmp6_seq5 ttl=62 time=1.140 ms

VPCS> trace 2001:db8:c0de:11::a/64

trace to 2001:db8:c0de:11::a, 64 hops max
1 2001:db8:c0de:13::1  1.419 ms  0.646 ms  1.189 ms
2 2001:db8:c0de:11::a  2.060 ms  0.978 ms  1.314 ms

VPCS> ping 172.16.20.138/25

host (172.16.20.138) not reachable

VPCS> trace 172.16.20.138/25
trace to 172.16.20.138, 25 hops max, press Ctrl+C to stop
host (172.16.20.138) not reachable
```

Рис. 13: Проверка подключения с PC-4

```
PC1-ioithenko - PuTTY
IP/MASK      : 172.16.20.10/25
GATEWAY     : 172.16.20.1
DNS          :
MAC          : 00:50:79:66:68:00
LPORT        : 20022
RHOST:PORT  : 127.0.0.1:20023
MTU          : 1500

VPCS> show ipv6

NAME          : VPCS[1]
LINK-LOCAL SCOPE : fe80::250:79ff:fe66:6800/64
GLOBAL SCOPE   :
DNS          :
ROUTER LINK-LAYER :
MAC          : 00:50:79:66:68:00
LPORT        : 20022
RHOST:PORT  : 127.0.0.1:20023
MTU          : 1500

VPCS> ping 172.16.20.138/25

84 bytes from 172.16.20.138 icmp_seq=1 ttl=63 time=1.917 ms
84 bytes from 172.16.20.138 icmp_seq=2 ttl=63 time=2.884 ms
84 bytes from 172.16.20.138 icmp_seq=3 ttl=63 time=1.047 ms
84 bytes from 172.16.20.138 icmp_seq=4 ttl=63 time=1.915 ms
84 bytes from 172.16.20.138 icmp_seq=5 ttl=63 time=2.028 ms

VPCS> trace 172.16.20.138/25
trace to 172.16.20.138, 25 hops max, press Ctrl+C to stop
1 172.16.20.1  0.889 ms  0.377 ms  0.472 ms
2  *172.16.20.138  0.893 ms (ICMP type:3, code:3, Destination port unreachable)
e)

VPCS> trace 172.16.20.138/25
trace to 172.16.20.138, 25 hops max, press Ctrl+C to stop
1  172.16.20.1  1.358 ms  0.709 ms  0.781 ms
2  *172.16.20.138  0.968 ms (ICMP type:3, code:3, Destination port unreachable)
e)

VPCS> ping 64.100.1.10/24

84 bytes from 64.100.1.10 icmp_seq=1 ttl=63 time=4.042 ms
84 bytes from 64.100.1.10 icmp_seq=2 ttl=63 time=2.952 ms
84 bytes from 64.100.1.10 icmp_seq=3 ttl=63 time=1.060 ms
84 bytes from 64.100.1.10 icmp_seq=4 ttl=63 time=1.540 ms
84 bytes from 64.100.1.10 icmp_seq=5 ttl=63 time=1.713 ms

VPCS> trace 64.100.1.10/24
trace to 64.100.1.10, 24 hops max, press Ctrl+C to stop
1  172.16.20.1  1.699 ms  1.243 ms  0.415 ms
2  *64.100.1.10  0.981 ms (ICMP type:3, code:3, Destination port unreachable)

VPCS> ping 2001:db8:c0de:12::a/64
host (2001:db8:c0de:12::a) not reachable

VPCS> trace 2001:db8:c0de:12::a/64
host (2001:db8:c0de:12::a) not reachable

VPCS>
```

Рис. 14: Проверка доступности устройств из подсети IPv4 для устройств из подсети IPv6

```
Server-iothenko - PuTTY

NAME      : VPCS[1]
IP/MASK   : 64.100.1.10/24
GATEWAY   : 64.100.1.1
DNS       :
MAC       : 00:50:79:66:68:04
LPORT     : 20030
RHOST:PORT: 127.0.0.1:20031
MTU       : 1500

VPCS> show ipv6

NAME      : VPCS[1]
LINK-LOCAL SCOPE : fe80::250:79ff:fe66:6804/64
GLOBAL SCOPE   : 2001:db8:c0de:11::a/64
DNS       :
ROUTER LINK-LAYER :
MAC       : 00:50:79:66:68:04
LPORT     : 20030
RHOST:PORT   : 127.0.0.1:20031
MTU       : 1500

VPCS> ping 2001:db8:c0de:12::a/64

2001:db8:c0de:12::a icmp6_seq=1 ttl=62 time=825.921 ms
2001:db8:c0de:12::a icmp6_seq=2 ttl=62 time=1.273 ms
2001:db8:c0de:12::a icmp6_seq=3 ttl=62 time=3.446 ms
2001:db8:c0de:12::a icmp6_seq=4 ttl=62 time=1.653 ms
2001:db8:c0de:12::a icmp6_seq=5 ttl=62 time=10.805 ms

VPCS> ping 172.16.20.10/25

84 bytes from 172.16.20.10 icmp_seq=1 ttl=63 time=3.157 ms
84 bytes from 172.16.20.10 icmp_seq=2 ttl=63 time=2.925 ms
84 bytes from 172.16.20.10 icmp_seq=3 ttl=63 time=2.464 ms
84 bytes from 172.16.20.10 icmp_seq=4 ttl=63 time=2.699 ms
84 bytes from 172.16.20.10 icmp_seq=5 ttl=63 time=1.645 ms

VPCS>
```

Рис. 15: Проверка доступности устройств из обеих подсетей с сервера двойного стека

Захват из Standard input [Server-ioithenko Ethernet0 to msk-ioithenko-sw-05 Ethernet0]

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

Примените фильтр отображения ... <Ctrl-/>

```
Encapsulation type: Ethernet (1)
Arrival Time: Nov 22, 2024 23:27:22.641945000 RTZ 2 (зима)
UTC Arrival Time: Nov 22, 2024 20:27:22.641945000 UTC
Epoch Arrival Time: 1732307242.641945000
[Time shift for this packet: 0.00000000 seconds]
[Time delta from previous captured frame: 1.242552000 seconds]
[Time delta from previous displayed frame: 1.242552000 seconds]
[Time since reference or first frame: 17.186613000 seconds]
Frame Number: 23
Frame Length: 60 bytes (480 bits)
Capture Length: 60 bytes (480 bits)
[Frame is marked: False]
[Frame is ignored: False]
[Protocols in frame: eth:ethertype:arp]
[Coloring Rule Name: ARP]
[Coloring Rule String: arp]
▼ Ethernet II, Src: 0c:24:e1:09:00:02 (0c:24:e1:09:00:02), Dst: Private_66:68:04 (00:50:79:66:68:04)
  ▼ Destination: Private_66:68:04 (00:50:79:66:68:04)
    .... ..0. .... .... .... = LG bit: Globally unique address (factory default)
    .... ..0. .... .... .... = IG bit: Individual address (unicast)
  ▼ Source: 0c:24:e1:09:00:02 (0c:24:e1:09:00:02)
    .... ..0. .... .... .... = LG bit: Globally unique address (factory default)
    .... ..0. .... .... .... = IG bit: Individual address (unicast)
  Type: ARP (0x0806)
  [Stream index: 2]
  Padding: 00000000000000000000000000000000
▼ Address Resolution Protocol (request)
  Hardware type: Ethernet (1)
  Protocol type: IPv4 (0x0800)
  Hardware size: 6
  Protocol size: 4
  Opcode: request (1)
  Sender MAC address: 0c:24:e1:09:00:02 (0c:24:e1:09:00:02)
  Sender IP address: 64.100.1.1
  Target MAC address: 00:00:00_00:00:00 (00:00:00:00:00:00)
  Target IP address: 64.100.1.10
```

Standard input - «live capture in progress» | Пакеты 24

Рис. 16: Захваченный трафик ARP

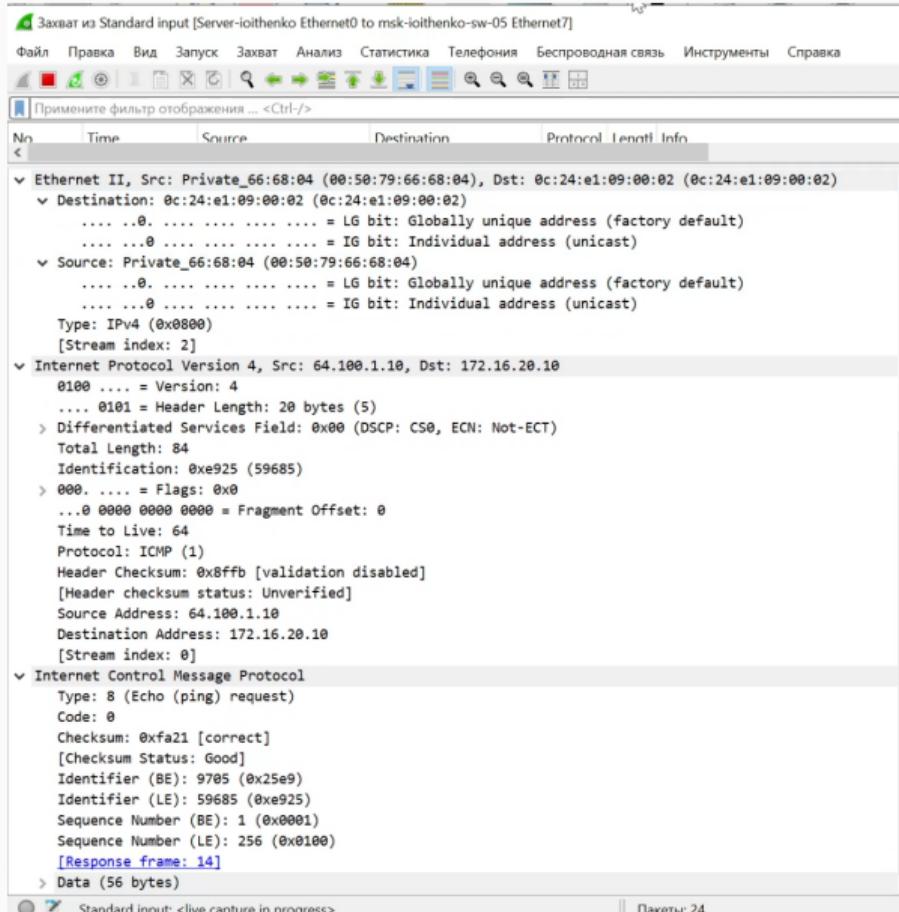


Рис. 17: Захваченный трафик ICMP

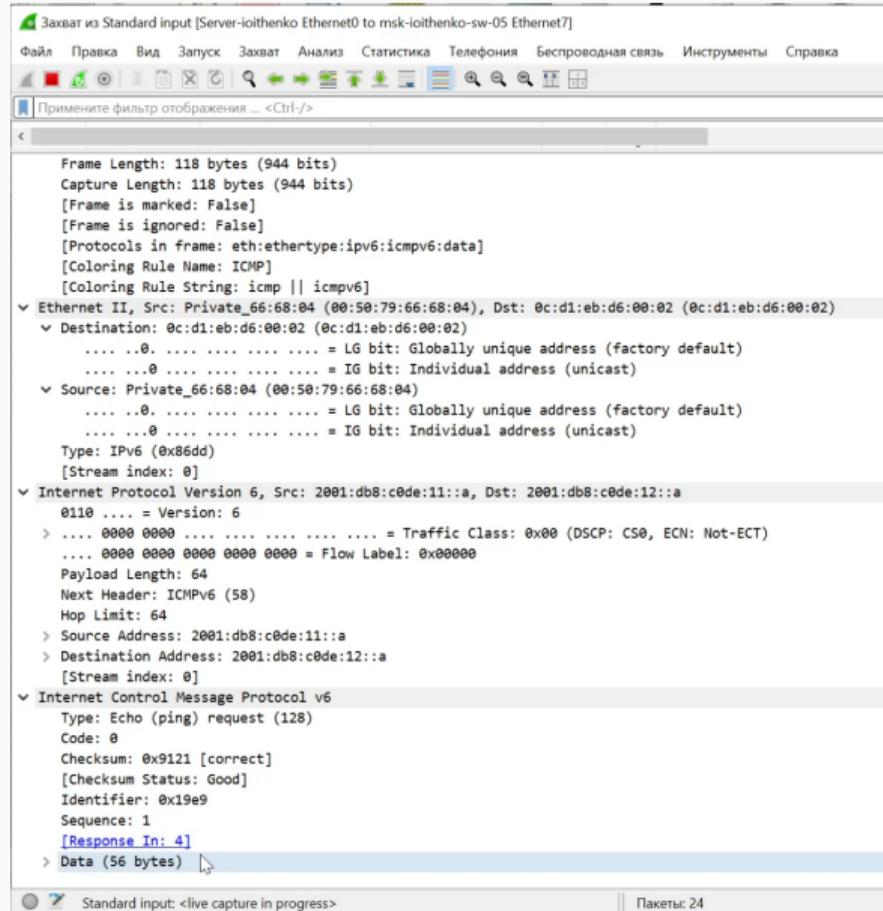


Рис. 18: Захваченный трафик ICMPv6

Таблица 6: Подсеть 1

Характеристика	Значение
IPv4	10.10.1.96/27
длина префикса	27
маска подсети	255.255.255.224
broadcast	10.10.1.127
диапазон	10.10.1.97 - 10.10.1.126
IPv6	2001:DB8:1:1::/64
длина префикса	64
диапазон	2001:db8:1:1:0:0:0:0 - 2001:db8:1:1:ffff:ffff:ffff:ffff

Таблица 7: Подсеть 2

Характеристика	Значение
IPv4	10.10.1.16/28
длина префикса	28
маска подсети	255.255.255.240
broadcast	10.10.1.31
диапазон адресов	10.10.1.17 - 10.10.1.30
IPv6	2001:DB8:1:4::/64
длина префикса	64
диапазон	2001:db8:1:4:0:0:0:0 - 2001:db8:1:4:ffff:ffff:ffff:ffff

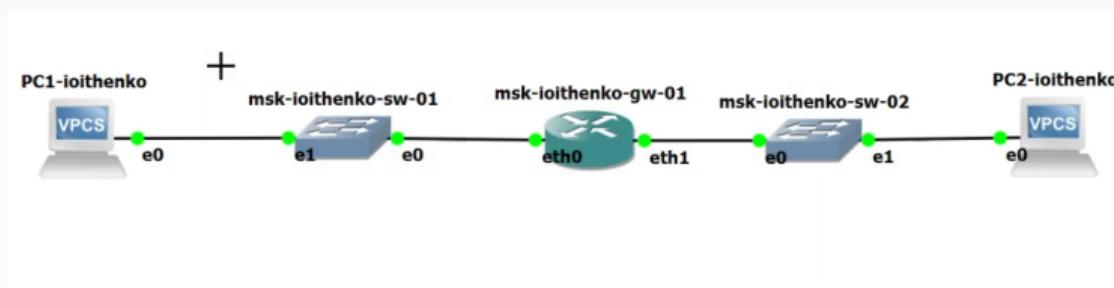


Рис. 19: Топология

Таблица 8: Таблица адресации для заданной топологии

Устройство	Интерфейс	IPv4	IPv6	Шлюз
PC-1	NIC	10.10.1.99/27	2001:db8:1:1::a/64	10.10.1.97
PC-2	NIC	10.10.1.18/28	2001:db8:1:4::a/64	10.10.1.17
gw-01	eth0	10.10.1.97/27	2001:db8:1:1::1/64	
gw-01	eth1	10.10.1.17/28	2001:db8:1:4::1/64	

PC1-ioithenko - Putty

```
Welcome to Virtual PC Simulator, version 0.8.3
Sdedicated to Daling.
Build time: Sep 9 2023 11:15:00
Copyright (c) 2007-2015, Paul Meng (mirnshi@gmail.com)
All rights reserved.

VPCS is free software, distributed under the terms of the "BSD" licence.
Source code and license can be found at vpcas.sf.net.
For more information, please visit wiki.freecode.com.cn.

Press '?' to get help.

Executing the startup file

Hostname is too long. (Maximum 12 characters)

VPCS> ip 10.10.1.99/27 10.10.1.97
Checking for duplicate address...
VPCS : 10.10.1.99 255.255.255.224 gateway 10.10.1.97

VPCS> sace
Bad command: "sace". Use ? for help.

VPCS> save
Saving startup configuration to startup.vpc
. done

VPCS> ip 2001:db8:1:1::a/64
PCI : 2001:db8:1:1::a/64

VPCS> save
Saving startup configuration to startup.vpc
. done

VPCS> show ip

NAME      : VPCS[1]
IP/MASK   : 10.10.1.99/27
GATEWAY   : 10.10.1.97
DNS       :
MAC       : 00:50:79:66:68:00
LPORT     : 20008
RHOST:PORT : 127.0.0.1:20009
MTU       : 1500

VPCS> show ipv6

NAME      : VPCS[1]
LINK-LOCAL SCOPE : fe80::250:79ff:fe66:6800/64
GLOBAL SCOPE   : 2001:db8:1:1::a/64
DNS       :
ROUTER LINK-LAYER :
MAC       : 00:50:79:66:68:00
LPORT     : 20008
RHOST:PORT   : 127.0.0.1:20009
MTU       : 1500

VPCS> █
```

Рис. 20: Настройка IPv4- и IPv6-адресации на PC-1

PC2-ioithenko - PuTTY

```
Welcome to Virtual PC Simulator, version 0.8.3
Dedicated to Daling.
Build time: Sep  9 2023 11:15:00
Copyright (c) 2007-2015, Paul Meng (mirnshi@gmail.com)
All rights reserved.

VFCs is free software, distributed under the terms of the "BSD" licence.
Source code and license can be found at vpcs.sf.net.
For more information, please visit wiki.freecode.com.cn.

Press "?" to get help.

Executing the startup file

Hostname is too long. (Maximum 12 characters)

VPCS> ip 10.10.1.18/28 10.10.1.17
Checking for duplicate address...
VPCS : 10.10.1.18 255.255.255.240 gateway 10.10.1.17

VPCS> ip 2001:db8:1:4::a/64
PCL : 2001:db8:1:4::a/64

VPCS> ssave
Bad command: "ssave". Use ? for help.

VPCS> save
Saving startup configuration to startup.vpc
. done

VPCS> show ip

NAME      : VPCS[1]
IP/MASK   : 10.10.1.18/28
GATEWAY   : 10.10.1.17
DNS       :
MAC       : 00:50:79:66:68:01
LPORT     : 20010
RHOST:PORT : 127.0.0.1:20011
MTU       : 1500

VPCS> show ipv6

NAME      : VPCS[1]
LINK-LOCAL SCOPE : fe80::250:79ff:fe66:6801/64
GLOBAL SCOPE   : 2001:db8:1:4::a/64
DNS       :
ROUTER LINK-LAYER :
MAC       : 00:50:79:66:68:01
LPORT     : 20010
RHOST:PORT   : 127.0.0.1:20011
MTU       : 1500

VPCS>
```

Рис. 21: Настройка IPv4- и IPv6-адресации на PC-2

```
[ 29.163076] systemd[1]: Detected architecture x86-64.
[ 29.211653] systemd[1]: Set hostname to <msk-ioithenko-gw-01>.
[ 31.542083] systemd[1]: Reached target Swap.
[ 31.555619] systemd[1]: Reached target Remote File Systems.
[ 31.568277] systemd[1]: Listening on Journal Socket (/dev/log).
[ 31.584662] systemd[1]: Listening on Syslog Socket.
[ 31.597663] systemd[1]: Listening on Journal Audit Socket.
[ 31.623315] systemd[1]: Created slice system-serial\x2dgetty.slice.
[ 32.490571] bridge: filtering via arp/ip/ip6tables is no longer available by default
. Update your scripts to load br_netfilter if you need this.
[ 32.601672] Bridge firewalling registered
[ 32.682261] mpls_gso: MPLS GSO support

Welcome to VyOS - msk-ioithenko-gw-01 ttyS0

msk-ioithenko-gw-01 login: vyos
Password:
Welcome to VyOS!

Check out project news at https://blog.vyos.io
and feel free to report bugs at https://vyos.dev

You can change this banner using "set system login banner post-login" command.

VyOS is a free software distribution that includes multiple components,
you can check individual component licenses under /usr/share/doc/*copyright
vyos@msk-ioithenko-gw-01:~$ configure
[edit]
vyos@msk-ioithenko-gw-01# set interfaces ethernet eth0 address 10.10.1.97/27
[edit]
vyos@msk-ioithenko-gw-01# set interfaces ethernet eth1 address 10.10.1.17/27
[edit]
vyos@msk-ioithenko-gw-01# delete interfaces ethernet eth0 address dhcp
[edit]
vyos@msk-ioithenko-gw-01# compare
[edit interfaces ethernet eth0]
+address dhcp
+address 10.10.1.97/27
[edit interfaces ethernet eth1]
+address 10.10.1.17/27
[edit]
vyos@msk-ioithenko-gw-01# commit
[edit]
vyos@msk-ioithenko-gw-01# save
Saving configuration to '/config/config.boot'...
done
[edit]
vyos@msk-ioithenko-gw-01# show interfaces
ethernet eth0 {
    address 10.10.1.97/27
    hw-id 0c:30:44:c3:00:00
}
ethernet eth1 {
    address 10.10.1.17/27
    hw-id 0c:30:44:c3:00:01
}
ethernet eth2 {
    hw-id 0c:30:44:c3:00:02
}
loopback lo {
}
[edit]
vyos@msk-ioithenko-gw-01#
```

Рис. 22: Настройка IPv4-адресации на маршрутизаторе VyOS

```
vyos@msk-ioithenko-gw-01# show interfaces
  ethernet eth0 {
    address 10.10.1.97/27
    address 2001:db8:1:1::1/64
    hw-id 0c:30:44:c3:00:00
  }
  ethernet eth1 {
    address 10.10.1.17/27
    address 2001:db8:1:4::1/64
    hw-id 0c:30:44:c3:00:01
  }
  ethernet eth2 {
    hw-id 0c:30:44:c3:00:02
  }
  loopback lo {
  }
[edit]
vyos@msk-ioithenko-gw-01#
```

Рис. 23: Просмотр интерфейсов на маршрутизаторе VyOS

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

VPCS> ip 2001:db8:1::1::a/64
PC1 : 2001:db8:1::1::a/64

VPCS> save
Saving startup configuration to startup.vpc
. done

VPCS> show ip

NAME      : VPCS[1]
IP/MASK   : 10.10.1.99/27
GATEWAY   : 10.10.1.97
DNS       :
MAC       : 00:50:79:66:68:00
LPORT     : 20008
RHOST:PORT : 127.0.0.1:20009
MTU       : 1500

VPCS> show ipv6

NAME      : VPCS[1]
LINK-LOCAL SCOPE : fe80::250:79ff:fe66:6800/64
GLOBAL SCOPE   : 2001:db8:1::1::a/64
DNS       :
ROUTER LINK-LAYER :
MAC       : 00:50:79:66:68:00
LPORT     : 20008
RHOST:PORT : 127.0.0.1:20009
MTU       : 1500

VPCS> ping 10.10.1.18/28
@4 bytes from 10.10.1.18 icmp_seq=1 ttl=63 time=3.807 ms
@4 bytes from 10.10.1.18 icmp_seq=2 ttl=63 time=2.473 ms
@4 bytes from 10.10.1.18 icmp_seq=3 ttl=63 time=2.956 ms
@4 bytes from 10.10.1.18 icmp_seq=4 ttl=63 time=2.978 ms
@4 bytes from 10.10.1.18 icmp_seq=5 ttl=63 time=3.583 ms

VPCS> trace 10.10.1.18/28
Trace to 10.10.1.18, 28 hops max, press Ctrl+C to stop
1 10.10.1.97 1.986 ms 1.909 ms 4.602 ms
2 *10.10.1.18 3.118 ms (ICMP type:3, code:3, Destination port unreachable)

VPCS> ping 2001:db8:1::4::a/64
2001:db8:1:4::a icmp6_seq=1 ttl=62 time=10.748 ms
2001:db8:1:4::a icmp6_seq=2 ttl=62 time=3.927 ms
2001:db8:1:4::a icmp6_seq=3 ttl=62 time=4.307 ms
2001:db8:1:4::a icmp6_seq=4 ttl=62 time=5.496 ms
2001:db8:1:4::a icmp6_seq=5 ttl=62 time=6.732 ms

VPCS> trace 2001:db8:1:4::a/64
trace to 2001:db8:1:4::a, 64 hops max
1 2001:db8:1:1::1 2.542 ms 2.621 ms 2.067 ms
2 2001:db8:1:4::a 2.165 ms 3.551 ms 2.054 ms
```

Рис. 24: Проверка подключения с PC-1 на PC-2 по IPv4 и IPv6



VPCS : 10.10.1.18 255.255.255.240 gateway 10.10.1.17
VPCS> ip 2001:db8:1:4::a/64
FC1 : 2001:db8:1:4::a/64

VPCS> ssave
Bad command: "ssave". Use ? for help.

VPCS> save
Saving startup configuration to startup.vpc
. done

VPCS> show ip

NAME : VPCS[1]
IP/MASK : 10.10.1.18/28
GATEWAY : 10.10.1.17
DNS :
MAC : 00:50:79:66:68:01
LPORT : 20010
RHOST:PORT : 127.0.0.1:20011
MTU : 1500

VPCS> show ipv6

NAME : VPCS[1]
LINK-LOCAL SCOPE : fe80::250:79ff:fe66:6801/64
GLOBAL SCOPE : 2001:db8:1:4::a/64
DNS :
ROUTER LINK-LAYER :
MAC : 00:50:79:66:68:01
LPORT : 20010
RHOST:PORT : 127.0.0.1:20011
MTU : 1500

VPCS> ping 10.10.1.99/27
84 bytes from 10.10.1.99 icmp_seq=1 ttl=63 time=3.716 ms
84 bytes from 10.10.1.99 icmp_seq=2 ttl=63 time=1.975 ms
84 bytes from 10.10.1.99 icmp_seq=3 ttl=63 time=4.238 ms
84 bytes from 10.10.1.99 icmp_seq=4 ttl=63 time=3.111 ms
84 bytes from 10.10.1.99 icmp_seq=5 ttl=63 time=3.144 ms

VPCS> trace 10.10.1.99/27
trace to 10.10.1.99, 27 hops max, press Ctrl+C to stop
1 10.10.1.17 6.357 ms 2.112 ms 1.362 ms
2 *10.10.1.99 3.168 ms (ICMP type:3, code:3, Destination port unreachable)

VPCS> ping 2001:db8:1:1::a/64
2001:db8:1:1::a icmp6_seq=1 ttl=62 time=4.261 ms
2001:db8:1:1::a icmp6_seq=2 ttl=62 time=3.776 ms
2001:db8:1:1::a icmp6_seq=3 ttl=62 time=3.191 ms
2001:db8:1:1::a icmp6_seq=4 ttl=62 time=2.989 ms
2001:db8:1:1::a icmp6_seq=5 ttl=62 time=3.823 ms

VPCS> trace 2001:db8:1:1::a/64
trace to 2001:db8:1:1::a, 64 hops max
1 2001:db8:1:4::1 6.686 ms 1.980 ms 2.098 ms
2 2001:db8:1:1::a 6.759 ms 7.042 ms 3.168 ms

Рис. 25: Проверка подключения с PC-2 на PC-1 по IPv4 и IPv6

Выводы

В ходе выполнения лабораторной работы я изучила принципы распределения и настройки адресного пространства на устройствах сети.