

Лабораторная работа №5

Простые сети в GNS3. Анализ трафика

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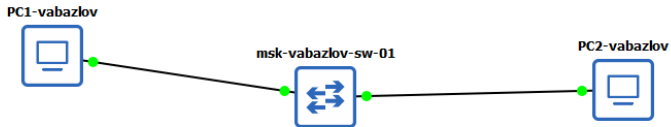
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Цель работы

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

- 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> ?

?                               Print help
arp                             Shortcut for: show arp. Show arp table
clear ARG                      Clear IPv4/IPv6, arp/neighbor cache, command history
dhcp [OPTION]                  Shortcut for: ip dhcp. Get IPv4 address via DHCP
disconnect                     Exit the telnet session (daemon 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 ...                  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

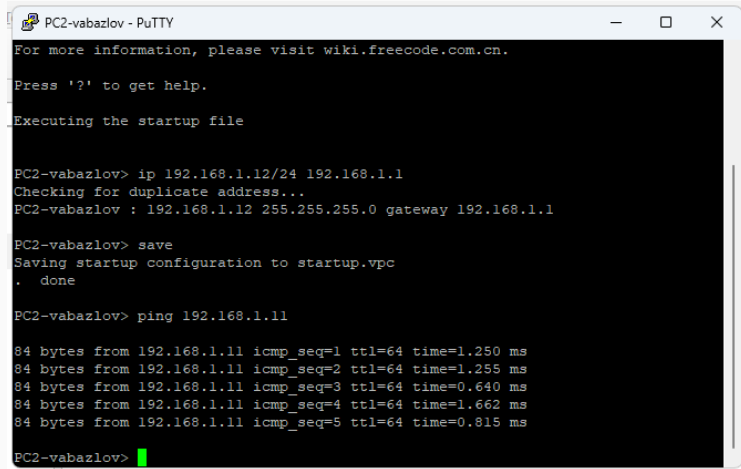
To get command syntax help, please enter '?' as an argument of the command.

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

PC1-vabazlov>
```

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

- 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: 0000000000000000000000000000000000
 - 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

- 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	73.565708	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 TSval=1764748969 TSecr=0 WS=2
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 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 (0x0800)

[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: 0x001c [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 0b 08 00 80
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	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	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 TSval=17647488
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 TSval=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 (0x0800)
[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: 0xeea5 (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

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

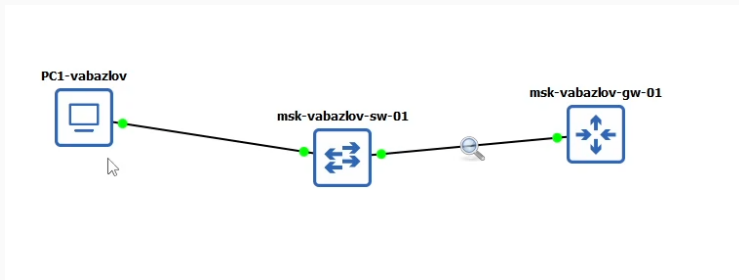


Рис. 6: Топология FRR

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

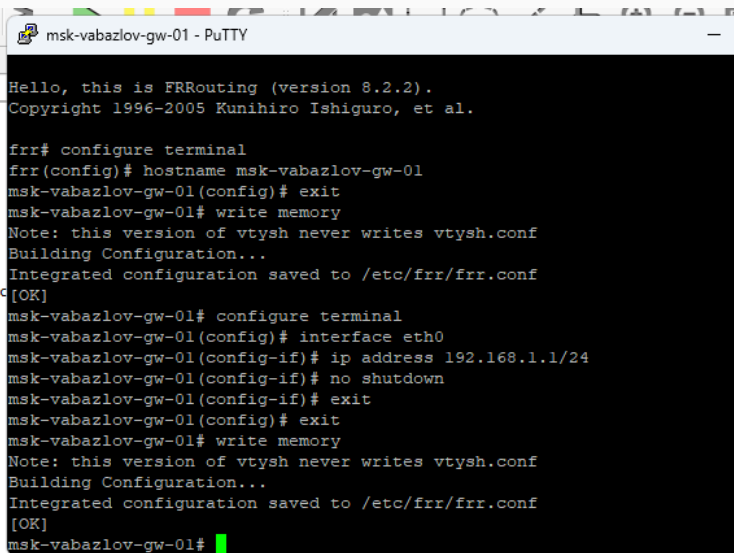
PC1-vabazlov> show ip

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



```
msk-vabazlov-gw-01 - PuTTY

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	0000	0c 19 91
> 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)	0010	00 54 f0
▼ Internet Protocol Version 4, Src: 192.168.1.10, Dst: 192.168.1.1	0020	01 01 08
0100 = Version: 4	0030	0e 0f 10
.... 0101 = Header Length: 20 bytes (5)	0040	1e 1f 20
> Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)	0050	2e 2f 30
Total Length: 84	0060	3e 3f
Identification: 0xf0f7 (61687)		
> 000. = Flags: 0x0		
...0 0000 0000 0000 = Fragment Offset: 0		
Time to Live: 64		
Protocol: ICMP (1)		
Header Checksum: 0x0656 [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

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

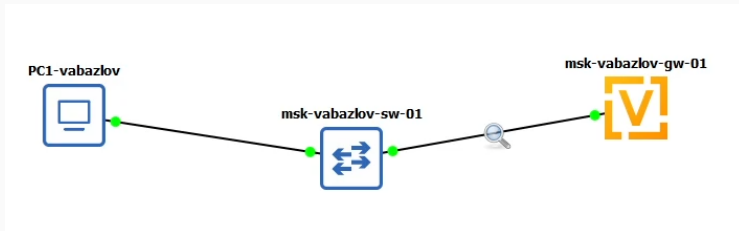


Рис. 10: Топология VyOS

```
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

```
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  
6 PC1-vabazlov> █
```

Рис. 12: Пинг VyOS

Итоги работы

- 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