

# Сетевые технологии

Адресация IPv4 и IPv6. Двойной стек

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## Цель работы

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Изучить методы распределения IPv4/IPv6-адресов, разбиение сетей на подсети и настройку двойного стека в виртуальной лабораторной среде.

## Настройка двойного стека адресации IPv4 и IPv6

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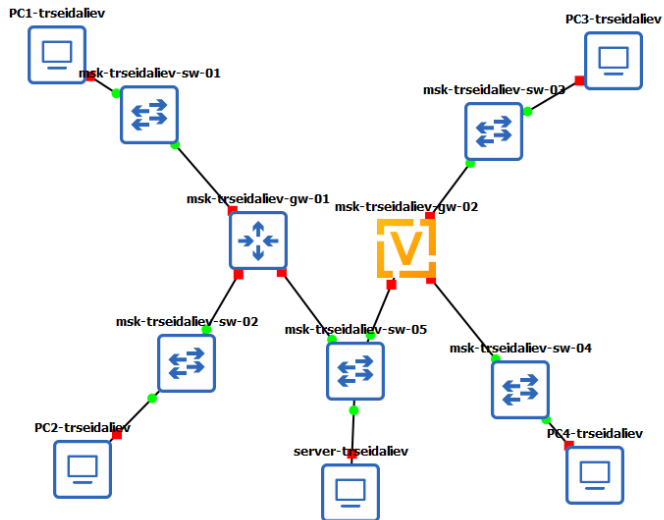


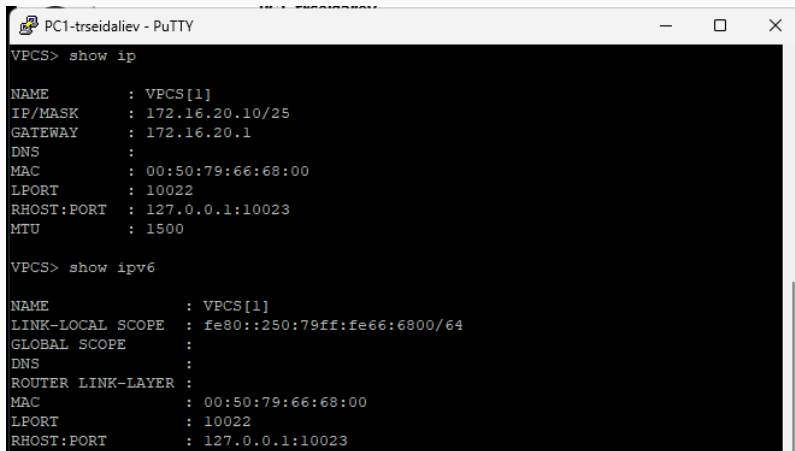
Рис. 1: Топология

# Конфигурация PC1

IPv4: 172.16.20.x

IPv6: автоматическое назначение SLAAC

Проверка командой `show ip`

A screenshot of a PuTTY terminal window titled "PC1-trseidaliev - PuTTY". The terminal shows the output of two commands: "show ip" and "show ipv6". The "show ip" command displays IPv4 configuration details for VPCS[1], including IP/MASK (172.16.20.10/25), GATEWAY (172.16.20.1), DNS, MAC (00:50:79:66:68:00), LPORT (10022), RHOST:PORT (127.0.0.1:10023), and MTU (1500). The "show ipv6" command displays IPv6 configuration details for VPCS[1], including LINK-LOCAL SCOPE (fe80::250:79ff:fe66:6800/64), GLOBAL SCOPE, DNS, ROUTER LINK-LAYER, MAC (00:50:79:66:68:00), LPORT (10022), and RHOST:PORT (127.0.0.1:10023).

```
PC1-trseidaliev - 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      : 10022
RHOST:PORT : 127.0.0.1:10023
MTU        : 1500

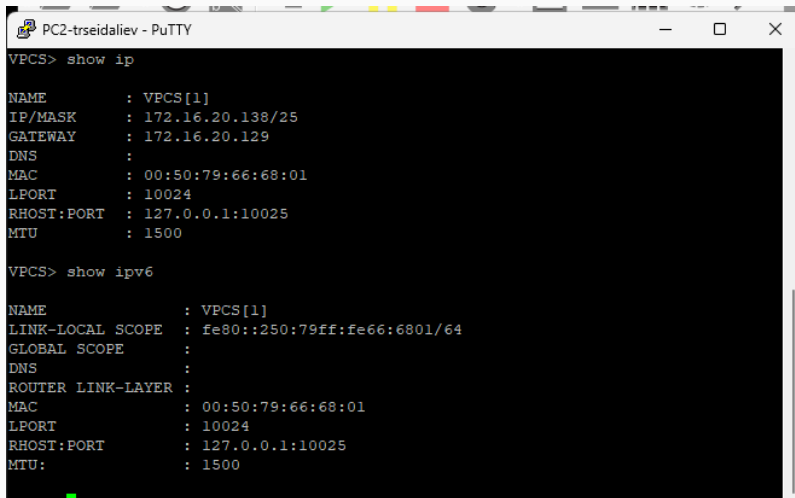
VPCS> show ipv6

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          : 10022
RHOST:PORT     : 127.0.0.1:10023
```

## Конфигурация PC2

IPv4: из диапазона 172.16.20.128/26

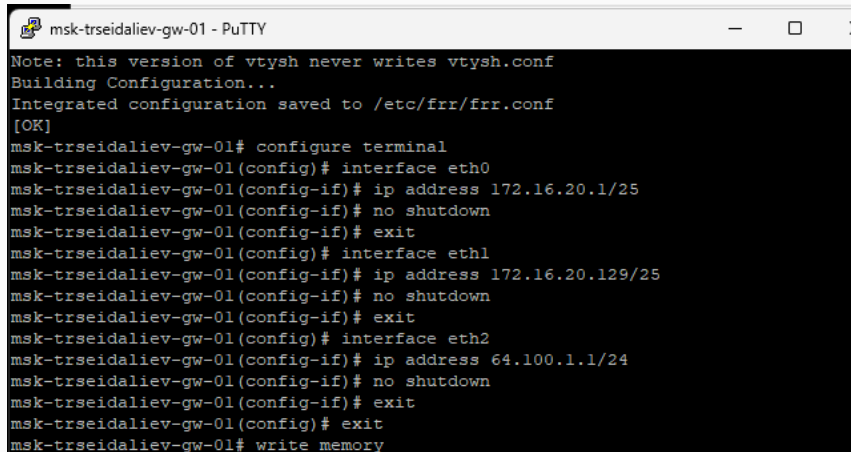
IPv6: SLAAC

A screenshot of a PuTTY terminal window titled "PC2-trseidaliev - PuTTY". The terminal shows the output of two commands: "show ip" and "show ipv6". The "show ip" command displays IPv4 configuration details for VPCS[1], including IP/MASK (172.16.20.138/25), GATEWAY (172.16.20.129), DNS, MAC (00:50:79:66:68:01), LPORT (10024), RHOST:PORT (127.0.0.1:10025), and MTU (1500). The "show ipv6" command displays IPv6 configuration details for VPCS[1], including LINK-LOCAL SCOPE (fe80::250:79ff:fe66:6801/64), GLOBAL SCOPE, DNS, ROUTER LINK-LAYER, MAC (00:50:79:66:68:01), LPORT (10024), RHOST:PORT (127.0.0.1:10025), and MTU (1500).

```
PC2-trseidaliev - 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      : 10024
RHOST:PORT : 127.0.0.1:10025
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          : 10024
RHOST:PORT     : 127.0.0.1:10025
MTU            : 1500
```

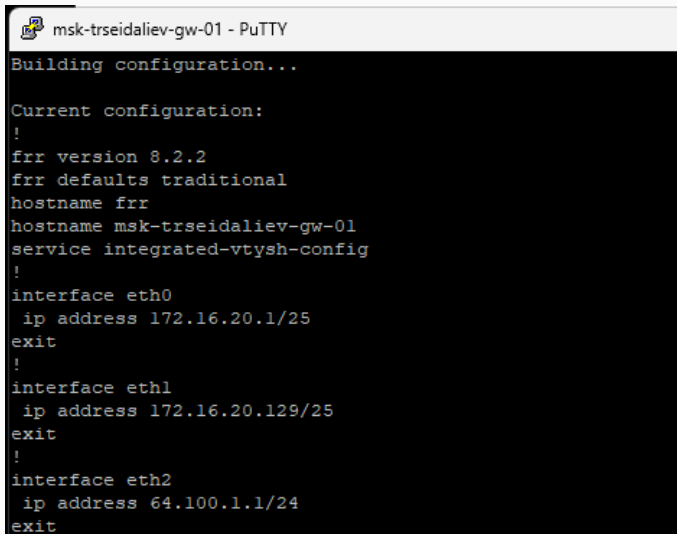
- eth0 — 172.16.20.1/25
- eth1 — 172.16.20.129/25
- eth2 — 64.100.1.1/24



```
msk-trseidaliev-gw-01 - PuTTY
Note: this version of vtysh never writes vtysh.conf
Building Configuration...
Integrated configuration saved to /etc/frr/frr.conf
[OK]
msk-trseidaliev-gw-01# configure terminal
msk-trseidaliev-gw-01(config)# interface eth0
msk-trseidaliev-gw-01(config-if)# ip address 172.16.20.1/25
msk-trseidaliev-gw-01(config-if)# no shutdown
msk-trseidaliev-gw-01(config-if)# exit
msk-trseidaliev-gw-01(config)# interface eth1
msk-trseidaliev-gw-01(config-if)# ip address 172.16.20.129/25
msk-trseidaliev-gw-01(config-if)# no shutdown
msk-trseidaliev-gw-01(config-if)# exit
msk-trseidaliev-gw-01(config)# interface eth2
msk-trseidaliev-gw-01(config-if)# ip address 64.100.1.1/24
msk-trseidaliev-gw-01(config-if)# no shutdown
msk-trseidaliev-gw-01(config-if)# exit
msk-trseidaliev-gw-01(config)# exit
msk-trseidaliev-gw-01# write memory
```



show running-config и show interface brief



```
msk-trseidaliev-gw-01 - PuTTY
Building configuration...

Current configuration:
!
frr version 8.2.2
frr defaults traditional
hostname frr
hostname msk-trseidaliev-gw-01
service integrated-vtysh-config
!
interface eth0
 ip address 172.16.20.1/25
exit
!
interface eth1
 ip address 172.16.20.129/25
exit
!
interface eth2
 ip address 64.100.1.1/24
exit
```

# Ping и трассировка

- PC1 → PC2
- PC1 → Server

```
PC1-trseidaliev - PuTTY

VPCS> ping 172.16.20.138

84 bytes from 172.16.20.138 icmp_seq=1 ttl=63 time=3.258 ms
84 bytes from 172.16.20.138 icmp_seq=2 ttl=63 time=4.224 ms
84 bytes from 172.16.20.138 icmp_seq=3 ttl=63 time=1.336 ms
84 bytes from 172.16.20.138 icmp_seq=4 ttl=63 time=4.678 ms
84 bytes from 172.16.20.138 icmp_seq=5 ttl=63 time=4.397 ms

VPCS> ping 64.100.1.10

84 bytes from 64.100.1.10 icmp_seq=1 ttl=63 time=5.028 ms
84 bytes from 64.100.1.10 icmp_seq=2 ttl=63 time=4.257 ms
84 bytes from 64.100.1.10 icmp_seq=3 ttl=63 time=3.892 ms
84 bytes from 64.100.1.10 icmp_seq=4 ttl=63 time=3.494 ms
84 bytes from 64.100.1.10 icmp_seq=5 ttl=63 time=2.916 ms

VPCS> trace 172.16.20.138
trace to 172.16.20.138, 8 hops max, press Ctrl+C to stop
 1  172.16.20.1    5.462 ms  0.897 ms  0.817 ms
 2  *172.16.20.138  1.146 ms (ICMP type:3, code:3, Destination port unreachable)

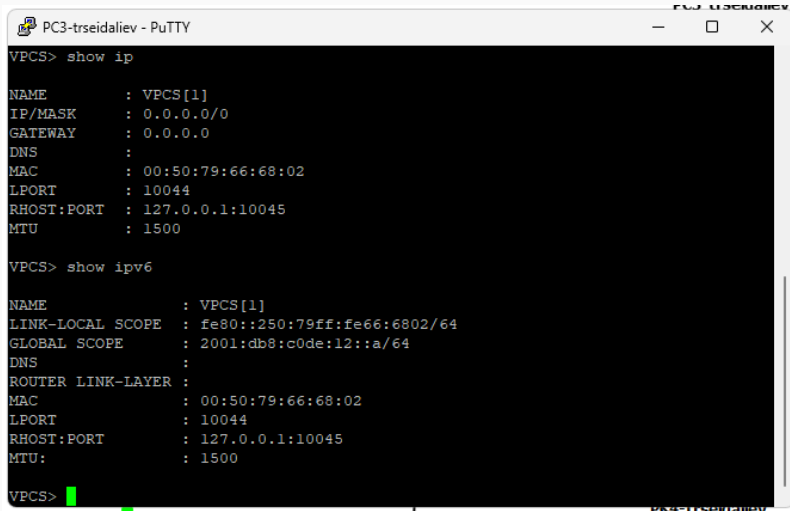
VPCS> trace 64.100.1.10
trace to 64.100.1.10, 8 hops max, press Ctrl+C to stop
 1  172.16.20.1    1.944 ms  2.141 ms  1.598 ms
 2  172.16.20.2    1.753 ms  1.753 ms  1.753 ms
 3  172.16.20.3    1.753 ms  1.753 ms  1.753 ms
 4  172.16.20.4    1.753 ms  1.753 ms  1.753 ms
 5  172.16.20.5    1.753 ms  1.753 ms  1.753 ms
 6  172.16.20.6    1.753 ms  1.753 ms  1.753 ms
 7  172.16.20.7    1.753 ms  1.753 ms  1.753 ms
 8  172.16.20.8    1.753 ms  1.753 ms  1.753 ms
 9  172.16.20.9    1.753 ms  1.753 ms  1.753 ms
10  172.16.20.10   1.753 ms  1.753 ms  1.753 ms
11  172.16.20.11   1.753 ms  1.753 ms  1.753 ms
12  172.16.20.12   1.753 ms  1.753 ms  1.753 ms
13  172.16.20.13   1.753 ms  1.753 ms  1.753 ms
14  172.16.20.14   1.753 ms  1.753 ms  1.753 ms
15  172.16.20.15   1.753 ms  1.753 ms  1.753 ms
16  172.16.20.16   1.753 ms  1.753 ms  1.753 ms
17  172.16.20.17   1.753 ms  1.753 ms  1.753 ms
18  172.16.20.18   1.753 ms  1.753 ms  1.753 ms
19  172.16.20.19   1.753 ms  1.753 ms  1.753 ms
20  172.16.20.20   1.753 ms  1.753 ms  1.753 ms
21  172.16.20.21   1.753 ms  1.753 ms  1.753 ms
22  172.16.20.22   1.753 ms  1.753 ms  1.753 ms
23  172.16.20.23   1.753 ms  1.753 ms  1.753 ms
24  172.16.20.24   1.753 ms  1.753 ms  1.753 ms
25  172.16.20.25   1.753 ms  1.753 ms  1.753 ms
26  172.16.20.26   1.753 ms  1.753 ms  1.753 ms
27  172.16.20.27   1.753 ms  1.753 ms  1.753 ms
28  172.16.20.28   1.753 ms  1.753 ms  1.753 ms
29  172.16.20.29   1.753 ms  1.753 ms  1.753 ms
30  172.16.20.30   1.753 ms  1.753 ms  1.753 ms
31  172.16.20.31   1.753 ms  1.753 ms  1.753 ms
32  172.16.20.32   1.753 ms  1.753 ms  1.753 ms
33  172.16.20.33   1.753 ms  1.753 ms  1.753 ms
34  172.16.20.34   1.753 ms  1.753 ms  1.753 ms
35  172.16.20.35   1.753 ms  1.753 ms  1.753 ms
36  172.16.20.36   1.753 ms  1.753 ms  1.753 ms
37  172.16.20.37   1.753 ms  1.753 ms  1.753 ms
38  172.16.20.38   1.753 ms  1.753 ms  1.753 ms
39  172.16.20.39   1.753 ms  1.753 ms  1.753 ms
40  172.16.20.40   1.753 ms  1.753 ms  1.753 ms
41  172.16.20.41   1.753 ms  1.753 ms  1.753 ms
42  172.16.20.42   1.753 ms  1.753 ms  1.753 ms
43  172.16.20.43   1.753 ms  1.753 ms  1.753 ms
44  172.16.20.44   1.753 ms  1.753 ms  1.753 ms
45  172.16.20.45   1.753 ms  1.753 ms  1.753 ms
46  172.16.20.46   1.753 ms  1.753 ms  1.753 ms
47  172.16.20.47   1.753 ms  1.753 ms  1.753 ms
48  172.16.20.48   1.753 ms  1.753 ms  1.753 ms
49  172.16.20.49   1.753 ms  1.753 ms  1.753 ms
50  172.16.20.50   1.753 ms  1.753 ms  1.753 ms
51  172.16.20.51   1.753 ms  1.753 ms  1.753 ms
52  172.16.20.52   1.753 ms  1.753 ms  1.753 ms
53  172.16.20.53   1.753 ms  1.753 ms  1.753 ms
54  172.16.20.54   1.753 ms  1.753 ms  1.753 ms
55  172.16.20.55   1.753 ms  1.753 ms  1.753 ms
56  172.16.20.56   1.753 ms  1.753 ms  1.753 ms
57  172.16.20.57   1.753 ms  1.753 ms  1.753 ms
58  172.16.20.58   1.753 ms  1.753 ms  1.753 ms
59  172.16.20.59   1.753 ms  1.753 ms  1.753 ms
60  172.16.20.60   1.753 ms  1.753 ms  1.753 ms
61  172.16.20.61   1.753 ms  1.753 ms  1.753 ms
62  172.16.20.62   1.753 ms  1.753 ms  1.753 ms
63  172.16.20.63   1.753 ms  1.753 ms  1.753 ms
64  172.16.20.64   1.753 ms  1.753 ms  1.753 ms
65  172.16.20.65   1.753 ms  1.753 ms  1.753 ms
66  172.16.20.66   1.753 ms  1.753 ms  1.753 ms
67  172.16.20.67   1.753 ms  1.753 ms  1.753 ms
68  172.16.20.68   1.753 ms  1.753 ms  1.753 ms
69  172.16.20.69   1.753 ms  1.753 ms  1.753 ms
70  172.16.20.70   1.753 ms  1.753 ms  1.753 ms
71  172.16.20.71   1.753 ms  1.753 ms  1.753 ms
72  172.16.20.72   1.753 ms  1.753 ms  1.753 ms
73  172.16.20.73   1.753 ms  1.753 ms  1.753 ms
74  172.16.20.74   1.753 ms  1.753 ms  1.753 ms
75  172.16.20.75   1.753 ms  1.753 ms  1.753 ms
76  172.16.20.76   1.753 ms  1.753 ms  1.753 ms
77  172.16.20.77   1.753 ms  1.753 ms  1.753 ms
78  172.16.20.78   1.753 ms  1.753 ms  1.753 ms
79  172.16.20.79   1.753 ms  1.753 ms  1.753 ms
80  172.16.20.80   1.753 ms  1.753 ms  1.753 ms
81  172.16.20.81   1.753 ms  1.753 ms  1.753 ms
82  172.16.20.82   1.753 ms  1.753 ms  1.753 ms
83  172.16.20.83   1.753 ms  1.753 ms  1.753 ms
84  172.16.20.84   1.753 ms  1.753 ms  1.753 ms
85  172.16.20.85   1.753 ms  1.753 ms  1.753 ms
86  172.16.20.86   1.753 ms  1.753 ms  1.753 ms
87  172.16.20.87   1.753 ms  1.753 ms  1.753 ms
88  172.16.20.88   1.753 ms  1.753 ms  1.753 ms
89  172.16.20.89   1.753 ms  1.753 ms  1.753 ms
90  172.16.20.90   1.753 ms  1.753 ms  1.753 ms
91  172.16.20.91   1.753 ms  1.753 ms  1.753 ms
92  172.16.20.92   1.753 ms  1.753 ms  1.753 ms
93  172.16.20.93   1.753 ms  1.753 ms  1.753 ms
94  172.16.20.94   1.753 ms  1.753 ms  1.753 ms
95  172.16.20.95   1.753 ms  1.753 ms  1.753 ms
96  172.16.20.96   1.753 ms  1.753 ms  1.753 ms
97  172.16.20.97   1.753 ms  1.753 ms  1.753 ms
98  172.16.20.98   1.753 ms  1.753 ms  1.753 ms
99  172.16.20.99   1.753 ms  1.753 ms  1.753 ms
100 172.16.20.100  1.753 ms  1.753 ms  1.753 ms
101 172.16.20.101  1.753 ms  1.753 ms  1.753 ms
102 172.16.20.102  1.753 ms  1.753 ms  1.753 ms
103 172.16.20.103  1.753 ms  1.753 ms  1.753 ms
104 172.16.20.104  1.753 ms  1.753 ms  1.753 ms
105 172.16.20.105  1.753 ms  1.753 ms  1.753 ms
106 172.16.20.106  1.753 ms  1.753 ms  1.753 ms
107 172.16.20.107  1.753 ms  1.753 ms  1.753 ms
108 172.16.20.108  1.753 ms  1.753 ms  1.753 ms
109 172.16.20.109  1.753 ms  1.753 ms  1.753 ms
110 172.16.20.110  1.753 ms  1.753 ms  1.753 ms
111 172.16.20.111  1.753 ms  1.753 ms  1.753 ms
112 172.16.20.112  1.753 ms  1.753 ms  1.753 ms
113 172.16.20.113  1.753 ms  1.753 ms  1.753 ms
114 172.16.20.114  1.753 ms  1.753 ms  1.753 ms
115 172.16.20.115  1.753 ms  1.753 ms  1.753 ms
116 172.16.20.116  1.753 ms  1.753 ms  1.753 ms
117 172.16.20.117  1.753 ms  1.753 ms  1.753 ms
118 172.16.20.118  1.753 ms  1.753 ms  1.753 ms
119 172.16.20.119  1.753 ms  1.753 ms  1.753 ms
120 172.16.20.120  1.753 ms  1.753 ms  1.753 ms
121 172.16.20.121  1.753 ms  1.753 ms  1.753 ms
122 172.16.20.122  1.753 ms  1.753 ms  1.753 ms
123 172.16.20.123  1.753 ms  1.753 ms  1.753 ms
124 172.16.20.124  1.753 ms  1.753 ms  1.753 ms
125 172.16.20.125  1.753 ms  1.753 ms  1.753 ms
126 172.16.20.126  1.753 ms  1.753 ms  1.753 ms
127 172.16.20.127  1.753 ms  1.753 ms  1.753 ms
128 172.16.20.128  1.753 ms  1.753 ms  1.753 ms
129 172.16.20.129  1.753 ms  1.753 ms  1.753 ms
130 172.16.20.130  1.753 ms  1.753 ms  1.753 ms
131 172.16.20.131  1.753 ms  1.753 ms  1.753 ms
132 172.16.20.132  1.753 ms  1.753 ms  1.753 ms
133 172.16.20.133  1.753 ms  1.753 ms  1.753 ms
134 172.16.20.134  1.753 ms  1.753 ms  1.753 ms
135 172.16.20.135  1.753 ms  1.753 ms  1.753 ms
136 172.16.20.136  1.753 ms  1.753 ms  1.753 ms
137 172.16.20.137  1.753 ms  1.753 ms  1.753 ms
138 172.16.20.138  1.753 ms  1.753 ms  1.753 ms
```

## ARP-запросы и ICMP-ответы

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	172.16.20.10	64.100.1.10	ICMP	98	Echo (ping) request id=0x5907, seq=1/256, ttl=63 (reply in 4
2	0.000697	Private 66:68:04	Broadcast	ARP	64	Who has 64.100.1.1? Tell 64.100.1.10
3	0.001661	0c:06:fc:75:00:02	Private 66:68:04	ARP	60	64.100.1.1 is at 0c:06:fc:75:00:02
4	0.002144	64.100.1.10	172.16.20.10	ICMP	98	Echo (ping) reply id=0x5907, seq=1/256, ttl=64 (request in
5	1.005321	172.16.20.10	64.100.1.10	ICMP	98	Echo (ping) request id=0x5a07, seq=2/512, ttl=63 (reply in 0
6	1.005756	64.100.1.10	172.16.20.10	ICMP	98	Echo (ping) reply id=0x5a07, seq=2/512, ttl=64 (request in
7	2.009163	172.16.20.10	64.100.1.10	ICMP	98	Echo (ping) request id=0x5b07, seq=3/768, ttl=63 (reply in 0
8	2.009670	64.100.1.10	172.16.20.10	ICMP	98	Echo (ping) reply id=0x5b07, seq=3/768, ttl=64 (request in
9	3.012905	172.16.20.10	64.100.1.10	ICMP	98	Echo (ping) request id=0x5c07, seq=4/1024, ttl=63 (reply in
10	3.013171	64.100.1.10	172.16.20.10	ICMP	98	Echo (ping) reply id=0x5c07, seq=4/1024, ttl=64 (request :
11	4.015071	172.16.20.10	64.100.1.10	ICMP	98	Echo (ping) request id=0x5d07, seq=5/1280, ttl=63 (reply in
12	4.015368	64.100.1.10	172.16.20.10	ICMP	98	Echo (ping) reply id=0x5d07, seq=5/1280, ttl=64 (request :
13	5.048474	0c:06:fc:75:00:02	Private 66:68:04	ARP	60	Who has 64.100.1.10? Tell 64.100.1.1
14	5.049574	Private 66:68:04	0c:06:fc:75:00:02	ARP	60	64.100.1.10 is at 00:50:79:66:68:04

▶ Frame 13: 60 bytes on wire (480 bits), 60 bytes captured (480 bits)		0000	00 50 79 66 68 04 0c 06 fc 75 00 02 08 06 00 01	Pyfh ... u
▶ Ethernet II, Src: 0c:06:fc:75:00:02 (0c:06:fc:75:00:02), Dst: Priv		0010	08 00 06 04 00 01 0c 06 fc 75 00 02 40 64 01 01	..... u
▼ Address Resolution Protocol (request)		0020	00 00 00 00 00 00 40 64 01 0a 00 00 00 00 00 00	..... @d ...
Hardware type: Ethernet (1)		0030	00 00 00 00 00 00 00 00 00 00 00 00	.....
Protocol type: IPv4 (0x0800)				
Hardware size: 6				
Protocol size: 4				
Opcode: request (1)				
Sender MAC address: 0c:06:fc:75:00:02 (0c:06:fc:75:00:02)				
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				

Адрес: 2001:db8:c0de:12::/64



```
PC3-trseidaliev - PuTTY
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     : 10044
RHOST:PORT : 127.0.0.1:10045
MTU       : 1500

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        : 10044
RHOST:PORT    : 127.0.0.1:10045
MTU          : 1500

VPCS>
```

Адрес: 2001:db8:c0de:13::/64



```
PC4-trseidaliev - PuTTY
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      : 10046
RHOST:PORT  : 127.0.0.1:10047
MTU        : 1500

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        : 10046
RHOST:PORT    : 127.0.0.1:10047
MTU:         : 1500

VPCS>
```

IPv6: 2001:db8:c0de:11::/64

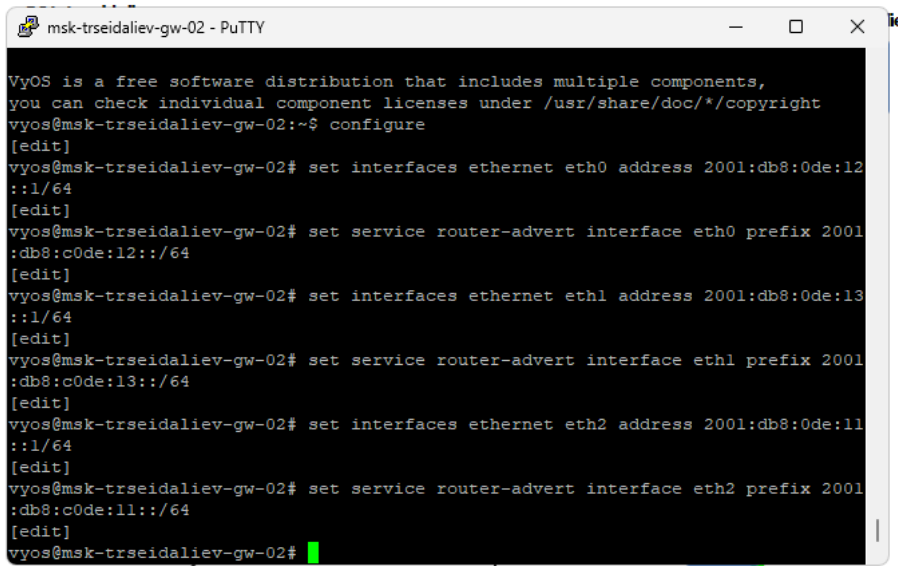
Двойной стек: IPv4 + IPv6



```
server-trseidaliev - PuTTY
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      : 10026
RHOST:PORT : 127.0.0.1:10027
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          : 10026
RHOST:PORT     : 127.0.0.1:10027
MTU            : 1500
VPCS>
```

## Назначение адресов и RA



```
msk-trseidaliev-gw-02 - PuTTY

VyOS is a free software distribution that includes multiple components,
you can check individual component licenses under /usr/share/doc/*/copyright
vyos@msk-trseidaliev-gw-02:~$ configure
[edit]
vyos@msk-trseidaliev-gw-02# set interfaces ethernet eth0 address 2001:db8:0de:12
::1/64
[edit]
vyos@msk-trseidaliev-gw-02# set service router-advert interface eth0 prefix 2001
:db8:c0de:12::/64
[edit]
vyos@msk-trseidaliev-gw-02# set interfaces ethernet eth1 address 2001:db8:0de:13
::1/64
[edit]
vyos@msk-trseidaliev-gw-02# set service router-advert interface eth1 prefix 2001
:db8:c0de:13::/64
[edit]
vyos@msk-trseidaliev-gw-02# set interfaces ethernet eth2 address 2001:db8:0de:11
::1/64
[edit]
vyos@msk-trseidaliev-gw-02# set service router-advert interface eth2 prefix 2001
:db8:c0de:11::/64
[edit]
vyos@msk-trseidaliev-gw-02#
```

```
msk-trseidaliev-gw-02 - PuTTY
[edit]
vyos@msk-trseidaliev-gw-02# commit
[edit]
vyos@msk-trseidaliev-gw-02# save
Saving configuration to '/config/config.boot'...
Done
[edit]
vyos@msk-trseidaliev-gw-02# show interfaces
  ethernet eth0 {
    address 2001:db8:c0de:12::1/64
    hw-id 0c:60:cb:ff:00:00
  }
  ethernet eth1 {
    address 2001:db8:c0de:13::1/64
    hw-id 0c:60:cb:ff:00:01
  }
  ethernet eth2 {
    address 2001:db8:c0de:11::1/64
    hw-id 0c:60:cb:ff:00:02
  }
  loopback lo {
  }
[edit]
vyos@msk-trseidaliev-gw-02#
```



## Ping PC4 → PC3 и Server

```
PC4-trseidaliev - PuTTY
2001:db8:c0de:12::a icmp6_seq=2 ttl=62 time=2.153 ms
2001:db8:c0de:12::a icmp6_seq=3 ttl=62 time=2.182 ms
2001:db8:c0de:12::a icmp6_seq=4 ttl=62 time=2.143 ms
2001:db8:c0de:12::a icmp6_seq=5 ttl=62 time=1.484 ms

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

2001:db8:c0de:11::a icmp6_seq=1 ttl=62 time=3.799 ms
2001:db8:c0de:11::a icmp6_seq=2 ttl=62 time=2.657 ms
2001:db8:c0de:11::a icmp6_seq=3 ttl=62 time=3.253 ms
2001:db8:c0de:11::a icmp6_seq=4 ttl=62 time=2.837 ms
2001:db8:c0de:11::a icmp6_seq=5 ttl=62 time=1.424 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  2.569 ms  1.390 ms  1.719 ms
 2 2001:db8:c0de:12::a  1.837 ms  1.448 ms  1.615 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  1.128 ms  1.328 ms  1.041 ms
 2 2001:db8:c0de:11::a  1.968 ms  2.501 ms  2.157 ms

VPCS>
VPCS> ping 64.100.1.10

host (64.100.1.10) not reachable

VPCS> ping 172.16.20.138

host (172.16.20.138) not reachable

VPCS>
```

No.	Time	Source	Destination	Protocol	Length	Info
• 1	0.000000	2001:db8:c0de:11::a	2001:db8:c0de:12::a	ICMPv6	118	Echo (ping) request id=0x100d, seq=1, hop limit=64 (reply in
2	0.002012	2001:db8:c0de:12::a	2001:db8:c0de:11::a	ICMPv6	118	Echo (ping) reply id=0x100d, seq=1, hop limit=62 (request in
3	1.003800	2001:db8:c0de:11::a	2001:db8:c0de:12::a	ICMPv6	118	Echo (ping) request id=0x100d, seq=2, hop limit=64 (reply in
4	1.005269	2001:db8:c0de:12::a	2001:db8:c0de:11::a	ICMPv6	118	Echo (ping) reply id=0x100d, seq=2, hop limit=62 (request in
5	2.007214	2001:db8:c0de:11::a	2001:db8:c0de:12::a	ICMPv6	118	Echo (ping) request id=0x100d, seq=3, hop limit=64 (reply in
6	2.010196	2001:db8:c0de:12::a	2001:db8:c0de:11::a	ICMPv6	118	Echo (ping) reply id=0x100d, seq=3, hop limit=62 (request in
7	3.011815	2001:db8:c0de:11::a	2001:db8:c0de:12::a	ICMPv6	118	Echo (ping) request id=0x100d, seq=4, hop limit=64 (reply in
8	3.012927	2001:db8:c0de:12::a	2001:db8:c0de:11::a	ICMPv6	118	Echo (ping) reply id=0x100d, seq=4, hop limit=62 (request in
9	4.014646	2001:db8:c0de:11::a	2001:db8:c0de:12::a	ICMPv6	118	Echo (ping) request id=0x100d, seq=5, hop limit=64 (reply in
10	4.017388	2001:db8:c0de:12::a	2001:db8:c0de:11::a	ICMPv6	118	Echo (ping) reply id=0x100d, seq=5, hop limit=62 (request in
11	5.162938	fe80::e60:cbff:feff...	2001:db8:c0de:11::a	ICMPv6	86	Neighbor Solicitation for 2001:db8:c0de:11::a from 0c:60:cb:1
12	6.187175	fe80::e60:cbff:feff...	2001:db8:c0de:11::a	ICMPv6	86	Neighbor Solicitation for 2001:db8:c0de:11::a from 0c:60:cb:1
13	7.210803	fe80::e60:cbff:feff...	2001:db8:c0de:11::a	ICMPv6	86	Neighbor Solicitation for 2001:db8:c0de:11::a from 0c:60:cb:1

```

Frame 2: 118 bytes on wire (944 bits), 118 bytes captured (944 bits) on interface 0
Ethernet II, Src: 0c:60:cb:ff:00:02 (0c:60:cb:ff:00:02), Dst: 2001:db8:c0de:12::a
Internet Protocol Version 6, Src: 2001:db8:c0de:12::a, Dst: 2001:db8:c0de:11::a
Internet Control Message Protocol v6
  Type: Echo (ping) reply (129)
  Code: 0
  Checksum: 0x99fd [correct]
  [Checksum Status: Good]
  Identifier: 0x100d
  Sequence: 1
  [Response To: 1]
  [Response Time: 2,012 ms]
Data (56 bytes)
  Data: 000102030405060708090a0b0c0d0e0f101112131415161718191a1b1c1d1e1f202122232425262728292a2b2c2d2e2f3031323334353637

```

## Самостоятельное задание

---

- IPv4: 10.10.1.96/27
- IPv6: 2001:db8:1:1::/64

- IPv4: 10.10.1.16/28
- IPv6: 2001:db8:1:4::/64

Устройство	Интерфейс	IPv4	Маска	IPv6	Префикс
gw	eth0	10.10.1.97	/27	2001:db8:1:1::1	/64
gw	eth1	10.10.1.17	/28	2001:db8:1:4::1	/64
PC1	vpcs	10.10.1.100	/27	2001:db8:1:1::a	/64
PC2	vpcs	10.10.1.20	/28	2001:db8:1:4::a	/64

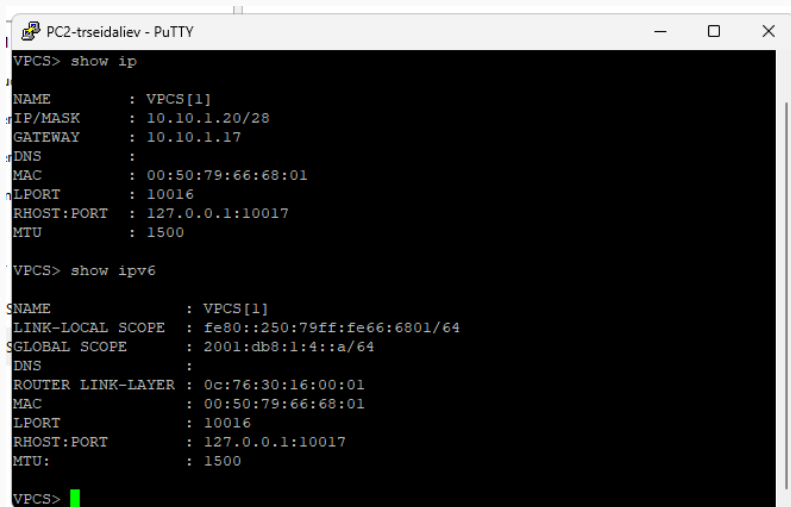
```
PC1-trseidaliev - PuTTY
VPCS> show ip

NAME       : VPCS[1]
IP/MASK    : 10.10.1.100/27
GATEWAY    : 10.10.1.97
DNS        :
MAC        : 00:50:79:66:68:00
LPORT      : 10008
RHOST:PORT : 127.0.0.1:10009
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        : 10008
RHOST:PORT    : 127.0.0.1:10009
MTU:          : 1500

VPCS> 
```



```
PC2-trseidaliev - PuTTY
VPCS> show ip
NAME      : VPCS[1]
IP/MASK    : 10.10.1.20/28
GATEWAY    : 10.10.1.17
DNS        :
MAC        : 00:50:79:66:68:01
LPORT     : 10016
RHOST:PORT : 127.0.0.1:10017
MTU        : 1500

VPCS> show ipv6
SNAME      : VPCS[1]
LINK-LOCAL SCOPE : fe80::250:79ff:fe66:6801/64
GLOBAL SCOPE    : 2001:db8:1:4::a/64
DNS            :
ROUTER LINK-LAYER : 0c:76:30:16:00:01
MAC            : 00:50:79:66:68:01
LPORT         : 10016
RHOST:PORT     : 127.0.0.1:10017
MTU            : 1500

VPCS>
```

Рис. 17: PC2 show ip



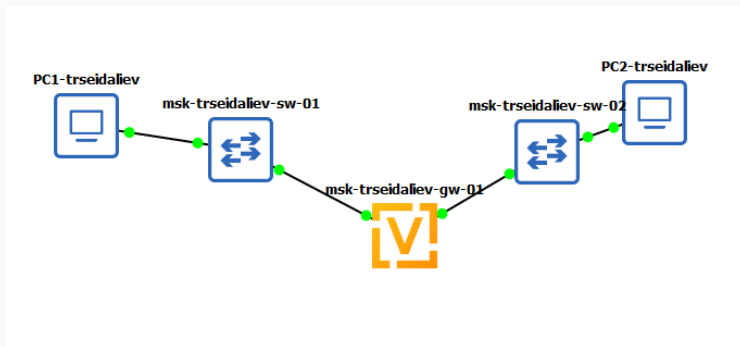


Рис. 18: Топология

## Настройка маршрутизатора

PC1-trseidaliev - PuTTY

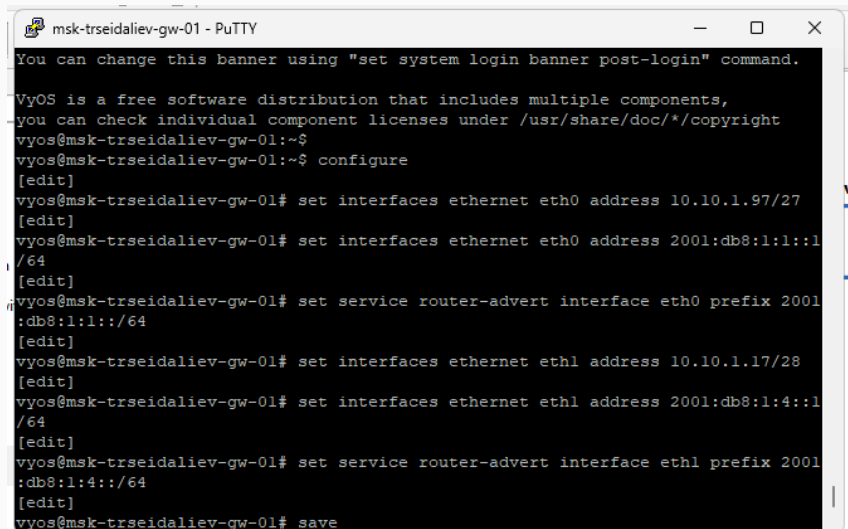
VPCS> show ip

```
NAME           : VPCS[1]
IP/MASK         : 10.10.1.100/27
GATEWAY        : 10.10.1.97
DNS            :
MAC            : 00:50:79:66:68:00
LPORT          : 10008
RHOST:PORT     : 127.0.0.1:10009
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 : 0c:76:30:16:00:00
MAC            : 00:50:79:66:68:00
LPORT          : 10008
RHOST:PORT     : 127.0.0.1:10009
MTU            : 1500
```

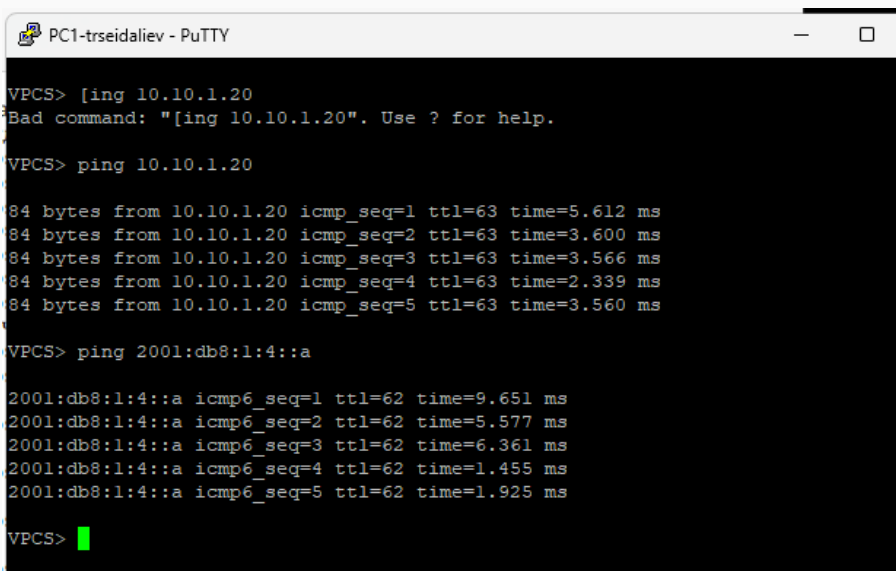
VPCS> █



```
msk-trseidaliev-gw-01 - PuTTY
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-trseidaliev-gw-01:~$
vyos@msk-trseidaliev-gw-01:~$ configure
[edit]
vyos@msk-trseidaliev-gw-01# set interfaces ethernet eth0 address 10.10.1.97/27
[edit]
vyos@msk-trseidaliev-gw-01# set interfaces ethernet eth0 address 2001:db8:1:1::1
/64
[edit]
vyos@msk-trseidaliev-gw-01# set service router-advert interface eth0 prefix 2001
:db8:1:1::/64
[edit]
vyos@msk-trseidaliev-gw-01# set interfaces ethernet eth1 address 10.10.1.17/28
[edit]
vyos@msk-trseidaliev-gw-01# set interfaces ethernet eth1 address 2001:db8:1:4::1
/64
[edit]
vyos@msk-trseidaliev-gw-01# set service router-advert interface eth1 prefix 2001
:db8:1:4::/64
[edit]
vyos@msk-trseidaliev-gw-01# save
```

Рис. 20: Ping PC1



```
PC1-trseidaliev - PuTTY

VPCS> [ing 10.10.1.20
Bad command: "[ing 10.10.1.20". Use ? for help.

VPCS> ping 10.10.1.20

84 bytes from 10.10.1.20 icmp_seq=1 ttl=63 time=5.612 ms
84 bytes from 10.10.1.20 icmp_seq=2 ttl=63 time=3.600 ms
84 bytes from 10.10.1.20 icmp_seq=3 ttl=63 time=3.566 ms
84 bytes from 10.10.1.20 icmp_seq=4 ttl=63 time=2.339 ms
84 bytes from 10.10.1.20 icmp_seq=5 ttl=63 time=3.560 ms

VPCS> ping 2001:db8:1:4::a

2001:db8:1:4::a icmp6_seq=1 ttl=62 time=9.651 ms
2001:db8:1:4::a icmp6_seq=2 ttl=62 time=5.577 ms
2001:db8:1:4::a icmp6_seq=3 ttl=62 time=6.361 ms
2001:db8:1:4::a icmp6_seq=4 ttl=62 time=1.455 ms
2001:db8:1:4::a icmp6_seq=5 ttl=62 time=1.925 ms

VPCS> █
```

## Итоги работы

---

- Выполнено детальное разбиение IPv4/IPv6-сетей
- Настроены двойные стеки на ПК и маршрутизаторах
- Проверена маршрутизация, ARP/ND, ICMPv4/ICMPv6
- Подтверждена корректная работа сетей и взаимодействие подсетей только через маршрутизатор