

Лабораторная работа №5

Простые сети в GNS3. Анализ трафика

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19 декабря 2025

Цель работы

Построение и исследование простейших сетевых топологий в среде моделирования **GNS3** с использованием:

- Ethernet-коммутаторов
- конечных устройств VPCS
- маршрутизаторов **FRR** и **VyOS**

А также анализ сетевого трафика с помощью **Wireshark**.

Простая сеть на базе коммутатора

- Два оконечных устройства VPCS
- Один Ethernet-коммутатор
- Все узлы находятся в одной подсети

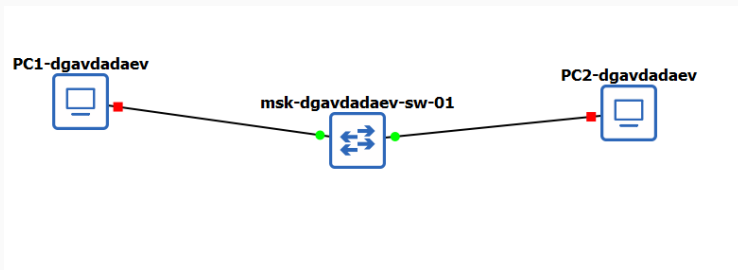


Рис. 1: Топология сети

- Зафиксированы gratuitous ARP-запросы
- Используются для:
 - проверки уникальности IP-адреса
 - объявления соответствия IP–MAC
- Передача осуществляется на широковещательный MAC-адрес

3	0.050386	Private_66:68:00	Broadcast	ARP	64 Gratuitous ARP for 192.168.1.11 (Request)
4	0.050426	Private_66:68:01	Broadcast	ARP	64 Gratuitous ARP for 192.168.1.12 (Request)
5	1.050376	Private_66:68:00	Broadcast	ARP	64 Gratuitous ARP for 192.168.1.11 (Request)
6	1.051310	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)
  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
```

Рис. 2: ARP-трафик

- Выполнены ICMP Echo Request / Reply
- Подтверждена корректная доставка пакетов
- TTL и идентификаторы соответствуют стандарту

→	11	191.085449	192.168.1.12	192.168.1.11	ICMP	98 Echo (ping) request	id=0x8405, seq=1/256, ttl=64 (reply in 12)
←	12	191.085880	192.168.1.11	192.168.1.12	ICMP	98 Echo (ping) reply	id=0x8405, seq=1/256, ttl=64 (request in 11)
	13	199.370404	192.168.1.12	192.168.1.11	ECHO	98 Request	

> 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)
v 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: 0x0584 (1412)
> 000. = Flags: 0x0
...0 0000 0000 0000 = Fragment Offset: 0
Time to Live: 64
Protocol: ICMP (1)
Header Checksum: 0xf1bd [validation disabled]
[Header checksum status: Unverified]
Source Address: 192.168.1.12
Destination Address: 192.168.1.11
[Stream index: 0]

v Internet Control Message Protocol
Type: 8 (Echo (ping) request)
Code: 0
Checksum: 0x9c05 [correct]
[Checksum Status: Good]
Identifier (BE): 33797 (0x8405)
Identifier (LE): 1412 (0x0584)
Sequence Number (BE): 1 (0x0001)
Sequence Number (LE): 256 (0x0100)
[\[Response frame: 12\]](#)

> Data (56 bytes)

Рис. 3: ICMP-трафик

- UDP:
 - отсутствует установление соединения
 - используется порт 7 (Echo)

11	191.085449	192.168.1.12	192.168.1.11	ICMP	98 Echo (ping) request	id=0x8405, seq=1/256, ttl=64 (reply in 12)
12	191.085800	192.168.1.11	192.168.1.12	ICMP	98 Echo (ping) reply	id=0x8405, seq=1/256, ttl=64 (request in 11)
13	199.370404	192.168.1.12	192.168.1.11	ECHO	98 Request	
14	199.371217	192.168.1.11	192.168.1.12	ECHO	98 Response	

> Frame 13: 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: 0x058c (1420)

> 000. = Flags: 0x0

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

Time to Live: 64

Protocol: UDP (17)

Header Checksum: 0xf1a5 [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: 23952, Dst Port: 7

Source Port: 23952

Destination Port: 7

Length: 64

Checksum: 0x82e4 [unverified]

[Checksum Status: Unverified]

[Stream index: 0]

[Stream Packet Number: 1]

> [Timestamps]

> UDP payload (56 bytes)

▼ Echo

Echo data: 0050796668010e0f101112131415161718191a1b1c1d1e1f20212223242526272829a2b2c2d2e2f303132333435363738393a3b3c3d3e3f

Рис. 4: UDP

Анализ ТСР

- TCP:
 - выполнено трёхстороннее рукопожатие
 - передача данных и корректное завершение сессии

[illegible]

Рис. 5: ТСР

Сеть с маршрутизатором FRR

- VPCS
- Ethernet-коммутатор
- Маршрутизатор FRR (шлюз)

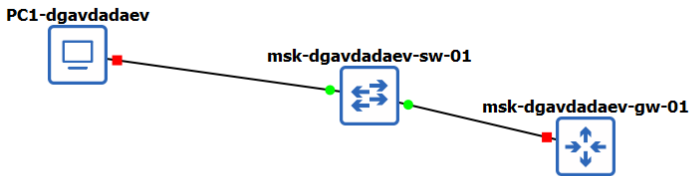
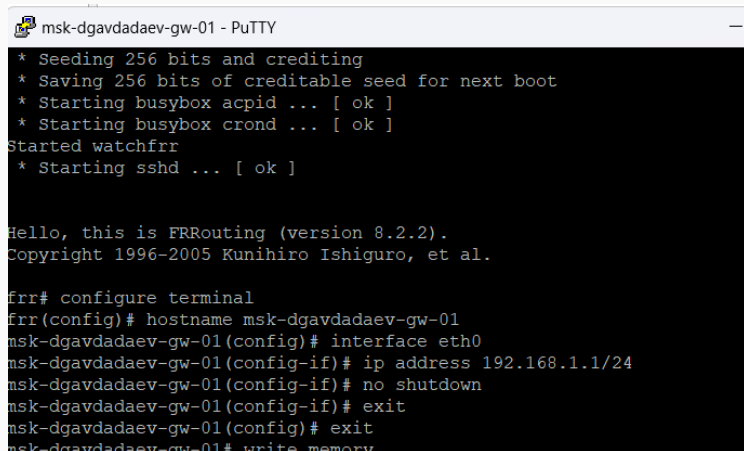


Рис. 6: Топология FRR

Настройка FRR

- Интерфейс eth0: 192.168.1.1/24
- Интерфейс активирован
- Конфигурация сохранена



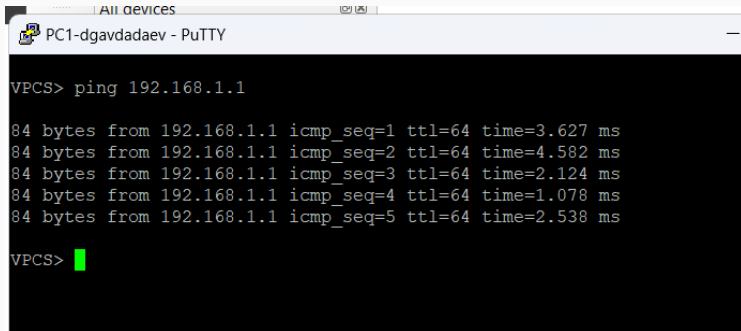
```
msk-dgavdadaev-gw-01 - PuTTY
* Seeding 256 bits and crediting
* Saving 256 bits of creditable seed for next boot
* Starting busybox acpid ... [ ok ]
* Starting busybox crond ... [ ok ]
Started watchfrr
* Starting sshd ... [ ok ]

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

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

Проверка связности (FRR)

- PC1 успешно отправляет ICMP-запросы на 192.168.1.1
- Связь подтверждена
- Ошибок маршрутизации не выявлено



The screenshot shows a PuTTY terminal window titled "PC1-dgavdadaev - PuTTY". The terminal output shows a successful ping command from VPCS to 192.168.1.1. The output displays five successful ping responses, each showing 84 bytes from 192.168.1.1 with varying ICMP sequence numbers and round-trip times.

```
VPCS> ping 192.168.1.1

84 bytes from 192.168.1.1 icmp_seq=1 ttl=64 time=3.627 ms
84 bytes from 192.168.1.1 icmp_seq=2 ttl=64 time=4.582 ms
84 bytes from 192.168.1.1 icmp_seq=3 ttl=64 time=2.124 ms
84 bytes from 192.168.1.1 icmp_seq=4 ttl=64 time=1.078 ms
84 bytes from 192.168.1.1 icmp_seq=5 ttl=64 time=2.538 ms

VPCS> █
```

Рис. 8: Ping FRR

Анализ трафика (FRR)

- ARP-разрешение адреса шлюза
- Последующий обмен ICMP-пакетами
- Корректная работа маршрутизатора подтверждена

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	Private_66:68:00	Broadcast	ARP	64	Who has 192.168.1.1? Tell 192.168.1.10
2	0.002931	0c:06:0a:33:00:00	Private_66:68:00	ARP	60	192.168.1.1 is at 0c:06:0a:33:00:00
→ 3	0.003214	192.168.1.10	192.168.1.1	ICMP	98	Echo (ping) request id=0xa907, seq=1/256, ttl=64 (r
← 4	0.006304	192.168.1.1	192.168.1.10	ICMP	98	Echo (ping) reply id=0xa907, seq=1/256, ttl=64 (r
5	1.009183	192.168.1.10	192.168.1.1	ICMP	98	Echo (ping) request id=0xaa07, seq=2/512, ttl=64 (r
6	1.012449	192.168.1.1	192.168.1.10	ICMP	98	Echo (ping) reply id=0xaa07, seq=2/512, ttl=64 (r
7	2.014530	192.168.1.10	192.168.1.1	ICMP	98	Echo (ping) request id=0xab07, seq=3/768, ttl=64 (r
8	2.016076	192.168.1.1	192.168.1.10	ICMP	98	Echo (ping) reply id=0xab07, seq=3/768, ttl=64 (r

0100 = Version: 4
.... 0101 = Header Length: 20 bytes (5)
> Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
Total Length: 84
Identification: 0x829e (33438)
> 000. = Flags: 0x0
...0 0000 0000 0000 = Fragment Offset: 0
Time to Live: 64
Protocol: ICMP (1)
Header Checksum: 0x74af [validation disabled]
[Header checksum status: Unverified]
Source Address: 192.168.1.1
Destination Address: 192.168.1.10
[Stream index: 0]

Internet Control Message Protocol
Type: 0 (Echo (ping) reply)
Code: 0
Checksum: 0x7f03 [correct]
[Checksum Status: Good]
Identifier (BE): 43271 (0xa907)
Identifier (LE): 1961 (0x07a9)

Сеть с маршрутизатором VyOS

- VPCS
- Ethernet-коммутатор
- Маршрутизатор VyOS

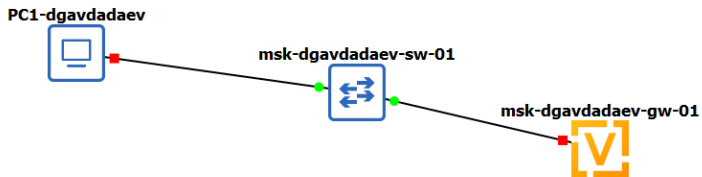
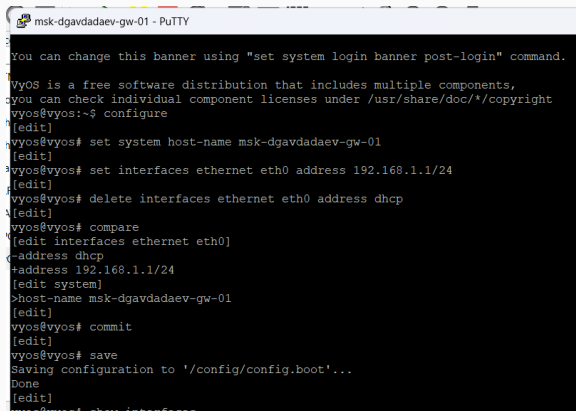


Рис. 10: Топология VyOS

Настройка VyOS

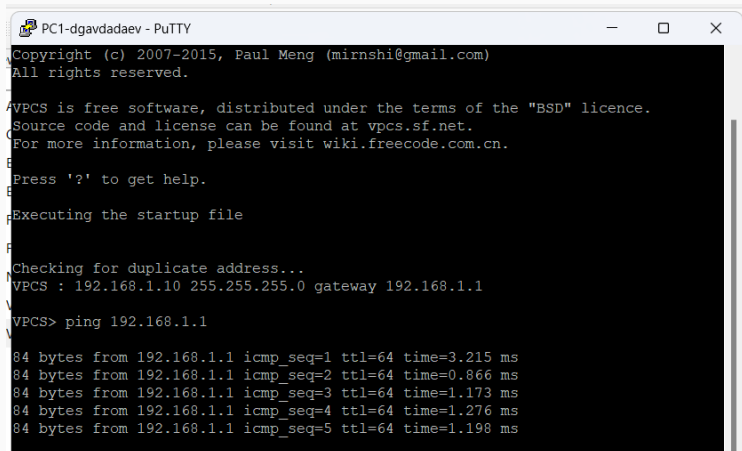
- Задано имя устройства
- Интерфейс eth0: 192.168.1.1/24
- DHCP отключён
- Конфигурация применена и сохранена

A screenshot of a PuTTY terminal window titled 'msk-dgavdadaev-gw-01 - PuTTY'. The terminal shows a VyOS configuration session. It starts with a banner message about changing the login banner. The user enters 'configure' to enter configuration mode. Then, they set the host name to 'msk-dgavdadaev-gw-01'. Next, they configure the 'eth0' interface with the IP address '192.168.1.1/24' and disable DHCP. They then compare the configuration, showing the changes for the interface and system. Finally, they commit and save the configuration to the boot file.

```
msk-dgavdadaev-gw-01 - PuTTY
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:~$ configure
[edit]
vyos@vyos# set system host-name msk-dgavdadaev-gw-01
[edit]
vyos@vyos# set interfaces ethernet eth0 address 192.168.1.1/24
[edit]
vyos@vyos# delete interfaces ethernet eth0 address dhcp
[edit]
vyos@vyos# compare
[edit interfaces ethernet eth0]
- address dhcp
+ address 192.168.1.1/24
[edit system]
> host-name msk-dgavdadaev-gw-01
[edit]
vyos@vyos# commit
[edit]
vyos@vyos# save
Saving configuration to '/config/config.boot'...
Done
[edit]
vyos@vyos# show interfaces
```

Проверка связности (VyOS)

- Успешные ICMP Echo Reply
- Маршрутизатор функционирует как шлюз
- Сетевая связность подтверждена



```
PC1-dgavdadaev - PuTTY
Copyright (c) 2007-2015, Paul Meng (mirnshi@gmail.com)
All rights reserved.

VPCS is free software, distributed under the terms of the "BSD" licence.
Source code and license can be found at vpcs.sf.net.
For more information, please visit wiki.freecode.com.cn.

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=3.215 ms
84 bytes from 192.168.1.1 icmp_seq=2 ttl=64 time=0.866 ms
84 bytes from 192.168.1.1 icmp_seq=3 ttl=64 time=1.173 ms
84 bytes from 192.168.1.1 icmp_seq=4 ttl=64 time=1.276 ms
84 bytes from 192.168.1.1 icmp_seq=5 ttl=64 time=1.198 ms
```

Анализ трафика (VyOS)

- ARP-запросы и ответы
- ICMP Echo Request / Reply
- Корректная обработка пакетов маршрутизатором

The screenshot shows the Wireshark interface with a packet capture from 'Standard input [msk-dgavdadaev-sw-01 Ethernet1 to msk-dgavdadaev-gw-01 eth0]'. The packet list shows several ICMP Echo (ping) requests and replies. The selected packet (No. 3) is an ICMP Echo (ping) request from 192.168.1.10 to 192.168.1.1. The packet details pane shows the following information:

- 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 (DSCP: CS0, ECN: Not-ECT)
- Total Length: 84
- Identification: 0x08b8 (2232)
- > 000. = Flags: 0x0
- ...0 0000 0000 0000 = Fragment Offset: 0
- Time to Live: 64
- Protocol: ICMP (1)
- Header Checksum: 0xee95 [validation disabled]
- [Header checksum status: Unverified]
- Source Address: 192.168.1.10
- Destination Address: 192.168.1.1
- [Stream index: 0]

Итоги работы

- Освоено моделирование сетей в GNS3
- Настроены:
 - коммутатор
 - VPCS
 - маршрутизаторы FRR и VyOS
- Проанализированы протоколы:
 - ARP
 - ICMP
 - UDP
 - TCP