

Сетевые технологии

Лабораторная работа №5

Метвалли Ахмед Фарг Набеех

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Российский университет дружбы народов, Москва, Россия

Цели и задачи работы

Цель лабораторной работы

Построение простейших моделей сети на базе коммутатора и маршрутизаторов **FRR** и **VyOS** в GNS3, а также анализ сетевого трафика с помощью **Wireshark**.

Моделирование сети на базе коммутатора

Построение топологии

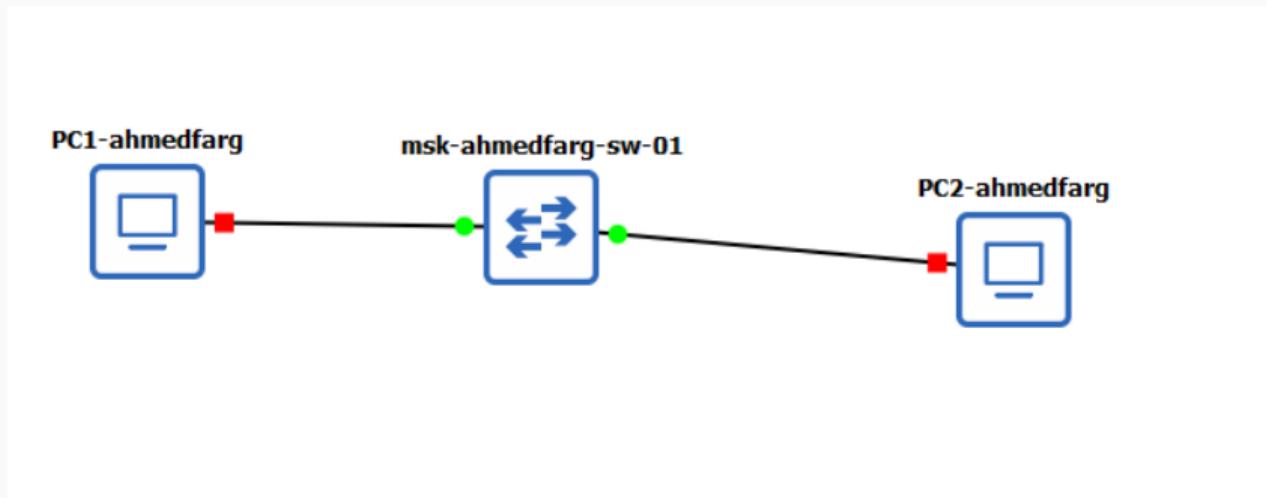


Рис. 1: Топология сети в GNS3

Настройка IP-адресов

```
history          Shortcut for: show history. List the command history
ip ARG ... [OPTION]   Configure the current VPC's IP settings. See ip ?
load [FILENAME]    Load the configuration/script from the file FILENAME
ping HOST [OPTION ...] Ping HOST with ICMP (default) or TCP/UDP. See ping ?
quit              Quit program
relay ARG ...      Configure packet relay between UDP ports. See relay ?
rlogin [ip] port   Telnet to port on host at ip (relative to host PC)
save [FILENAME]    Save the configuration to the file FILENAME
set ARG ...        Set VPC name and other options. Try set ?
show [ARG ...]     Print the information of VPCs (default). See show ?
sleep [seconds] [TEXT] Print TEXT and pause running script for seconds
trace HOST [OPTION ...] Print the path packets take to network HOST
version           Shortcut for: show version

To get command syntax help, please enter '?' as an argument of the command.

VPCS> ip 192.168.1.11/24 192.168.1.1
Checking for duplicate address...
VPCS : 192.168.1.11 255.255.255.0 gateway 192.168.1.1

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

VPCS> ping 192.168.1.12

84 bytes from 192.168.1.12 icmp_seq=1 ttl=64 time=2.121 ms
84 bytes from 192.168.1.12 icmp_seq=2 ttl=64 time=1.559 ms
84 bytes from 192.168.1.12 icmp_seq=3 ttl=64 time=2.012 ms
84 bytes from 192.168.1.12 icmp_seq=4 ttl=64 time=2.750 ms
84 bytes from 192.168.1.12 icmp_seq=5 ttl=64 time=2.290 ms

VPCS>
```

```
PC2-ahmedfarg - PuTTY
Press '?' to get help.

Executing the startup file

Hostname is too long. (Maximum 12 characters)

VPCS> ip 192.168.1.12/24 192.168.1.1
Checking for duplicate address...
VPCS : 192.168.1.12 255.255.255.0 gateway 192.168.1.1

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

VPCS> ping 192.168.1.11

84 bytes from 192.168.1.11 icmp_seq=1 ttl=64 time=1.261 ms
84 bytes from 192.168.1.11 icmp_seq=2 ttl=64 time=1.672 ms
84 bytes from 192.168.1.11 icmp_seq=3 ttl=64 time=1.583 ms
84 bytes from 192.168.1.11 icmp_seq=4 ttl=64 time=2.009 ms
84 bytes from 192.168.1.11 icmp_seq=5 ttl=64 time=0.909 ms

VPCS>
```

Рис. 2: Проверка связи

Анализ трафика ARP и ICMP

No.	Time	Source	Destination	Protocol	Length Info
1	0.000000	::	ff02::2	ICMPv6	62 Router Solicitation
2	0.000917	::	ff02::2	ICMPv6	62 Router Solicitation
3	0.050606	Private_66:68:01	Broadcast	ARP	64 Gratuitous ARP for 192.168.1.12 (Request)
4	0.051254	Private_66:68:00	Broadcast	ARP	64 Gratuitous ARP for 192.168.1.11 (Request)
5	1.051596	Private_66:68:01	Broadcast	ARP	64 Gratuitous ARP for 192.168.1.12 (Request)
6	1.051703	Private_66:68:00	Broadcast	ARP	64 Gratuitous ARP for 192.168.1.11 (Request)
7	2.052226	Private_66:68:01	Broadcast	ARP	64 Gratuitous ARP for 192.168.1.12 (Request)
8	2.052371	Private_66:68:00	Broadcast	ARP	64 Gratuitous ARP for 192.168.1.11 (Request)


```
Frame 4: 64 bytes on wire (512 bits), 64 bytes captured (512 bits) on interface -, id 0
Ethernet II, Src: Private_66:68:00 (00:50:79:66:68:00), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
  Destination: Broadcast (ff:ff:ff:ff:ff:ff)
  Source: Private_66:68:00 (00:50:79:66:68:00)
  Type: ARP (0x8006)
    [Stream index: 3]
  Padding: 00000000000000000000000000000000
  Frame check sequence: 0x00000000 [unverified]
    [FCS Status: Unverified]
Address Resolution Protocol (request/gratuitous ARP)
  Hardware type: Ethernet (1)
  Protocol type: IPv4 (0x0800)
  Hardware size: 6
  Protocol size: 4
  Opcode: request (1)
    [Is gratuitous: True]
  Sender MAC address: Private_66:68:00 (00:50:79:66:68:00)
  Sender IP address: 192.168.1.11
  Target MAC address: Broadcast (ff:ff:ff:ff:ff:ff)
  Target IP address: 192.168.1.11
```

Анализ трафика ARP и ICMP

№	Источник	Назначение	Протокол	Описание	Служебные данные
1	0.000000	::	ff02::2	ICMPv6	62 Router Solicitation
2	0.000917	::	ff02::2	ICMPv6	62 Router Solicitation
3	0.050606	Private_66:68:01	Broadcast	ARP	64 Gratuitous ARP for 192.168.1.12 (Request)
4	0.051254	Private_66:68:00	Broadcast	ARP	64 Gratuitous ARP for 192.168.1.11 (Request)
5	1.051596	Private_66:68:01	Broadcast	ARP	64 Gratuitous ARP for 192.168.1.12 (Request)
6	1.051703	Private_66:68:00	Broadcast	ARP	64 Gratuitous ARP for 192.168.1.11 (Request)
7	2.052226	Private_66:68:01	Broadcast	ARP	64 Gratuitous ARP for 192.168.1.12 (Request)
8	2.052371	Private_66:68:00	Broadcast	ARP	64 Gratuitous ARP for 192.168.1.11 (Request)
9	72.429825	Private_66:68:01	Broadcast	ARP	64 Who has 192.168.1.11? Tell 192.168.1.12
10	72.431223	Private_66:68:00	Private_66:68:01	ARP	64 192.168.1.11 is at 00:50:79:66:68:00
→ 11	72.432292	192.168.1.12	192.168.1.11	ICMP	98 Echo (ping) request id=0xcd29, seq=1/256, ttl=64 (reply in 12)
→ 12	72.434067	192.168.1.11	192.168.1.12	ICMP	98 Echo (ping) reply id=0xcd29, seq=1/256, ttl=64 (request in 11)

Frame 11: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface -, id 0

Ethernet II, Src: Private_66:68:01 (00:50:79:66:68:01), Dst: Private_66:68:00 (00:50:79:66:68:00)

Internet Protocol Version 4, Src: 192.168.1.12, Dst: 192.168.1.11

 0100 = Version: 4

 0101 = Header Length: 20 bytes (5)

 Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)

 Total Length: 84

 Identification: 0x29cd (10701)

 000. = Flags: 0x0

 ...0 0000 0000 0000 = Fragment Offset: 0

 Time to Live: 64

 Protocol: ICMP (1)

 Header Checksum: 0xcd74 [validation disabled]

 [Header checksum status: Unverified]

 Source Address: 192.168.1.12

 Destination Address: 192.168.1.11

 [Stream index: 0]

 Internet Control Message Protocol

 Type: 8 (Echo (ping) request)

 Code: 0

 Checksum: 0x52e1 [correct]

 [Checksum Status: Good]

 Identifier (BE): 52521 (0xcd29)

 Identifier (LE): 10701 (0x29cd)

 Sequence Number (BE): 1 (0x0001)

 Sequence Number (LE): 256 (0x0100)

 [Response frame: 12]

 Data (56 bytes)

Моделирование сети на базе маршрутизатора FRR

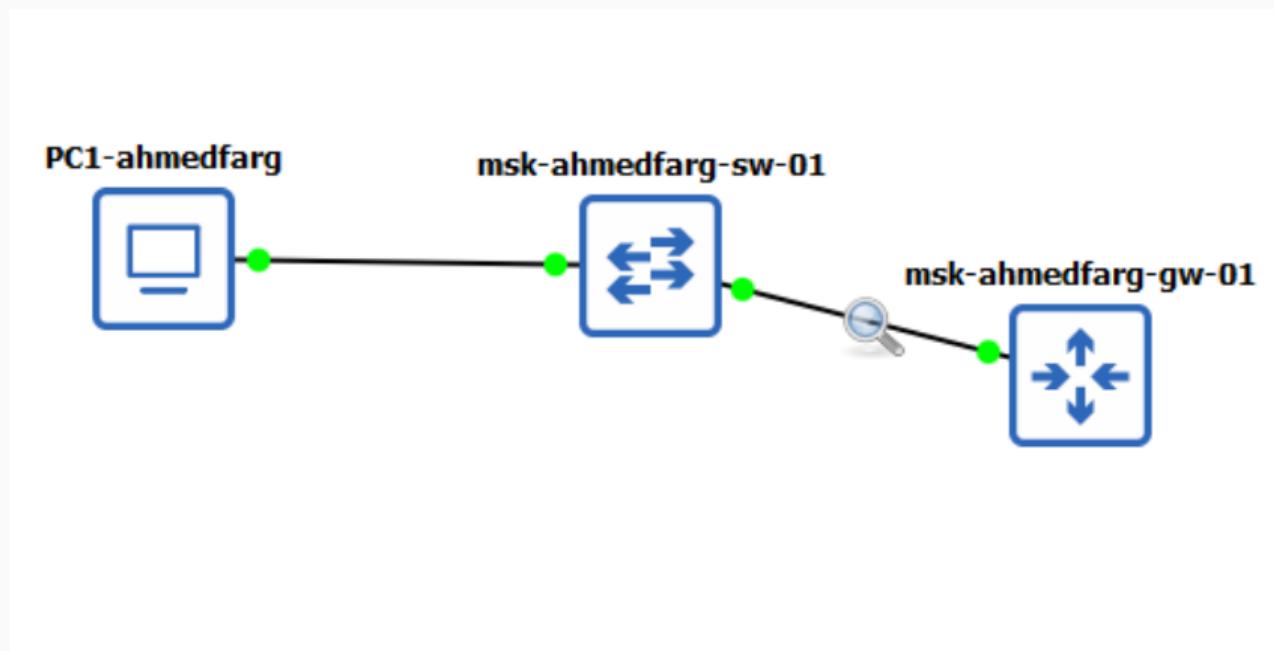


Рис. 5: Топология FRR

Настройка маршрутизатора FRR

```
frr#  
frr# configure terminal  
frr(config)# hostname msk-ahmedfarg-gw-01  
msk-ahmedfarg-gw-01(config)# exit  
msk-ahmedfarg-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-ahmedfarg-gw-01# configure terminal  
msk-ahmedfarg-gw-01(config)# interface eth0  
msk-ahmedfarg-gw-01(config-if)# ip address 192.168.1.1/24  
msk-ahmedfarg-gw-01(config-if)# no shutdown  
msk-ahmedfarg-gw-01(config-if)# exit  
msk-ahmedfarg-gw-01(config)# exit  
msk-ahmedfarg-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-ahmedfarg-gw-01#
```

Рис. 6: Конфигурация FRR

Проверка связи и анализ ICMP

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

VPCS> show ip

NAME      : VPCS[1]
IP/MASK   : 192.168.1.10/24
GATEWAY   : 192.168.1.1
DNS       :
MAC       : 00:50:79:66:68:00
LPORT     : 10004
RHOST:PORT: 127.0.0.1:10005
MTU       : 1500

VPCS>
VPCS> ping 192.168.1.1

84 bytes from 192.168.1.1 icmp_seq=1 ttl=64 time=5.054 ms
84 bytes from 192.168.1.1 icmp_seq=2 ttl=64 time=3.336 ms
84 bytes from 192.168.1.1 icmp_seq=3 ttl=64 time=3.501 ms
84 bytes from 192.168.1.1 icmp_seq=4 ttl=64 time=4.085 ms
84 bytes from 192.168.1.1 icmp_seq=5 ttl=64 time=3.708 ms
```

VPCS> 

Проверка связи и анализ ICMP

No.	Time	Source	Destination	Protocol	Length	Info
15	247.702524	Private_66:68:00	Broadcast	ARP	64	Who has 192.168.1.1? Tell 192.168.1.10
16	247.706995	0c:be:b1:30:00:00	Private_66:68:00	ARP	60	192.168.1.1 is at 0c:be:b1:30:00:00
17	247.708986	192.168.1.10	192.168.1.1	ICMP	98	Echo (ping) request id=0xa42b, seq=1/256, ttl=64 (reply in 18)
18	247.712756	192.168.1.1	192.168.1.10	ICMP	98	Echo (ping) reply id=0xa42b, seq=1/256, ttl=64 (request in 17)
19	248.714566	192.168.1.10	192.168.1.1	ICMP	98	Echo (ping) request id=0xa52b, seq=2/512, ttl=64 (reply in 20)
20	248.717031	192.168.1.1	192.168.1.10	ICMP	98	Echo (ping) reply id=0xa52b, seq=2/512, ttl=64 (request in 19)
21	249.719663	192.168.1.10	192.168.1.1	ICMP	98	Echo (ping) request id=0xa62b, seq=3/768, ttl=64 (reply in 22)
22	249.721816	192.168.1.1	192.168.1.10	ICMP	98	Echo (ping) reply id=0xa62b, seq=3/768, ttl=64 (request in 21)
23	250.724441	192.168.1.10	192.168.1.1	ICMP	98	Echo (ping) request id=0xa72b, seq=4/1024, ttl=64 (reply in 24)
24	250.727281	192.168.1.1	192.168.1.10	ICMP	98	Echo (ping) reply id=0xa72b, seq=4/1024, ttl=64 (request in 23)
25	251.728606	192.168.1.10	192.168.1.1	ICMP	98	Echo (ping) request id=0xa82b, seq=5/1280, ttl=64 (reply in 26)
26	251.731391	192.168.1.1	192.168.1.10	ICMP	98	Echo (ping) reply id=0xa82b, seq=5/1280, ttl=64 (request in 25)
27	252.773800	0c:be:b1:30:00:00	Private_66:68:00	ARP	60	Who has 192.168.1.10? Tell 192.168.1.1
28	252.774428	Private_66:68:00	0c:be:b1:30:00:00	ARP	60	192.168.1.10 is at 00:50:79:66:68:00

Frame 21: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface -, id 0

Ethernet II, Src: Private_66:68:00 (00:50:79:66:68:00), Dst: 0c:be:b1:30:00:00 (0c:be:b1:30:00:00)

Internet Protocol Version 4, Src: 192.168.1.10, Dst: 192.168.1.1

 0100 = Version: 4

 0101 = Header Length: 20 bytes (5)

 Differentiated Services Field: 0x00 (DS2P: CS0, ECN: Not-ECT)

 Total Length: 84

 Identification: 0x2ba6 (11174)

 000. = Flags: 0x0

...0 0000 0000 0000 = Fragment Offset: 0

Time to Live: 64

Protocol: ICMP (1)

Header Checksum: 0xcb a7 [validation disabled]

[Header checksum status: Unverified]

Source Address: 192.168.1.10

Destination Address: 192.168.1.1

[Stream index: 0]

Internet Control Message Protocol

Type: 8 (Echo (ping) request)

Code: 0

Checksum: 0x79dd [correct]

[Checksum Status: Good]

Identifier (BE): 42539 (0xa62b)

Identifier (LE): 11174 (0x2ba6)

Sequence Number (BE): 3 (0x0003)

Sequence Number (LE): 768 (0x0300)

[Response frame: 22]

Data (56 bytes)

Моделирование сети на базе маршрутизатора VyOS

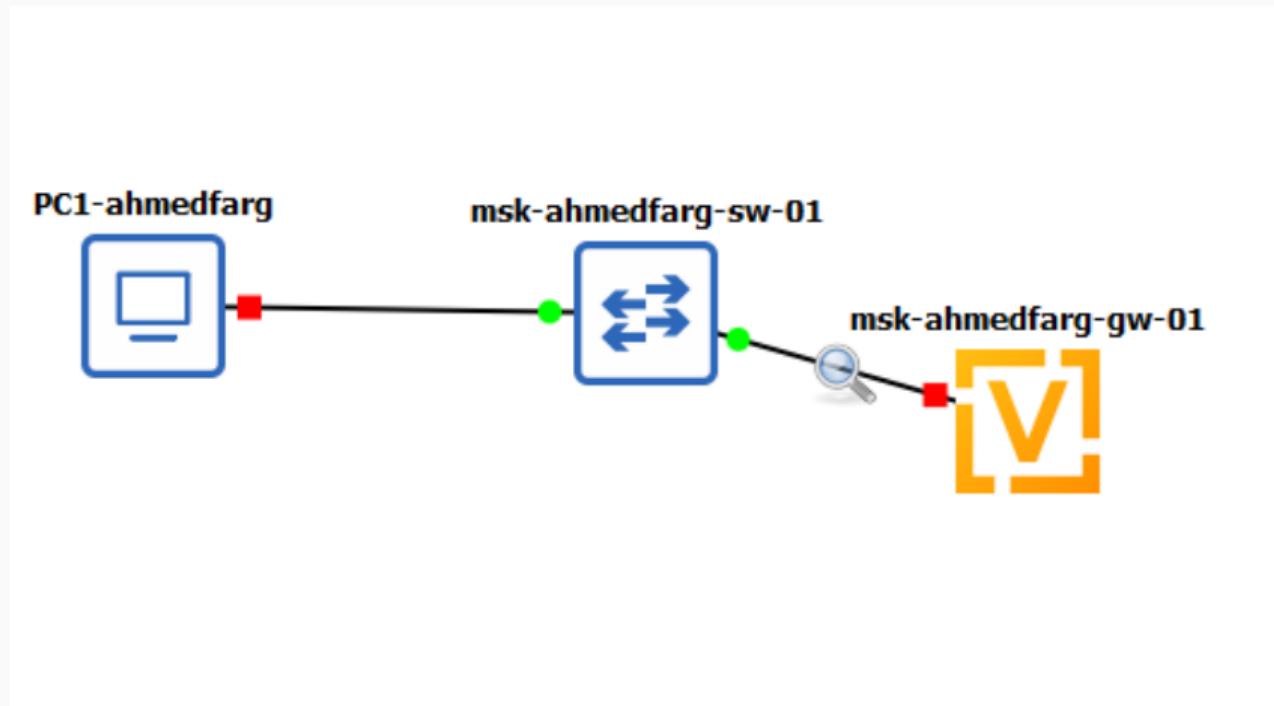


Рис. 9: Топология VyOS

Настройка маршрутизатора VyOS

```
vyos 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@vyos:~$ install image
You are trying to install from an already installed system. An ISO
image file to install or URL must be specified.
Exiting...
vyos@vyos:~$ configure
[edit]
vyos@vyos# system

    Invalid command: [system]

[edit]
vyos@vyos# set system host-name msk-ahmedfarg-gw-01
[edit]
vyos@vyos# set interfaces ethernet eth0 address 192.168.1.1/24
[edit]
vyos@vyos# compare
[edit interfaces ethernet eth0]
+address 192.168.1.1/24
[edit system]
>host-name msk-ahmedfarg-gw-01
[edit]
vyos@vyos#
```

Проверка связи и анализ ICMP

```
Press '?' to get help.  
Executing the startup file  
  
Checking for duplicate address...  
VPCS : 192.168.1.10 255.255.255.0 gateway 192.168.1.1  
  
VPCS> ping 192.168.1.1  
  
84 bytes from 192.168.1.1 icmp_seq=1 ttl=64 time=1.505 ms  
84 bytes from 192.168.1.1 icmp_seq=2 ttl=64 time=1.008 ms  
84 bytes from 192.168.1.1 icmp_seq=3 ttl=64 time=1.074 ms  
84 bytes from 192.168.1.1 icmp_seq=4 ttl=64 time=1.315 ms  
84 bytes from 192.168.1.1 icmp_seq=5 ttl=64 time=0.871 ms  
  
VPCS>
```

Рис. 11: Ping с ПК к VyOS

Проверка связи и анализ ICMP

No.	Time	Source	Destination	Protocol	Length	Info
24	207.171678	Private_66:68:00	Broadcast	ARP	64	Who has 192.168.1.1? Tell 192.168.1.10
25	207.173006	0c:25:cc:60:00:00	Private_66:68:00	ARP	60	192.168.1.1 is at 0c:25:cc:60:00:00
26	207.174567	192.168.1.10	192.168.1.1	ICMP	98	Echo (ping) request id=0xfd2d, seq=1/256, ttl=64 (reply in 27)
27	207.175768	192.168.1.1	192.168.1.10	ICMP	98	Echo (ping) reply id=0xfd2d, seq=1/256, ttl=64 (request in 26)
28	208.177295	192.168.1.10	192.168.1.1	ICMP	98	Echo (ping) request id=0xfe2d, seq=2/512, ttl=64 (reply in 29)
29	208.177977	192.168.1.1	192.168.1.10	ICMP	98	Echo (ping) reply id=0xfe2d, seq=2/512, ttl=64 (request in 28)
30	209.179371	192.168.1.10	192.168.1.1	ICMP	98	Echo (ping) request id=0xff2d, seq=3/768, ttl=64 (reply in 31)
31	209.179982	192.168.1.1	192.168.1.10	ICMP	98	Echo (ping) reply id=0xff2d, seq=3/768, ttl=64 (request in 30)
32	210.180731	192.168.1.10	192.168.1.1	ICMP	98	Echo (ping) request id=0x002e, seq=4/1024, ttl=64 (reply in 33)
33	210.181719	192.168.1.1	192.168.1.10	ICMP	98	Echo (ping) reply id=0x002e, seq=4/1024, ttl=64 (request in 32)
→	34 211.183440	192.168.1.10	192.168.1.1	ICMP	98	Echo (ping) request id=0x012e, seq=5/1280, ttl=64 (reply in 35)
→	35 211.184039	192.168.1.1	192.168.1.10	ICMP	98	Echo (ping) reply id=0x012e, seq=5/1280, ttl=64 (request in 34)
36	212.625879	0c:25:cc:60:00:00	Private_66:68:00	ARP	60	Who has 192.168.1.10? Tell 192.168.1.1
37	212.626166	Private_66:68:00	0c:25:cc:60:00:00	ARP	60	192.168.1.10 is at 00:50:79:66:68:00
.....						
▶ Frame 35: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface -, id 0						
▶ Ethernet II, Src: 0c:25:cc:60:00:00 (0c:25:cc:60:00:00), Dst: Private_66:68:00 (00:50:79:66:68:00)						
▼ Internet Protocol Version 4, Src: 192.168.1.1, Dst: 192.168.1.10						
0100 = Version: 4						
... 0101 = Header Length: 20 bytes (5)						
▶ Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)						
Total Length: 84						
Identification: 0x175d (5981)						
000. = Flags: 0x0						
... 0 0000 0000 0000 = Fragment Offset: 0						
Time to Live: 64						
Protocol: ICMP (1)						
Header Checksum: 0xdff0 [validation disabled]						
[Header checksum status: Unverified]						
Source Address: 192.168.1.1						
Destination Address: 192.168.1.10						
[Stream index: 1]						
▼ Internet Control Message Protocol						
Type: 0 (Echo (ping) reply)						
Code: 0						
Checksum: 0x26d9 [correct]						
[Checksum Status: Good]						
Identifier (BE): 302 (0x012e)						
Identifier (LE): 11777 (0x2e01)						
Sequence Number (BE): 5 (0x0005)						
Sequence Number (LE): 1280 (0x0500)						
[Request frame: 34]						
[Response time: 0,599 ms]						
Data (56 bytes)						

Вывод

Вывод

Оба маршрутизатора — **FRR** и **VyOS** — успешно функционируют, обеспечивая корректный обмен пакетами в локальной сети.

Полученные результаты подтверждают правильность конфигурации и работу сетевых протоколов в среде **GNS3**.