
Лабораторная работа №1. Введение в Mininet

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Цель работы

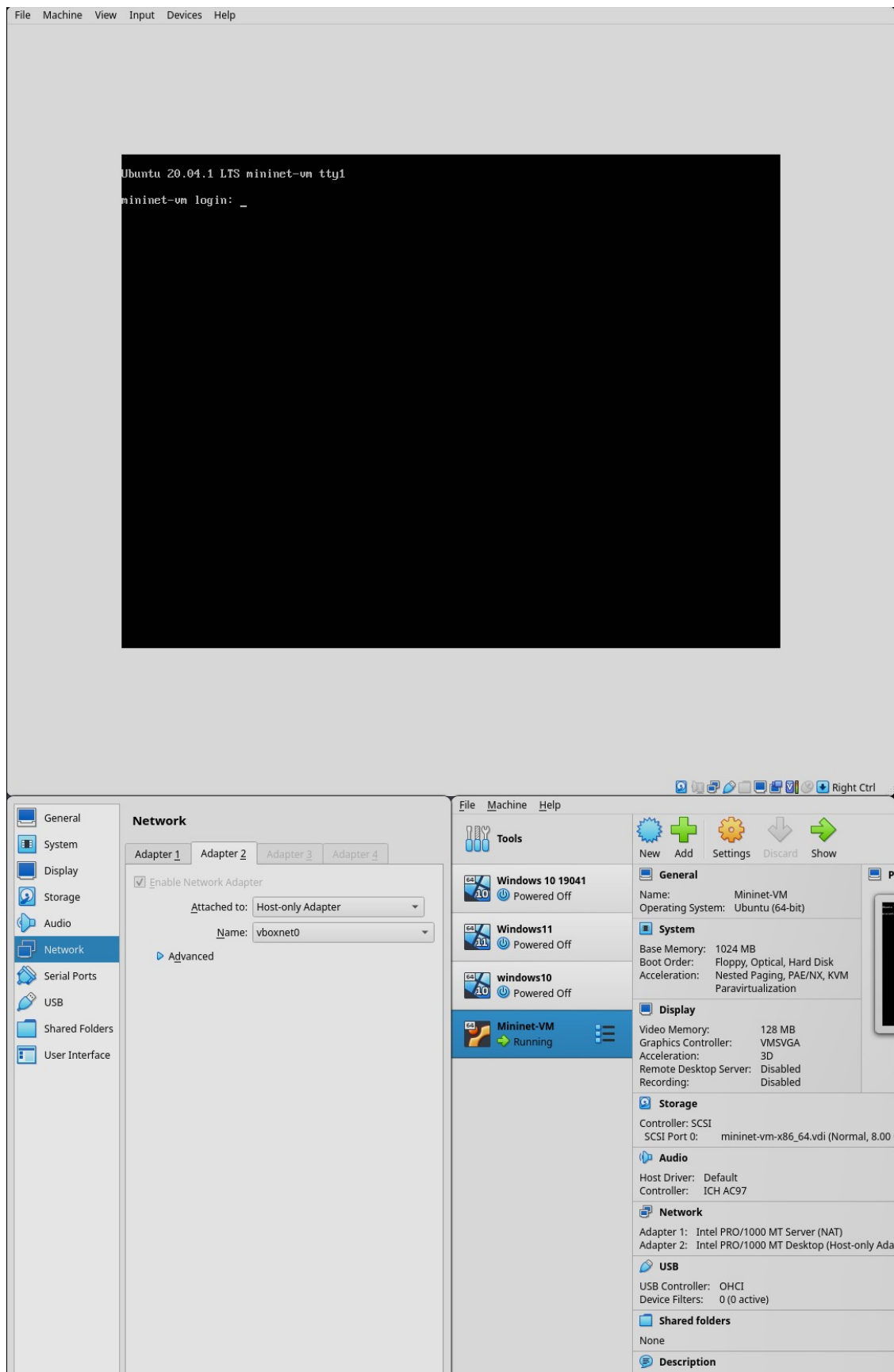
Основной целью работы является развёртывание в системе виртуализации (например, в VirtualBox) mininet, знакомство с основными командами для работы с Mininet через командную строку и через графический интерфейс.

Теоретическое введение

Mininet (<http://mininet.org/>) — это виртуальная среда, которая позволяет разрабатывать и тестировать сетевые инструменты и протоколы. В сетях Mininet работают реальные сетевые приложения Unix/Linux, а также реальное ядро Linux и сетевой стек.

Выполнение лабораторной работы

1. Настройка и первый запуск VM Mininet.



Настройка и первый запуск VM Mininet

2. Подключение к VM по ssh

```
~ via @ v22.11.0
) ssh -Y mininet@192.168.56.101
The authenticity of host '192.168.56.101 (192.168.56.101)' can't be established.
ED25519 key fingerprint is SHA256:yn+zKf54ZJplqx+24t0VcQCv18w74JrC00bafDPntHA.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])?
Host key verification failed.

~ via @ v22.11.0
) ssh -Y mininet@192.168.56.101
The authenticity of host '192.168.56.101 (192.168.56.101)' can't be established.
ED25519 key fingerprint is SHA256:yn+zKf54ZJplqx+24t0VcQCv18w74JrC00bafDPntHA.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '192.168.56.101' (ED25519) to the list of known hosts.
mininet@192.168.56.101's password:
Warning: No xauth data; using fake authentication data for X11 forwarding.
Welcome to Ubuntu 20.04.1 LTS (GNU/Linux 5.4.0-42-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:       https://ubuntu.com/advantage

Failed to connect to https://changelogs.ubuntu.com/meta-release-lts. Check your Internet connection or proxy settings

Last login: Fri Nov 15 12:59:22 2024
/usr/bin/xauth: file /home/mininet/.Xauthority does not exist
mininet@mininet-vm:~$
```

Подключение к VM по ssh

3. Настройка сети.

```
mininet@mininet-vm:~$ ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 192.168.56.101 netmask 255.255.255.0 broadcast 192.168.56.255
    ether 08:00:27:a4:ab:97 txqueuelen 1000 (Ethernet)
    RX packets 316 bytes 48296 (48.2 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 325 bytes 53892 (53.8 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    loop txqueuelen 1000 (Local Loopback)
    RX packets 288 bytes 22072 (22.0 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 288 bytes 22072 (22.0 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

mininet@mininet-vm:~$ sudo dhclient eth1
mininet@mininet-vm:~$ ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 192.168.56.101 netmask 255.255.255.0 broadcast 192.168.56.255
    ether 08:00:27:a4:ab:97 txqueuelen 1000 (Ethernet)
    RX packets 379 bytes 53534 (53.5 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 358 bytes 58122 (58.1 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

eth1: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 10.0.2.15 netmask 255.255.255.0 broadcast 10.0.2.255
    ether 08:00:27:ba:7c:31 txqueuelen 1000 (Ethernet)
    RX packets 2 bytes 1180 (1.1 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 2 bytes 684 (684.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    loop txqueuelen 1000 (Local Loopback)
    RX packets 288 bytes 22072 (22.0 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 288 bytes 22072 (22.0 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

mininet@mininet-vm:~$
```

Настройка сети

4. Настройка 01-netcfg.yaml

```
# This file describes the network interfaces available on your system
# For more information, see netplan(5).
network:
  version: 2
  renderer: networkd
  ethernets:
    eth0:
      dhcp4: yes
    eth1:
      dhcp4: yes
```

Настройка 01-netcfg.yaml

5. Обновление Mininet

```
Processing triggers for hicolor-icon-theme (0.17-2) ...
Processing triggers for libc-bin (2.31-0ubuntu9) ...
mininet@mininet-vm:~$ sudo mcedit /etc/netplan/01-netcfg.yaml

mininet@mininet-vm:~$ sudo vim /etc/netplan/01-netcfg.yaml
mininet@mininet-vm:~$ mv ~/mininet ~/mininet.orig
mv: missing destination file operand after '/home/mininet/mininet~/mininet.orig'
Try 'mv --help' for more information.
mininet@mininet-vm:~$ mv ~/mininet ~/mininet.orig
mininet@mininet-vm:~$ cd ~
mininet@mininet-vm:~$ git clone https://github.com/mininet/mininet.git
Cloning into 'mininet'...
remote: Enumerating objects: 10388, done.
remote: Counting objects: 100% (234/234), done.
remote: Compressing objects: 100% (140/140), done.
remote: Total 10388 (delta 129), reused 174 (delta 92), pack-reused 10154 (from 1)
Receiving objects: 100% (10388/10388), 3.36 MiB | 5.09 MiB/s, done.
Resolving deltas: 100% (6911/6911), done.
mininet@mininet-vm:~$ cd mininet
mininet@mininet-vm:~/mininet$ ls
bin          custom      doc          INSTALL      Makefile     mnexec.c     setup.py
CONTRIBUTORS  debian     examples    LICENSE      mininet      README.md    util
mininet@mininet-vm:~/mininet$ sudo make install
cc -Wall -Wextra \
-DVERSION=\"PYTHONPATH=. python -B bin/mn --version 2>&1\" mnexec.c -o mnexec
install -D mnexec /usr/bin/mnexec
PYTHONPATH=. help2man -N -n "create a Mininet network." \
--no-discard-stderr "python -B bin/mn" -o mn.1
help2man -N -n "execution utility for Mininet." \
-h "-h" -v "-v" --no-discard-stderr ./mnexec -o mnexec.1
install -D -t /usr/share/man/man1 mn.1 mnexec.1
python -m pip uninstall -y mininet || true
Found existing installation: mininet 2.3.0
Uninstalling mininet-2.3.0:
  Successfully uninstalled mininet-2.3.0
python -m pip install .
Processing /home/mininet/mininet
Requirement already satisfied: setuptools in /usr/lib/python3/dist-packages (from mininet==2.3.1b4) (45.2.0)
Building wheels for collected packages: mininet
  Building wheel for mininet (setup.py) ... done
  Created wheel for mininet: filename=mininet-2.3.1b4-py3-none-any.whl size=160942 sha256=09298534617cc87321707407d671da7ccee8bf665088b9b75d36ca2aec598cc9
  Stored in directory: /tmp/pip-ephem-wheel-cache-sx7h_08h/wheels/cd/7d/a7/aafe1b3eaff31efd6ba4e2ea6c9690a717bdf739db6cfe8d45
Successfully built mininet
Installing collected packages: mininet
Successfully installed mininet-2.3.1b4
mininet@mininet-vm:~/mininet$ mn --version
2.3.1b4
mininet@mininet-vm:~/mininet$
```

Обновление Mininet

6. Настройка xterm

```
! Depending on your environment, you may wish to disable those by default by
! uncommenting one or more of the resource settings below:
!*allowFontOps: false
!*allowTcapOps: false
!*allowTitleOps: false
!*allowWindowOps: false

xterm*faceName: Monospace
xterm*faceSize: 12
mininet@mininet-vm:~/mininet$ xauth list $DISPLAY
mininet-vm/unix:10 MIT-MAGIC-COOKIE-1 31c4bc765b44837cc92ac61e8b3eb7dd
mininet@mininet-vm:~/mininet$ sudo -i
root@mininet-vm:~# xauth list
xauth: file /root/.Xauthority does not exist
root@mininet-vm:~# auth add mininet-vm/unix:10

Command 'auth' not found, did you mean:

  command 'xauth' from deb xauth (1:1.1-0ubuntu1)
  command 'iauth' from deb ircd-irc2 (2.11.2p3~dfsg-5build1)
  command 'oauth' from deb ruby-oauth (0.5.4-1)

Try: apt install <deb name>

root@mininet-vm:~# xauth add mininet-vm/unix:10
xauth: file /root/.Xauthority does not exist
xauth: (argv):1: bad "add" command line
root@mininet-vm:~# xauth add mininet-vm/unix:10 MIT-MAGIC-COOKIE-1 31c4bc765b44837cc92ac61e8b3eb7dd
xauth: file /root/.Xauthority does not exist
root@mininet-vm:~# ^C
root@mininet-vm:~# touch /root/.Xauthority
root@mininet-vm:~# xauth add mininet-vm/unix:10 MIT-MAGIC-COOKIE-1 31c4bc765b44837cc92ac61e8b3eb7dd
root@mininet-vm:~# xauth list $DISPLAY
mininet-vm/unix:10 MIT-MAGIC-COOKIE-1 31c4bc765b44837cc92ac61e8b3eb7dd
root@mininet-vm:~#
```

Настройка xterm

7. Основы работы с Mininet

```
mininet@mininet-vm:~/mininet$ sudo mn
*** Creating network
*** Adding controller
*** Adding hosts:
h1 h2
*** Adding switches:
s1
*** Adding links:
(h1, s1) (h2, s1)
*** Configuring hosts
h1 h2
*** Starting controller
c0
*** Starting 1 switches
s1 ...
*** Starting CLI:
mininet> help

Documented commands (type help <topic>):
=====
EOF      gterm  iperfudp  nodes      pingpair    py      switch  xterm
dpctl    help   link      noecho     pingpairfull  quit    time
dump     intfs  links     pingall    ports       sh      wait
exit     iperf  net       pingallfull  px          source  x

You may also send a command to a node using:
  <node> command {args}
For example:
  mininet> h1 ifconfig

The interpreter automatically substitutes IP addresses
for node names when a node is the first arg, so commands
like
  mininet> h2 ping h3
should work.

Some character-oriented interactive commands require
noecho:
  mininet> noecho h2 vi foo.py
However, starting up an xterm/gterm is generally better:
  mininet> xterm h2

mininet> nodes
available nodes are:
c0 h1 h2 s1
mininet> net
h1 h1-eth0:s1-eth1
h2 h2-eth0:s1-eth2
s1 lo: s1-eth1:h1-eth0 s1-eth2:h2-eth0
c0
mininet> 
```

Основы работы с Mininet

8. Проверка связности

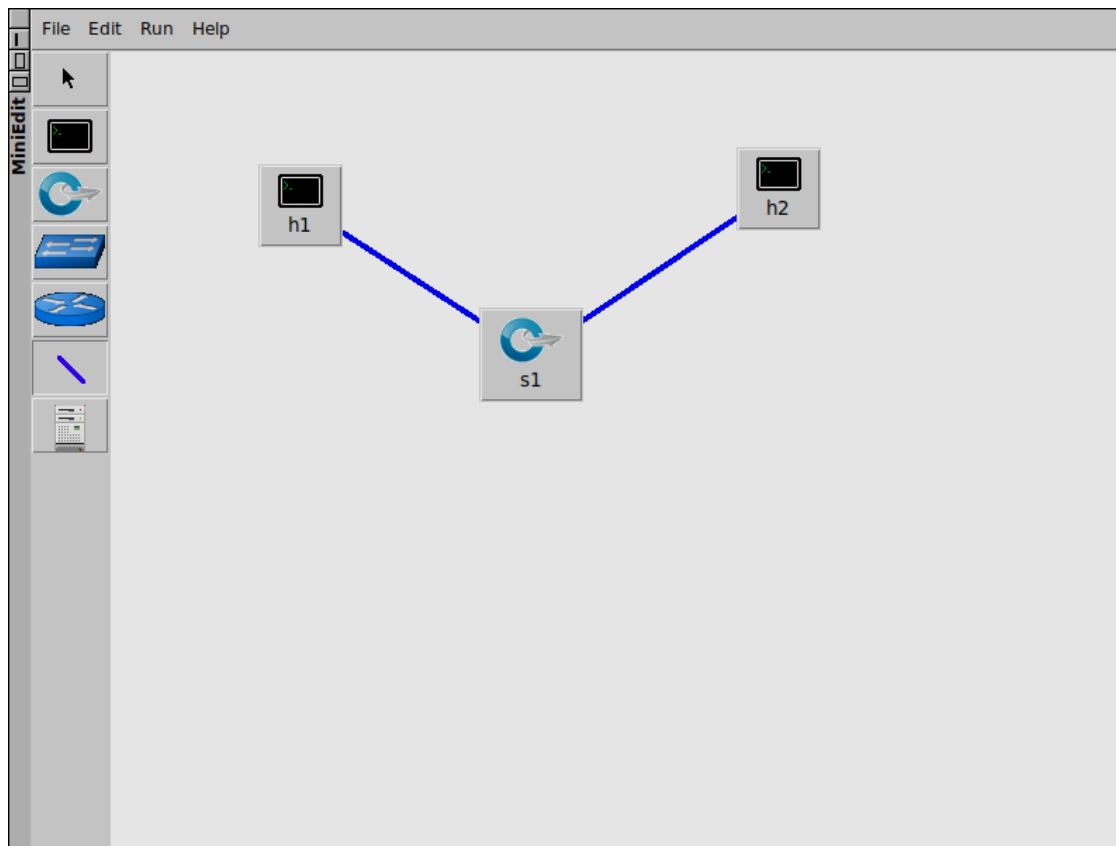
```
mininet> h1 ifconfig
h1-eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 10.0.0.1 netmask 255.0.0.0 broadcast 10.255.255.255
    ether a6:65:96:89:9b:50 txqueuelen 1000 (Ethernet)
    RX packets 0 bytes 0 (0.0 B)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 0 bytes 0 (0.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    loop txqueuelen 1000 (Local Loopback)
    RX packets 0 bytes 0 (0.0 B)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 0 bytes 0 (0.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

mininet> h1 ping 10.0.0.2
PING 10.0.0.2 (10.0.0.2) 56(84) bytes of data.
64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=0.915 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=0.095 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.028 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=0.031 ms
64 bytes from 10.0.0.2: icmp_seq=5 ttl=64 time=0.035 ms
^C
--- 10.0.0.2 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4100ms
rtt min/avg/max/mdev = 0.028/0.220/0.915/0.347 ms
mininet> exit
*** Stopping 1 controllers
c0
*** Stopping 2 links
..
*** Stopping 1 switches
s1
*** Stopping 2 hosts
h1 h2
*** Done
completed in 99.041 seconds
mininet@mininet-vm:~/mininet$
```

Проверка связности

9. Топология сети



Топология сети

10. ifconfig на хостах

```
root@mininet-vm:/home/mininet# ifconfig
h1-eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 10.0.0.1 netmask 255.0.0.0 broadcast 10.255.255.255
    ether 5e:6b:60:fe:07:97 txqueuelen 1000 (Ethernet)
    RX packets 0 bytes 0 (0.0 B)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 6 bytes 252 (252.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    loop txqueuelen 1000 (Local Loopback)
    RX packets 6 bytes 672 (672.0 B)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 6 bytes 672 (672.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

root@mininet-vm:/home/mininet# ping 10.0.0.2
PING 10.0.0.2 (10.0.0.2) 56(84) bytes of data.
From 10.0.0.1 icmp_seq=1 Destination Host Unreachable
From 10.0.0.1 icmp_seq=2 Destination Host Unreachable
From 10.0.0.1 icmp_seq=3 Destination Host Unreachable
From 10.0.0.1 icmp_seq=4 Destination Host Unreachable
From 10.0.0.1 icmp_seq=5 Destination Host Unreachable
```

ifconfig на h1

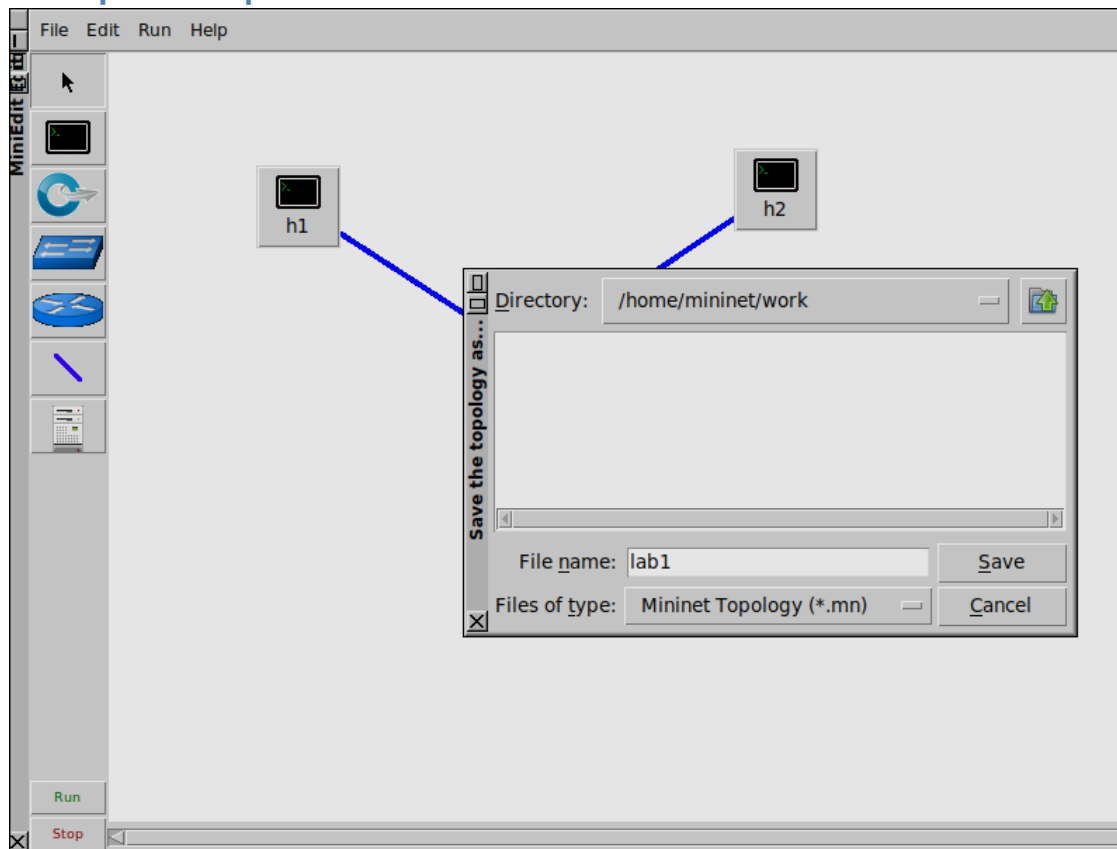
11. ifconfig на h1 после автоматического назначения айпи адресов

```
root@mininet-vm:/home/mininet# ifconfig
h1-eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 15.0.0.1 netmask 255.0.0.0 broadcast 15.255.255.255
    ether 72:7d:fc:56:1b:0b txqueuelen 1000 (Ethernet)
    RX packets 0 bytes 0 (0.0 B)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 0 bytes 0 (0.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    loop txqueuelen 1000 (Local Loopback)
    RX packets 0 bytes 0 (0.0 B)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 0 bytes 0 (0.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
```

ifconfig на h1

12. Сохранение работы



Сохранение работы

Выводы

Я успешно развернул mininet в среде виртуализации VirtualBox и познакомился с основными командами работы с Mininet через командную оболочку и графический интерфейс.