Сетевые технологии

Двойной стек IPv4/IPv6. Анализ трафика в GNS3

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Цель работы

Основная цель

Построение сети с маршрутизаторами **FRR** и **VyOS** в GNS3, настройка двойного стека IPv4 и IPv6, анализ трафика в Wireshark.

Разбиение адресного пространства

- Разбивка `172.16.20.0/24` на подсети с VLSM:
  - `/25` → 126 хостов
  - `/26` → 62 хоста
  - `/26` → 62 хоста
- Пример:

  `172.16.20.0/25` — диапазон `172.16.20.1–126`

- Исходная сеть: `2001:db8:c0de::/48`
- Разбиение:
  - по Subnet ID → две сети `/49`
  - по Interface ID → два диапазона `/65`

Построение сети в GNS3

Топология

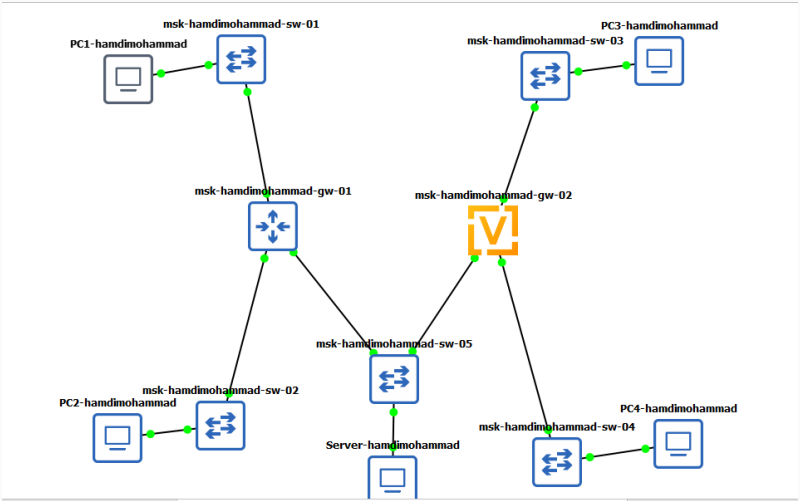


Рис. 1: Топология сети

IPv4 (VPCS)

Узел	Адрес
PC1	`172.16.20.10/25`
PC2	`172.16.20.138/25`
Server	`64.100.1.10/24`

IPv4 (маршрутизатор FRR)

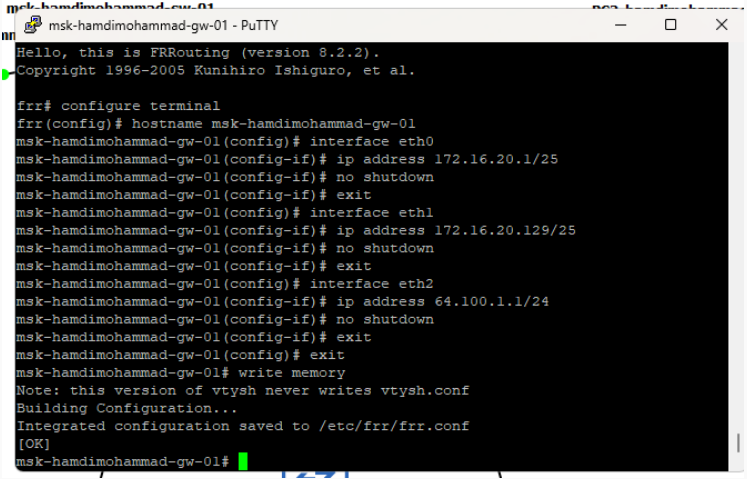


Рис. 2: FRR config

Проверка связности (IPv4)

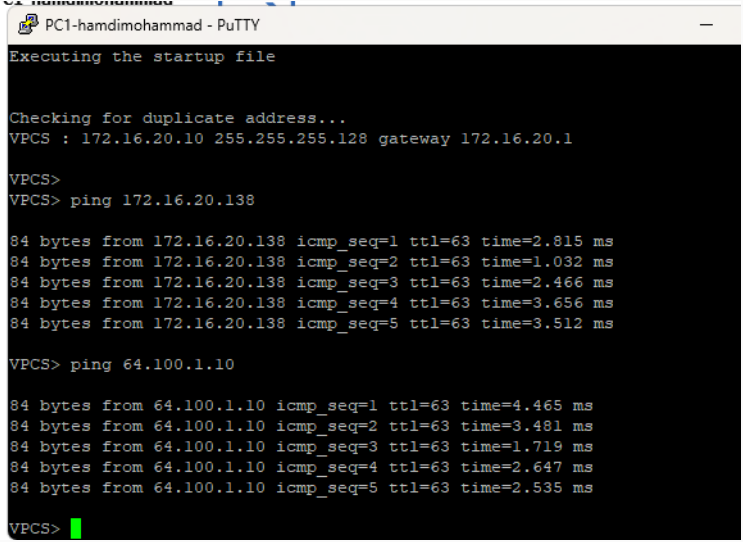


Рис. 3: Ping IPv4

Адресация узлов PC3, PC4, Server

Узел	IPv6 адрес
PC3	`2001:db8:c0de:12::a/64`
PC4	`2001:db8:c0de:13::a/64`
Server	`2001:db8:c0de:11::a/64`

IPv6 (маршрутизатор VyOS)

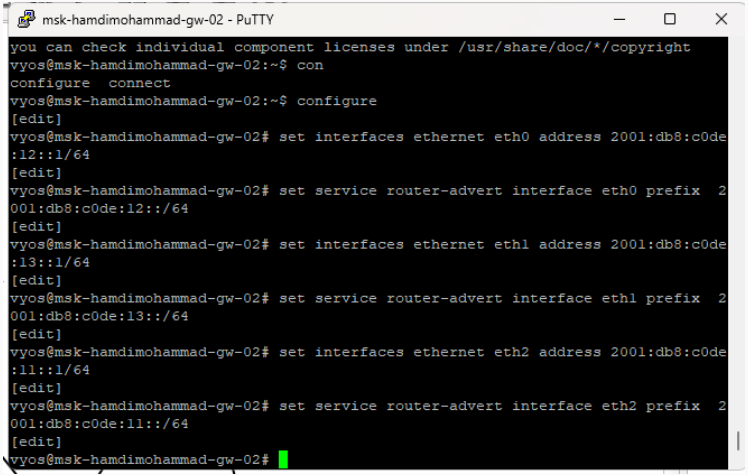


Рис. 4: VyOS

Проверка связности (IPv6)

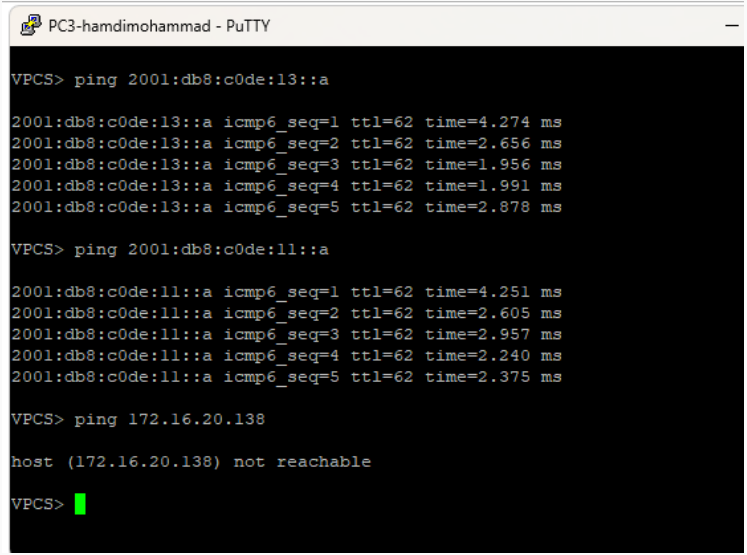
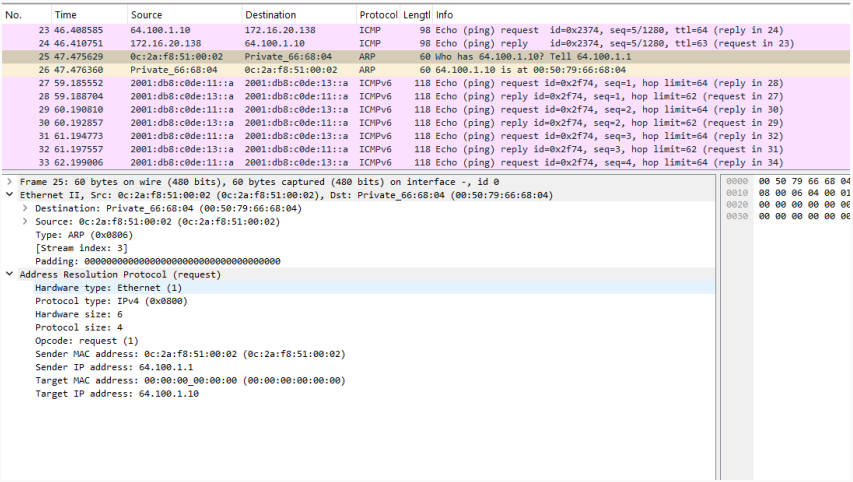


Рис. 5: Ping IPv6

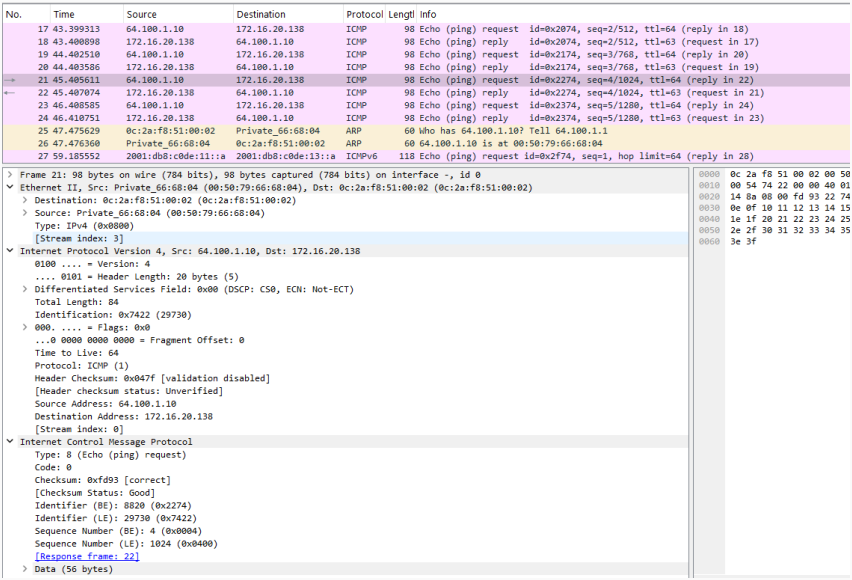
Анализ трафика Wireshark



No.	Time	Source	Destination	Protocol	Length	Info
23	46.408585	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x2374, seq=5/1280, ttl=64 (reply in 24)
24	46.410751	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x2374, seq=5/1280, ttl=63 (request in 23)
25	47.475629	0c:2a:f8:51:00:02	Private_66:68:04	ARP	60	Who has 64.100.1.10? Tell 64.100.1.1
26	47.476360	Private_66:68:04	0c:2a:f8:51:00:02	ARP	60	64.100.1.10 is at 00:50:79:66:68:04
27	59.185552	2001:db8:c0de:11::a	2001:db8:c0de:13::a	ICMPv6	118	Echo (ping) request id=0x2f74, seq=1, hop limit=64 (reply in 28)
28	59.188704	2001:db8:c0de:13::a	2001:db8:c0de:11::a	ICMPv6	118	Echo (ping) reply id=0x2f74, seq=1, hop limit=62 (request in 27)
29	60.190810	2001:db8:c0de:11::a	2001:db8:c0de:13::a	ICMPv6	118	Echo (ping) request id=0x2f74, seq=2, hop limit=64 (reply in 30)
30	60.192857	2001:db8:c0de:13::a	2001:db8:c0de:11::a	ICMPv6	118	Echo (ping) reply id=0x2f74, seq=2, hop limit=62 (request in 29)
31	61.194773	2001:db8:c0de:11::a	2001:db8:c0de:13::a	ICMPv6	118	Echo (ping) request id=0x2f74, seq=3, hop limit=64 (reply in 32)
32	61.197557	2001:db8:c0de:13::a	2001:db8:c0de:11::a	ICMPv6	118	Echo (ping) reply id=0x2f74, seq=3, hop limit=62 (request in 31)
33	62.199006	2001:db8:c0de:11::a	2001:db8:c0de:13::a	ICMPv6	118	Echo (ping) request id=0x2f74, seq=4, hop limit=64 (reply in 34)

Рис. 6: Wireshark ARP

ICMP



No.	Time	Source	Destination	Protocol	Length	Info
17	43.399313	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x2074, seq=2/512, ttl=64 (reply in 18)
18	43.400898	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x2074, seq=2/512, ttl=63 (request in 17)
19	44.402510	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x2174, seq=3/768, ttl=64 (reply in 20)
20	44.403586	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x2174, seq=3/768, ttl=63 (request in 19)
21	45.405611	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x2274, seq=4/1024, ttl=64 (reply in 22)
22	45.407074	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x2274, seq=4/1024, ttl=63 (request in 21)
23	46.408585	64.100.1.10	172.16.20.138	ICMP	98	Echo (ping) request id=0x2374, seq=5/1280, ttl=64 (reply in 24)
24	46.410751	172.16.20.138	64.100.1.10	ICMP	98	Echo (ping) reply id=0x2374, seq=5/1280, ttl=63 (request in 23)
25	47.475629	0c:2a:f8:51:00:02	Private_66:68:04	ARP	60	Who has 64.100.1.10? Tell 64.100.1.1
26	47.476360	Private_66:68:04	0c:2a:f8:51:00:02	ARP	60	64.100.1.10 is at 00:50:79:66:68:04
27	59.185552	2001:db8:c0de:11::a	2001:db8:c0de:13::a	ICMPv6	118	Echo (ping) request id=0x2f74, seq=1, hop limit=64 (reply in 28)

```
> Frame 21: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface -, id 0
v Ethernet II, Src: Private_66:68:04 (00:50:79:66:68:04), Dst: 0c:2a:f8:51:00:02 (0c:2a:f8:51:00:02)
    > Destination: 0c:2a:f8:51:00:02 (0c:2a:f8:51:00:02)
    > Source: Private_66:68:04 (00:50:79:66:68:04)
      Type: IPv4 (0x0800)
      [Stream index: 3]
v Internet Protocol Version 4, Src: 64.100.1.10, Dst: 172.16.20.138
      0100 .... = Version: 4
      .... 0101 = Header Length: 20 bytes (5)
    > Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
      Total Length: 84
      Identification: 0x7422 (29730)
    > 000. .... = Flags: 0x0
      ...0 0000 0000 0000 = Fragment Offset: 0
      Time to Live: 64
      Protocol: ICMP (1)
      Header Checksum: 0x047f [validation disabled]
      [Header checksum status: Unverified]
      Source Address: 64.100.1.10
      Destination Address: 172.16.20.138
      [Stream index: 0]
v Internet Control Message Protocol
      Type: 8 (Echo (ping) request)
      Code: 0
      Checksum: 0xfd93 [correct]
      [Checksum Status: Good]
      Identifier (BE): 8820 (0x2274)
      Identifier (LE): 29730 (0x7422)
      Sequence Number (BE): 4 (0x0004)
      Sequence Number (LE): 1024 (0x0400)
      [Response frame: 22]
    > Data (56 bytes)
```

```
0000  0c 2a f8 51 00 02 00 50
0010  00 54 74 22 00 00 40 01
0020  14 8a 08 00 fd 93 22 74
0030  0e 0f 10 11 12 13 14 15
0040  1e 1f 20 21 22 23 24 25
0050  2e 2f 30 31 32 33 34 35
0060  3e 3f
```

ICMPv6

No.	Time	Source	Destination	Protocol	Length	Info
26	47.476360	Private_66:68:04	0c:2a:f8:51:00:02	ARP	60	64.100.1.10 is at 00:50:79:66:68:04
27	59.185552	2001:db8:c0de:11::a	2001:db8:c0de:13::a	ICMPv6	118	Echo (ping) request id=0x2f74, seq=1, hop limit=64 (reply in 28)
28	59.188704	2001:db8:c0de:13::a	2001:db8:c0de:11::a	ICMPv6	118	Echo (ping) reply id=0x2f74, seq=1, hop limit=62 (request in 27)
29	60.190810	2001:db8:c0de:11::a	2001:db8:c0de:13::a	ICMPv6	118	Echo (ping) request id=0x2f74, seq=2, hop limit=64 (reply in 30)
30	60.192857	2001:db8:c0de:13::a	2001:db8:c0de:11::a	ICMPv6	118	Echo (ping) reply id=0x2f74, seq=2, hop limit=62 (request in 29)
31	61.194773	2001:db8:c0de:11::a	2001:db8:c0de:13::a	ICMPv6	118	Echo (ping) request id=0x2f74, seq=3, hop limit=64 (reply in 32)
32	61.197557	2001:db8:c0de:13::a	2001:db8:c0de:11::a	ICMPv6	118	Echo (ping) reply id=0x2f74, seq=3, hop limit=62 (request in 31)
33	62.199006	2001:db8:c0de:11::a	2001:db8:c0de:13::a	ICMPv6	118	Echo (ping) request id=0x2f74, seq=4, hop limit=64 (reply in 34)
34	62.201520	2001:db8:c0de:13::a	2001:db8:c0de:11::a	ICMPv6	118	Echo (ping) reply id=0x2f74, seq=4, hop limit=62 (request in 33)
35	63.203701	2001:db8:c0de:11::a	2001:db8:c0de:13::a	ICMPv6	118	Echo (ping) request id=0x2f74, seq=5, hop limit=64 (reply in 36)
36	63.206051	2001:db8:c0de:13::a	2001:db8:c0de:11::a	ICMPv6	118	Echo (ping) reply id=0x2f74, seq=5, hop limit=62 (request in 35)

```
> Frame 31: 118 bytes on wire (944 bits), 118 bytes captured (944 bits) on interface -, id 0
v Ethernet II, Src: Private_66:68:04 (00:50:79:66:68:04), Dst: 0c:49:01:40:00:02 (0c:49:01:40:00:02)
  > Destination: 0c:49:01:40:00:02 (0c:49:01:40:00:02)
  > Source: Private_66:68:04 (00:50:79:66:68:04)
    Type: IPv6 (0x86dd)
    [Stream index: 1]
v Internet Protocol Version 6, Src: 2001:db8:c0de:11::a, Dst: 2001:db8:c0de:13::a
    0110 .... = Version: 6
  > .... 0000 0000 .... .... .... .... .... = Traffic Class: 0x00 (DSCP: CS0, ECN: Not-ECT)
    .... 0000 0000 0000 0000 0000 = Flow Label: 0x00000
    Payload Length: 64
    Next Header: ICMPv6 (58)
    Hop Limit: 64
  > Source Address: 2001:db8:c0de:11::a
  > Destination Address: 2001:db8:c0de:13::a
    [Stream index: 3]
v Internet Control Message Protocol v6
    Type: Echo (ping) request (128)
    Code: 0
    Checksum: 0x7b93 [correct]
    [Checksum Status: Good]
    Identifier: 0x2f74
    Sequence: 3
    [Response In: 32]
  > Data (56 bytes)
```

```
0000  0c 49 01
0010  00 00 0
0020  00 00 0
0030  00 00 0
0040  02 03 0
0050  12 13 1
0060  22 23 2
0070  32 33 3
```

Самостоятельная часть

Разбиение IPv4 и IPv6 на подсети

Подсеть	IPv4	IPv6
LAN1	`10.10.1.96/27`	`2001:db8:1:1::/64`
LAN2	`10.10.1.16/28`	`2001:db8:1:4::/64`

Разбиение IPv4 и IPv6 на подсети

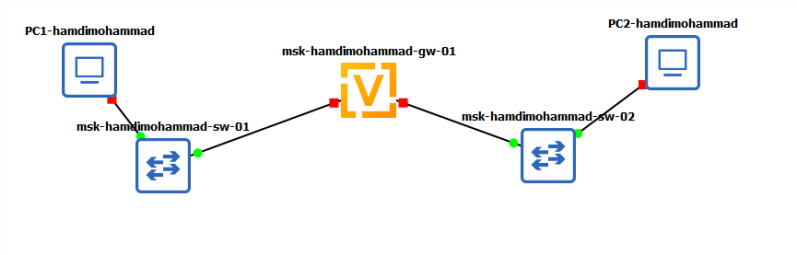


Рис. 9: Топология подсетей

Проверка связности между подсетями

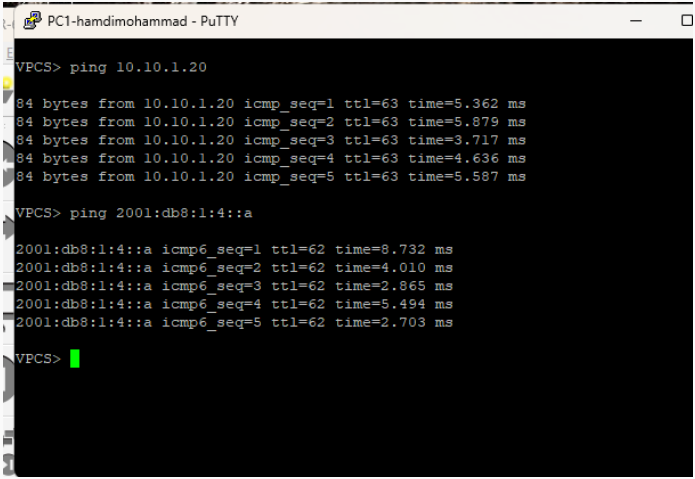


Рис. 10: Ping final

Итог

Результаты

- Сети с IPv4 и IPv6 успешно настроены.
- FRR обеспечивает маршрутизацию IPv4, VyOS — IPv6.
- Wireshark подтвердил корректную работу ARP, ICMP и ICMPv6.