Сетевые технологии

Адресация IPv4 и IPv6. Двойной стек (Лабораторная работа №6)

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11 ноября 2025

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Цель лабораторной работы

Цель

Изучить распределение адресного пространства и настройку IPv4/IPv6 в GNS3: - Разбиение сетей на подсети (VLSM, IPv6-subnetting) - Настройка **FRRouting (FRR)** и **VyOS** - Анализ трафика: **ARP, ICMP, ICMPv6**

Разбиение сети IPv4

IPv4: сеть 172.16.20.0/24 → подсети

Подсеть	Префикс	Диапазон узлов	Broadcast
№1 (126 узлов)	/25	172.16.20.1 – 172.16.20.126	172.16.20.127
№2 (62 узла)	/26	172.16.20.129 – 172.16.20.190	172.16.20.191
№3 (62 узла)	/26	172.16.20.193 – 172.16.20.254	172.16.20.255

Разбиение IPv4: пример VLSM

Сеть **10.10.1.0/26**

- Требуется подсеть на **14 узлов** → **/28**

Подсеть	Маска	Диапазон узлов
10.10.1.16/28	255.255.255.240	10.10.1.17 – 10.10.1.30

Разбиение сети IPv6

IPv6: сеть 2001:db8:c0de::/48

Две подсети:

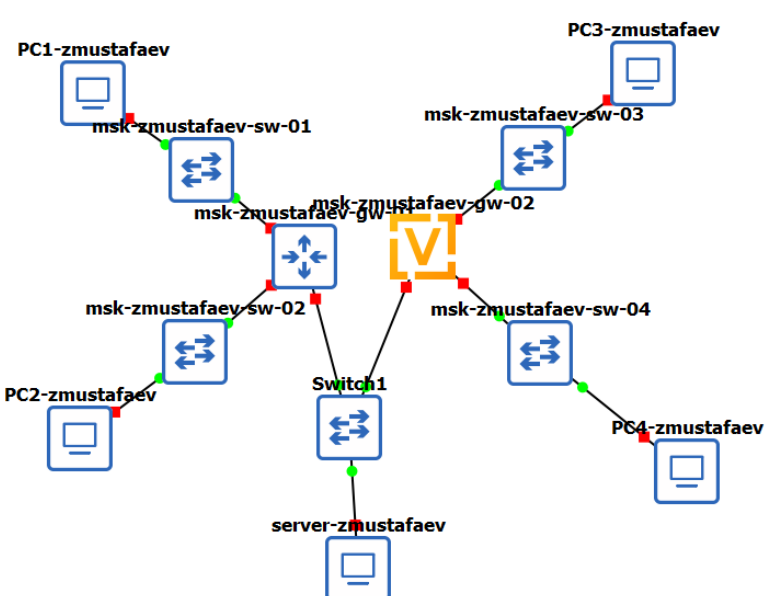
Подсеть	Префикс
A	2001:db8:c0de:0::/49
B	2001:db8:c0de:8000::/49

IPv6: разбивка по IID

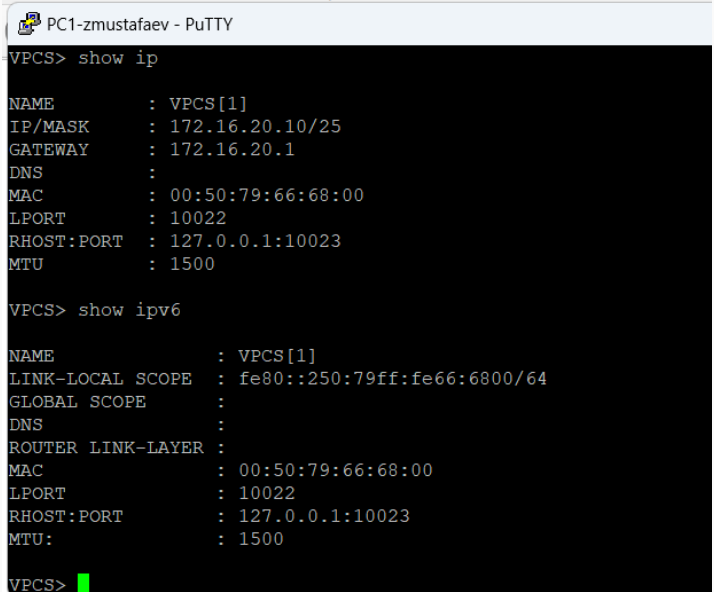
Подсеть	Префикс
2001:db8:c0de:0::/65	
2001:db8:c0de:0:8000::/65	

Построение сети в GNS3

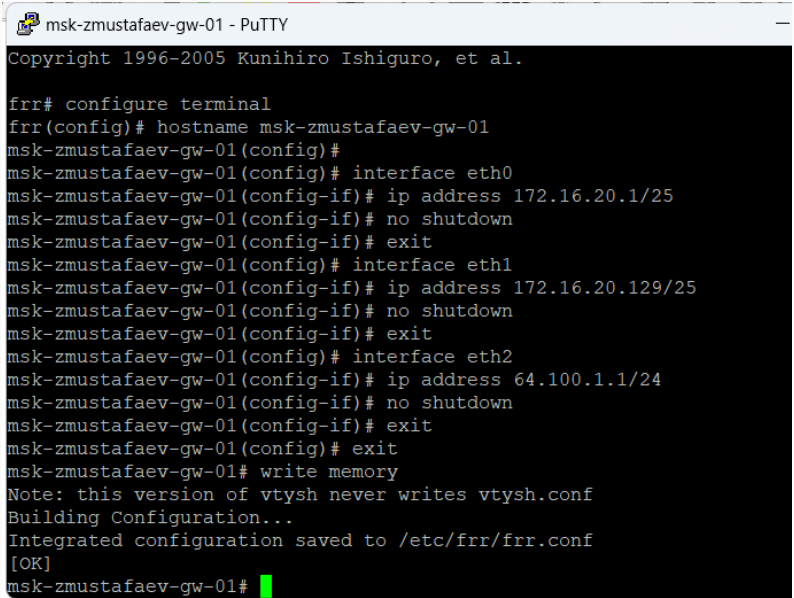
Используемое оборудование



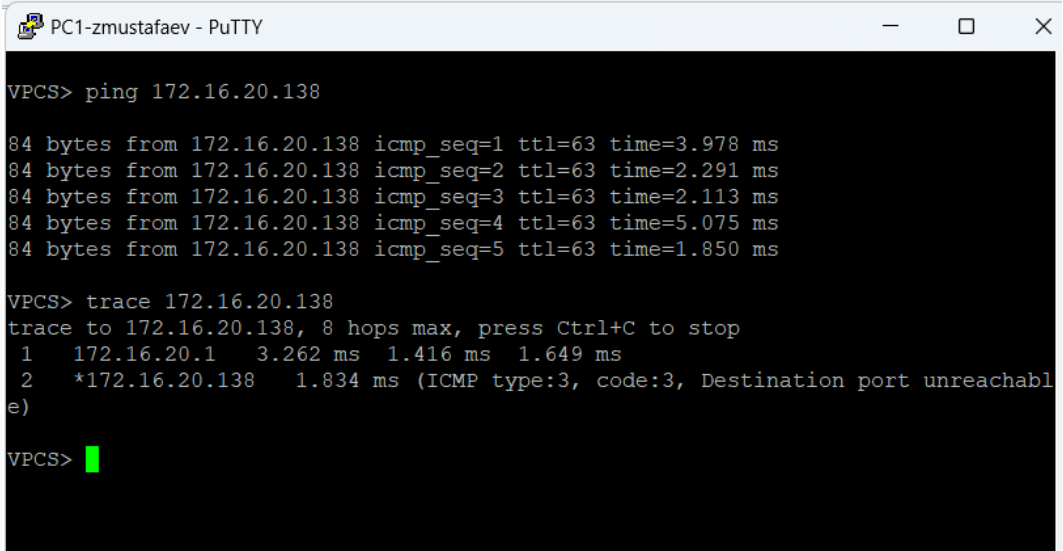
Пример — PC1


PC1-zmustafaev - 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
MTU: : 1500
VPCS>

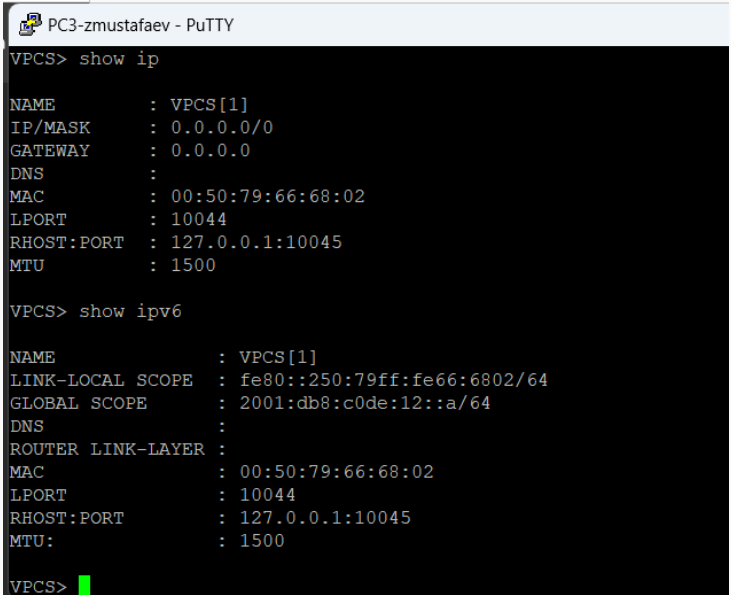
Интерфейсы


msk-zmustafaev-gw-01 - PuTTY
Copyright 1996-2005 Kunihiro Ishiguro, et al.
frr# configure terminal
frr(config)# hostname msk-zmustafaev-gw-01
msk-zmustafaev-gw-01(config)#
msk-zmustafaev-gw-01(config)# interface eth0
msk-zmustafaev-gw-01(config-if)# ip address 172.16.20.1/25
msk-zmustafaev-gw-01(config-if)# no shutdown
msk-zmustafaev-gw-01(config-if)# exit
msk-zmustafaev-gw-01(config)# interface eth1
msk-zmustafaev-gw-01(config-if)# ip address 172.16.20.129/25
msk-zmustafaev-gw-01(config-if)# no shutdown
msk-zmustafaev-gw-01(config-if)# exit
msk-zmustafaev-gw-01(config)# interface eth2
msk-zmustafaev-gw-01(config-if)# ip address 64.100.1.1/24
msk-zmustafaev-gw-01(config-if)# no shutdown
msk-zmustafaev-gw-01(config-if)# exit
msk-zmustafaev-gw-01(config)# exit
msk-zmustafaev-gw-01# write memory
Note: this version of vtysh never writes vtysh.conf
Building Configuration...
Integrated configuration saved to /etc/frr/frr.conf
[OK]
msk-zmustafaev-gw-01#

Проверка соединений IPv4



Пример — PC3


PC3-zmustafaev - 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>

Настройка VyOS

msk-zmustafaev-gw-02 - PuTTY

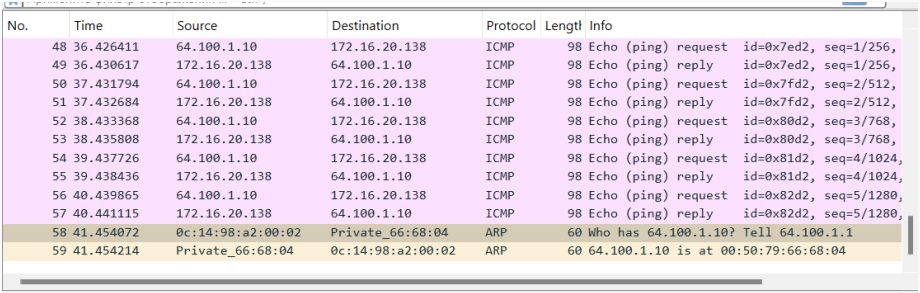
```
VyOS is a free software distribution that includes multiple components,
you can check individual component licenses under /usr/share/doc/*/copyright
vyos@msk-zmustafaev-gw-02:~$
vyos@msk-zmustafaev-gw-02:~$ configure
[edit]
vyos@msk-zmustafaev-gw-02# set interfaces ethernet eth0 address 2001:db8:c0de:12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

Проверка соединений IPv6

PC3-zmustafaev - PuTTY

```
VPCS> ping 2001:db8:c0de:13::a

2001:db8:c0de:13::a icmp6_seq=1 ttl=62 time=5.989 ms
2001:db8:c0de:13::a icmp6_seq=2 ttl=62 time=2.050 ms
2001:db8:c0de:13::a icmp6_seq=3 ttl=62 time=3.124 ms
2001:db8:c0de:13::a icmp6_seq=4 ttl=62 time=2.630 ms
2001:db8:c0de:13::a icmp6_seq=5 ttl=62 time=2.119 ms

VPCS> trace 2001:db8:c0de:13::a

trace to 2001:db8:c0de:13::a, 64 hops max
 1 2001:db8:c0de:12::1   2.046 ms  1.198 ms  2.945 ms
 2 2001:db8:c0de:13::a   2.551 ms  3.530 ms  4.364 ms

VPCS> ping 172.16.20.10

host (172.16.20.10) not reachable

VPCS>
```

Анализ трафика

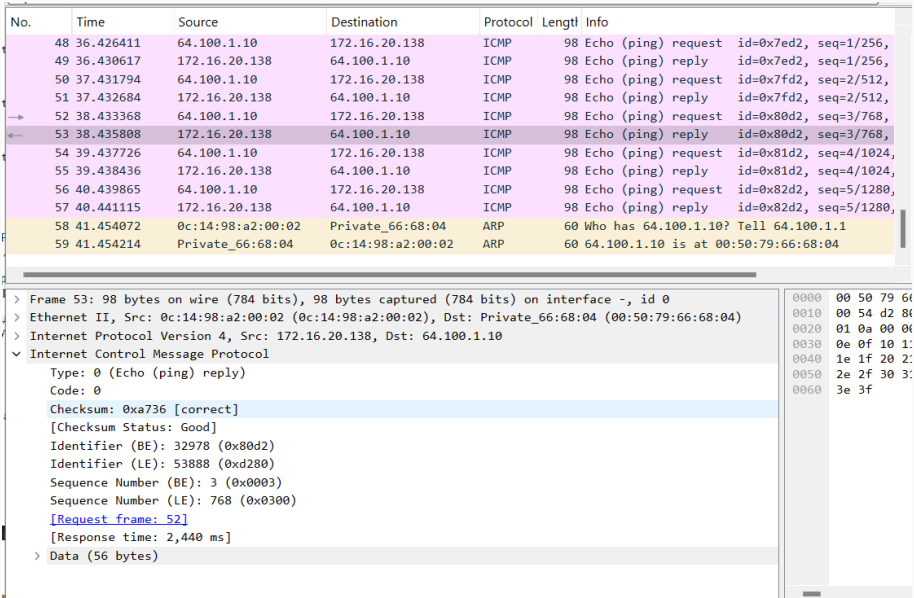


No.	Time	Source	Destination	Protocol	Length	Info
48	36.426411	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x7ed2, seq=1/256,
49	36.430617	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x7ed2, seq=1/256,
50	37.431794	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x7fd2, seq=2/512,
51	37.432684	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x7fd2, seq=2/512,
52	38.433368	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x80d2, seq=3/768,
53	38.435808	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x80d2, seq=3/768,
54	39.437726	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x81d2, seq=4/1024,
55	39.438436	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x81d2, seq=4/1024,
56	40.439865	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x82d2, seq=5/1280,
57	40.441115	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x82d2, seq=5/1280,
58	41.454072	0c:14:98:a2:00:02	Private_66:68:04	ARP	60	Who has 64.100.1.10? Tell 64.100.1.1
59	41.454214	Private_66:68:04	0c:14:98:a2:00:02	ARP	60	64.100.1.10 is at 00:50:79:66:68:04

```
> Frame 58: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface -, id 0
> Ethernet II, Src: 0c:14:98:a2:00:02 (0c:14:98:a2:00:02), Dst: Private_66:68:04 (00:50:79:66:68:04)
v 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:14:98:a2:00:02 (0c:14:98:a2:00:02)
    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
```

```
0000  00 50 79 6
0010  08 00 06 0
0020  00 00 00 0
0030  00 00 00 0
```

Анализ трафика

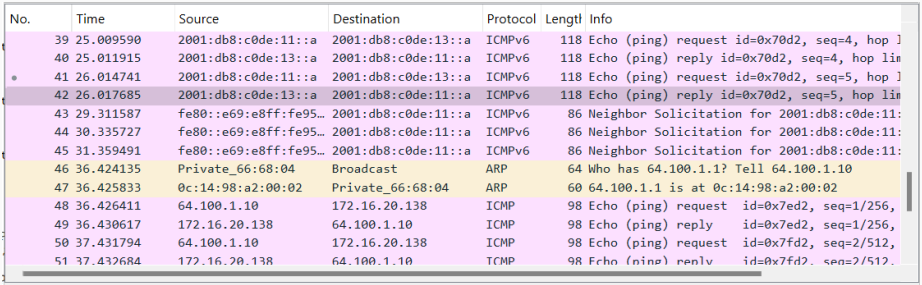


No.	Time	Source	Destination	Protocol	Length	Info
48	36.426411	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x7ed2, seq=1/256,
49	36.430617	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x7ed2, seq=1/256,
50	37.431794	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x7fd2, seq=2/512,
51	37.432684	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x7fd2, seq=2/512,
52	38.433368	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x80d2, seq=3/768,
53	38.435808	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x80d2, seq=3/768,
54	39.437726	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x81d2, seq=4/1024,
55	39.438436	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x81d2, seq=4/1024,
56	40.439865	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x82d2, seq=5/1280,
57	40.441115	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x82d2, seq=5/1280,
58	41.454072	0c:14:98:a2:00:02	Private_66:68:04	ARP	60	Who has 64.100.1.10? Tell 64.100.1.1
59	41.454214	Private_66:68:04	0c:14:98:a2:00:02	ARP	60	64.100.1.10 is at 00:50:79:66:68:04

```
> Frame 53: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface -, id 0
> Ethernet II, Src: 0c:14:98:a2:00:02 (0c:14:98:a2:00:02), Dst: Private_66:68:04 (00:50:79:66:68:04)
> Internet Protocol Version 4, Src: 172.16.20.138, Dst: 64.100.1.10
v Internet Control Message Protocol
    Type: 0 (Echo (ping) reply)
    Code: 0
    Checksum: 0xa736 [correct]
    [Checksum Status: Good]
    Identifier (BE): 32978 (0x80d2)
    Identifier (LE): 53888 (0xd280)
    Sequence Number (BE): 3 (0x0003)
    Sequence Number (LE): 768 (0x0300)
    [Request frame: 52]
    [Response time: 2,440 ms]
  > Data (56 bytes)
```

```
0000  00 50 79 66
0010  00 54 d2 80
0020  01 0a 00 00
0030  0e 0f 10 11
0040  1e 1f 20 21
0050  2e 2f 30 31
0060  3e 3f
```

Анализ трафика



No.	Time	Source	Destination	Protocol	Lengtl	Info
39	25.009590	2001:db8:c0de:11::a	2001:db8:c0de:13::a	ICMPv6	118	Echo (ping) request id=0x70d2, seq=4, hop l
40	25.011915	2001:db8:c0de:13::a	2001:db8:c0de:11::a	ICMPv6	118	Echo (ping) reply id=0x70d2, seq=4, hop lim
41	26.014741	2001:db8:c0de:11::a	2001:db8:c0de:13::a	ICMPv6	118	Echo (ping) request id=0x70d2, seq=5, hop l
42	26.017685	2001:db8:c0de:13::a	2001:db8:c0de:11::a	ICMPv6	118	Echo (ping) reply id=0x70d2, seq=5, hop lim
43	29.311587	fe80::e69:e8ff:fe95…	2001:db8:c0de:11::a	ICMPv6	86	Neighbor Solicitation for 2001:db8:c0de:11:
44	30.335727	fe80::e69:e8ff:fe95…	2001:db8:c0de:11::a	ICMPv6	86	Neighbor Solicitation for 2001:db8:c0de:11:
45	31.359491	fe80::e69:e8ff:fe95…	2001:db8:c0de:11::a	ICMPv6	86	Neighbor Solicitation for 2001:db8:c0de:11:
46	36.424135	Private_66:68:04	Broadcast	ARP	64	Who has 64.100.1.1? Tell 64.100.1.10
47	36.425833	0c:14:98:a2:00:02	Private_66:68:04	ARP	60	64.100.1.1 is at 0c:14:98:a2:00:02
48	36.426411	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x7ed2, seq=1/256,
49	36.430617	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x7ed2, seq=1/256,
50	37.431794	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x7fd2, seq=2/512,
51	37.432684	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x7fd2, seq=2/512,

```
> Frame 42: 118 bytes on wire (944 bits), 118 bytes captured (944 bits) on interface -, id 0
> Ethernet II, Src: 0c:69:e8:95:00:02 (0c:69:e8:95:00:02), Dst: Private_66:68:04 (00:50:79:66:68:04)
> Internet Protocol Version 6, Src: 2001:db8:c0de:13::a, Dst: 2001:db8:c0de:11::a
v Internet Control Message Protocol v6
    Type: Echo (ping) reply (129)
    Code: 0
    Checksum: 0x3933 [correct]
    [Checksum Status: Good]
    Identifier: 0x70d2
    Sequence: 5
    [Response To: 41]
    [Response Time: 2,944 ms]
  > Data (56 bytes)
```

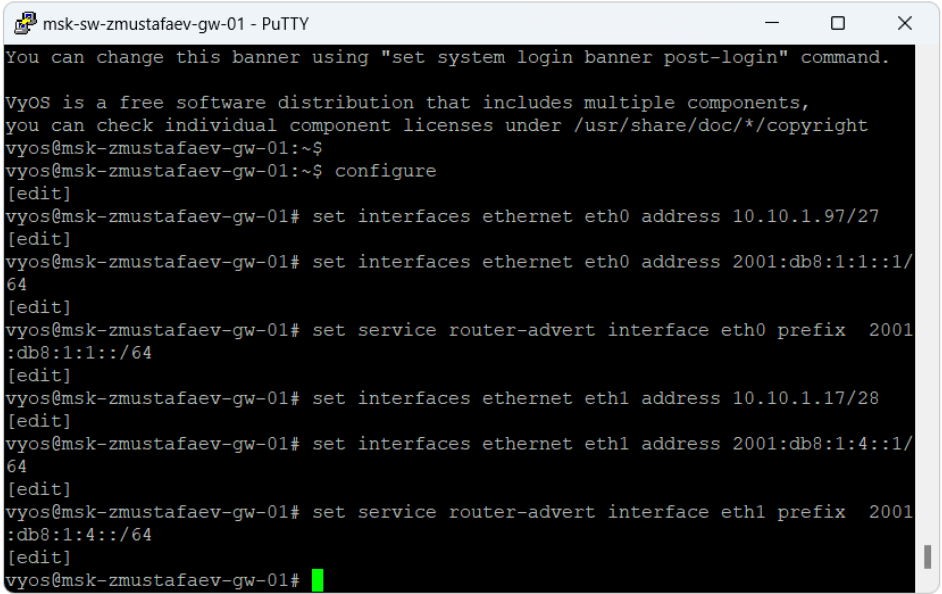
```
0000  00 50 79 66
0010  00 00 00 40
0020  00 00 00 00
0030  00 00 00 00
0040  02 03 04 05
0050  12 13 14 15
0060  22 23 24 25
0070  32 33 34 35
```

Самостоятельное задание

Итоговое адресное пространство

Устройство	IPv4	IPv6
PC1	10.10.1.100/27	2001:db8:1:1::a/64
PC2	10.10.1.20/28	2001:db8:1:4::a/64
Router eth0	10.10.1.97/27	2001:db8:1:1::1
Router eth1	10.10.1.17/28	2001:db8:1:4::1

Конфигурация маршрутизатора VyOS



Проверка связности

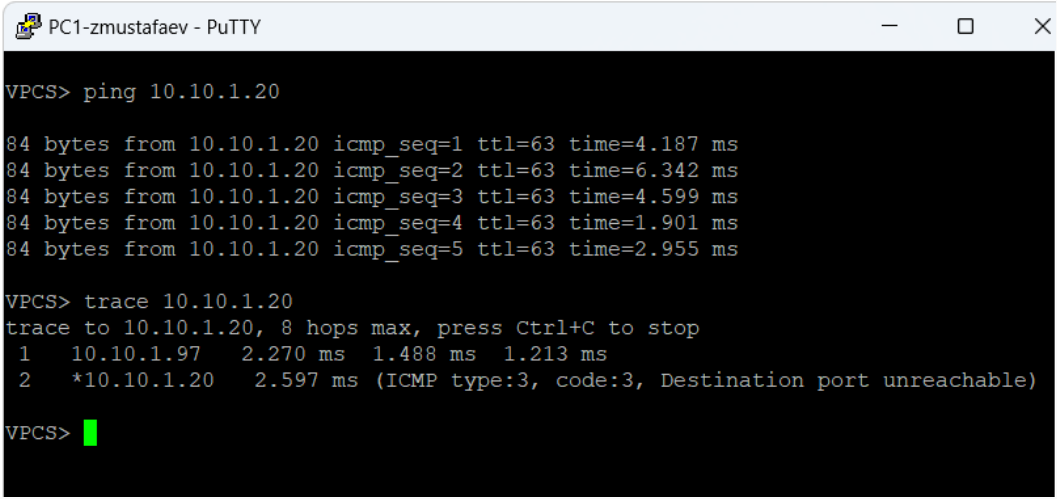
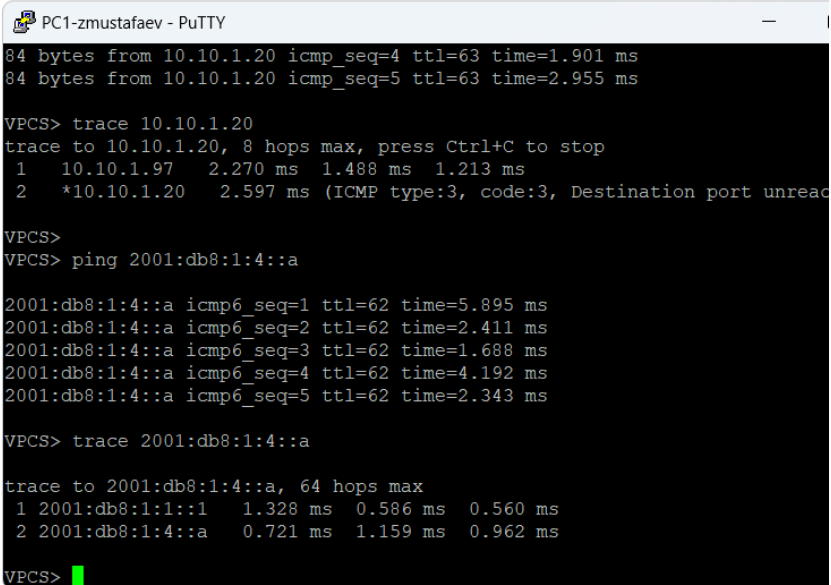


Рис. 12: IPv4 ping/trace

Проверка связности



Выводы

Выводы

- Выполнено разбиение IPv4 и IPv6 (VLSM и Subnetting)
- Смоделированы сети в GNS3 с использованием **FRR и VyOS**
- Проверена связность по **IPv4 и IPv6**
- Проанализированы кадры ARP, ICMP, ICMPv6 в Wireshark