

# Лабораторная работа №5

Простые сети в GNS3. Анализ трафика

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## Цель работы

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## Основная цель

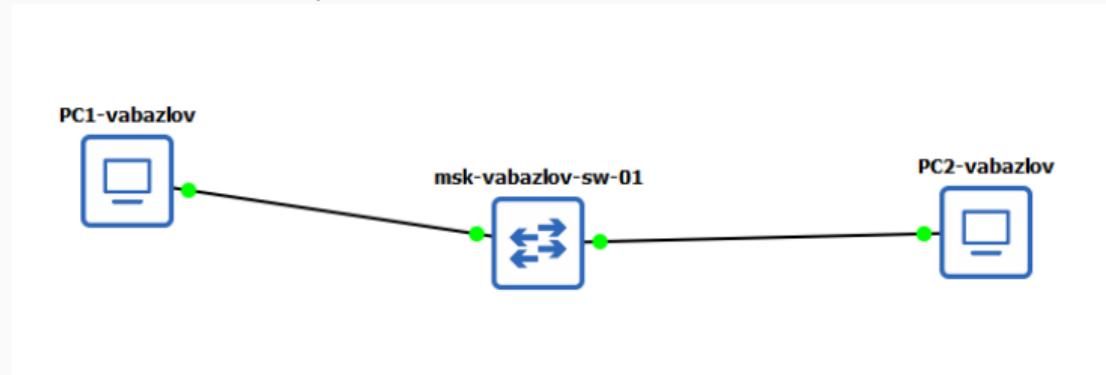
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Построить простые модели сетей в GNS3  
на базе коммутатора, маршрутизаторов FRR и VyOS,  
а также выполнить анализ трафика с помощью Wireshark.

## Простая сеть в GNS3

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- PC1: 192.168.1.11/24, шлюз 192.168.1.1
- PC2: 192.168.1.12/24, шлюз 192.168.1.1



# Настройка PC1 и PC2

```
PC1-vabazlov - PuTTY
Press '?' to get help.

Executing the startup file

PC1-vabazlov> ?

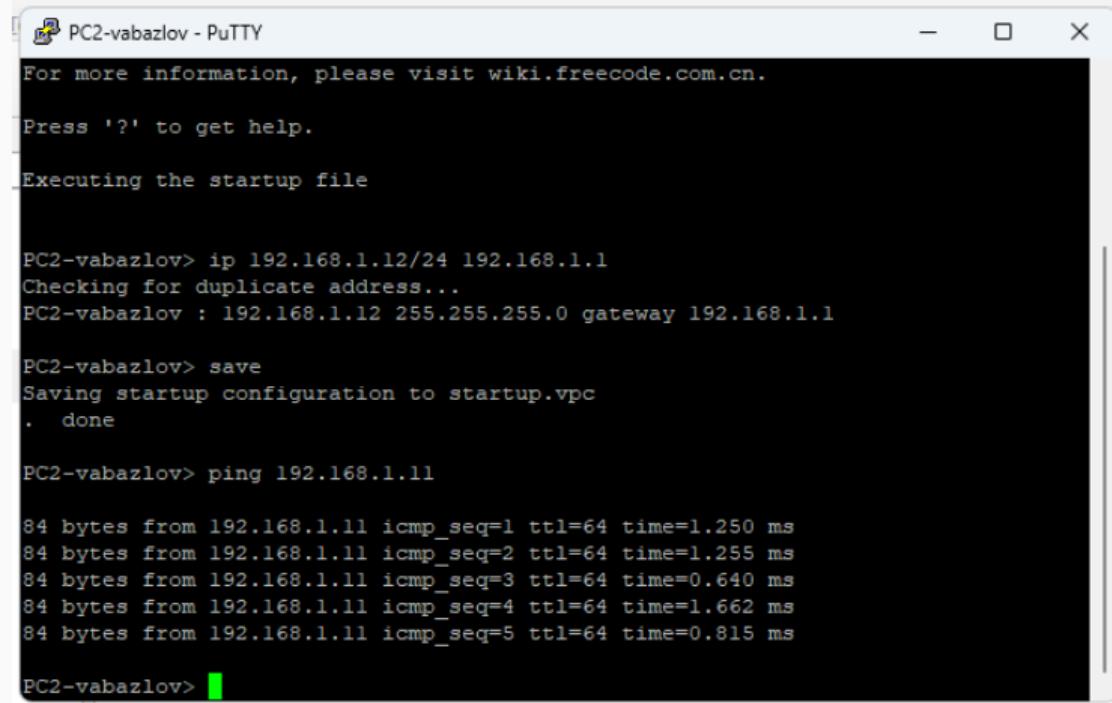
?
arp Print help
clear ARG Shortcut for: show arp. Show arp table
dhcp [OPTION] Clear IPv4/IPv6, arp/neighbor cache, command history
disconnect Shortcut for: ip dhcp. Get IPv4 address via DHCP
echo TEXT Exit the telnet session (daemon mode)
help Display TEXT in output. See also set echo ?
history Print help
ip ARG ... [OPTION] Shortcut for: show history. List the command history
load [FILENAME] Configure the current VPC's IP settings. See ip ?
ping HOST [OPTION ...] Load the configuration/script from the file FILENAME
quit Ping HOST with ICMP (default) or TCP/UDP. See ping ?
relay ARG ... Quit program
rlogin [ip] port Configure packet relay between UDP ports. See relay ?
save [FILENAME] Telnet to port on host at ip (relative to host PC)
set ARG ... Save the configuration to the file FILENAME
show [ARG ...] Set VPC name and other options. Try set ?
sleep [seconds] [TEXT] Print the information of VPCs (default). See show ?
trace HOST [OPTION ...] Print TEXT and pause running script for seconds
version Shortcut for: show version

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

PC1-vabazlov> ip 192.168.1.11/24 192.168.1.1
Checking for duplicate address...
PC1-vabazlov : 192.168.1.11 255.255.255.0 gateway 192.168.1.1

PC1-vabazlov> save
Saving startup configuration to startup.vpc
. done
```

## Настройка PC1 и PC2



```
PC2-vabazlov - PuTTY

For more information, please visit wiki.freecode.com.cn.

Press '?' to get help.

Executing the startup file

PC2-vabazlov> ip 192.168.1.12/24 192.168.1.1
Checking for duplicate address...
PC2-vabazlov : 192.168.1.12 255.255.255.0 gateway 192.168.1.1

PC2-vabazlov> save
Saving startup configuration to startup.vpc
. done

PC2-vabazlov> ping 192.168.1.11

84 bytes from 192.168.1.11 icmp_seq=1 ttl=64 time=1.250 ms
84 bytes from 192.168.1.11 icmp_seq=2 ttl=64 time=1.255 ms
84 bytes from 192.168.1.11 icmp_seq=3 ttl=64 time=0.640 ms
84 bytes from 192.168.1.11 icmp_seq=4 ttl=64 time=1.662 ms
84 bytes from 192.168.1.11 icmp_seq=5 ttl=64 time=0.815 ms

PC2-vabazlov>
```

Рис. 2: Настройка PC2

## Анализ трафика Wireshark

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# ARP-трафик

- Gratuitous ARP
- ARP Request / Reply
- Разрешение MAC-адресов

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	::	ff02::2	ICMPv6	62	Router Solicitation
2	0.001863	::	ff02::2	ICMPv6	62	Router Solicitation
3	0.051094	Private_66:68:00	Broadcast	ARP	64	Gratuitous ARP for 192.168.1.11 (Request)
4	0.052431	Private_66:68:01	Broadcast	ARP	64	Gratuitous ARP for 192.168.1.12 (Request)
5	1.051507	Private_66:68:00	Broadcast	ARP	64	Gratuitous ARP for 192.168.1.11 (Request)
6	1.052965	Private_66:68:01	Broadcast	ARP	64	Gratuitous ARP for 192.168.1.12 (Request)
7	2.052676	Private_66:68:00	Broadcast	ARP	64	Gratuitous ARP for 192.168.1.11 (Request)
8	2.053906	Private_66:68:01	Broadcast	ARP	64	Gratuitous ARP for 192.168.1.12 (Request)

```
> Frame 3: 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: 2]
        Padding: 0000000000000000000000000000000000000000000000000000000000000000
        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
```

# ICMP-трафик

- Echo Request / Echo Reply
- TTL, идентификаторы, полезная нагрузка

No.	Time	Source	Destination	Protocol	Length	Info
8	2.053906	Private_66:68:01	Broadcast	ARP	64	Gratuitous ARP for 192.168.1.12 (Request)
9	67.413337	Private_66:68:01	Broadcast	ARP	64	Who has 192.168.1.11? Tell 192.168.1.12
10	67.414603	Private_66:68:00	Private_66:68:01	ARP	64	192.168.1.11 is at 00:50:79:66:68:00
+ 11	67.416234	192.168.1.12	192.168.1.11	ICMP	98	Echo (ping) request id=0x9fee, seq=1/256, ttl=64 (reply in 12)
-+ 12	67.417354	192.168.1.11	192.168.1.12	ICMP	98	Echo (ping) reply id=0x9fee, seq=1/256, ttl=64 (request in 11)
13	73.505708	192.168.1.12	192.168.1.11	ECHO	98	Request
14	73.507071	192.168.1.11	192.168.1.12	ECHO	98	Response
15	77.737326	192.168.1.12	192.168.1.11	TCP	74	23969 + 7 [SYN] Seq=0 Win=2920 Len=0 MSS=1460 TSval=1764748969 TSecr=0 NS=2
16	77.738961	192.168.1.11	192.168.1.12	TCP	54	7 + 23969 [SYN, ACK] Seq=0 Ack=1 Win=2920 Len=0
17	77.760472	192.168.1.12	192.168.1.11	TCP	66	23969 + 7 [ACK] Seq=1 Ack=1 Win=2920 Len=0 TSval=1764748969 TSecr=0
18	77.761834	192.168.1.12	192.168.1.11	ECHO	122	Request

> Destination: Private\_66:68:00 (00:50:79:66:68:00)  
> Source: Private\_66:68:01 (00:50:79:66:68:01)  
Type: IPv4 (0x0000)  
[Stream index: 4]  
▼ 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: 0xee9f (61087)  
> 000. .... = Flags: 0x0  
...0 0000 0000 0000 = Fragment Offset: 0  
Time to Live: 64  
Protocol: ICMP (1)  
Header Checksum: 0x08a2 [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: 0x801c [correct]  
[Checksum Status: Good]  
Identifier (BE): 40942 (0x9fee)  
Identifier (LE): 61087 (0xee9f)  
Sequence Number (BE): 1 (0x0001)  
Sequence Number (LE): 256 (0x0100)  
[Response frame: 12]  
> Data (56 bytes)  
0000 00 50 79 66 68  
0010 00 54 ee 9f 00  
0020 01 00 00 00 00  
0030 0e 0f 10 11 12  
0040 1e 1f 20 21 22  
0050 2e 2f 30 31 32  
0060 3e 3f

# UDP Echo

- Исходный порт — случайный
- Порт назначения — 7
- Без установления соединения

No.	Time	Source	Destination	Protocol	Length	Info
8	2.053906	Private_66:68:01	Broadcast	ARP	64	Gratuitous ARP for 192.168.1.12 (Request)
9	6.413337	Private_66:68:01	Broadcast	ARP	64	Who has 192.168.1.11? Tell 192.168.1.12
10	67.414603	Private_66:68:00	Private_66:68:01	ARP	64	192.168.1.11 is at 00:50:79:66:68:00
11	67.416234	192.168.1.12	192.168.1.11	ICMP	98	Echo (ping) request id=0x9fee, seq=1/256, ttl=64 (reply in
12	67.417354	192.168.1.11	192.168.1.12	ICMP	98	Echo (ping) reply id=0x9fee, seq=1/256, ttl=64 (request i
13	73.565708	192.168.1.12	192.168.1.11	ECHO	98	Request
14	73.567071	192.168.1.11	192.168.1.12	ECHO	98	Response
15	77.757326	192.168.1.12	192.168.1.11	TCP	74	23969 → 7 [SYN] Seq=0 Win=2920 Len=0 MSS=1460 TStamp=17647489
16	77.758961	192.168.1.11	192.168.1.12	TCP	54	7 → 23969 [SYN, ACK] Seq=0 Ack=1 Win=2920 Len=0
17	77.760472	192.168.1.12	192.168.1.11	TCP	66	23969 → 7 [ACK] Seq=1 Ack=1 Win=2920 Len=0 TStamp=1764748969
18	77.761834	192.168.1.12	192.168.1.11	ECHO	122	Request

> Source: Private\_66:68:01 (00:50:79:66:68:01)  
Type: IPv4 (0x0000)  
[Stream index: 4]

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: 0xeaa5 (61093)  
> 000. .... = Flags: 0x0  
...0 0000 0000 0000 = Fragment Offset: 0  
Time to Live: 64  
Protocol: UDP (17)  
Header Checksum: 0x088c [validation disabled]  
[Header checksum status: Unverified]  
Source Address: 192.168.1.12  
Destination Address: 192.168.1.11  
[Stream index: 0]

User Datagram Protocol, Src Port: 18673, Dst Port: 7  
Source Port: 18673  
Destination Port: 7  
Length: 64

- Трёхстороннее рукопожатие
- Передача данных
- Закрытие соединения

## Сеть с маршрутизатором FRR

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## Топология

- PC1: 192.168.1.10/24
- FRR eth0: 192.168.1.1/24

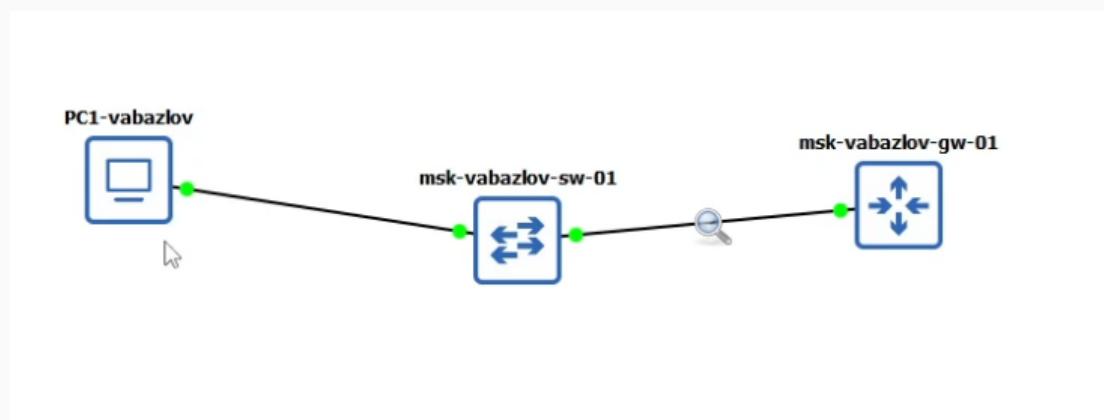


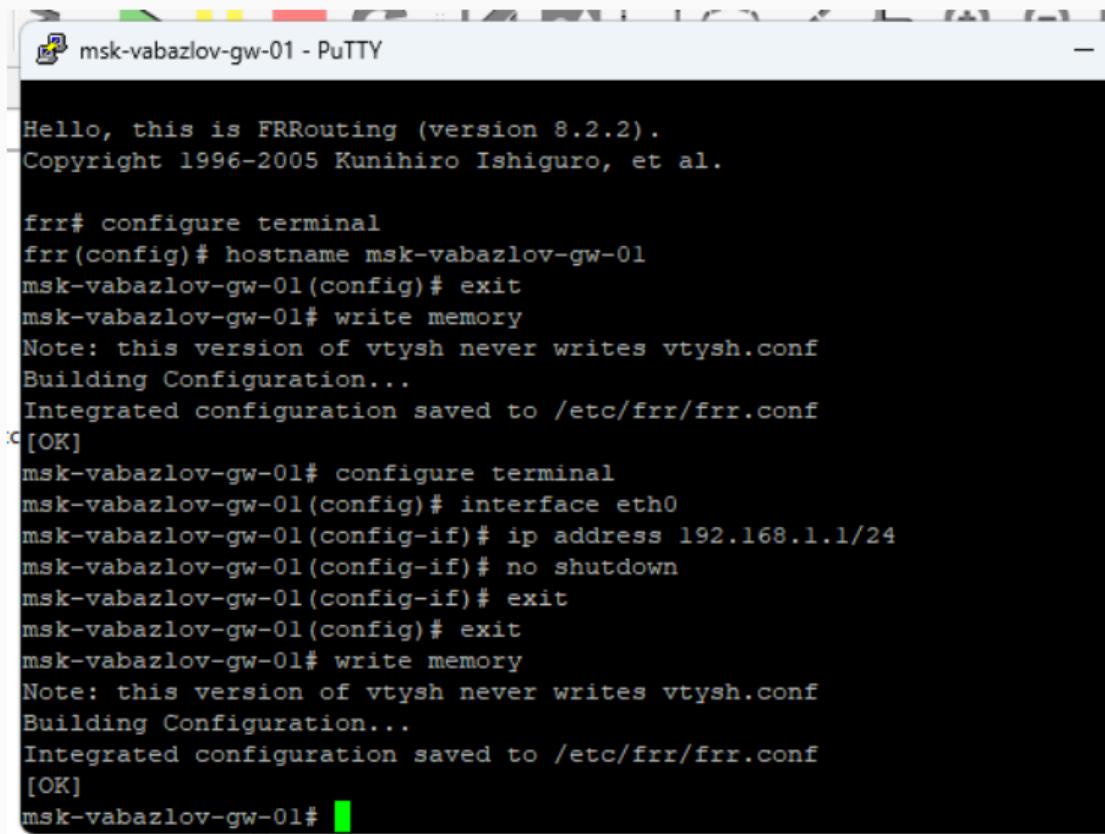
Рис. 6: Топология FRR

## Настройка PC1 и маршрутизатора

```
PC1-vabazlov>
PC1-vabazlov>
PC1-vabazlov> ip 192.168.1.10/24 192.168.1.1
Checking for duplicate address...
PC1-vabazlov : 192.168.1.10 255.255.255.0 gateway 192.168.1.1
PC1-vabazlov> save
Saving startup configuration to startup.vpc
. done
PC1-vabazlov> show ip
NAME      : PC1-vabazlov[1]
IP/MASK   : 192.168.1.10/24
GATEWAY   : 192.168.1.1
DNS       :
MAC       : 00:50:79:66:68:00
LPORT     : 10006
RHOST:PORT: 127.0.0.1:10007
MTU       : 1500
PC1-vabazlov>
```

Рис. 7: PC1

## Настройка PC1 и маршрутизатора



```
Hello, this is FRRouting (version 8.2.2).
Copyright 1996-2005 Kunihiro Ishiguro, et al.

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

## Проверка работоспособности

No.	Time	Source	Destination	Protocol	Length	Info
13	168.452846	0c:19:91:64:00:00	Private_66:68:00	ARP	60	192.168.1.1 is at 0c:19:91:64:00:00
→ 14	168.454477	192.168.1.10	192.168.1.1	ICMP	98	Echo (ping) request id=0xf7f0, seq=1/256, ttl=64 (reply in 15)
← 15	168.457672	192.168.1.1	192.168.1.10	ICMP	98	Echo (ping) reply id=0xf7f0, seq=1/256, ttl=64 (request in 14)
16	169.458654	192.168.1.10	192.168.1.1	ICMP	98	Echo (ping) request id=0xf8f0, seq=2/512, ttl=64 (reply in 17)
17	169.460585	192.168.1.1	192.168.1.10	ICMP	98	Echo (ping) reply id=0xf8f0, seq=2/512, ttl=64 (request in 16)
18	170.461876	192.168.1.10	192.168.1.1	ICMP	98	Echo (ping) request id=0xf9f0, seq=3/768, ttl=64 (reply in 19)
19	170.464105	192.168.1.1	192.168.1.10	ICMP	98	Echo (ping) reply id=0xf9f0, seq=3/768, ttl=64 (request in 18)
20	171.467151	192.168.1.10	192.168.1.1	ICMP	98	Echo (ping) request id=0xfaf0, seq=4/1024, ttl=64 (reply in 21)
21	171.468854	192.168.1.1	192.168.1.10	ICMP	98	Echo (ping) reply id=0xfaf0, seq=4/1024, ttl=64 (request in 20)
22	172.470351	192.168.1.10	192.168.1.1	ICMP	98	Echo (ping) request id=0xfb0, seq=5/1280, ttl=64 (reply in 23)
23	172.470972	192.168.1.1	192.168.1.10	ICMP	98	Echo (ping) reply id=0xfb0, seq=5/1280, ttl=64 (request in 22)
> Frame 14: 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:19:91:64:00:00 (0c:19:91:64:00:00)						
Internet Protocol Version 4, Src: 192.168.1.10, Dst: 192.168.1.1						
0100 .... = Version: 4						
.... 0101 = Header Length: 20 bytes (5)						
Internet Protocol Version 4, Src: 192.168.1.10, Dst: 192.168.1.1						
0100 .... = Version: 4						
.... 0101 = Header Length: 20 bytes (5)						
Internet Protocol Version 4, Src: 192.168.1.10, Dst: 192.168.1.1						
0000 .... = Flags: 0x0						
...0 0000 0000 0000 = Fragment Offset: 0						
Time to Live: 64						
Protocol: ICMP (1)						
Header Checksum: 0x0056 [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: 0x281a [correct]						
[Checksum Status: Good]						
Identifier (BE): 63472 (0xf7f0)						
Identifier (LE): 61687 (0xf0f7)						
Sequence Number (BE): 1 (0x0001)						
Sequence Number (LE): 256 (0x0100)						
[Response frame: 15]						
Data (56 bytes)						

Рис. 9: ICMP FRR

## Сеть с маршрутизатором VyOS

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- PC1: 192.168.1.10/24
- VyOS eth0: 192.168.1.1/24

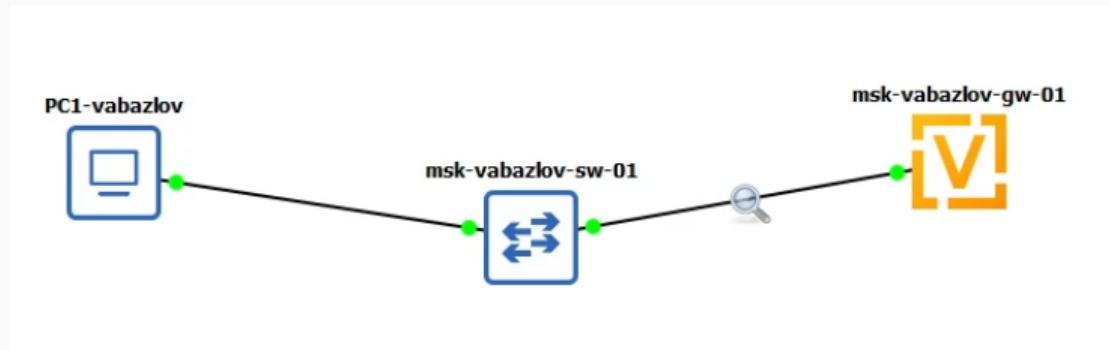


Рис. 10: Топология VyOS

## Настройка устройств

```
you can check individual component licenses under /usr/share/doc/ /copyright
vyos@vyos:~$ configure
[edit]
vyos@vyos# set system host-name msk-vabazlov-gw-01
[edit]
vyos@vyos# delete interfaces ethernet eth0 address dhcp
[edit]
vyos@vyos# set interfaces ethernet eth0 address 192.168.1.1/24
[edit]
vyos@vyos# compare
[edit interfaces ethernet eth0]
-address dhcp
+address 192.168.1.1/24
[edit system]
>host-name msk-vabazlov-gw-01
[edit]
vyos@vyos# commit
[edit]
vyos@vyos# save
Saving configuration to '/config/config.boot'...
Done
[edit]
vyos@vyos#
```

Рис. 11: VyOS конфигурация

## Проверка связности

```
PC1-vabazlov>
PC1-vabazlov> ping 192.168.1.1

84 bytes from 192.168.1.1 icmp_seq=1 ttl=64 time=3.694 ms
=84 bytes from 192.168.1.1 icmp_seq=2 ttl=64 time=1.838 ms
=84 bytes from 192.168.1.1 icmp_seq=3 ttl=64 time=3.181 ms
=84 bytes from 192.168.1.1 icmp_seq=4 ttl=64 time=5.053 ms
=84 bytes from 192.168.1.1 icmp_seq=5 ttl=64 time=1.938 ms
6
6PC1-vabazlov>
```

Рис. 12: Пинг VyOS

## Итоги работы

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## Выводы

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- Построены три сетевые топологии в GNS3
- Настроена IPv4-адресация на всех устройствах
- Выполнена проверка ICMP-доступности
- Проанализированы ARP, ICMP, UDP, TCP-пакеты
- Подтверждена корректная работа маршрутизаторов FRR и VyOS
- Захват трафика показал правильное формирование ARP-таблицы и передачу ICMP-пакетов