

Простые сети в GNS3. Анализ трафика

Лабораторная работа №5

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30 октября 2025

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Цель работы

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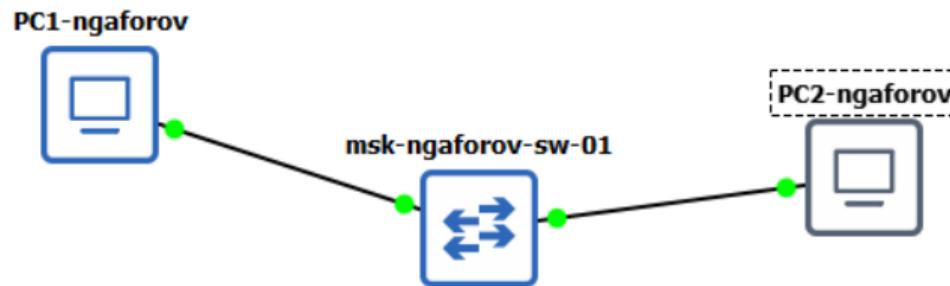
Изучить принципы построения простейших сетей на базе коммутатора и маршрутизаторов FRR и VyOS в среде GNS3, а также провести анализ сетевого трафика с помощью программы Wireshark.

Ход выполнения

Топология сети на коммутаторе

В GNS3 создана сеть, включающая коммутатор и два компьютера (PC1, PC2).

Проверена связь между узлами с помощью ping.



Настройка IP-адресов

- PC1 — 192.168.1.11/24
- PC2 — 192.168.1.12/24

Шлюз по умолчанию: 192.168.1.1

The screenshot shows two PuTTY sessions side-by-side.

PC1-ngaforov - PuTTY session details:

- Configuration file: startup.vpc
- Host IP: 192.168.1.11
- Port: 22
- Protocol: SSH
- Session type: VNC
- Display settings: 1024x768, 16.7M colors
- Font: Consolas
- Character encoding: UTF-8
- Terminal type: xterm
- Session name: PC1-ngaforov

PC2-ngaforov - PuTTY session details:

- Configuration file: startup.vpo
- Host IP: 192.168.1.12
- Port: 22
- Protocol: SSH
- Session type: VNC
- Display settings: 1024x768, 16.7M colors
- Font: Consolas
- Character encoding: UTF-8
- Terminal type: xterm
- Session name: PC2-ngaforov

PC1-ngaforov terminal output (partial):

```
arp          Shortcut for: show arp. Show arp table
clear ARG   Clear IPv4/IPv6, arp/neighbor cache, command history
dshow [OPTION] Shortcut for: ip dhcp. Get IPv4 address via DHCP
dshow       DRAWS the current session (selected mode)
echo TEXT   Display TEXT in output. See also set echo ?
help        Print help
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 ...
rlogin [ARG] EXEC  Configure packet relay between UDP ports. See relay ?
setvnc [FILENAME] Set the VNC connection to the file FILENAME
setvnc ...
set ARG ...
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.

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

PC1-ngaforov> save
Saving startup configuration to startup.vpc
... done

PC1-ngaforov> ping 192.168.1.12

84 bytes from 192.168.1.12 icmp_seq=1 ttl=64 time=2.058 ms
84 bytes from 192.168.1.12 icmp_seq=2 ttl=64 time=0.784 ms
84 bytes from 192.168.1.12 icmp_seq=3 ttl=64 time=1.034 ms
84 bytes from 192.168.1.12 icmp_seq=4 ttl=64 time=0.769 ms
84 bytes from 192.168.1.12 icmp_seq=5 ttl=64 time=1.154 ms

PC1-ngaforov>
```

PC2-ngaforov terminal output (partial):

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

Press '?' to get help.

Executing the startup file

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

PC2-ngaforov> save
Saving startup configuration to startup.vpo
... done

PC2-ngaforov> ping 192.168.1.11

84 bytes from 192.168.1.11 icmp_seq=1 ttl=64 time=1.861 ms
84 bytes from 192.168.1.11 icmp_seq=2 ttl=64 time=1.861 ms
84 bytes from 192.168.1.11 icmp_seq=3 ttl=64 time=1.837 ms
84 bytes from 192.168.1.11 icmp_seq=4 ttl=64 time=0.737 ms
84 bytes from 192.168.1.11 icmp_seq=5 ttl=64 time=0.730 ms

PC2-ngaforov>
```

Рис. 2: Настройка IP-адресов

При захвате трафика в Wireshark зафиксированы ARP-запросы и ICMP Echo Request/Reply, подтверждающие успешную связность между узлами.

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	::	ff02::2	ICMPv6	62	Router Solicitation
2	0.001316	::	ff02::2	ICMPv6	62	Router Solicitation
3	0.050246	Private_66:68:01	Broadcast	ARP	64	Gratuitous ARP for 192.168.1.12 (Request)
4	0.051650	Private_66:68:00	Broadcast	ARP	64	Gratuitous ARP for 192.168.1.11 (Request)
5	1.051224	Private_66:68:01	Broadcast	ARP	64	Gratuitous ARP for 192.168.1.12 (Request)
6	1.052672	Private_66:68:00	Broadcast	ARP	64	Gratuitous ARP for 192.168.1.11 (Request)
7	2.052937	Private_66:68:01	Broadcast	ARP	64	Gratuitous ARP for 192.168.1.12 (Request)
8	2.056520	Private_66:68:00	Broadcast	ARP	64	Gratuitous ARP for 192.168.1.11 (Request)

```
> Frame 5: 64 bytes on wire (512 bits), 64 bytes captured (512 bits) on interface -, id 0
> Ethernet II, Src: Private_66:68:01 (00:50:79:66:68:01), 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_66:68:01 (00:50:79:66:68:01)
```

Анализ UDP и TCP

В режимах `ping udp` и `ping tcp` зафиксированы пакеты с соответствующими протоколами.
При TCP-соединении наблюдалась трёхфазная установка (`SYN`, `SYN/ACK`, `ACK`).

No.	Time	Source	Destination	Protocol	Length	Info
3	0.050246	Private_66:68:01	Broadcast	ARP	64	Gratuitous ARP for 192.168.1.12 (Request)
4	0.051658	Private_66:68:00	Broadcast	ARP	64	Gratuitous ARP for 192.168.1.11 (Request)
5	1.051224	Private_66:68:01	Broadcast	ARP	64	Gratuitous ARP for 192.168.1.12 (Request)
6	1.052672	Private_66:68:00	Broadcast	ARP	64	Gratuitous ARP for 192.168.1.11 (Request)
7	2.052937	Private_66:68:01	Broadcast	ARP	64	Gratuitous ARP for 192.168.1.12 (Request)
8	2.056520	Private_66:68:00	Broadcast	ARP	64	Gratuitous ARP for 192.168.1.11 (Request)
9	54.030194	Private_66:68:01	Broadcast	ARP	64	I who has 192.168.1.1? Tell 192.168.1.12
10	55.030911	Private_66:68:01	Broadcast	ARP	64	I who has 192.168.1.1? Tell 192.168.1.12
11	56.031626	Private_66:68:01	Broadcast	ARP	64	I who has 192.168.1.1? Tell 192.168.1.12
12	61.614174	Private_66:68:01	Broadcast	ARP	64	I who has 192.168.1.11? Tell 192.168.1.12
13	61.614599	Private_66:68:00	Private_66:68:01	ARP	64	192.168.1.11 is at 00:50:79:66:68:00
14	61.616298	192.168.1.12	192.168.1.11	ICMP	96	Echo (ping) request id=0x3341, seq=1/256, ttl=64 (reply in 15)
15	61.616941	192.168.1.11	192.168.1.12	ICMP	96	Echo (ping) reply id=0x3341, seq=1/256, ttl=64 (request in 14)
16	74.453887	192.168.1.12	192.168.1.11	ECHO	98	Request
17	74.454788	192.168.1.11	192.168.1.12	ECHO	98	Response
18	78.111146	192.168.1.12	192.168.1.11	TCP	74	17298 → 7 [SYN] Seq=0 Win=2920 Len=0 MSS=1460 TStamp=1761558852 TSecr=0..
19	78.111228	192.168.1.11	192.168.1.12	TCP	54	7 → 17298 [SYN, ACK] Seq=0 Ack=1 Win=2920 Len=0
20	78.113918	192.168.1.12	192.168.1.11	TCP	66	17298 → 7 [ACK] Seq=1 Ack=1 Win=2920 Len=0 TStamp=1761558852 TSecr=0
21	78.115400	192.168.1.12	192.168.1.11	ECHO	122	Request
22	78.115995	192.168.1.11	192.168.1.12	TCP	54	7 → 17298 [ACK] Seq=1 Ack=57 Win=2920 Len=0
23	78.119390	192.168.1.12	192.168.1.11	TCP	66	17298 → 7 [FIN, PSH, ACK] Seq=57 Ack=1 Win=2920 Len=0 TStamp=1761558852..
24	78.121334	192.168.1.11	192.168.1.12	TCP	54	7 → 17298 [ACK] Seq=1 Ack=58 Win=2920 Len=0
25	78.121380	192.168.1.11	192.168.1.12	TCP	54	7 → 17298 [FIN, ACK] Seq=1 Ack=58 Win=2920 Len=0
26	78.123690	192.168.1.12	192.168.1.11	TCP	66	17298 → 7 [ACK] Seq=58 Ack=2 Win=2920 Len=0 TStamp=1761558852 TSecr=0

> Frame 22: 54 bytes on wire (432 bits), 54 bytes captured (432 bits) on interface -, id 0
> Ethernet II, Src: Private_66:68:00 (00:50:79:66:68:00), Dst: Private_66:68:01 (00:50:79:66:68:01)
> Internet Protocol Version 4, Src: 192.168.1.11, Dst: 192.168.1.12

▼ Transmission Control Protocol, Src Port: 7, Dst Port: 17298, Seq: 1, Ack: 57, Len: 0

 Source Port: 7

 Destination Port: 17298

 [Stream index: 0]

 [Stream Packet Number: 5]

 > [Conversation completeness: Complete, WITH_DATA (31)]

 [TCP Segment Len: 0]

 Sequence Number: 1 (relative sequence number)

 Sequence Number (raw): 962961661

 [Next Sequence Number: 1 (relative sequence number)]

 Acknowledgment Number: 57 (relative ack number)

 Acknowledgment number (raw): 1816988663

 0101 ... = Header Length: 20 bytes (5)

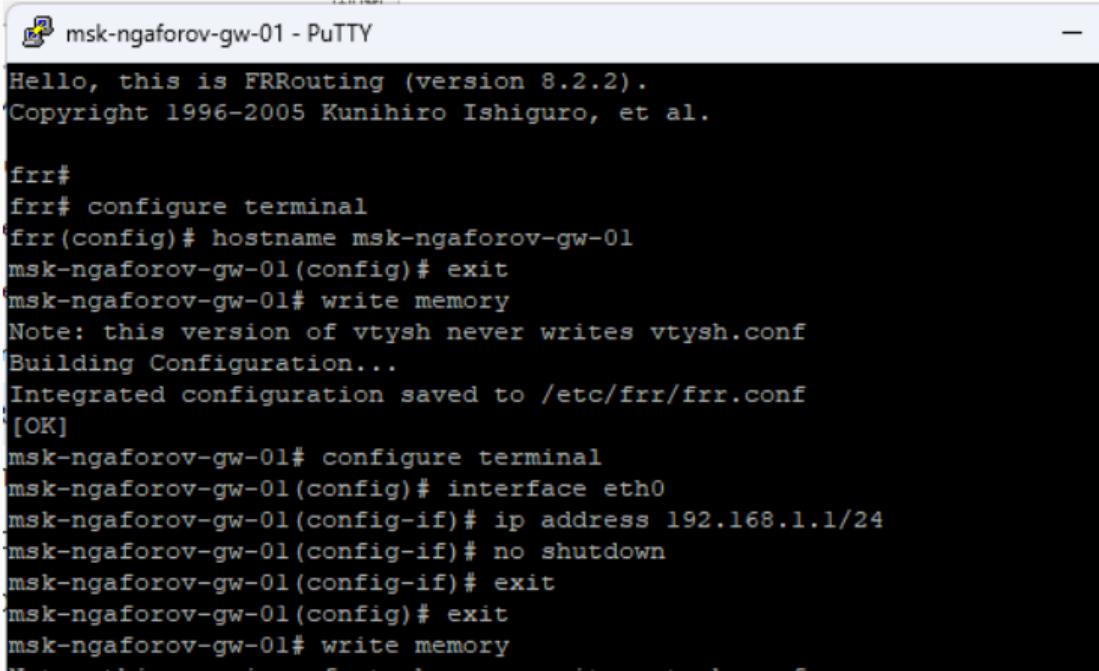
 > Flags: 0x0010 (ACK)

0000	00 50 79 66
0010	00 28 41 46
0020	01 0c 00 07
0030	0b 68 9e c3

Моделирование сети с FRR

Создана сеть с маршрутизатором FRR.

- PC1: IP 192.168.1.10/24
- FRR: интерфейс eth0 – 192.168.1.1/24



The screenshot shows a PuTTY terminal window titled "msk-ngaforov-gw-01 - PuTTY". The session is connected to a FRRouting device. The terminal displays the following configuration commands:

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

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

Проверка связи

Проверка ping 192.168.1.1 показала отсутствие потерь.

В Wireshark видны пакеты ARP и ICMP, что подтверждает корректную маршрутизацию.

No.	Time	Source	Destination	Protocol	Length	Info
12	181.361525	fe80::ec2:7cff:fe0a.. ff02::16		ICMPv6	90	Multicast Listener Report Message v2
13	181.741813	fe80::ec2:7cff:fe0a.. ff02::16		ICMPv6	90	Multicast Listener Report Message v2
14	181.802640	fe80::ec2:7cff:fe0a.. ff02::16		ICMPv6	150	Multicast Listener Report Message v2
15	217.559924	Private_66:68:00	Broadcast	ARP	64	Who has 192.168.1.1? Tell 192.168.1.10
16	217.565553	0c:c2:7c:0a:00:00	Private_66:68:00	ARP	60	192.168.1.1 is at 0c:c2:7c:0a:00:00
17	217.567202	192.168.1.10	192.168.1.1	ICMP	98	Echo (ping) request id=0x3a43, seq=1/256, ttl=64 (rep)
18	217.570148	192.168.1.1	192.168.1.10	ICMP	98	Echo (ping) reply id=0x3a43, seq=1/256, ttl=64 (req)
19	218.572339	192.168.1.10	192.168.1.1	ICMP	98	Echo (ping) request id=0xb43, seq=2/512, ttl=64 (rep)
20	218.573717	192.168.1.1	192.168.1.10	ICMP	98	Echo (ping) reply id=0xb43, seq=2/512, ttl=64 (req)
21	219.575856	192.168.1.10	192.168.1.1	ICMP	98	Echo (ping) request id=0x3c43, seq=3/768, ttl=64 (rep)
22	219.577190	192.168.1.1	192.168.1.10	ICMP	98	Echo (ping) reply id=0x3c43, seq=3/768, ttl=64 (req)
23	220.578974	192.168.1.10	192.168.1.1	ICMP	98	Echo (ping) request id=0xd43, seq=4/1024, ttl=64 (rep)
24	220.580321	192.168.1.1	192.168.1.10	ICMP	98	Echo (ping) reply id=0xd43, seq=4/1024, ttl=64 (req)
→	25 221.582242	192.168.1.10	192.168.1.1	ICMP	98	Echo (ping) request id=0xe43, seq=5/1280, ttl=64 (rep)
←	26 221.583207	192.168.1.1	192.168.1.10	ICMP	98	Echo (ping) reply id=0xe43, seq=5/1280, ttl=64 (req)
27	222.579565	0c:c2:7c:0a:00:00	Private_66:68:00	ARP	60	Who has 192.168.1.10? Tell 192.168.1.1
28	222.580170	Private_66:68:00	0c:c2:7c:0a:00:00	ARP	60	192.168.1.10 is at 00:50:79:66:68:00

> Frame 25: 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:c2:7c:0a:00:00 (0c:c2:7c:0a:00:00)
> Internet Protocol Version 4, Src: 192.168.1.10, Dst: 192.168.1.1
└ Internet Control Message Protocol
 Type: 8 (Echo (ping) request)
 Code: 0
 Checksum: 0xe1c3 [correct]
 [Checksum Status: Good]
 Identifier (BE): 15939 (0x3e43)
 Identifier (LE): 17214 (0x433e)
 Sequence Number (BE): 5 (0x0005)
 Sequence Number (LE): 1280 (0x0500)
 [Response frame: 26]
> Data (56 bytes)

0000	0c c2 7c 00
0010	00 54 43 3e
0020	01 01 08 06
0030	0e 0f 10 11
0040	1e 1f 20 21
0050	2e 2f 30 31
0060	3e 3f

Моделирование сети с VyOS

Создана аналогичная топология с маршрутизатором VyOS.

Задано имя устройства и IP-адрес 192.168.1.1/24 на интерфейсе eth0.

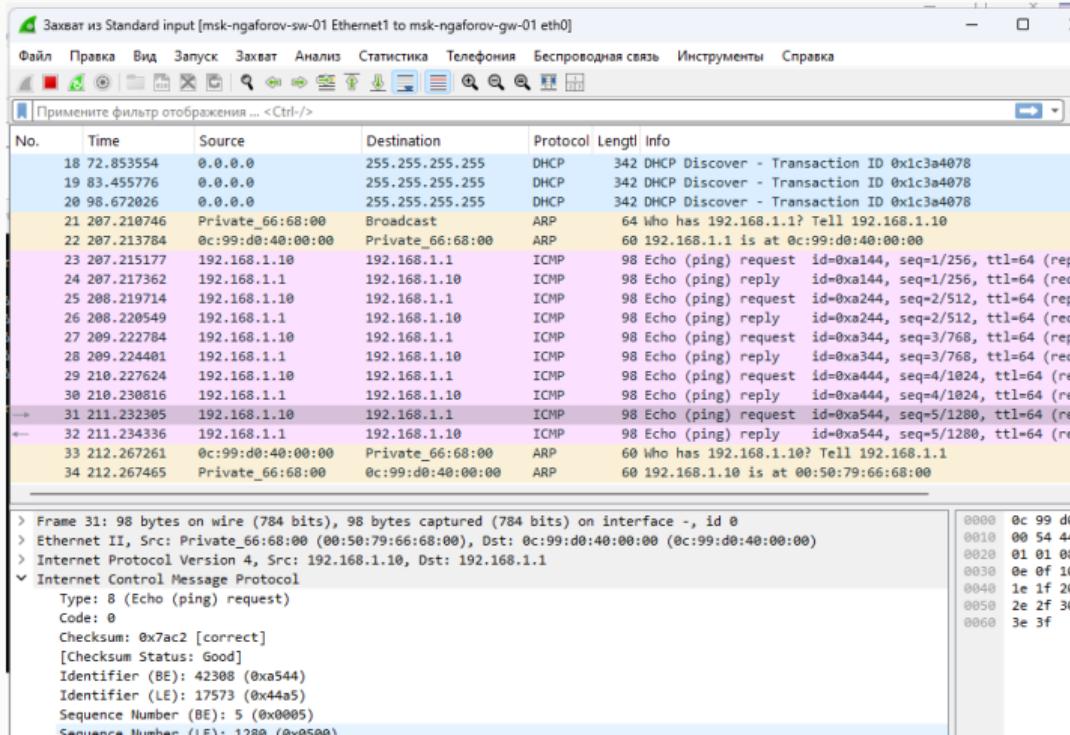
```
You can change this banner using "set system login banner post-login" command.

, 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# set system host-name msk-ngaforov-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-ngaforov-gw-01
[edit]
vyos@vyos#
```

Проверка ICMP-обмена

ПК успешно взаимодействует с маршрутизатором VyOS через ICMP-запросы.

Трафик фиксируется в Wireshark, что подтверждает правильность конфигурации сети.



Выводы

Выводы

В ходе лабораторной работы:

- Изучены принципы настройки сетей в **GNS3**.
- Проверена работа протоколов ARP, ICMP, UDP, TCP.
- Освоены базовые приёмы анализа трафика в **Wireshark**.
- Подтверждена корректность установки TCP-соединений по схеме **Three-Way Handshake**.

Результаты подтвердили надёжную работу сетевых протоколов и правильность построения модели сети.