

Сетевые технологии

Лабораторная работа №5

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Цели и задачи 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

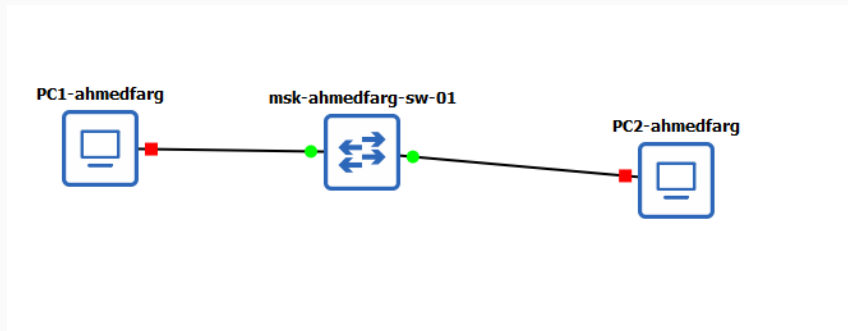
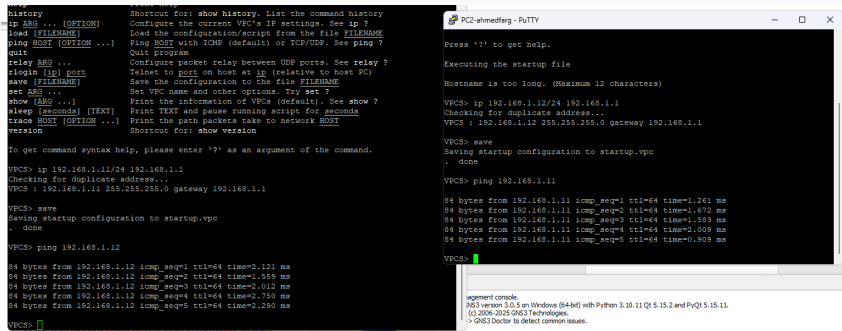


Рис. 1: Топология сети в GNS3

Настройка IP-адресов



```
history
ip ARG ... [OPTION]
load [FILENAME]
ping HOST [OPTION ...]
quit
relay ARG ...
rlogin [ip] port
save [FILENAME]
set ARG ...
show [ARG ...]
sleep [seconds] [TEXT]
trace HOST [OPTION ...]
version

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

agement console.
PNS3 version 3.0.5 on Windows (64-bit) with Python 3.10.11 Qt 5.15.2 and PyQt 5.15.11.
(c) 2006-2025 GNS3 Technologies.
> GNS3 Doctor to detect common issues.

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 (0x0806)
 - [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

| | | | | | |
|----|-----------|------------------|------------------|--------------|--|
| 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 | 0000 | 00 50 7 |
| ▶ Ethernet II, Src: Private_66:68:01 (00:50:79:66:68:01), Dst: Private_66:68:00 (00:50:79:66:68:00) | 0010 | 00 54 2 |
| ▼ Internet Protocol Version 4, Src: 192.168.1.12, Dst: 192.168.1.11 | 0020 | 01 0b 0 |
| 0100 = Version: 4 | 0030 | 0e 0f 1 |
| 0101 = Header Length: 20 bytes (5) | 0040 | 1e 1f 2 |
| ▶ Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT) | 0050 | 2e 2f 3 |
| Total Length: 84 | 0060 | 3e 3f |
| 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

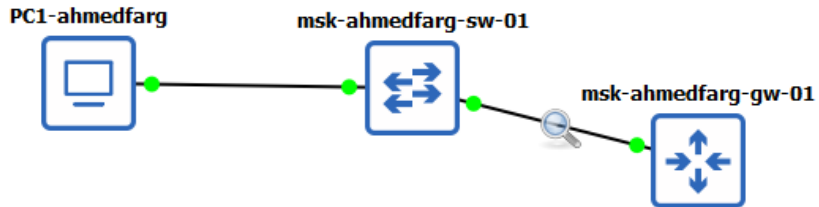


Рис. 5: Топология FRR

```
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 | | | | | | | 0000 | 00 |
| ▶ 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) | | | | | | | 0010 | 00 |
| ▼ Internet Protocol Version 4, Src: 192.168.1.10, Dst: 192.168.1.1 | | | | | | | 0020 | 01 |
| 0100 = Version: 4 | | | | | | | 0030 | 0e |
| 0101 = Header Length: 20 bytes (5) | | | | | | | 0040 | 1e |
| ▶ Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT) | | | | | | | 0050 | 2e |
| Total Length: 84 | | | | | | | 0060 | 3e |
| Identification: 0x2ba6 (11174) | | | | | | | | |
| 000. = Flags: 0x0 | | | | | | | | |
| ...0 0000 0000 0000 = Fragment Offset: 0 | | | | | | | | |
| Time to Live: 64 | | | | | | | | |
| Protocol: ICMP (1) | | | | | | | | |
| Header Checksum: 0xcba7 [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

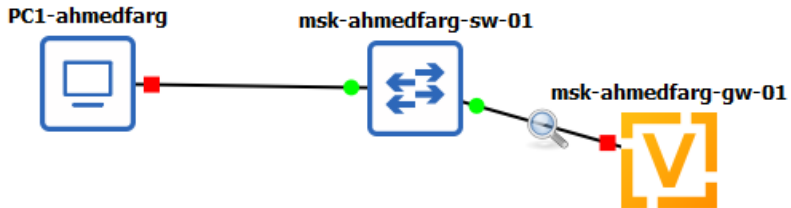


Рис. 9: Топология VyOS

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#
```



```
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)

0000 00 5

0010 00 5

0020 01 4

0030 0e 4

0040 1e 1

0050 2e 2

0060 3e 3

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**.