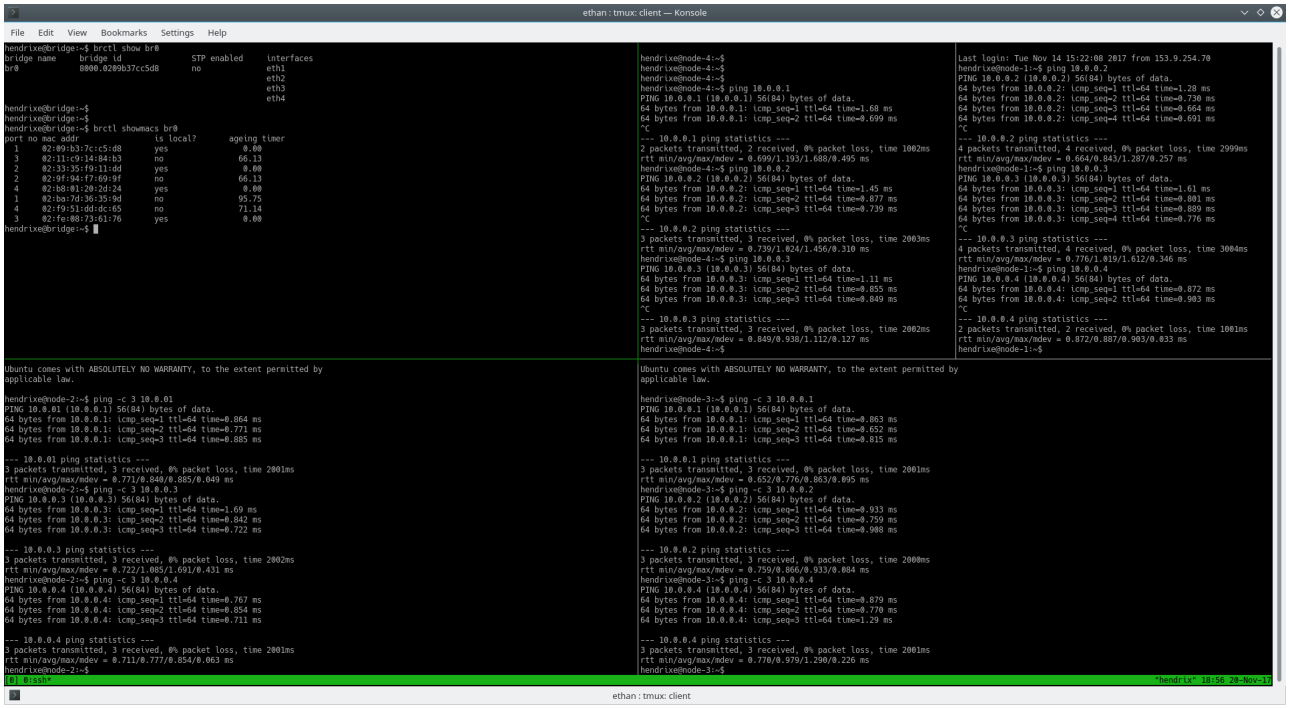
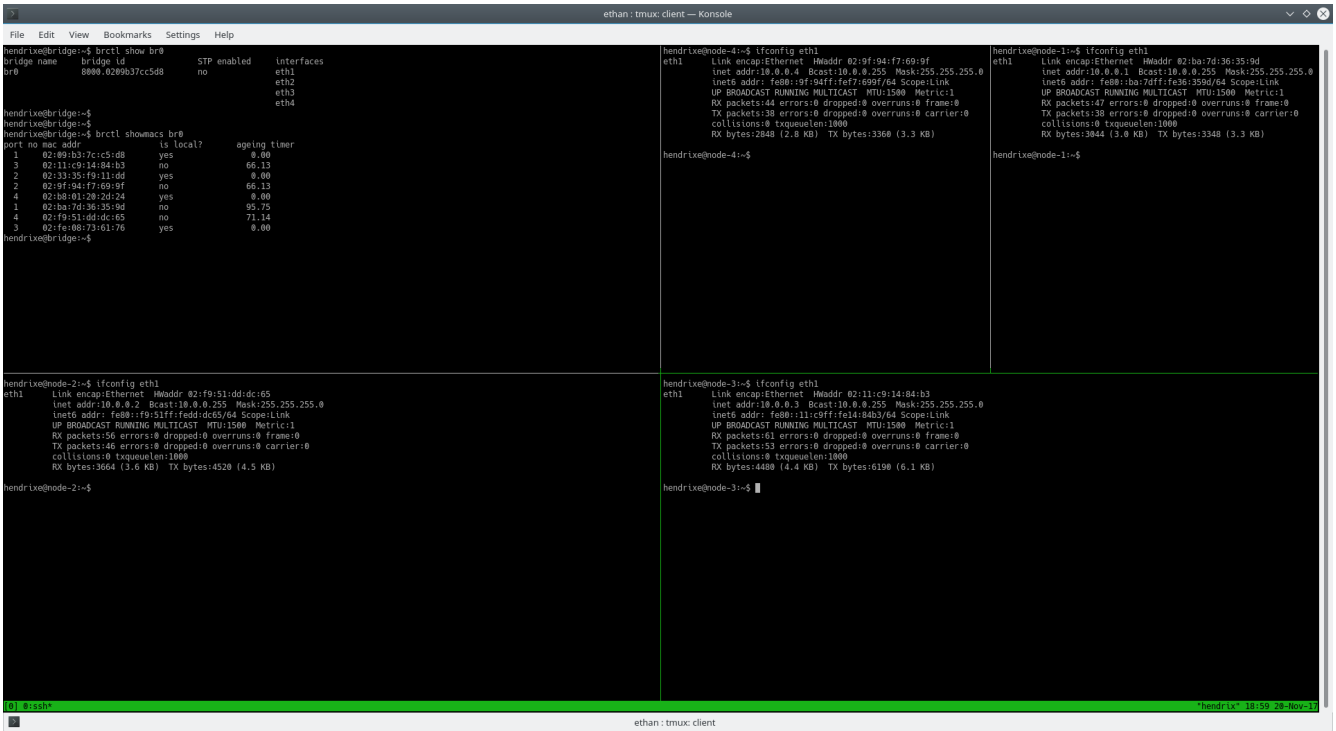
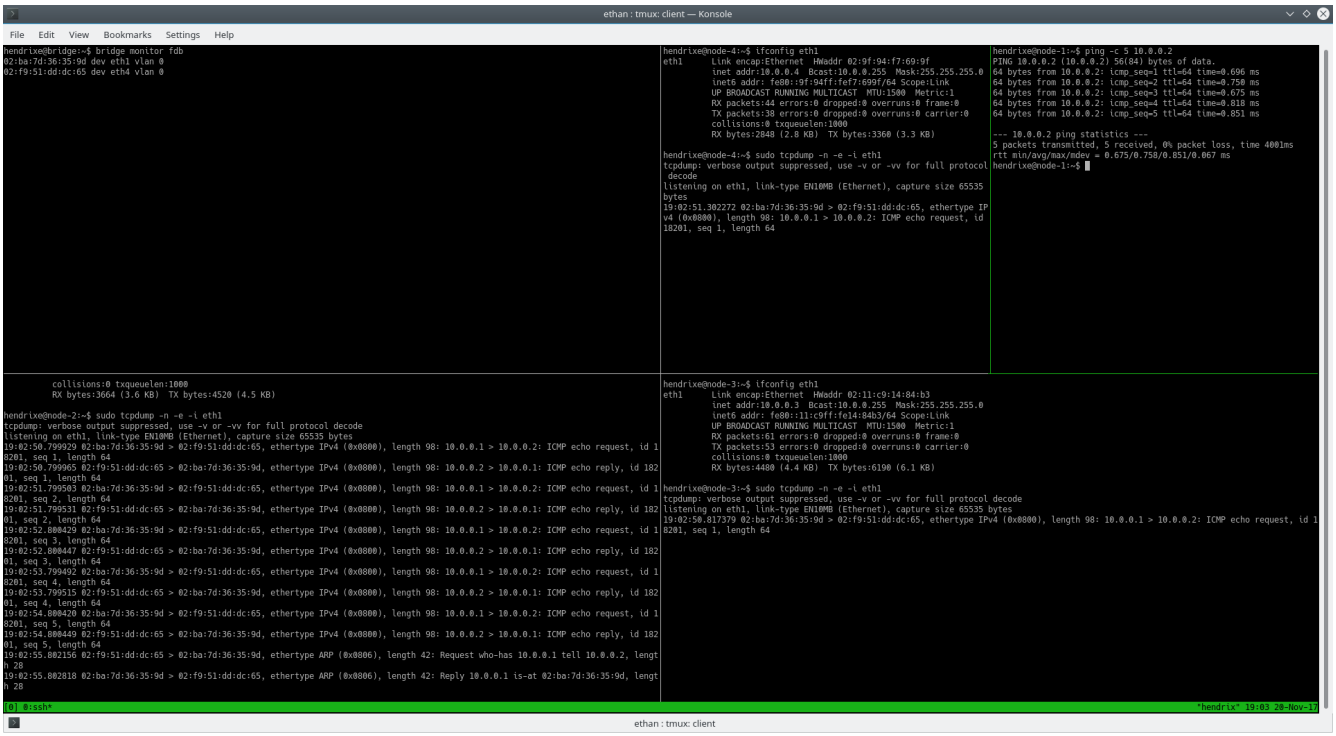
1.


ethan : tmux: client — Konsole
File Edit View Bookmarks Settings Help
hendrixe@bridge:~$ brctl show br0
bridge name bridge id STP enabled interfaces
br0 8000.0209b37cc5d8 no eth1
eth2
eth3
eth4
hendrixe@bridge:~$
hendrixe@bridge:~$
hendrixe@bridge:~$ brctl showmacs br0
port no mac addr is local? ageing timer
1 02:09:b3:7c:c5:d8 yes 0.00
3 02:11:c9:14:84:b3 no 66.13
2 02:33:35:f9:11:dd yes 0.00
2 02:9f:94:f7:69:9f no 66.13
4 02:b8:01:20:2d:24 yes 0.00
1 02:ba:7d:36:35:9d no 95.75
4 02:f9:51:dd:dc:65 no 71.14
3 02:fe:08:73:61:76 yes 0.00
hendrixe@bridge:~$
hendrixe@node-4:~$
hendrixe@node-4:~$
hendrixe@node-4:~$
hendrixe@node-4:~$ ping 10.0.0.1
PING 10.0.0.1 (10.0.0.1) 56(84) bytes of data.
64 bytes from 10.0.0.1: icmp_seq=1 ttl=64 time=1.68 ms
64 bytes from 10.0.0.1: icmp_seq=2 ttl=64 time=0.699 ms
^C
--- 10.0.0.1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1002ms
rtt min/avg/max/mdev = 0.699/1.193/1.688/0.495 ms
hendrixe@node-4:~$ 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=1.45 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=0.877 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.739 ms
^C
--- 10.0.0.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2003ms
rtt min/avg/max/mdev = 0.739/1.024/1.456/0.310 ms
hendrixe@node-4:~$ ping 10.0.0.3
PING 10.0.0.3 (10.0.0.3) 56(84) bytes of data.
64 bytes from 10.0.0.3: icmp_seq=1 ttl=64 time=1.11 ms
64 bytes from 10.0.0.3: icmp_seq=2 ttl=64 time=0.855 ms
64 bytes from 10.0.0.3: icmp_seq=3 ttl=64 time=0.849 ms
^C
--- 10.0.0.3 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2002ms
rtt min/avg/max/mdev = 0.849/0.938/1.112/0.127 ms
hendrixe@node-4:~$
Last login: Tue Nov 14 15:22:08 2017 from 153.9.254.70
hendrixe@node-1:~$ 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=1.28 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=0.730 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.664 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=0.691 ms
^C
--- 10.0.0.2 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 2999ms
rtt min/avg/max/mdev = 0.664/0.843/1.287/0.257 ms
hendrixe@node-1:~$ ping 10.0.0.3
PING 10.0.0.3 (10.0.0.3) 56(84) bytes of data.
64 bytes from 10.0.0.3: icmp_seq=1 ttl=64 time=1.61 ms
64 bytes from 10.0.0.3: icmp_seq=2 ttl=64 time=0.801 ms
64 bytes from 10.0.0.3: icmp_seq=3 ttl=64 time=0.809 ms
64 bytes from 10.0.0.3: icmp_seq=4 ttl=64 time=0.776 ms
^C
--- 10.0.0.3 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3004ms
rtt min/avg/max/mdev = 0.776/1.019/1.612/0.346 ms
hendrixe@node-1:~$ ping 10.0.0.4
PING 10.0.0.4 (10.0.0.4) 56(84) bytes of data.
64 bytes from 10.0.0.4: icmp_seq=1 ttl=64 time=0.872 ms
64 bytes from 10.0.0.4: icmp_seq=2 ttl=64 time=0.903 ms
^C
--- 10.0.0.4 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1001ms
rtt min/avg/max/mdev = 0.872/0.887/0.903/0.033 ms
hendrixe@node-1:~$
Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.
hendrixe@node-2:~$ ping -c 3 10.0.0.1
PING 10.0.0.1 (10.0.0.1) 56(84) bytes of data.
64 bytes from 10.0.0.1: icmp_seq=1 ttl=64 time=0.864 ms
64 bytes from 10.0.0.1: icmp_seq=2 ttl=64 time=0.771 ms
64 bytes from 10.0.0.1: icmp_seq=3 ttl=64 time=0.885 ms
--- 10.0.0.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2001ms
rtt min/avg/max/mdev = 0.771/0.840/0.885/0.049 ms
hendrixe@node-2:~$ ping -c 3 10.0.0.3
PING 10.0.0.3 (10.0.0.3) 56(84) bytes of data.
64 bytes from 10.0.0.3: icmp_seq=1 ttl=64 time=1.69 ms
64 bytes from 10.0.0.3: icmp_seq=2 ttl=64 time=0.842 ms
64 bytes from 10.0.0.3: icmp_seq=3 ttl=64 time=0.722 ms
--- 10.0.0.3 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2002ms
rtt min/avg/max/mdev = 0.722/1.085/1.691/0.431 ms
hendrixe@node-2:~$ ping -c 3 10.0.0.4
PING 10.0.0.4 (10.0.0.4) 56(84) bytes of data.
64 bytes from 10.0.0.4: icmp_seq=1 ttl=64 time=0.767 ms
64 bytes from 10.0.0.4: icmp_seq=2 ttl=64 time=0.854 ms
64 bytes from 10.0.0.4: icmp_seq=3 ttl=64 time=0.711 ms
--- 10.0.0.4 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2001ms
rtt min/avg/max/mdev = 0.711/0.777/0.854/0.063 ms
hendrixe@node-2:~$
Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.
hendrixe@node-3:~$ ping -c 3 10.0.0.1
PING 10.0.0.1 (10.0.0.1) 56(84) bytes of data.
64 bytes from 10.0.0.1: icmp_seq=1 ttl=64 time=0.863 ms
64 bytes from 10.0.0.1: icmp_seq=2 ttl=64 time=0.652 ms
64 bytes from 10.0.0.1: icmp_seq=3 ttl=64 time=0.815 ms
--- 10.0.0.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2001ms
rtt min/avg/max/mdev = 0.652/0.776/0.863/0.095 ms
hendrixe@node-3:~$ 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=0.933 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=0.759 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.908 ms
--- 10.0.0.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2000ms
rtt min/avg/max/mdev = 0.759/0.866/0.933/0.084 ms
hendrixe@node-3:~$ ping -c 3 10.0.0.4
PING 10.0.0.4 (10.0.0.4) 56(84) bytes of data.
64 bytes from 10.0.0.4: icmp_seq=1 ttl=64 time=0.879 ms
64 bytes from 10.0.0.4: icmp_seq=2 ttl=64 time=0.770 ms
64 bytes from 10.0.0.4: icmp_seq=3 ttl=64 time=1.29 ms
--- 10.0.0.4 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2001ms
rtt min/avg/max/mdev = 0.770/0.979/1.290/0.226 ms
hendrixe@node-3:~$
[0] 0:ssh*
"hendrix" 18:56 20-Nov-17
ethan : tmux: client

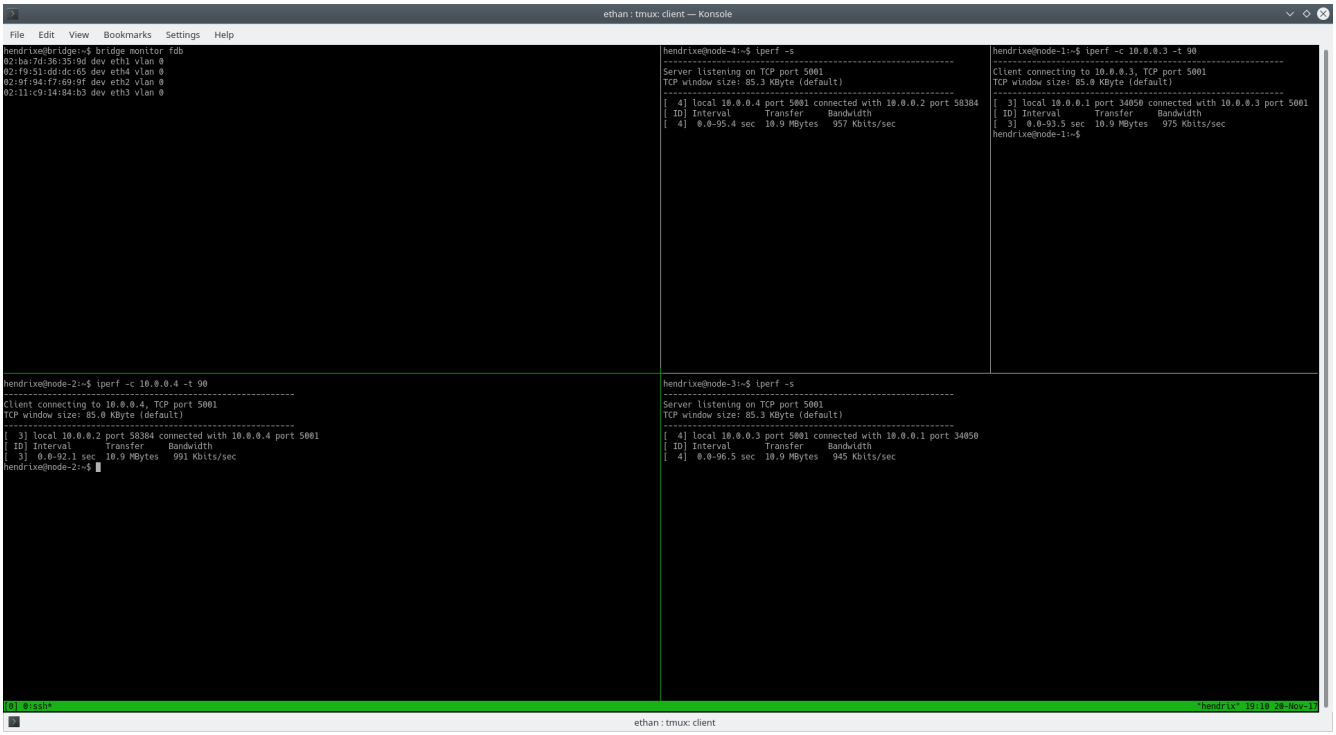
2.


ethan : tmux: client — Konsole
File Edit View Bookmarks Settings Help
hendrixe@bridge:~$ brctl show br0
bridge name bridge id STP enabled interfaces
br0 8000.0209b37cc5d8 no eth1
eth2
eth3
eth4
hendrixe@bridge:~$
hendrixe@bridge:~$
hendrixe@bridge:~$ brctl showmacs br0
port no mac addr is local? ageing timer
1 02:09:b3:7c:c5:d8 yes 0.00
3 02:11:c9:14:84:b3 no 66.13
2 02:33:35:f9:11:dd yes 0.00
2 02:9f:94:f7:69:9f no 66.13
4 02:b8:01:20:2d:24 yes 0.00
1 02:ba:7d:36:35:9d no 95.75
4 02:f9:51:dd:dc:65 no 71.14
3 02:fe:08:73:61:76 yes 0.00
hendrixe@bridge:~$
hendrixe@node-4:~$ ifconfig eth1
eth1 Link encap:Ethernet HWaddr 02:9f:94:f7:69:9f
inet addr:10.0.0.4 Bcast:10.0.0.255 Mask:255.255.255.0
inet6 addr: fe80::9f:94ff:fef7:699f/64 Scope:Link
UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
RX packets:44 errors:0 dropped:0 overruns:0 frame:0
TX packets:38 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:1000
RX bytes:2848 (2.8 KB) TX bytes:3360 (3.3 KB)
hendrixe@node-4:~$
hendrixe@node-1:~$ ifconfig eth1
eth1 Link encap:Ethernet HWaddr 02:ba:7d:36:35:9d
inet addr:10.0.0.1 Bcast:10.0.0.255 Mask:255.255.255.0
inet6 addr: fe80::ba:7dff:fe36:359d/64 Scope:Link
UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
RX packets:47 errors:0 dropped:0 overruns:0 frame:0
TX packets:38 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:1000
RX bytes:3044 (3.0 KB) TX bytes:3348 (3.3 KB)
hendrixe@node-1:~$
hendrixe@node-2:~$ ifconfig eth1
eth1 Link encap:Ethernet HWaddr 02:f9:51:dd:dc:65
inet addr:10.0.0.2 Bcast:10.0.0.255 Mask:255.255.255.0
inet6 addr: fe80::f9:51ff:fedd:dc65/64 Scope:Link
UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
RX packets:56 errors:0 dropped:0 overruns:0 frame:0
TX packets:46 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:1000
RX bytes:3664 (3.6 KB) TX bytes:4520 (4.5 KB)
hendrixe@node-2:~$
hendrixe@node-3:~$ ifconfig eth1
eth1 Link encap:Ethernet HWaddr 02:11:c9:14:84:b3
inet addr:10.0.0.3 Bcast:10.0.0.255 Mask:255.255.255.0
inet6 addr: fe80::11:c9ff:fe14:84b3/64 Scope:Link
UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
RX packets:61 errors:0 dropped:0 overruns:0 frame:0
TX packets:53 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:1000
RX bytes:4480 (4.4 KB) TX bytes:6190 (6.1 KB)
hendrixe@node-3:~$
[0] 0:ssh*
"hendrix" 18:59 20-Nov-17
ethan : tmux: client

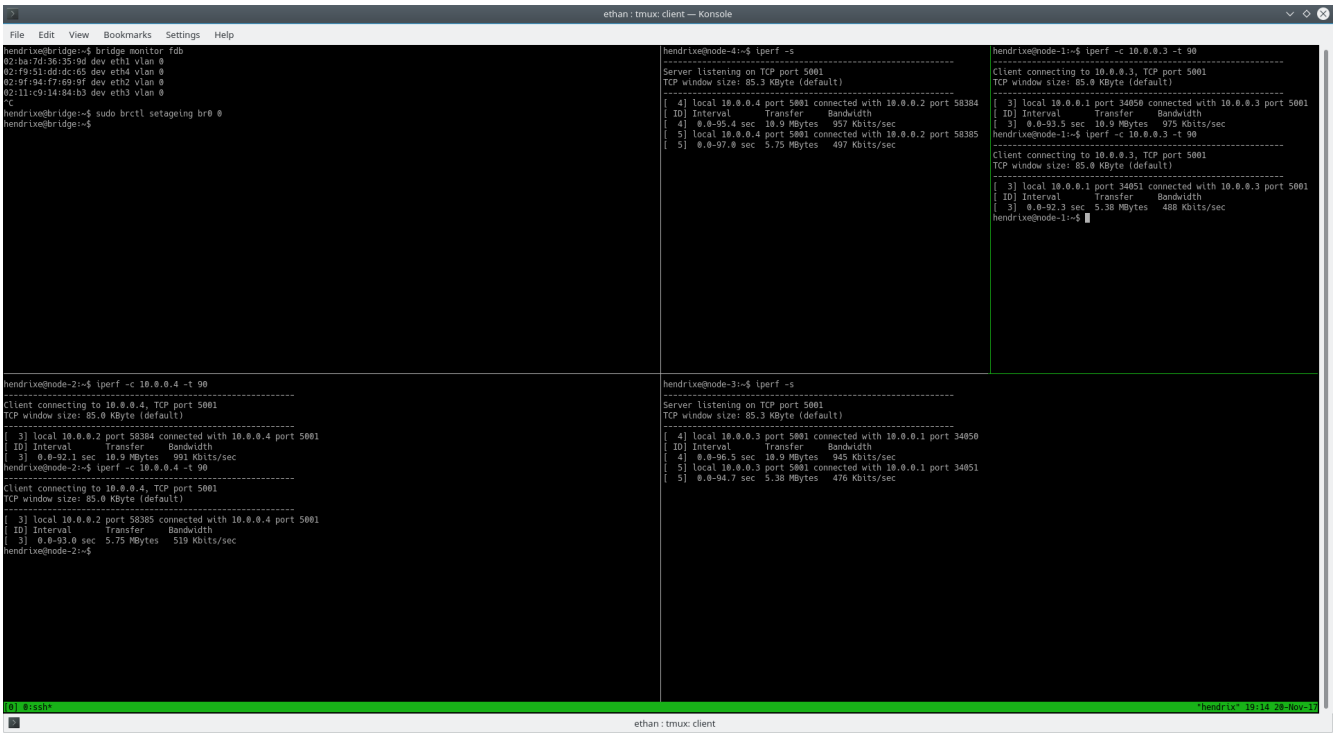
3.


ethan : tmux: client — Konsole
File Edit View Bookmarks Settings Help
hendrixe@bridge:~$ bridge monitor fdb
02:ba:7d:36:35:9d dev eth1 vlan 0
02:f9:51:dd:dc:65 dev eth4 vlan 0
hendrixe@node-4:~$ ifconfig eth1
eth1 Link encap:Ethernet HWaddr 02:9f:94:f7:69:9f
inet addr:10.0.0.4 Bcast:10.0.0.255 Mask:255.255.255.0
inet6 addr: fe80::9f:94ff:fef7:699f/64 Scope:Link
UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
RX packets:44 errors:0 dropped:0 overruns:0 frame:0
TX packets:38 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:1000
RX bytes:2848 (2.8 KB) TX bytes:3360 (3.3 KB)
hendrixe@node-4:~$ sudo tcpdump -n -e -i eth1
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth1, link-type EN10MB (Ethernet), capture size 65535 bytes
19:02:51.302272 02:ba:7d:36:35:9d > 02:f9:51:dd:dc:65, ethertype IPv4 (0x0800), length 98: 10.0.0.1 > 10.0.0.2: ICMP echo request, id 18201, seq 1, length 64
hendrixe@node-1:~$ ping -c 5 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=0.696 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=0.758 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.675 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=0.818 ms
64 bytes from 10.0.0.2: icmp_seq=5 ttl=64 time=0.851 ms
--- 10.0.0.2 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4001ms
rtt min/avg/max/mdev = 0.675/0.758/0.851/0.067 ms
hendrixe@node-1:~$
collisions:0 txqueuelen:1000
RX bytes:3664 (3.6 KB) TX bytes:4520 (4.5 KB)
hendrixe@node-2:~$ sudo tcpdump -n -e -i eth1
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth1, link-type EN10MB (Ethernet), capture size 65535 bytes
19:02:50.799929 02:ba:7d:36:35:9d > 02:f9:51:dd:dc:65, ethertype IPv4 (0x0800), length 98: 10.0.0.1 > 10.0.0.2: ICMP echo request, id 18201, seq 1, length 64
19:02:50.799965 02:f9:51:dd:dc:65 > 02:ba:7d:36:35:9d, ethertype IPv4 (0x0800), length 98: 10.0.0.2 > 10.0.0.1: ICMP echo reply, id 18201, seq 1, length 64
19:02:51.799503 02:ba:7d:36:35:9d > 02:f9:51:dd:dc:65, ethertype IPv4 (0x0800), length 98: 10.0.0.1 > 10.0.0.2: ICMP echo request, id 18201, seq 2, length 64
19:02:51.799531 02:f9:51:dd:dc:65 > 02:ba:7d:36:35:9d, ethertype IPv4 (0x0800), length 98: 10.0.0.2 > 10.0.0.1: ICMP echo reply, id 18201, seq 2, length 64
19:02:52.800429 02:ba:7d:36:35:9d > 02:f9:51:dd:dc:65, ethertype IPv4 (0x0800), length 98: 10.0.0.1 > 10.0.0.2: ICMP echo request, id 18201, seq 3, length 64
19:02:52.800447 02:f9:51:dd:dc:65 > 02:ba:7d:36:35:9d, ethertype IPv4 (0x0800), length 98: 10.0.0.2 > 10.0.0.1: ICMP echo reply, id 18201, seq 3, length 64
19:02:53.799492 02:ba:7d:36:35:9d > 02:f9:51:dd:dc:65, ethertype IPv4 (0x0800), length 98: 10.0.0.1 > 10.0.0.2: ICMP echo request, id 18201, seq 4, length 64
19:02:53.799515 02:f9:51:dd:dc:65 > 02:ba:7d:36:35:9d, ethertype IPv4 (0x0800), length 98: 10.0.0.2 > 10.0.0.1: ICMP echo reply, id 18201, seq 4, length 64
19:02:54.800420 02:ba:7d:36:35:9d > 02:f9:51:dd:dc:65, ethertype IPv4 (0x0800), length 98: 10.0.0.1 > 10.0.0.2: ICMP echo request, id 18201, seq 5, length 64
19:02:54.800449 02:f9:51:dd:dc:65 > 02:ba:7d:36:35:9d, ethertype IPv4 (0x0800), length 98: 10.0.0.2 > 10.0.0.1: ICMP echo reply, id 18201, seq 5, length 64
19:02:55.802156 02:f9:51:dd:dc:65 > 02:ba:7d:36:35:9d, ethertype ARP (0x0806), length 42: Request who-has 10.0.0.1 tell 10.0.0.2, length 28
19:02:55.802818 02:ba:7d:36:35:9d > 02:f9:51:dd:dc:65, ethertype ARP (0x0806), length 42: Reply 10.0.0.1 is-at 02:ba:7d:36:35:9d, length 28
hendrixe@node-3:~$ ifconfig eth1
eth1 Link encap:Ethernet HWaddr 02:11:c9:14:84:b3
inet addr:10.0.0.3 Bcast:10.0.0.255 Mask:255.255.255.0
inet6 addr: fe80::11:c9ff:fe14:84b3/64 Scope:Link
UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
RX packets:61 errors:0 dropped:0 overruns:0 frame:0
TX packets:53 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:1000
RX bytes:4480 (4.4 KB) TX bytes:6190 (6.1 KB)
hendrixe@node-3:~$ sudo tcpdump -n -e -i eth1
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth1, link-type EN10MB (Ethernet), capture size 65535 bytes
19:02:50.817379 02:ba:7d:36:35:9d > 02:f9:51:dd:dc:65, ethertype IPv4 (0x0800), length 98: 10.0.0.1 > 10.0.0.2: ICMP echo request, id 18201, seq 1, length 64
[0] 0:ssh*
"hendrix" 19:03 20-Nov-17
ethan : tmux: client

4.


ethan : tmux: client — Konsole
File Edit View Bookmarks Settings Help
hendrixe@bridge:~$ bridge monitor fdb
02:ba:7d:36:35:9d dev eth1 vlan 0
02:f9:51:dd:dc:65 dev eth4 vlan 0
02:9f:94:f7:69:9f dev eth2 vlan 0
02:11:c9:14:84:b3 dev eth3 vlan 0
hendrixe@node-4:~$ iperf -s
Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)
[4] local 10.0.0.4 port 5001 connected with 10.0.0.2 port 58384
[ID] Interval Transfer Bandwidth
[4] 0.0-95.4 sec 10.9 MBytes 957 Kbits/sec
hendrixe@node-1:~$ iperf -c 10.0.0.3 -t 90
Client connecting to 10.0.0.3, TCP port 5001
TCP window size: 85.0 KByte (default)
[3] local 10.0.0.1 port 34050 connected with 10.0.0.3 port 5001
[ID] Interval Transfer Bandwidth
[3] 0.0-93.5 sec 10.9 MBytes 975 Kbits/sec
hendrixe@node-1:~$
hendrixe@node-2:~$ iperf -c 10.0.0.4 -t 90
Client connecting to 10.0.0.4, TCP port 5001
TCP window size: 85.0 KByte (default)
[3] local 10.0.0.2 port 58384 connected with 10.0.0.4 port 5001
[ID] Interval Transfer Bandwidth
[3] 0.0-92.1 sec 10.9 MBytes 991 Kbits/sec
hendrixe@node-2:~$
hendrixe@node-3:~$ iperf -s
Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)
[4] local 10.0.0.3 port 5001 connected with 10.0.0.1 port 34050
[ID] Interval Transfer Bandwidth
[4] 0.0-96.5 sec 10.9 MBytes 945 Kbits/sec
[0] 0:ssh*
"hendrix" 19:10 20-Nov-17
ethan : tmux: client

5.



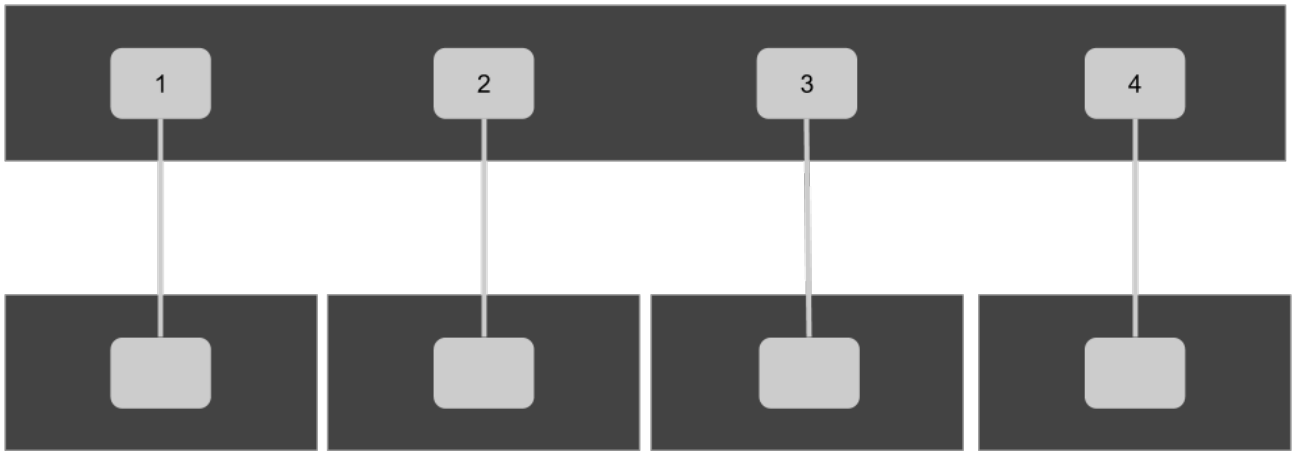
Switch Learning Table

Bridge port	1
Interface name	eth1
MAC address	02:09:b3:7c:c5:d8

Bridge port	2
Interface name	eth2
MAC address	02:33:35:f9:11:dd

Bridge port	3
Interface name	eth-3
MAC address	02:fe:08:73:61:76

Bridge port	4
Interface name	eth-4
MAC address	02:b8:01:20:2d:24



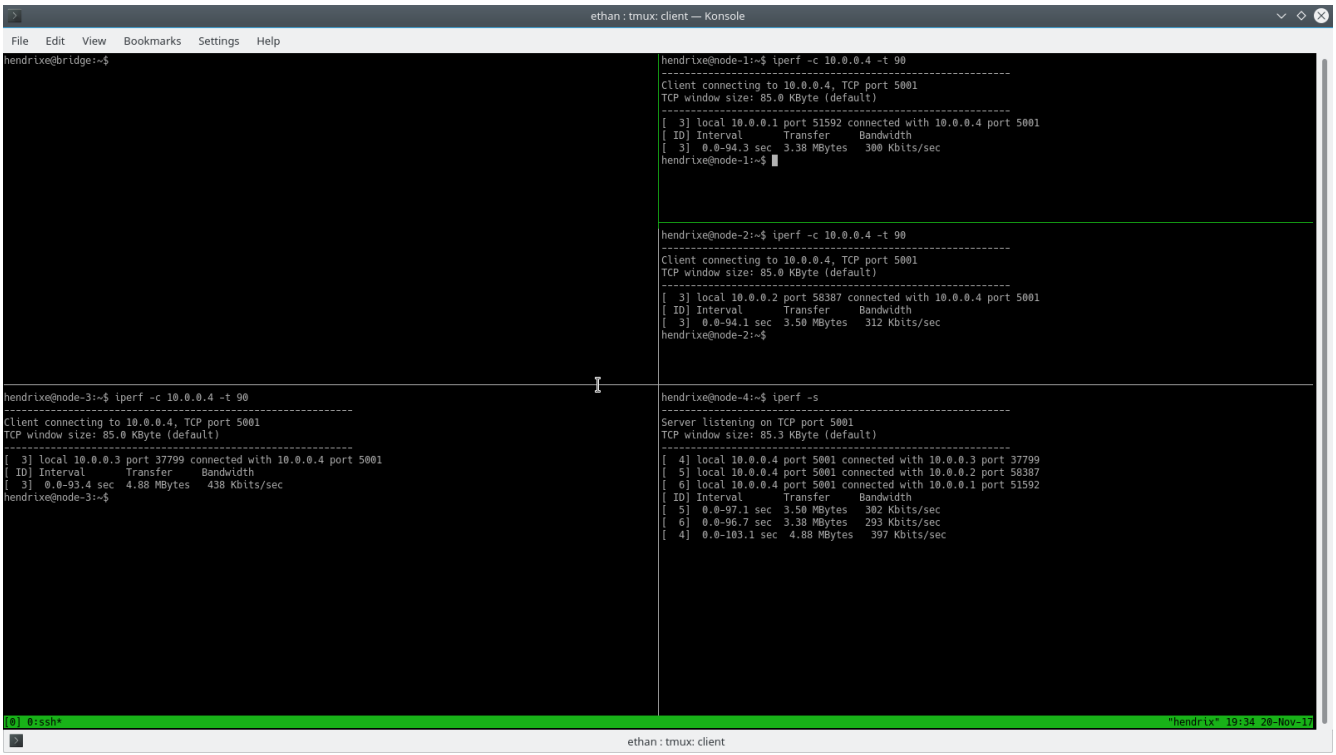
Host name	node-1
IP address	10.0.0.1
MAC address	02:ba:7d:36:35:9d

Host name	node-4
IP address	10.0.0.4
MAC address	02:9f:94:f7:69:9f

Host name	node-3
IP address	10.0.0.3
MAC address	02:11:c9:14:84:b3

Host name	node-2
IP address	10.0.0.2
MAC address	02:f9:51:dd:dc:65

Effect on a smaller collision domain variation



With MAC learning on, each transmitter sees relatively the same bandwith (~300Kbits/sec). Some of these may be more or less, but they all hover around this benchmark. Without MAC learning on, the bridge cannot offer consistent and efficient performance to each of the transmitters and receiver, because it must broadcast every time to determine where a frame is traveling. With MAC learning on, however, the bridge can learn where frames are going based upon their destination MAC address, and it will not have to determine this every time it receives a frame (assuming that the destination MAC is already in its MAC table).