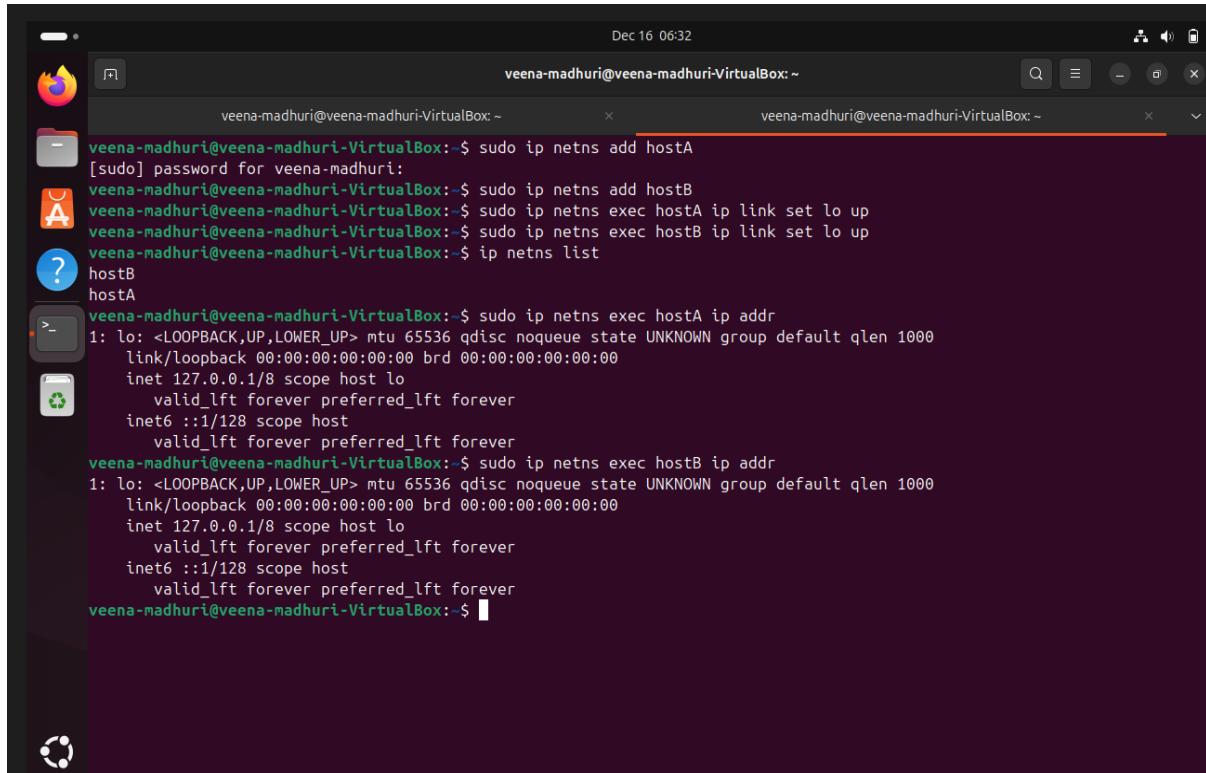


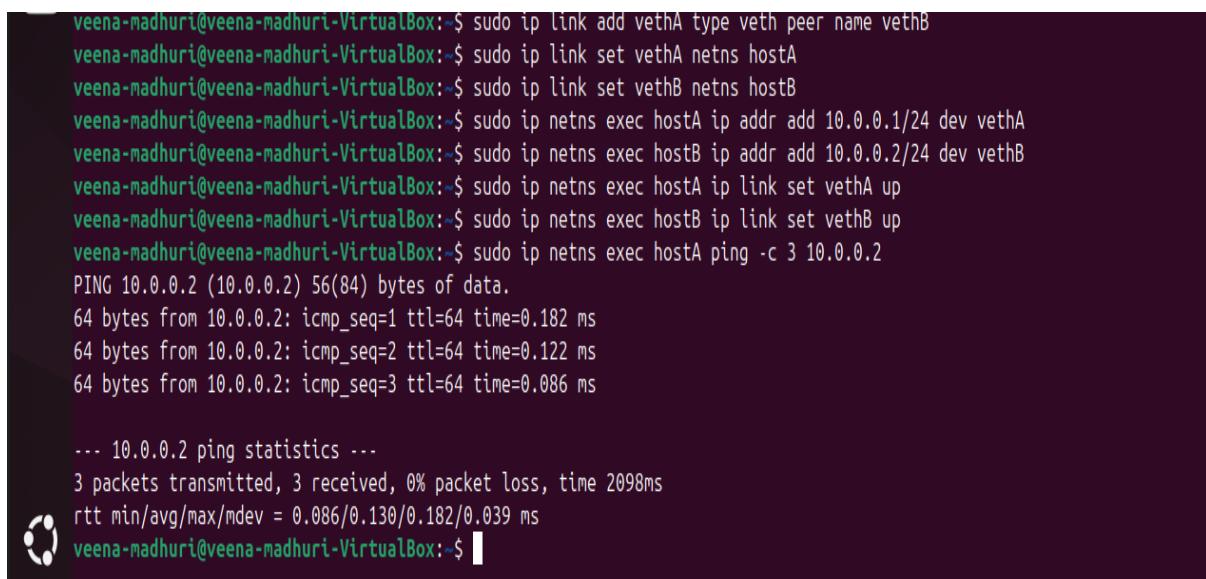
Step 3: Introduce Network Namespaces ("Virtual Hosts")



The screenshot shows a terminal window titled "veena-madhuri@veena-madhuri-VirtualBox: ~". The terminal displays the following commands and their output:

```
veena-madhuri@veena-madhuri-VirtualBox: ~$ sudo ip netns add hostA
[sudo] password for veena-madhuri:
veena-madhuri@veena-madhuri-VirtualBox: ~$ sudo ip netns add hostB
veena-madhuri@veena-madhuri-VirtualBox: ~$ sudo ip netns exec hostA ip link set lo up
veena-madhuri@veena-madhuri-VirtualBox: ~$ sudo ip netns exec hostB ip link set lo up
veena-madhuri@veena-madhuri-VirtualBox: ~$ ip netns list
hostB
hostA
veena-madhuri@veena-madhuri-VirtualBox: ~$ sudo ip netns exec hostA ip addr
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00 brd 00:00:00:00:00:00
        inet 127.0.0.1/8 scope host lo
            valid_lft forever preferred_lft forever
            inet6 ::1/128 scope host
                valid_lft forever preferred_lft forever
veena-madhuri@veena-madhuri-VirtualBox: ~$ sudo ip netns exec hostB ip addr
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00 brd 00:00:00:00:00:00
        inet 127.0.0.1/8 scope host lo
            valid_lft forever preferred_lft forever
            inet6 ::1/128 scope host
                valid_lft forever preferred_lft forever
veena-madhuri@veena-madhuri-VirtualBox: ~$
```

Step 4: Create a Point-to-Point Virtual Link



The screenshot shows a terminal window titled "veena-madhuri@veena-madhuri-VirtualBox: ~". The terminal displays the following commands and their output:

```
veena-madhuri@veena-madhuri-VirtualBox: ~$ sudo ip link add vethA type veth peer name vethB
veena-madhuri@veena-madhuri-VirtualBox: ~$ sudo ip link set vethA netns hostA
veena-madhuri@veena-madhuri-VirtualBox: ~$ sudo ip link set vethB netns hostB
veena-madhuri@veena-madhuri-VirtualBox: ~$ sudo ip netns exec hostA ip addr add 10.0.0.1/24 dev vethA
veena-madhuri@veena-madhuri-VirtualBox: ~$ sudo ip netns exec hostB ip addr add 10.0.0.2/24 dev vethB
veena-madhuri@veena-madhuri-VirtualBox: ~$ sudo ip netns exec hostA ip link set vethA up
veena-madhuri@veena-madhuri-VirtualBox: ~$ sudo ip netns exec hostB ip link set vethB up
veena-madhuri@veena-madhuri-VirtualBox: ~$ sudo ip netns exec hostA ping -c 3 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=0.182 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=0.122 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.086 ms

--- 10.0.0.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2098ms
rtt min/avg/max/mdev = 0.086/0.130/0.182/0.039 ms
veena-madhuri@veena-madhuri-VirtualBox: ~$
```

Step 5: Build a Routed Three-Node Topology

```
Dec 17 01:01
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns add router
Cannot create namespace file "/run/netns/router": File exists
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns del router
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns add router
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec router ip link set lo up
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip link add vethA type veth peer name vethAR
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip link set vethA netns hostA
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip link set vethAR netns router
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip link add vethB type veth peer name vethBR
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip link set vethB netns hostB
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip link set vethBR netns router
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec hostA ip addr add 10.0.1.2/24 dev vethA
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec hostA ip link set vethA up
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec router ip addr add 10.0.1.1/24 dev vethAR
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec router ip link set vethAR up
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec hostB ip addr add 10.0.2.2/24 dev vethB
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec hostB ip link set vethB up
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec router ip addr add 10.0.2.1/24 dev vethBR
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec router ip link set vethBR up
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec router sysctl -w net.ipv4.ip_forward=1
net.ipv4.ip_forward = 1
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec hostA ping -c 3 10.0.1.1
PING 10.0.1.1 (10.0.1.1) 56(84) bytes of data.
64 bytes from 10.0.1.1: icmp_seq=1 ttl=64 time=0.167 ms
veena-madhuri@veena-madhuri-VirtualBox:~$
```

```
Dec 17 01:03
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec hostB ip route add default via 10.0.2.1
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec hostA ping -c 3 10.0.1.1
PING 10.0.1.1 (10.0.1.1) 56(84) bytes of data.
64 bytes from 10.0.1.1: icmp_seq=1 ttl=64 time=0.167 ms
64 bytes from 10.0.1.1: icmp_seq=2 ttl=64 time=0.070 ms
64 bytes from 10.0.1.1: icmp_seq=3 ttl=64 time=0.268 ms
--- 10.0.1.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2064ms
rtt min/avg/max/mdev = 0.070/0.168/0.268/0.080 ms
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec hostB ping -c 3 10.0.2.1
PING 10.0.2.1 (10.0.2.1) 56(84) bytes of data.
64 bytes from 10.0.2.1: icmp_seq=1 ttl=64 time=0.488 ms
64 bytes from 10.0.2.1: icmp_seq=2 ttl=64 time=0.056 ms
64 bytes from 10.0.2.1: icmp_seq=3 ttl=64 time=0.063 ms
--- 10.0.2.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2041ms
rtt min/avg/max/mdev = 0.056/0.202/0.488/0.202 ms
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec hostA ping -c 3 10.0.2.2
PING 10.0.2.2 (10.0.2.2) 56(84) bytes of data.
64 bytes from 10.0.2.2: icmp_seq=1 ttl=63 time=0.125 ms
64 bytes from 10.0.2.2: icmp_seq=2 ttl=63 time=0.083 ms
64 bytes from 10.0.2.2: icmp_seq=3 ttl=63 time=0.066 ms
--- 10.0.2.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2056ms
rtt min/avg/max/mdev = 0.066/0.091/0.125/0.024 ms
veena-madhuri@veena-madhuri-VirtualBox:~$
```

Step 6: Observation and Troubleshooting Tasks

```
rtt min/avg/max/mdev = 0.072/0.251/0.607/0.251 ms
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec hostA ping -c 3 10.0.2.2
PING 10.0.2.2 (10.0.2.2) 56(84) bytes of data.
64 bytes from 10.0.2.2: icmp_seq=1 ttl=63 time=0.275 ms
64 bytes from 10.0.2.2: icmp_seq=2 ttl=63 time=0.084 ms
64 bytes from 10.0.2.2: icmp_seq=3 ttl=63 time=0.119 ms

--- 10.0.2.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2064ms
rtt min/avg/max/mdev = 0.084/0.159/0.275/0.083 ms
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec hostA ip route del 10.0.2.0/24 veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec hostA ip route del 10.0.2.0/24 via 10.0.1.1
RTNETLINK answers: No such process
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec hostA ip route
default via 10.0.1.1 dev vethA
10.0.1.0/24 dev vethA proto kernel scope link src 10.0.1.2
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec hostA ip route del default
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec hostA ping -c 3 10.0.2.2
ping: connect: Network is unreachable
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec hostA ip route add 10.0.2.0/24 via 10.0.1.1
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec hostA ping -c 3 10.0.2.2
PING 10.0.2.2 (10.0.2.2) 56(84) bytes of data.
64 bytes from 10.0.2.2: icmp_seq=1 ttl=63 time=0.442 ms
64 bytes from 10.0.2.2: icmp_seq=2 ttl=63 time=0.088 ms
64 bytes from 10.0.2.2: icmp_seq=3 ttl=63 time=0.112 ms

--- 10.0.2.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2094ms
rtt min/avg/max/mdev = 0.088/0.214/0.442/0.161 ms
```

```
rtt min/avg/max/mdev = 0.088/0.214/0.442/0.161 ms
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec router ip link set vethBR down
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec hostA ping -c 3 10.0.2.2
PING 10.0.2.2 (10.0.2.2) 56(84) bytes of data.
From 10.0.1.1 icmp_seq=1 Destination Net Unreachable
From 10.0.1.1 icmp_seq=2 Destination Net Unreachable
From 10.0.1.1 icmp_seq=3 Destination Net Unreachable

--- 10.0.2.2 ping statistics ---
3 packets transmitted, 0 received, +3 errors, 100% packet loss, time 2039ms

veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec router ip link set vethBR up
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec hostA ping -c 3 10.0.2.2
PING 10.0.2.2 (10.0.2.2) 56(84) bytes of data.
64 bytes from 10.0.2.2: icmp_seq=1 ttl=63 time=0.220 ms
64 bytes from 10.0.2.2: icmp_seq=2 ttl=63 time=0.091 ms
64 bytes from 10.0.2.2: icmp_seq=3 ttl=63 time=0.090 ms

--- 10.0.2.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2036ms
rtt min/avg/max/mdev = 0.090/0.133/0.220/0.061 ms
```

```
Dec 17 02:14
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec hostA ping -c 3 10.0.2.2
[sudo] password for veena-madhuri:
PING 10.0.2.2 (10.0.2.2) 56(84) bytes of data.
64 bytes from 10.0.2.2: icmp_seq=1 ttl=63 time=0.085 ms
64 bytes from 10.0.2.2: icmp_seq=2 ttl=63 time=0.100 ms
64 bytes from 10.0.2.2: icmp_seq=3 ttl=63 time=0.103 ms

... 10.0.2.2 ping statistics ...
3 packets transmitted, 0 received, 100% packet loss, time 2037ms

veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec hostA ping -c 3 10.0.1.1
PING 10.0.1.1 (10.0.1.1) 56(84) bytes of data.
64 bytes from 10.0.1.1: icmp_seq=1 ttl=64 time=0.051 ms
64 bytes from 10.0.1.1: icmp_seq=2 ttl=64 time=0.073 ms
64 bytes from 10.0.1.1: icmp_seq=3 ttl=64 time=0.075 ms

... 10.0.1.1 ping statistics ...
3 packets transmitted, 3 received, 0% packet loss, time 2065ms
rtt min/avg/max/mdev = 0.051/0.066/0.075/0.010 ms
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec router sysctl -w net.ipv4.ip_forward=1
net.ipv4.ip_forward = 1
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec router tcpdump -i vethBR -n
tcpdump: verbose output suppressed, use -v[v]... for full protocol decode
listening on vethBR, link-type EN10MB (Ethernet), snapshot length 262144 bytes
```

```
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec router sysctl -w net.ipv4.ip_forward=0
net.ipv4.ip_forward = 0
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec hostA ping -c 3 10.0.2.2
PING 10.0.2.2 (10.0.2.2) 56(84) bytes of data.

... 10.0.2.2 ping statistics ...
3 packets transmitted, 0 received, 100% packet loss, time 2037ms

veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec hostA ping -c 3 10.0.1.1
PING 10.0.1.1 (10.0.1.1) 56(84) bytes of data.
64 bytes from 10.0.1.1: icmp_seq=1 ttl=64 time=0.051 ms
64 bytes from 10.0.1.1: icmp_seq=2 ttl=64 time=0.073 ms
64 bytes from 10.0.1.1: icmp_seq=3 ttl=64 time=0.075 ms

... 10.0.1.1 ping statistics ...
3 packets transmitted, 3 received, 0% packet loss, time 2065ms
rtt min/avg/max/mdev = 0.051/0.066/0.075/0.010 ms
veena-madhuri@veena-madhuri-VirtualBox:~$ sudo ip netns exec router sysctl -w net.ipv4.ip_forward=1
net.ipv4.ip_forward = 1
```