

Лабораторная работа №6

Адресация IPv4 и IPv6. Двойной стек

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Цель работы

Основная цель

Изучить принципы распределения IPv4- и IPv6-адресов
и выполнить настройку адресного пространства на устройствах сети.

Настройка в GNS3

Назначение адресов

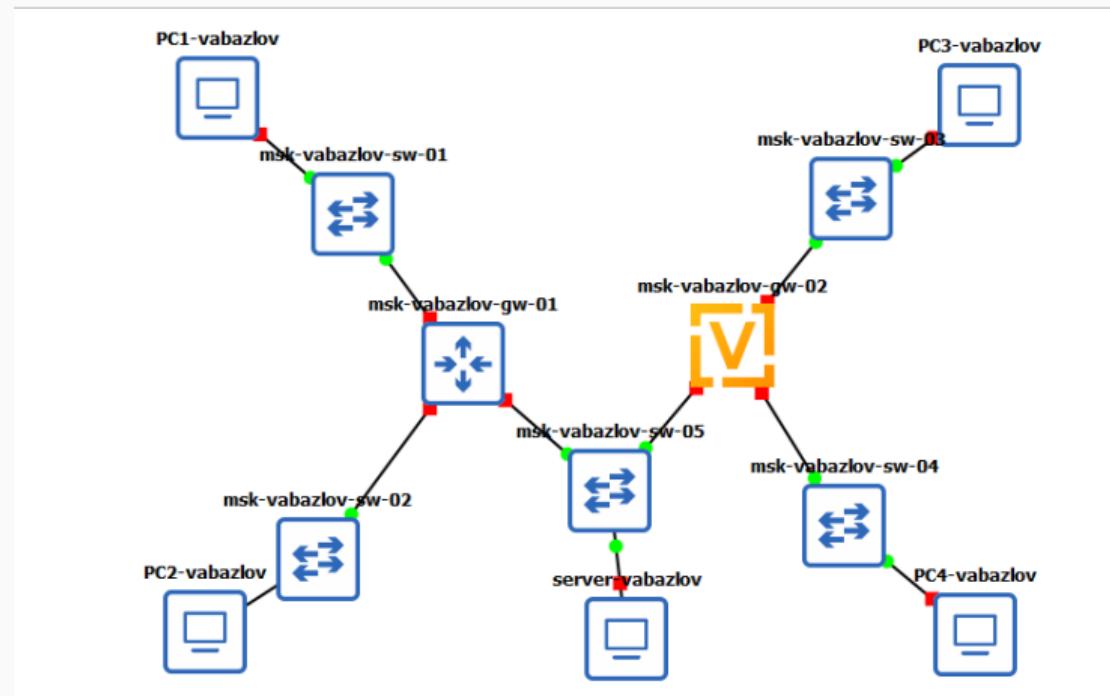


Рис. 1: Топология сети

Проверка сетевой связности

```
server-vabazlov - PuTTY

VPCS> ping 172.16.20.10

84 bytes from 172.16.20.10 icmp_seq=1 ttl=63 time=2.365 ms
84 bytes from 172.16.20.10 icmp_seq=2 ttl=63 time=4.191 ms
84 bytes from 172.16.20.10 icmp_seq=3 ttl=63 time=3.351 ms
84 bytes from 172.16.20.10 icmp_seq=4 ttl=63 time=4.044 ms
84 bytes from 172.16.20.10 icmp_seq=5 ttl=63 time=3.637 ms

VPCS> trace 172.16.20.10
trace to 172.16.20.10, 8 hops max, press Ctrl+C to stop
 1  64.100.1.1    2.416 ms   1.283 ms   0.977 ms
 2  *172.16.20.10   1.636 ms (ICMP type:3, code:3, Destination port unreachable
)

VPCS> ping 172.16.20.138

84 bytes from 172.16.20.138 icmp_seq=1 ttl=63 time=6.067 ms
84 bytes from 172.16.20.138 icmp_seq=2 ttl=63 time=3.727 ms
84 bytes from 172.16.20.138 icmp_seq=3 ttl=63 time=3.543 ms
84 bytes from 172.16.20.138 icmp_seq=4 ttl=63 time=2.887 ms
84 bytes from 172.16.20.138 icmp_seq=5 ttl=63 time=2.254 ms

VPCS> trace 172.16.20.138
trace to 172.16.20.138, 8 hops max, press Ctrl+C to stop
 1  64.100.1.1    2.572 ms   1.020 ms   1.166 ms
 2  *172.16.20.138   1.594 ms (ICMP type:3, code:3, Destination port unreachable

e)

VPCS>
```

Адреса узлов

```
PC3-vabazlov - PuTTY
Executing the startup file

PC3-vabazlov> ip 2001:db8:c0de:12::a/64
PC1 : 2001:db8:c0de:12::a/64

PC3-vabazlov> save
Saving startup configuration to startup.vpc
. done

PC3-vabazlov> show ip

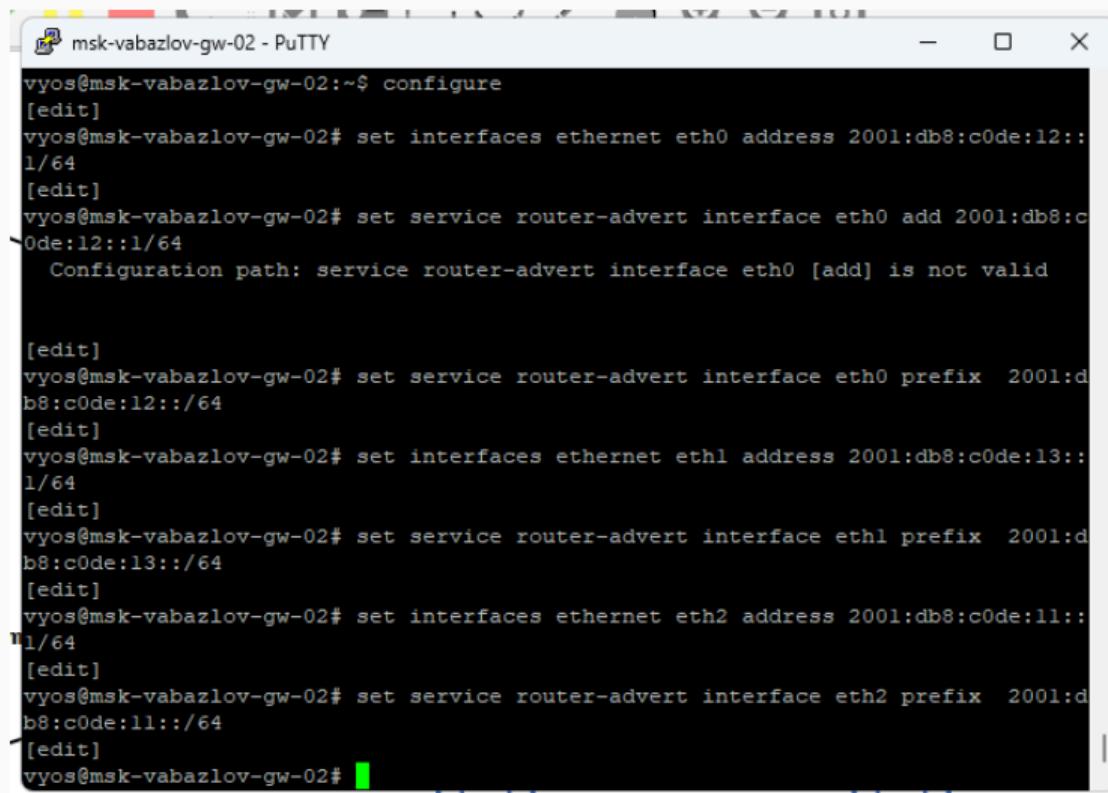
NAME      : PC3-vabazlov[1]
IP/MASK   : 0.0.0.0/0
GATEWAY   : 0.0.0.0
DNS       :
MAC       : 00:50:79:66:68:02
LPORT     : 10044
RHOST:PORT : 127.0.0.1:10045
MTU       : 1500

PC3-vabazlov> show ipv6

NAME      : PC3-vabazlov[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     : 10044
RHOST:PORT : 127.0.0.1:10045
MTU       : 1500

PC3-vabazlov>
```

Маршрутизатор VyOS



```
msk-vabazlov-gw-02 - PuTTY
vyos@msk-vabazlov-gw-02:~$ configure
[edit]
vyos@msk-vabazlov-gw-02# set interfaces ethernet eth0 address 2001:db8:c0de:12::
1/64
[edit]
vyos@msk-vabazlov-gw-02# set service router-advert interface eth0 add 2001:db8:c
0de:12::1/64
    Configuration path: service router-advert interface eth0 [add] is not valid

[edit]
vyos@msk-vabazlov-gw-02# set service router-advert interface eth0 prefix 2001:d
b8:c0de:12::/64
[edit]
vyos@msk-vabazlov-gw-02# set interfaces ethernet eth1 address 2001:db8:c0de:13::
1/64
[edit]
vyos@msk-vabazlov-gw-02# set service router-advert interface eth1 prefix 2001:d
b8:c0de:13::/64
[edit]
vyos@msk-vabazlov-gw-02# set interfaces ethernet eth2 address 2001:db8:c0de:11::
1/64
[edit]
vyos@msk-vabazlov-gw-02# set service router-advert interface eth2 prefix 2001:d
b8:c0de:11::/64
[edit]
vyos@msk-vabazlov-gw-02#
```

Рис. 4: VyOS IPv6 config

PC3 → PC4 и сервер

```
PC3-vabazlov - PuTTY
2001:db8:c0de:12::a icmp_seq=1 ttl=64 time=0.001 ms
2001:db8:c0de:12::a icmp_seq=2 ttl=64 time=0.001 ms
2001:db8:c0de:12::a icmp_seq=3 ttl=64 time=0.001 ms
2001:db8:c0de:12::a icmp_seq=4 ttl=64 time=0.001 ms
2001:db8:c0de:12::a icmp_seq=5 ttl=64 time=0.001 ms

PC3-vabazlov>
PC3-vabazlov> ping 2001:db8:c0de:13::a
PC3-vabazlov>
2001:db8:c0de:13::a icmp6_seq=1 ttl=62 time=3.644 ms
2001:db8:c0de:13::a icmp6_seq=2 ttl=62 time=3.274 ms
2001:db8:c0de:13::a icmp6_seq=3 ttl=62 time=2.642 ms
2001:db8:c0de:13::a icmp6_seq=4 ttl=62 time=2.286 ms
2001:db8:c0de:13::a icmp6_seq=5 ttl=62 time=1.408 ms

PC3-vabazlov> ping 2001:db8:c0de:11::a
PC3-vabazlov>
2001:db8:c0de:11::a icmp6_seq=1 ttl=62 time=4.961 ms
2001:db8:c0de:11::a icmp6_seq=2 ttl=62 time=2.127 ms
2001:db8:c0de:11::a icmp6_seq=3 ttl=62 time=3.241 ms
2001:db8:c0de:11::a icmp6_seq=4 ttl=62 time=1.797 ms
2001:db8:c0de:11::a icmp6_seq=5 ttl=62 time=1.787 ms

PC3-vabazlov>
```

Анализ сетевого трафика

ARP (IPv4)

Захват из Standard input [msk-vabazlov-sw-05 Ethernet7 to server-vabazlov Ethernet0]

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

ПРИМЕНЯЙТЕ ФИЛЬР ОТБРАЖЕНИЯ ... <Ctrl-/>

No.	Time	Source	Destination	Protocol	Length	Info
6	2.0008290	2001:db8:c0de:12::a	2001:db8:c0de:11::a	ICMPv6	118	Echo (ping) reply id=0x8510, seq=3, hop limit=62 (re)
7	3.0009675	2001:db8:c0de:11::a	2001:db8:c0de:12::a	ICMPv6	118	Echo (ping) request id=0x8510, seq=4, hop limit=64 (re)
8	3.011087	2001:db8:c0de:12::a	2001:db8:c0de:11::a	ICMPv6	118	Echo (ping) reply id=0x8510, seq=4, hop limit=62 (re)
9	4.012852	2001:db8:c0de:11::a	2001:db8:c0de:12::a	ICMPv6	118	Echo (ping) request id=0x8510, seq=5, hop limit=64 (re)
10	4.014237	2001:db8:c0de:12::a	2001:db8:c0de:11::a	ICMPv6	118	Echo (ping) reply id=0x8510, seq=5, hop limit=62 (re)
11	5.374008	fe80::e0b:36ff:fedc	2001:db8:c0de:11::a	ICMPv6	86	Neighbor Solicitation for 2001:db8:c0de:11::a from 0
12	6.398311	fe80::e0b:36ff:fedc	2001:db8:c0de:11::a	ICMPv6	86	Neighbor Solicitation for 2001:db8:c0de:11::a from 0
13	7.421921	fe80::e0b:36ff:fedc	2001:db8:c0de:11::a	ICMPv6	86	Neighbor Solicitation for 2001:db8:c0de:11::a from 0
14	16.255722	Private_66:68:04	Broadcast	ARP	64	Who has 64.100.1.1? Tell 64.100.1.10
15	16.258788	0:c:f7:4d:1b:00:02	Private_66:68:04	ARP	60	64.100.1.1 is at 0:c:f7:4d:1b:00:02
16	16.260150	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x9510, seq=1/256, ttl=64 (r)
17	16.265717	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x9510, seq=1/256, ttl=63 (r)
18	17.266724	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x9610, seq=2/512, ttl=64 (r)
19	17.268891	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x9610, seq=2/512, ttl=63 (r)
20	18.270722	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x9710, seq=3/768, ttl=64 (r)
21	18.272268	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x9710, seq=3/768, ttl=63 (r)
22	19.273535	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x9810, seq=4/1024, ttl=64 (r)

> Frame 14: 64 bytes on wire (512 bits), 64 bytes captured (512 bits) on interface -, id 0
> Ethernet II, Src: Private_66:68:04 (00:50:79:66:68:04), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
✓ Address Resolution Protocol (request)
 Hardware type: Ethernet (1)
 Protocol type: IPv4 (0x0800)
 Hardware size: 6
 Protocol size: 4
 Opcode: request (1)
 Sender MAC address: Private_66:68:04 (00:50:79:66:68:04)
 Sender IP address: 64.100.1.10
 Target MAC address: Broadcast (ff:ff:ff:ff:ff:ff)
 Target IP address: 64.100.1.1

0000 ff ff ff ff
0010 08 00 06 04
0020 ff ff ff ff
0030 00 00 00 00

ICMPv4

Захват из Standard input [msk-vabazlov-sw-05 Ethernet7 to server-vabazlov Ethernet0]

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ПРИМЕНЯЙТЕ ФИЛЬР ОТСОРТИВАНИЯ ... <Ctrl-/>

No.	Time	Source	Destination	Protocol	Length	Info
13	7.421921	fe80::e0b:36ff:fedc..	2001:db8:c0de:11::a	ICMPv6	86	Neighbor Solicitation for 2001:db8:c0de:11::a from 64.100.1.10
14	16.255722	Private_66:68:04	Broadcast	ARP	64	Who has 64.100.1.1? Tell 64.100.1.10
15	16.258788	0:c:f7:4d:1b:00:02	Private_66:68:04	ARP	68	64.100.1.1 is at 0:c:f7:4d:1b:00:02
16	16.260150	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x9510, seq=1/256, ttl=64 (r)
17	16.265717	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x9510, seq=1/256, ttl=63 (r)
18	17.266724	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x9610, seq=2/512, ttl=64 (r)
19	17.268891	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x9610, seq=2/512, ttl=63 (r)
20	18.270722	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x9710, seq=3/768, ttl=64 (r)
21	18.272268	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x9710, seq=3/768, ttl=63 (r)
22	19.273535	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x9810, seq=4/1024, ttl=64 (r)
23	19.274741	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x9810, seq=4/1024, ttl=63 (r)
24	20.276784	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x9910, seq=5/1280, ttl=64 (r)
25	20.277902	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x9910, seq=5/1280, ttl=63 (r)
26	21.270495	0:c:f7:4d:1b:00:02	Private_66:68:04	ARP	68	Who has 64.100.1.10? Tell 64.100.1.1
27	21.270674	Private_66:68:04	0:c:f7:4d:1b:00:02	ARP	68	64.100.1.10 is at 00:50:79:66:68:04
28	140.164447	fe80::e0b:36ff:fedc..	ff02::1	ICMPv6	118	Router Advertisement from 0:c:0b:36:cd:00:02

> Frame 18: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface -, id 0
> Ethernet II, Src: Private_66:68:04 (00:50:79:66:68:04), Dst: 0:c:f7:4d:1b:00:02 (0:c:f7:4d:1b:00:02)
> Internet Protocol Version 4, Src: 64.100.1.10, Dst: 172.16.20.138
▼ Internet Control Message Protocol
 Type: 8 (Echo (ping) request)
 Code: 0
 Checksum: 0x89f9 [correct]
 [Checksum Status: Good]
 Identifier (BE): 38416 (0x9610)
 Identifier (LE): 4246 (0x1096)
 Sequence Number (BE): 2 (0x0002)
 Sequence Number (LE): 512 (0x0200)
 [Response frame: 19]
 > Data (56 bytes)

0000 0c f7 4d 1b
0010 00 54 10 06
0020 14 8a 08 06
0030 0e 0f 10 11
0040 1e 1f 20 21
0050 2e 2f 30 31
0060 3e 3f

ICMPv6

Захват из Standard input [msk-vabazlov-sw-05 Ethernet7 to server-vabazlov Ethernet0]

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

Примените фильтр отображения ... <Ctrl-/>

No.	Time	Source	Destination	Protocol	Length	Info
4	1.005421	2001:db8:c0de:12::a	2001:db8:c0de:11::a	ICMPv6	118	Echo (ping) reply id=0x8510, seq=2, hop limit=62 (re)
5	2.007059	2001:db8:c0de:11::a	2001:db8:c0de:12::a	ICMPv6	118	Echo (ping) request id=0x8510, seq=3, hop limit=64 (re)
6	2.008290	2001:db8:c0de:12::a	2001:db8:c0de:11::a	ICMPv6	118	Echo (ping) reply id=0x8510, seq=3, hop limit=62 (re)
7	3.009675	2001:db8:c0de:11::a	2001:db8:c0de:12::a	ICMPv6	118	Echo (ping) request id=0x8510, seq=4, hop limit=64 (re)
*	8.3.011087	2001:db8:c0de:12::a	2001:db8:c0de:11::a	ICMPv6	118	Echo (ping) reply id=0x8510, seq=4, hop limit=62 (re)
9	4.012852	2001:db8:c0de:11::a	2001:db8:c0de:12::a	ICMPv6	118	Echo (ping) request id=0x8510, seq=5, hop limit=64 (re)
10	4.014237	2001:db8:c0de:12::a	2001:db8:c0de:11::a	ICMPv6	118	Echo (ping) reply id=0x8510, seq=5, hop limit=62 (re)
11	5.374808	fe80::e0b:36ff:fed..	2001:db8:c0de:11::a	ICMPv6	86	Neighbor Solicitation for 2001:db8:c0de:11::a from 0
12	6.398311	fe80::e0b:36ff:fed..	2001:db8:c0de:11::a	ICMPv6	86	Neighbor Solicitation for 2001:db8:c0de:11::a from 0
13	7.421921	fe80::e0b:36ff:fed..	2001:db8:c0de:11::a	ICMPv6	86	Neighbor Solicitation for 2001:db8:c0de:11::a from 0
14	16.255722	Private_66:68:04	Broadcast	ARP	64	Who has 64.100.1.1? Tell 64.100.1.10
15	16.258788	0c:f7:4d:1b:00:02	Private_66:68:04	ARP	60	64.100.1.1 is at 0c:f7:4d:1b:00:02
16	16.260150	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x9510, seq=1/256, ttl=64 (r)
17	16.265717	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x9510, seq=1/256, ttl=63 (r)
18	17.266724	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x9610, seq=2/512, ttl=64 (r)
19	17.268891	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x9610, seq=2/512, ttl=63 (r)
20	18.270722	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x9710, seq=3/768, ttl=64 (r)

> Frame 7: 118 bytes on wire (944 bits), 118 bytes captured (944 bits) on interface -, id 0

> Ethernet II, Src: Private_66:68:04 (00:50:79:66:68:04), Dst: 0c:0b:36:cd:00:02 (0c:0b:36:cd:00:02)

> Internet Protocol Version 6, Src: 2001:db8:c0de:11::a, Dst: 2001:db8:c0de:12::a

Internet Control Message Protocol v6

Type: Echo (ping) request (128)
Code: 0
Checksum: 0x25f7 [correct]
[Checksum Status: Good]
Identifier: 0x8510
Sequence: 4
[Response_In: 8]
Data (56 bytes)

0000	0c 0b 36 cd
0010	00 00 00 00
0020	00 00 00 00
0030	00 00 00 00
0040	02 03 04 05
0050	12 13 14 15
0060	22 23 24 25
0070	32 33 34 35

Самостоятельная часть

Используемые подсети

IPv4 - Подсеть 1: **10.10.1.96/27**

- Подсеть 2: **10.10.1.16/28**

IPv6 - 2001:db8:1:1::/64

- 2001:db8:1:4::/64

Топология подсети

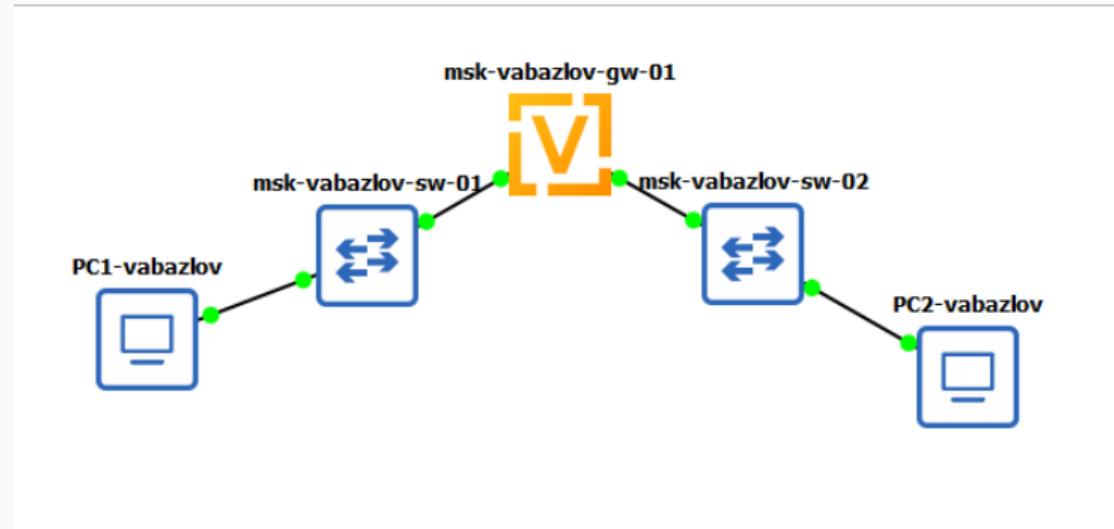
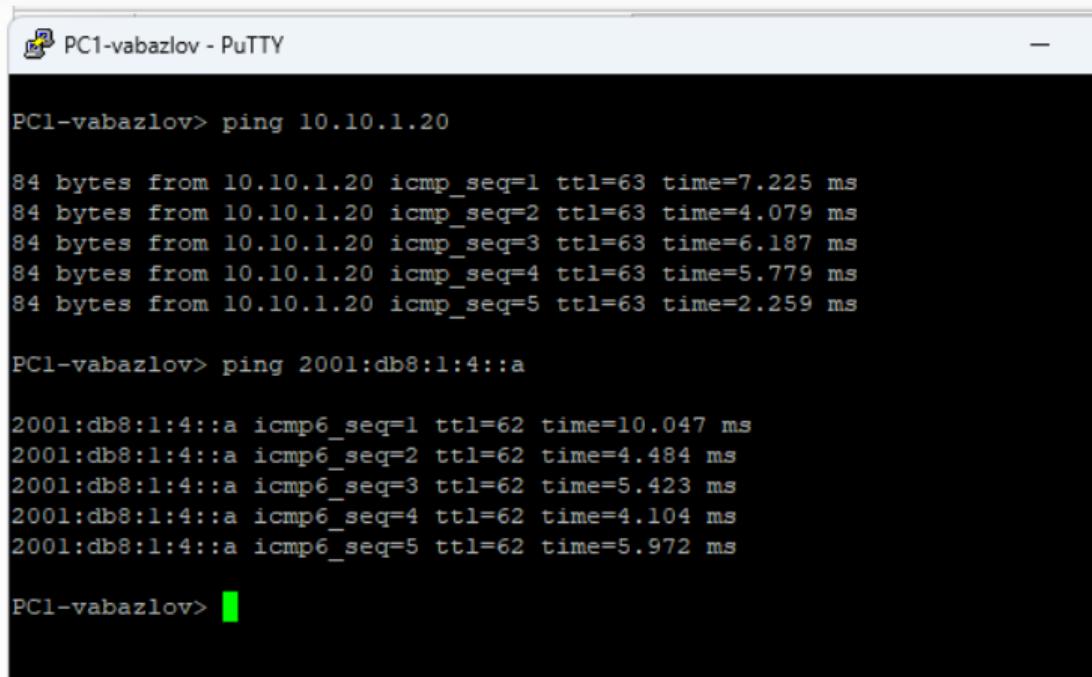


Рис. 9: Топология сети

Проверка устройств



PC1-vabazlov - PuTTY

```
PC1-vabazlov> ping 10.10.1.20

84 bytes from 10.10.1.20 icmp_seq=1 ttl=63 time=7.225 ms
84 bytes from 10.10.1.20 icmp_seq=2 ttl=63 time=4.079 ms
84 bytes from 10.10.1.20 icmp_seq=3 ttl=63 time=6.187 ms
84 bytes from 10.10.1.20 icmp_seq=4 ttl=63 time=5.779 ms
84 bytes from 10.10.1.20 icmp_seq=5 ttl=63 time=2.259 ms

PC1-vabazlov> ping 2001:db8:1:4::a

2001:db8:1:4::a icmp6_seq=1 ttl=62 time=10.047 ms
2001:db8:1:4::a icmp6_seq=2 ttl=62 time=4.484 ms
2001:db8:1:4::a icmp6_seq=3 ttl=62 time=5.423 ms
2001:db8:1:4::a icmp6_seq=4 ttl=62 time=4.104 ms
2001:db8:1:4::a icmp6_seq=5 ttl=62 time=5.972 ms

PC1-vabazlov>
```

Рис. 10: Проверка ping IPv4 и IPv6

Итоги работы

Выводы

- Выполнено разбиение подсетей IPv4 и IPv6
- Настроена адресация в топологии GNS3
- Проверена связность для обоих протоколов
- Изучены механизмы ARP, ICMP и ICMPv6
- Реализована работа сети с **двойным стеком IPv4/IPv6**