

High-speed Networks, Cybersecurity, and Software-defined Networking Workshop

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2020 Western Academy Support and Training Conference
Summer Conference
June 15 – June 19

Lab 1: Introduction to Mininet

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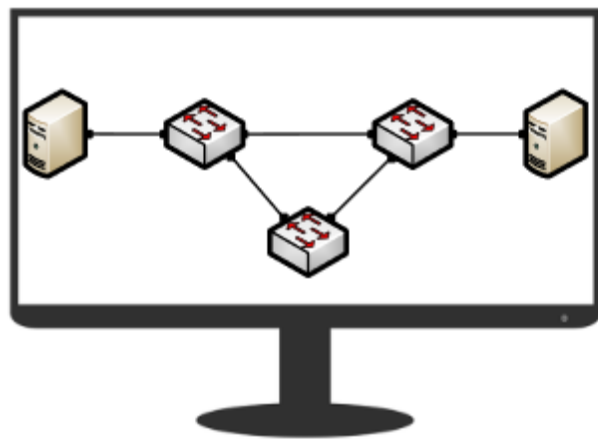
Section 1: Introduction to Mininet

Mininet

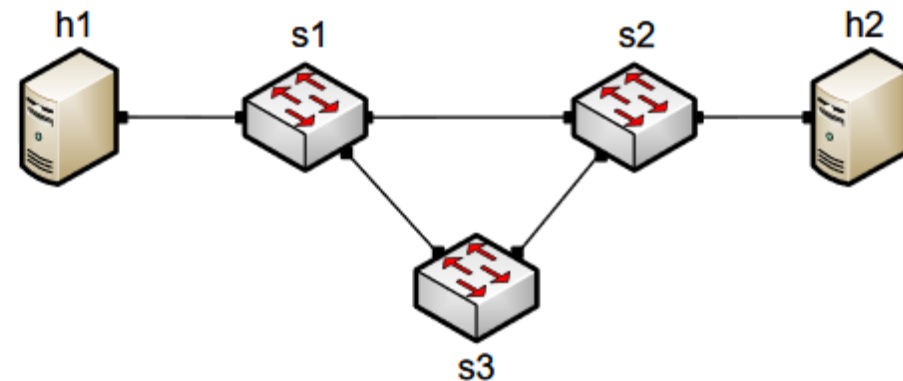
- Mininet is a virtual testbed enabling the development and testing of network tools and protocols
- It creates a realistic virtual network on any type of machine (VM, cloud-hosted, or native)
- It is an inexpensive solution and streamlined development running in line with production networks
- Mininet offers the following features
 - Fast prototyping for new networking protocols
 - Simplified testing for complex topologies without the need of buying expensive hardware
 - Realistic execution as it runs real code on the Unix and Linux kernels
 - Open source environment backed by a large community contributing extensive documentation
- Mininet is useful for development, teaching, and research
- Originally designed to experiment with Software-Defined Networking (SDN)

Mininet

- Mininet provides network *emulation* opposed to simulation, allowing all network software at any layer to be simply run as is
- Mininet's logical nodes can be connected into networks
- Nodes are sometimes called containers, or more accurately, *network namespaces*
- Containers consume sufficiently few resources that networks of over a thousand nodes have been created, running on a single laptop



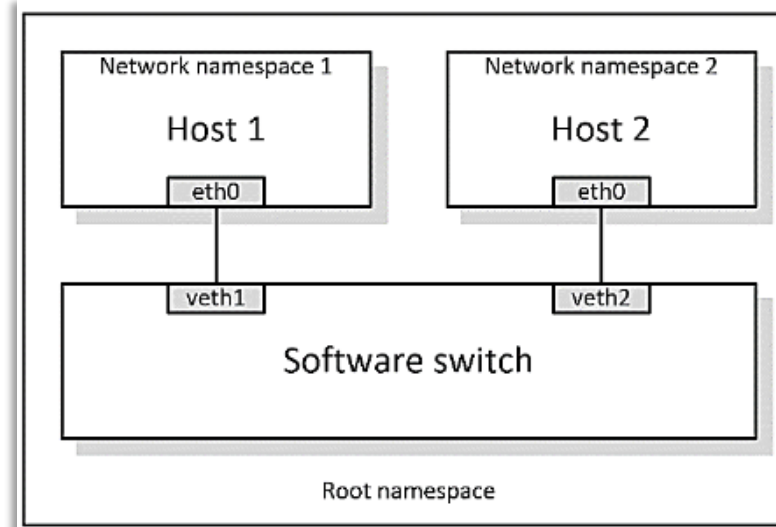
Mininet Emulated Network



Hardware Network

Mininet Nodes

- A Mininet container is a process (or group of processes) that no longer has access to all the host system's native network interfaces
- Containers are then assigned virtual Ethernet interfaces, which are connected to other containers through a virtual switch
- Mininet connects a host and a switch using a virtual Ethernet (veth) link
- The veth link is analogous to a wire connecting two virtual interfaces

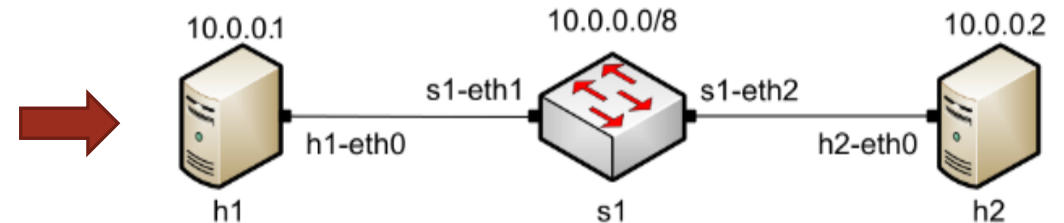


Section 2: Invoking Mininet using the CLI

Starting Mininet using the CLI

- To start a minimal topology, enter the command `sudo mn` at the CLI

```
admin@admin-pc:~$ sudo mn
[sudo] password for admin:
*** No default OpenFlow controller found for default switch
*** Falling back to OVS Bridge
*** Creating network
*** Adding controller
*** Adding hosts:
h1 h2
*** Adding switches:
s1
*** Adding links:
(h1, s1) (h2, s1)
*** Configuring hosts
h1 h2
*** Starting controller
*** Starting 1 switches
s1 ...
*** Starting CLI:
mininet>
```



Useful Commands

- To display the available nodes, type *nodes*

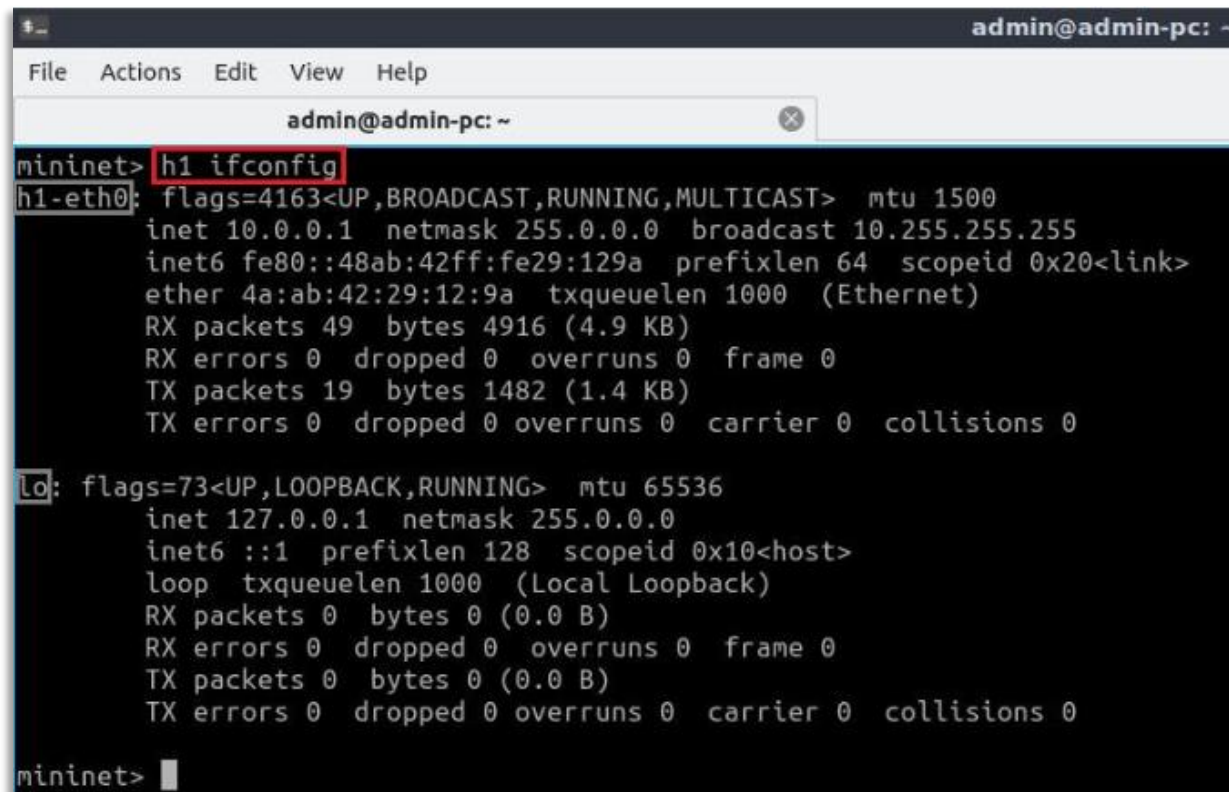
```
admin@admin-pc: ~
mininet> nodes
available nodes are:
h1 h2 s1
mininet>
```

- To display the links between the devices, type *net*

```
admin@admin-pc: ~
mininet> net
h1 h1-eth0:s1-eth1
h2 h2-eth0:s1-eth2
s1 lo: s1-eth1:h1-eth0 s1-eth2:h2-eth0
mininet>
```

Useful Commands

- To execute commands at a specific device, type the device first, followed by the command
- For example, to execute the command `ifconfig` on host `h1`, type `h1 ifconfig`



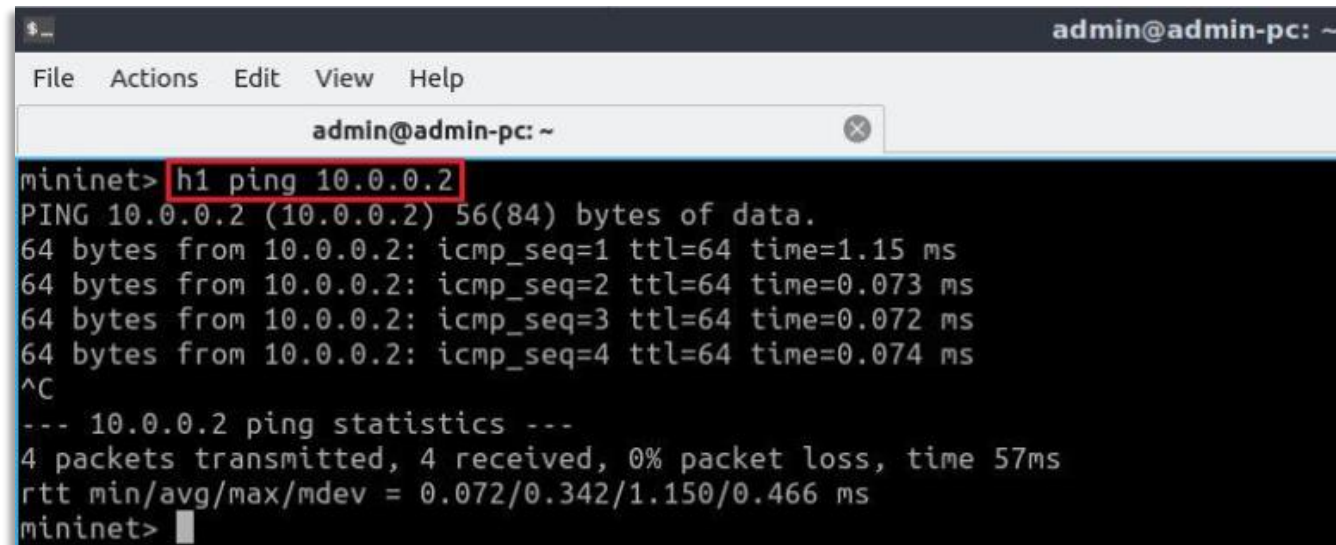
```
admin@admin-pc: ~
File Actions Edit View Help
admin@admin-pc: ~
mininet> h1 ifconfig
h1-eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
inet 10.0.0.1 netmask 255.0.0.0 broadcast 10.255.255.255
inet6 fe80::48ab:42ff:fe29:129a prefixlen 64 scopeid 0x20<link>
ether 4a:ab:42:29:12:9a txqueuelen 1000 (Ethernet)
RX packets 49 bytes 4916 (4.9 KB)
RX errors 0 dropped 0 overruns 0 frame 0
TX packets 19 bytes 1482 (1.4 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
inet6 ::1 prefixlen 128 scopeid 0x10<host>
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> █
```

Useful Commands

- To test connectivity between end-hosts, use the *ping* command.
- Type *h1 ping 10.0.0.2* to test the connectivity between host h1 and host h2 (10.0.0.2)

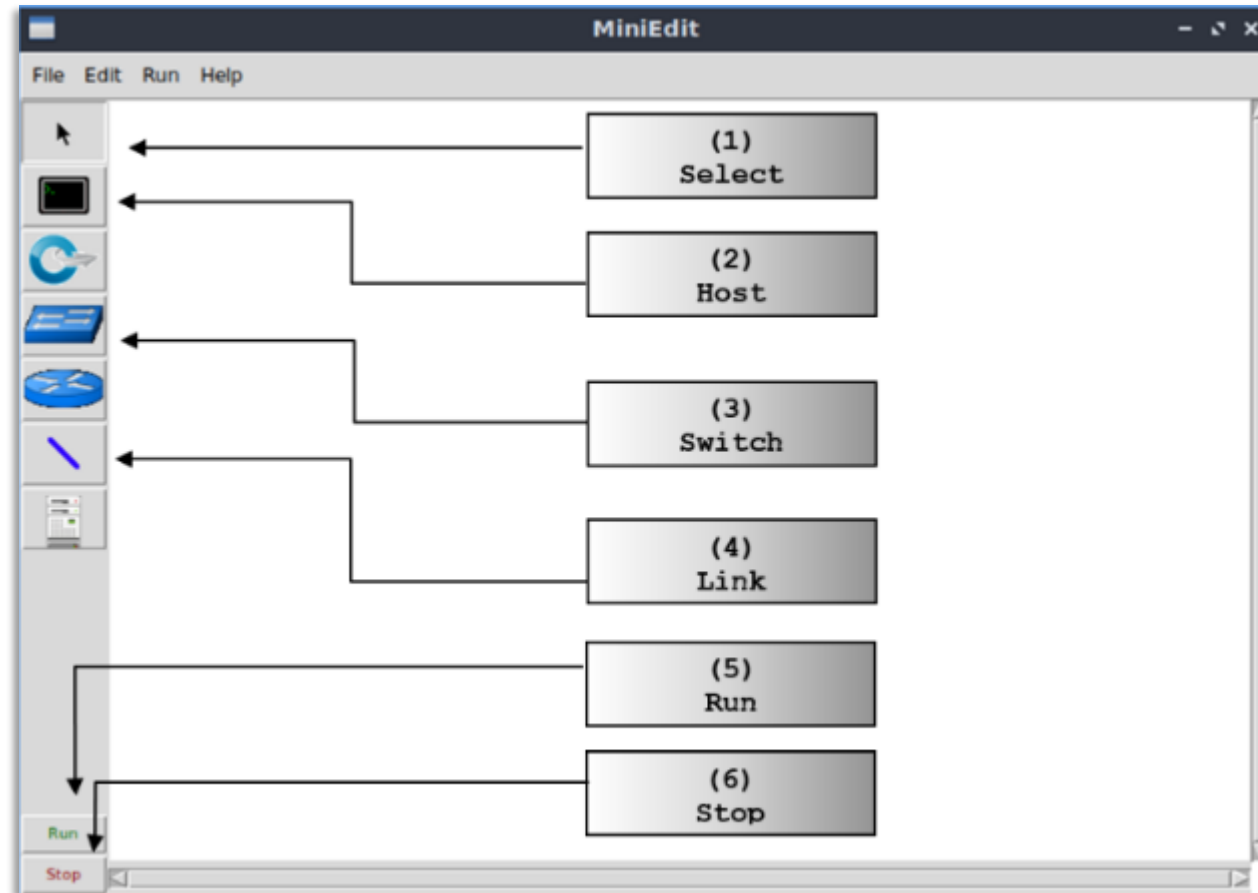


```
admin@admin-pc: ~
File Actions Edit View Help
admin@admin-pc: ~
mininet> h1 ping 10.0.0.2
PING 10.0.0.2 (10.0.0.2) 56(84) bytes of data.
64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=1.15 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=0.073 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.072 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=0.074 ms
^C
--- 10.0.0.2 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 57ms
rtt min/avg/max/mdev = 0.072/0.342/1.150/0.466 ms
mininet> █
```

Section 3: Building and emulating a network in Mininet using the GUI

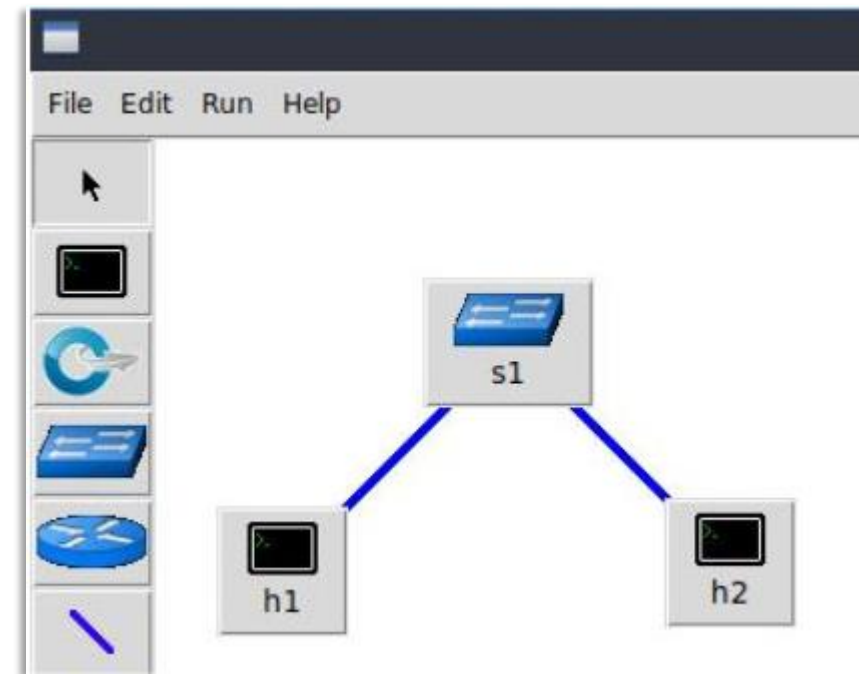
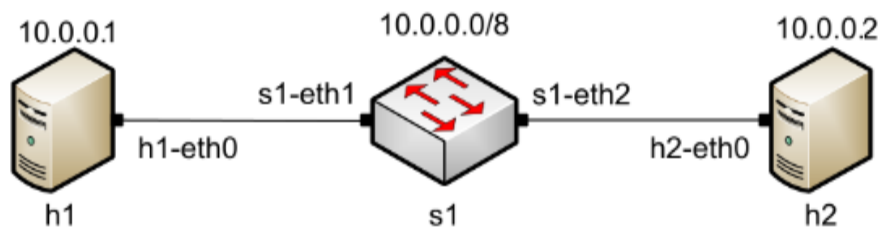
MiniEdit

- MiniEdit is a simple GUI network editor for Mininet



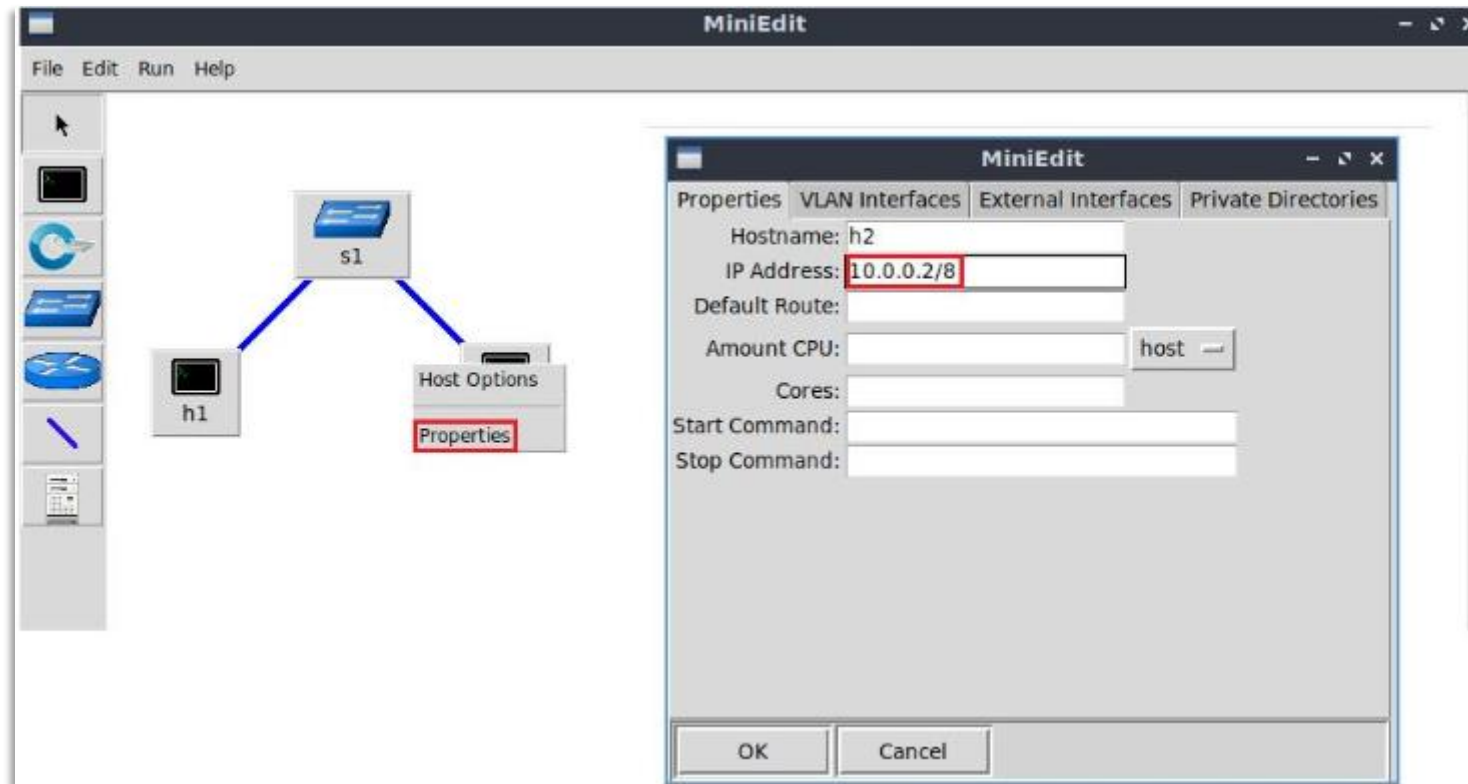
MiniEdit

- To build Mininet's minimal topology, two hosts and one switch must be deployed



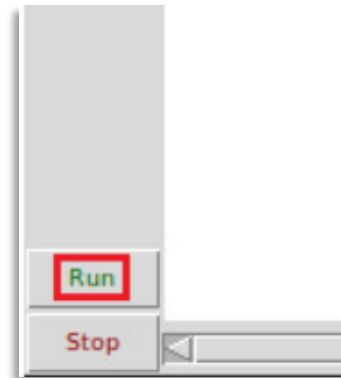
Host Configuration

- Configure the IP addresses at host h1 and host h2
- A host can be configured by holding the right click and selecting properties on the device



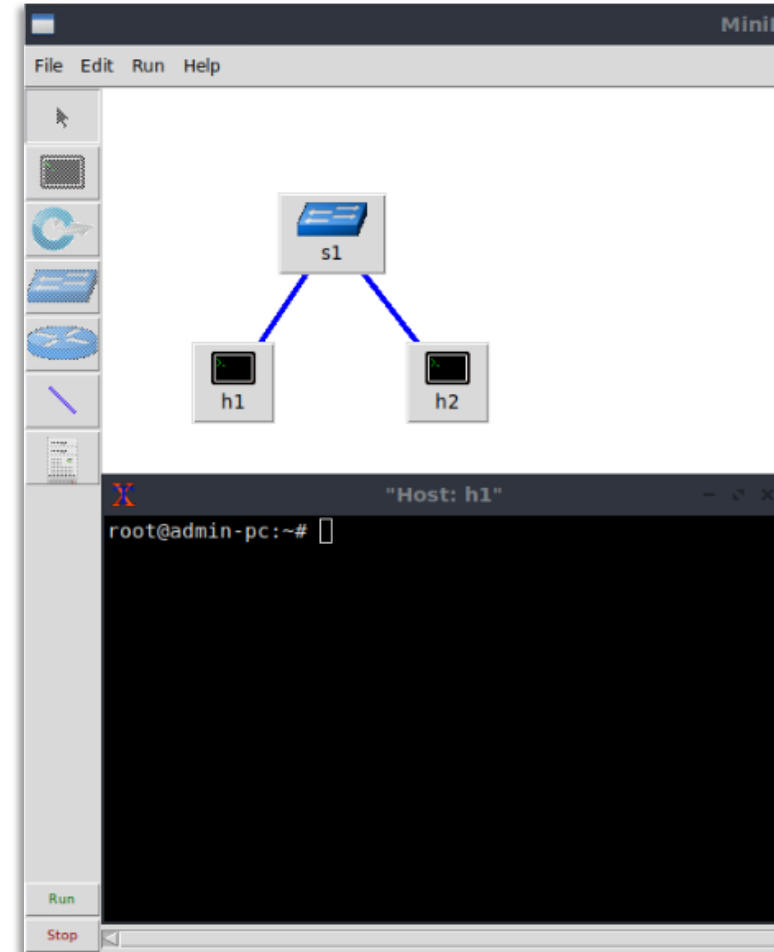
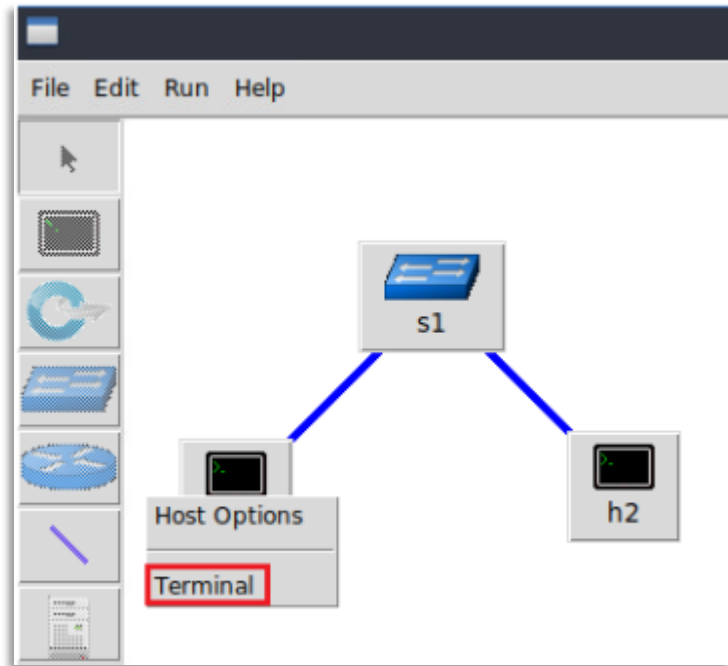
Starting Emulation

- Before testing the connection between host h1 and host h2, the emulation must be started
- Click on the Run button to start the emulation
- The emulation will start and the buttons of the MiniEdit panel will gray out, indicating that they are currently disabled



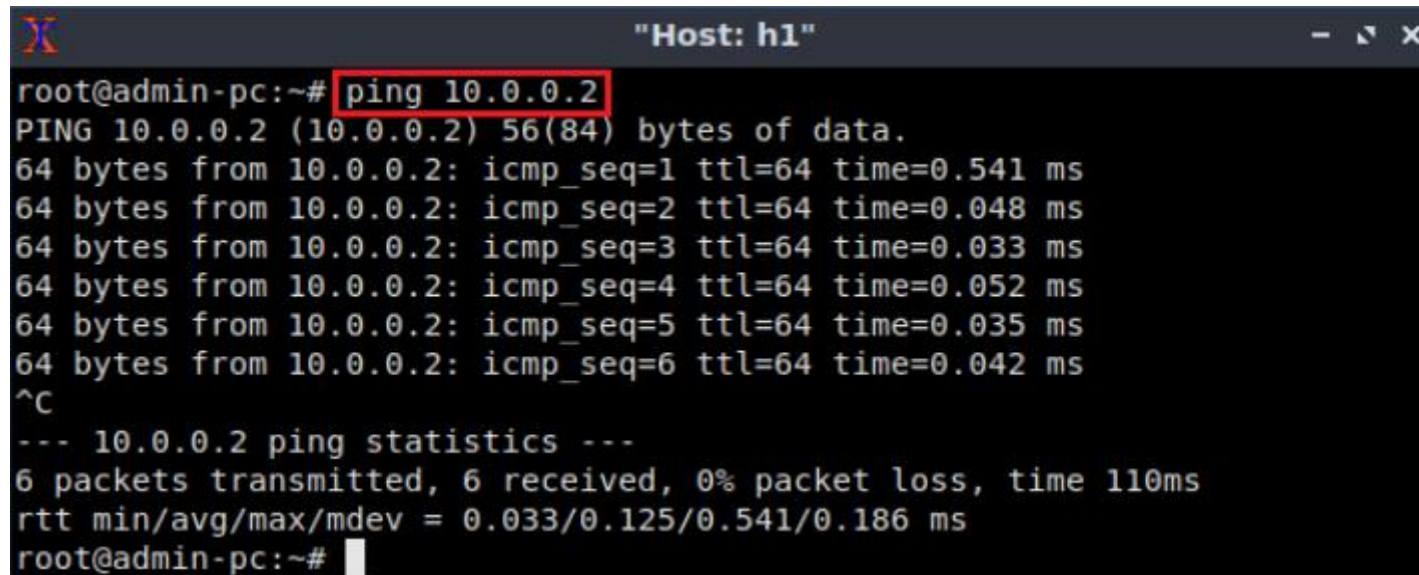
Executing Commands on Hosts

- Open a terminal on host by holding the right click and selecting *Terminal*



Testing Connectivity

- On host h1's terminal, type the command `ping 10.0.0.2`



```
root@admin-pc:~# 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=0.541 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=0.048 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.033 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=0.052 ms
64 bytes from 10.0.0.2: icmp_seq=5 ttl=64 time=0.035 ms
64 bytes from 10.0.0.2: icmp_seq=6 ttl=64 time=0.042 ms
^C
--- 10.0.0.2 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 110ms
rtt min/avg/max/mdev = 0.033/0.125/0.541/0.186 ms
root@admin-pc:~#
```

Stopping Emulation

- Stopping the emulation removes:
 - Network namespaces (nodes)
 - Virtual interfaces
 - Links between switches and hosts
- Stops the virtual switches instances
- Stop the emulation by clicking on the *Stop* button

