

1 Network Performance Analysis

1.1 Initial Traffic Flow

- **Primary Path (Switch s1)**
 - **Traffic Flow:** High tx_pkts and tx_bytes indicate active routing through Switch s2.
 - **Packet Drops:** None detected, confirming the stability of the primary path.
- **Backup Path (Switch s4)**
 - **Traffic Flow:** Minimal activity observed, as Switch s4 functions as a standby route.
 - **Meter Enforcement:** The 512 Kbps rate limit remains inactive due to low traffic volume.

1.2 Link Failure

- **Traffic Rerouting:** Traffic is redirected through Switch s4, evidenced by increased tx_pkts and tx_bytes on s4.
- **Primary Path Reduction:** Traffic on Switch s1 decreases without any packet drops, indicating a smooth failover process.

1.3 Port Statistics Analysis

- **Before Link Failure**
 - **Switch s1:** Exhibited high throughput on the s2 connection.
 - **Switch s4:** Displayed low traffic, confirming its role as a backup path.
- **After Link Failure**
 - **Switch s1:** Reduced traffic observed on the s2 port.
 - **Switch s4:** Increased traffic handling due to rerouted packets.
 - **Meter Drops:** Increased drops correlate with higher bandwidth tests, validating effective rate limiting.

2 iPerf Test Results

2.1 Before Link Failure

Bandwidth	Transfer Rate	Packet Loss
512 Kbps	527 Kbps	0%
1 Mbps	1.05 Mbps	0%
2 Mbps	2.10 Mbps	0%
512 Mbps	536 Mbps	0.09%

Table 1: iPerf Test Results Before Link Failure

2.2 After Link Failure

Bandwidth	Transfer Rate	Packet Loss
512 Kbps	527 Kbps	0%
1 Mbps	543 Kbps	48%
2 Mbps	447 Kbps	77%
512 Mbps	Blocked	100%

Table 2: iPerf Test Results After Link Failure

2.3 Summary of iPerf Test Results

- **Before Link Failure:**
 - All tested bandwidths achieved their respective transfer rates with negligible to no packet loss.
 - The highest bandwidth tested (512 Mbps) showed minimal packet loss (0.09%), indicating excellent network performance.
- **After Link Failure:**
 - **512 Kbps:** Maintained stability with no packet loss, ensuring essential services remained unaffected.
 - **1 Mbps:** Experienced significant packet loss (48%), which may affect medium-priority applications.
 - **2 Mbps:** Saw increased packet loss (77%), likely impacting high-priority or bandwidth-intensive applications.
 - **512 Mbps:** The link was completely blocked by the meter, resulting in 100% packet loss and rendering the connection unusable at this bandwidth.

3 Screenshots

The screenshot shows two terminal windows side-by-side. The left window displays the output of an iPerf test between hosts 10.6.1.2 and 10.6.1.1, with a bandwidth of 512 Kbps. The right window shows the configuration of the onos-netcfg tool, specifically the hostconfig.json file.

```

sdn@sdn-VirtualBox:~$ iPerf -c 10.6.1.2 -t 60 -b 512K
64 bytes from 10.6.1.2: icmp_seq=10 ttl=64 time=0.058 ms
--- 10.6.1.2 ping statistics ---
10 packets transmitted, 8 received, 20% packet loss, time 9229ms
rtt min/avg/max/mdev = 0.053/0.068/0.157/0.033 ms
mininet> h1 iperf -c 10.6.1.2 -u -b 512K
Client connecting to 10.6.1.2, UDP port 5001
Sending 1470 byte datagrams, IPG target: 22430.42 us (kalman adjust)
UDP buffer size: 208 Kbyte (default)

[ 1] local 10.6.1.2 port 44756 connected with 10.6.1.2 port 5001
[ ID] Interval Transfer Bandwidth Jitter Lost/Total Datagrams
[ 1] 0.0000-10.0270 sec 645 KBytes 527 Kbits/sec
[ 1] Sent 450 datagrams
[ 1] Server Report:
[ ID] Interval Transfer Bandwidth Jitter Lost/Total Datagrams
[ 1] 0.0000-10.0267 sec 645 KBytes 527 Kbits/sec 0.005 ms 0/449 (0%)
mininet> sh ovs-ofctl dump-ports -O OpenFlow14 s1
OFPT_PORT reply (OF1.4) (xid=0x2): 4 ports
  port LOCAL: rx pkts=0, bytes=0, drop=0, errs=0, over=0, crc=0
  tx pkts=0, bytes=0, drop=0, errs=0, coll=0
    duration=116.338s
  port "s1-eth1": rx pkts=921, bytes=696144, drop=0, errs=0, frame=0, over=0, c
rc=0
    tx pkts=116, bytes=15089, drop=0, errs=0, coll=0
    duration=116.343s
  port "s1-eth2": rx pkts=101, bytes=13593, drop=0, errs=0, frame=0, over=0, cr
c=0
    tx pkts=1011, bytes=709005, drop=0, errs=0, coll=0
  port "s1-eth3": rx pkts=110, bytes=14547, drop=0, errs=0, frame=0, over=0, cr
c=0
    tx pkts=103, bytes=13871, drop=0, errs=0, coll=0
    duration=116.343s
mininet> sh ovs-ofctl dump-ports -O OpenFlow14 s4
OFPT_PORT reply (OF1.4) (xid=0x2): 3 ports
  port LOCAL: rx pkts=0, bytes=0, drop=0, errs=0, frame=0, over=0, crc=0
  tx pkts=0, bytes=0, drop=0, errs=0, coll=0
    duration=121.131s
  port "s4-eth1": rx pkts=105, bytes=141469, drop=0, errs=0, frame=0, over=0, cr
c=0
    tx pkts=112, bytes=14825, drop=0, errs=0, coll=0
    duration=121.137s
  port "s4-eth2": rx pkts=112, bytes=14825, drop=0, errs=0, frame=0, over=0, cr
c=0
    tx pkts=104, bytes=13941, drop=0, errs=0, coll=0
    duration=121.137s
mininet> [0] 0:bash- 1:sudo*

```

Figure 1: iPerf with 512 Kbps (Before Link Failure)

The screenshot shows two terminal windows side-by-side. The left window displays the output of an iPerf test between hosts 10.6.1.2 and 10.6.1.1, with a bandwidth of 1 Mbps. The right window shows the configuration of the onos-netcfg tool, specifically the hostconfig.json file.

```

sdn@sdn-VirtualBox:~$ iPerf -c 10.6.1.2 -t 60 -b 1M
64 bytes from 10.6.1.2: icmp_seq=5 ttl=64 time=0.061 ms
--- 10.6.1.2 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4123ms
rtt min/avg/max/mdev = 0.056/0.123/0.381/0.128 ms
mininet> h1 iperf -c 10.6.1.2 -u -b 1M
Client connecting to 10.6.1.2, UDP port 5001
Sending 1470 byte datagrams, IPG target: 11215.21 us (kalman adjust)
UDP buffer size: 208 Kbyte (default)

[ 1] local 10.6.1.1 port 44443 connected with 10.6.1.2 port 5001
[ ID] Interval Transfer Bandwidth Jitter Lost/Total Datagrams
[ 1] 0.0000-10.0154 sec 1.25 MBytes 1.05 Mbits/sec
[ 1] Sent 896 datagrams
[ 1] Server Report:
[ ID] Interval Transfer Bandwidth Jitter Lost/Total Datagrams
[ 1] 0.0000-10.0148 sec 1.25 MBytes 1.05 Mbits/sec 0.027 ms 0/895 (0%)
mininet> sh ovs-ofctl dump-ports -O OpenFlow14 s1
OFPT_PORT reply (OF1.4) (xid=0x2): 4 ports
  port LOCAL: rx pkts=0, bytes=0, drop=0, errs=0, frame=0, over=0, crc=0
  tx pkts=0, bytes=0, drop=0, errs=0, coll=0
    duration=710.242s
  port "s1-eth1": rx pkts=1835501, bytes=1418809864, drop=0, errs=0, frame=0, o
ver=0, crc=0
    tx pkts=556, bytes=88908, drop=0, errs=0, coll=0
    duration=710.247s
  port "s1-eth2": rx pkts=362, bytes=49198, drop=0, errs=0, frame=0, over=0, cr
c=0
    tx pkts=916105, bytes=707907144, drop=0, errs=0, coll=0
    duration=710.247s
  port "s1-eth3": rx pkts=552, bytes=88114, drop=0, errs=0, frame=0, over=0, cr
c=0
    tx pkts=920235, bytes=711018830, drop=0, errs=0, coll=0
    duration=710.247s
mininet> sh ovs-ofctl dump-ports -O OpenFlow14 s4
OFPT_PORT reply (OF1.4) (xid=0x2): 3 ports
  port LOCAL: rx pkts=0, bytes=0, drop=0, errs=0, frame=0, over=0, crc=0
  tx pkts=0, bytes=0, drop=0, errs=0, coll=0
    duration=713.156s
  port "s4-eth1": rx pkts=220237, bytes=711019108, drop=0, errs=0, frame=0, o
ver=0, crc=0
    tx pkts=554, bytes=88392, drop=0, errs=0, coll=0
    duration=713.156s
  port "s4-eth2": rx pkts=554, bytes=88392, drop=0, errs=0, frame=0, over=0, cr
c=0
    tx pkts=18251, bytes=3208898, drop=0, errs=0, coll=0
    duration=713.156s
mininet> [0] 0:bash- 1:sudo*

```

Figure 2: iPerf with 1 Mbps (Before Link Failure)

```

sdn@sdn-VirtualBox:~(ssh) duration:713.156s
port "s4-eth2": rx pkts=554, bytes=88392, drop=0, errs=0, frame=0, over=0, cr
c=0
tx pkts=18251, bytes=3208898, drop=0, errs=0, coll=0
duration:713.156s
mininet> h1 iperf -c 10.6.1.2 -u -b 2M
-----
Client connecting to 10.6.1.2, UDP port 5001
Sending 1470 byte datagrams, IPG target: 5607.60 us (kalman adjust)
UDP buffer size: 208 KByte (default)
[ 1 ] local 10.6.1.1 port 44047 connected with 10.6.1.2 port 5001
[ ID] Interval Transfer Bandwidth
[ 1 ] 0.0000-10.0101 sec 2.51 MBytes 2.10 Mbits/sec
[ 1 ] Sent 1788 datagrams
[ 1 ] Server Report:
[ ID] Interval Transfer Bandwidth Jitter Lost/Total Datagrams
[ 1 ] 0.0000-10.0096 sec 2.51 MBytes/sec 0.01 ms 0/1787 (0%)
mininet> sh ovs-ofctl dump-ports -o OpenFlow14 s1
OFPT_PORT reply (OF1.4) (xid=0x2): 4 ports
  port LOCAL: rx pkts=0, bytes=0, drop=0, errs=0, frame=0, over=0, crc=0
    tx pkts=0, bytes=0, drop=0, errs=0, coll=0
    duration:738.056s
  port "s1-eth1": rx pkts=1839079, bytes=1421574352, drop=0, errs=0, frame=0, o
ver=0, crc=0
    tx pkts=585, bytes=91792, drop=0, errs=0, coll=0
    duration:738.061s
  port "s1-eth2": rx pkts=582, bytes=51877, drop=0, errs=0, frame=0, over=0, cr
c=0
    tx pkts=19702, bytes=710674269, drop=0, errs=0, coll=0
    duration:738.061s
  port "s1-eth3": rx pkts=572, bytes=90956, drop=0, errs=0, frame=0, over=0, cr
c=0
    tx pkts=920253, bytes=711021332, drop=0, errs=0, coll=0
    duration:738.061s
mininet> sh ovs-ofctl dump-ports -o OpenFlow14 s4
OFPT_PORT reply (OF1.4) (xid=0x2): 3 ports
  port LOCAL: rx pkts=0, bytes=0, drop=0, errs=0, frame=0, over=0, crc=0
    tx pkts=0, bytes=0, drop=0, errs=0, coll=0
    duration:740.025s
  port "s4-eth1": rx pkts=182255, bytes=711021610, drop=0, errs=0, frame=0, o
ver=0, crc=0
    tx pkts=57, bytes=91234, drop=0, errs=0, coll=0
    duration:740.031s
  port "s4-eth2": rx pkts=574, bytes=91234, drop=0, errs=0, frame=0, over=0, cr
c=0
    tx pkts=18269, bytes=3211400, drop=0, errs=0, coll=0
    duration:740.031s
mininet> [0] 0:bash-1:sudo*

```

onos-netcfg localhost hostconfig.json

```

sdn@sdn-VirtualBox:~/Desktop/NYCU_SDN-and-NFV/lab04/spec$ onos-netcfg localhost hostconfig.json
sdn@sdn-VirtualBox:~/Desktop/NYCU_SDN-and-NFV/lab04/spec$
```

Figure 3: iPerf with 2 Mbps (Before Link Failure)

```

sdn@sdn-VirtualBox:~(ssh) port "s4-eth2": rx pkts=12, bytes=14825, drop=0, errs=0, frame=0, over=0, cr
c=0
  tx pkts=104, bytes=13941, drop=0, errs=0, coll=0
  duration:121.137s
mininet> h1 iperf -c 10.6.1.2 -u -b 512M
-----
Client connecting to 10.6.1.2, UDP port 5001
Sending 1470 byte datagrams, IPG target: 21.90 us (kalman adjust)
UDP buffer size: 208 KByte (default)
[ 1 ] local 10.6.1.1 port 46367 connected with 10.6.1.2 port 5001
[ ID] Interval Transfer Bandwidth
[ 1 ] 0.0000-10.0000 sec 1.40 MBytes 537 Mbits/sec
[ 1 ] Sent 15620 datagrams
[ 1 ] Server Report:
[ ID] Interval Transfer Bandwidth Jitter Lost/Total Datagrams
[ 1 ] 0.0000-9.9997 sec 639 MBytes 536 Mbits/sec 0.000 ms 389/456519 (0.08%)
mininet> sh ovs-ofctl dump-ports -o OpenFlow14 s1
OFPT_PORT reply (OF1.4) (xid=0x2): 4 ports
  port LOCAL: rx pkts=0, bytes=0, drop=0, errs=0, frame=0, over=0, crc=0
    tx pkts=0, bytes=0, drop=0, errs=0, coll=0
    duration:159.808s
  port "s1-eth1": rx pkts=13961, bytes=706474630, drop=0, errs=0, frame=0, o
ver=0, crc=0
    tx pkts=148, bytes=19370, drop=0, errs=0, coll=0
    duration:159.813s
  port "s1-eth2": rx pkts=31, bytes=17662, drop=0, errs=0, frame=0, over=0, cr
c=0
    tx pkts=1, bytes=914079, bytes=706491448, drop=0, errs=0, coll=0
    duration:159.8138s
  port "s1-eth3": rx pkts=141, bytes=18786, drop=0, errs=0, frame=0, over=0, cr
c=0
    tx pkts=133, bytes=17940, drop=0, errs=0, coll=0
    duration:159.8138s
mininet> sh ovs-ofctl dump-ports -o OpenFlow14 s4
OFPT_PORT reply (OF1.4) (xid=0x2): 3 ports
  port LOCAL: rx pkts=0, bytes=0, drop=0, errs=0, frame=0, over=0, crc=0
    tx pkts=0, bytes=0, drop=0, errs=0, coll=0
    duration:161.440s
  port "s4-eth1": rx pkts=133, bytes=17940, drop=0, errs=0, frame=0, over=0, cr
c=0
    tx pkts=141, bytes=18786, drop=0, errs=0, coll=0
    duration:161.446s
  port "s4-eth2": rx pkts=141, bytes=18786, drop=0, errs=0, frame=0, over=0, cr
c=0
    tx pkts=131, bytes=17662, drop=0, errs=0, coll=0
    duration:161.446s
mininet> [0] 0:bash-1:sudo*

```

onos-netcfg localhost hostconfig.json

```

sdn@sdn-VirtualBox:~/groupmeter$ sudo mnexec -a 9542 iperf -s -u
Server listening on UDP port 5001
UDP buffer size: 208 KByte (default)
[ 1 ] local 10.6.1.2 port 5001 connected with 10.6.1.1 port 44756
[ ID] Interval Transfer Bandwidth Jitter Lost/Total Datagram
[ 1 ] 0.0000-10.0267 sec 645 KBytes 527 Kbits/sec 0.006 ms 0/449 (0%)
[ 2 ] local 10.6.1.2 port 5001 connected with 10.6.1.1 port 46367
[ ID] Interval Transfer Bandwidth Jitter Lost/Total Datagram
[ 2 ] 0.0000-9.9997 sec 639 MBytes 536 Mbits/sec 0.001 ms 389/456519 (0.085%)
[ 3 ] local 10.6.1.2 port 5001 connected with 10.6.1.1 port 39808
[ ID] Interval Transfer Bandwidth Jitter Lost/Total Datagram
[ 3 ] 0.0000-10.0264 sec 645 KBytes 527 Kbits/sec 0.032 ms 0/449 (0%)
[ 4 ] local 10.6.1.2 port 5001 connected with 10.6.1.1 port 60385
[ 5 ] local 10.6.1.2 port 5001 connected with 10.6.1.1 port 58194
[ ID] Interval Transfer Bandwidth Jitter Lost/Total Datagram
[ 5 ] 0.0000-10.0277 sec 584 KBytes 477 Kbits/sec 1.171 ms 1381/1788 (77%)
[ 6 ] local 10.6.1.2 port 5001 connected with 10.6.1.1 port 48589
[ 7 ] local 10.6.1.2 port 5001 connected with 10.6.1.1 port 44443
[ 7 ] 0.0000-10.0148 sec 1.25 MBytes 1.05 Mbits/sec 0.027 ms 0/895 (0%)
[ 8 ] local 10.6.1.2 port 5001 connected with 10.6.1.1 port 44047
[ 8 ] 0.0000-10.0096 sec 2.51 MBytes 2.10 Mbits/sec 0.012 ms 0/1787 (0%)
[ 7 ] WARNING: ack of last datagram failed.

```

Figure 4: iPerf with 512 Mbps (Before Link Failure)

```
sdn@sdn-VirtualBox: ~
```

64 bytes from 10.6.1.2: icmp_seq=10 ttl=64 time=0.062 ms
--- 10.6.1.2 ping statistics ---
10 packets transmitted, 9 received, 10% packet loss, time 9246ms
rtt min/avg/max/mdev = 0.037/0.075/0.175/0.043 ms
mininet> h1 iperf - 10.6.1.2 -u -b 512K

Client connecting to 10.6.1.2, UDP port 5001
Sending 1470 byte datagrams, IPG target: 22430.42 us (kalman adjust)
UDP buffer size: 208 KByte (default)

[1] local 10.6.1.1 port 39888 connected with 10.6.1.2 port 5001
[1] ID Interval Transfer Bandwidth Jitter Lost/Total Datagrams
[1] 0.0000-10.0266 sec 645 KBytes 527 Kbytes/sec 0.032 ms 0/449 (0%)
mininet> sh ovs-ofctl dump-ports -O OpenFlow14 s4
OFPST_PORT reply (OF1.4) (xid=0x2): 3 ports
 port LOCAL: rx pkts=0, bytes=0, drop=0, errs=0, frame=0, over=0, crc=0
 tx pkts=0, bytes=0, drop=0, errs=0, frame=0, over=0, duration=478.816us
port "s4-eth1": rx pkts=1255, bytes=742491, drop=0, errs=0, frame=0, over=0,
crc=0
 tx pkts=365, bytes=49255, drop=0, errs=0, coll=0
 duration=478.822s
port "s4-eth2": rx pkts=365, bytes=49255, drop=0, errs=0, frame=0, over=0, cr
c=0
 tx pkts=1253, bytes=742213, drop=0, errs=0, coll=0
 duration=478.822s
mininet> sh ovs-ofctl dump-ports -O OpenFlow14 s1
OFPST_PORT reply (OF1.4) (xid=0x2): 4 ports
 port LOCAL: rx pkts=0, bytes=0, drop=0, errs=0, frame=0, over=0, crc=0
 tx pkts=0, bytes=0, drop=0, errs=0, frame=0, over=0, duration=484.354s
 port "s1-eth1": rx pkts=914871, bytes=707169876, drop=0, errs=0, frame=0, ove
r=0, crc=0
 tx pkts=375, bytes=50159, drop=0, errs=0, coll=0
 duration=484.359s
 port "s1-eth2": rx pkts=321, bytes=43743, drop=0, errs=0, frame=0, over=0, cr
c=0
 tx pkts=914269, bytes=706517529, drop=0, errs=0, coll=0
 duration=484.359s
 port "s1-eth3": rx pkts=367, bytes=49533, drop=0, errs=0, frame=0, over=0, cr
c=0
 tx pkts=1257, bytes=742769, drop=0, errs=0, coll=0
 duration=484.359s
mininet> [0] 0:bash- 1:sudo*

```
sdn@sdn-VirtualBox: ~
```

hostconfig.json
sdn@sdn-VirtualBox: ~

```
sdn@sdn-VirtualBox: ~/Desktop/NYCU_SDN-and-NFV/lab04/spec$ onos-netcfg localhost
```

```
sdn@sdn-VirtualBox: ~/Desktop/NYCU_SDN-and-NFV/lab04/spec$
```

```
sdn@sdn-VirtualBox: ~
```

```
Sdn@sdn-VirtualBox: ~
```

sudo mnexec -a 9542 iperf -s -u

Server listening on UDP port 5001
UDP buffer size: 208 KByte (default)

[1] local 10.6.1.2 port 5001 connected with 10.6.1.1 port 4756
[1] ID Interval Transfer Bandwidth Jitter Lost/Total Datagram
[1] 0.0000-10.0267 sec 645 KBytes 527 Kbytes/sec 0.006 ms 0/449 (0%)
[2] local 10.6.1.2 port 5001 connected with 10.6.1.1 port 46367
[1] ID Interval Transfer Bandwidth Jitter Lost/Total Datagram
[2] 0.0000-9.9997 sec 639 MBytes 536 Mbytes/sec 0.001 ms 389/456519 (0.085%)
[3] local 10.6.1.2 port 5001 connected with 10.6.1.1 port 39808
[1] ID Interval Transfer Bandwidth Jitter Lost/Total Datagram
[3] 0.0000-10.0264 sec 645 KBytes 527 Kbytes/sec 0.032 ms 0/449 (0%)

```
sdn@sdn-VirtualBox: ~
```

Figure 5: iPerf with 512 Kbps (After Link Failure)

Figure 6: iPerf with 1 Mbps (After Link Failure)

The screenshot shows two terminal windows side-by-side. The left window is titled 'sdn@sdn-VirtualBox: ~ (ssh)' and displays the output of an iPerf test. The right window is titled 'sdn@sdn-VirtualBox: ~ (ssh)' and shows the configuration file 'hostconfig.json'.

```

sdn@sdn-VirtualBox: ~ (ssh)
duration=612.461s
port "s1-eth3": rx pkts=454, bytes=61556, drop=0, errs=0, frame=0, over=0, cr
c=0
tx pkts=916597, bytes=708245964, drop=0, errs=0, coll=0
duration=612.461s
mininet> h1 iperf -c 10.6.1.2 -u -b 2M
-----
Client connecting to 10.6.1.2, UDP port 5001
Sending 1470 byte datagrams, IPG target: 5607.60 us (kalman adjust)
UDP buffer size: 208 Kbyte (default)
[ 1 ] local 10.6.1.1 port 48589 connected with 10.6.1.2 port 5001
[ ID] Interval Transfer Bandwidth Jitter Lost/Total Datagrams
[ 1 ] 0.0000-10.0999 sec 2.51 MBytes 2.10 Mbits/sec
[ 1 ] Sent 1788 datagrams
[ 1 ] Server Report:
[ ID] Interval Transfer Bandwidth Jitter Lost/Total Datagrams
[ 1 ] 0.0000-10.0277 sec 584 KBytes 477 Kbits/sec 1.171 ms 1381/1788 (77%)
mininet> sh ovs-ofctl dump-ports -o OpenFlow14 s1
OFPT_PORT reply (OF1.4) (xid=0x2): 4 ports
  port LOCAL: rx pkts=0, bytes=0, drop=0, errs=0, frame=0, over=0, crc=0
    tx pkts=0, bytes=0, drop=0, errs=0, coll=0
    duration=652.476s
  port "s1-eth1": rx pkts=1833705, bytes=1417425662, drop=0, errs=0, frame=0, o
ver=0, crc=0
    tx pkts=506, bytes=74352, drop=0, errs=0, coll=0
    duration=652.481s
  port "s1-eth2": rx pkts=321, bytes=43743, drop=0, errs=0, frame=0, over=0, cr
c=0
    tx pkts=914269, bytes=706517529, drop=0, errs=0, coll=0
    duration=652.481s
  port "s1-eth3": rx pkts=495, bytes=73600, drop=0, errs=0, frame=0, over=0, cr
c=0
    tx pkts=920199, bytes=711013826, drop=0, errs=0, coll=0
mininet> sh ovs-ofctl dump-ports -o OpenFlow14 s4
OFPT_PORT reply (OF1.4) (xid=0x2): 3 ports
  port LOCAL: rx pkts=0, bytes=0, drop=0, errs=0, frame=0, over=0, crc=0
    tx pkts=0, bytes=0, drop=0, errs=0, coll=0
    duration=654.952s
  port "s4-eth1": rx pkts=920199, bytes=711013826, drop=0, errs=0, frame=0, o
ver=0, crc=0
    tx pkts=97, bytes=73878, drop=0, errs=0, coll=0
    duration=654.958s
  port "s4-eth2": rx pkts=97, bytes=73878, drop=0, errs=0, frame=0, over=0, cr
c=0
    tx pkts=18215, bytes=3203894, drop=0, errs=0, coll=0
    duration=654.958s
mininet> [0] 0:bash-1:sudo*

```

The right window shows the 'hostconfig.json' file:

```

sdn@sdn-VirtualBox: ~ (ssh)
sdn@sdn-VirtualBox: ~/Desktop/NYCU_SDN-and-NFV/lab04/spec$ onos-netcfg localhost
hostconfig.json
sdn@sdn-VirtualBox: ~/Desktop/NYCU_SDN-and-NFV/lab04/spec$ 

```

Figure 7: iPerf with 2 Mbps (After Link Failure)

The screenshot shows two terminal windows side-by-side. The left window is titled 'sdn@sdn-VirtualBox: ~ (ssh)' and displays the output of an iPerf test. The right window is titled 'sdn@sdn-VirtualBox: ~ (ssh)' and shows the configuration file 'hostconfig.json'. Below the right window, there is another terminal window titled 'sdn@sdn-VirtualBox: ~ (groupmeter)' running a 'mnexec' command.

```

sdn@sdn-VirtualBox: ~ (ssh)
c=0
  tx pkts=914269, bytes=706517529, drop=0, errs=0, coll=0
  duration=484.359s
  port "s1-eth3": rx pkts=367, bytes=49533, drop=0, errs=0, frame=0, over=0, cr
c=0
  tx pkts=1257, bytes=742769, drop=0, errs=0, coll=0
  duration=484.359s
mininet> h1 iperf -c 10.6.1.2 -u -b 512M
-----
Client connecting to 10.6.1.2, UDP port 5001
Sending 1470 byte datagrams, IPG target: 21.90 us (kalman adjust)
UDP buffer size: 208 Kbyte (default)
[ 1 ] local 10.6.1.1 port 60385 connected with 10.6.1.2 port 5001
[ ID] Interval Transfer Bandwidth Jitter Lost/Total Datagrams
[ 1 ] 0.0000-10.0080 sec 640 MBytes 536 Mbits/sec
[ 1 ] Sent 456531 datagrams
[ 3 ] WARNING: did not receive ack of last datagram after 10 tries.
mininet> sh ovs-ofctl dump-ports -o OpenFlow14 s4
OFPT_PORT reply (OF1.4) (xid=0x2): 3 ports
  port LOCAL: rx pkts=0, bytes=0, drop=0, errs=0, frame=0, over=0, crc=0
    tx pkts=0, bytes=0, drop=0, errs=0, coll=0
    duration=520.445s
  port "s4-eth1": rx pkts=914743, bytes=706850862, drop=0, errs=0, frame=0, o
ver=0, crc=0
    tx pkts=392, bytes=52976, drop=0, errs=0, coll=0
    duration=520.451s
  port "s4-eth2": rx pkts=92, bytes=52976, drop=0, errs=0, frame=0, over=0, cr
c=0
    tx pkts=16574, bytes=1652318, drop=0, errs=0, coll=0
    duration=520.451s
mininet> sh ovs-ofctl dump-ports -o OpenFlow14 s1
OFPT_PORT reply (OF1.4) (xid=0x2): 4 ports
  port LOCAL: rx pkts=0, bytes=0, drop=0, errs=0, frame=0, over=0, crc=0
    tx pkts=0, bytes=0, drop=0, errs=0, coll=0
    duration=523.611s
  port "s1-eth1": rx pkts=1828333, bytes=1413274568, drop=0, errs=0, frame=0, o
ver=0, crc=0
    tx pkts=404, bytes=53992, drop=0, errs=0, coll=0
    duration=523.616s
  port "s1-eth2": rx pkts=321, bytes=43743, drop=0, errs=0, frame=0, over=0, cr
c=0
    tx pkts=914269, bytes=706517529, drop=0, errs=0, coll=0
    duration=523.616s
  port "s1-eth3": rx pkts=394, bytes=53254, drop=0, errs=0, frame=0, over=0, cr
c=0
    tx pkts=914745, bytes=706851140, drop=0, errs=0, coll=0
    duration=523.616s
mininet> [0] 0:bash-1:sudo*

```

The right window shows the 'hostconfig.json' file:

```

sdn@sdn-VirtualBox: ~ (ssh)
sdn@sdn-VirtualBox: ~/Desktop/NYCU_SDN-and-NFV/lab04/spec$ onos-netcfg localhost
hostconfig.json
sdn@sdn-VirtualBox: ~/Desktop/NYCU_SDN-and-NFV/lab04/spec$ 

sdn@sdn-VirtualBox: ~ (groupmeter)
$ sudo mnexec -a 9542 iperf -s -u
Server listening on UDP port 5001
UDP buffer size: 208 Kbyte (default)
[ 1 ] local 10.6.1.2 port 5001 connected with 10.6.1.1 port 44756
[ ID] Interval Transfer Bandwidth Jitter Lost/Total Datagrams
[ 1 ] 0.0000-10.0267 sec 645 KBytes 527 Kbits/sec 0.006 ms 0/449 (0%)
[ 2 ] local 10.6.1.2 port 5001 connected with 10.6.1.1 port 46367
[ ID] Interval Transfer Bandwidth Jitter Lost/Total Datagrams
[ 2 ] 0.0000-9.9997 sec 639 MBytes 536 Mbits/sec 0.001 ms 389/456519 (0.0
85%)
[ 3 ] local 10.6.1.2 port 5001 connected with 10.6.1.1 port 39808
[ ID] Interval Transfer Bandwidth Jitter Lost/Total Datagram
[ 3 ] 0.0000-10.0264 sec 645 KBytes 527 Kbits/sec 0.032 ms 0/449 (0%)
[ 4 ] local 10.6.1.2 port 5001 connected with 10.6.1.1 port 60385
[ 5 ] local 10.6.1.2 port 5001 connected with 10.6.1.1 port 56194
[ ID] Interval Transfer Bandwidth Jitter Lost/Total Datagram
[ 5 ] 0.0000-10.0294 sec 665 KBytes 543 Kbits/sec 0.892 ms 433/896 (48%)
[ 6 ] local 10.6.1.2 port 5001 connected with 10.6.1.1 port 48589
[ 6 ] 0.0000-10.0277 sec 584 KBytes 477 Kbits/sec 1.171 ms 1381/1788 (77%
)

```

Below the right window, the 'groupmeter' terminal shows:

```

sdn@sdn-VirtualBox: ~ (groupmeter)
$ sudo mnexec -a 9542 iperf -s -u
Server listening on UDP port 5001
UDP buffer size: 208 Kbyte (default)
[ 1 ] local 10.6.1.2 port 5001 connected with 10.6.1.1 port 44756
[ ID] Interval Transfer Bandwidth Jitter Lost/Total Datagrams
[ 1 ] 0.0000-10.0267 sec 645 KBytes 527 Kbits/sec 0.006 ms 0/449 (0%)
[ 2 ] local 10.6.1.2 port 5001 connected with 10.6.1.1 port 46367
[ ID] Interval Transfer Bandwidth Jitter Lost/Total Datagrams
[ 2 ] 0.0000-9.9997 sec 639 MBytes 536 Mbits/sec 0.001 ms 389/456519 (0.0
85%)
[ 3 ] local 10.6.1.2 port 5001 connected with 10.6.1.1 port 39808
[ ID] Interval Transfer Bandwidth Jitter Lost/Total Datagram
[ 3 ] 0.0000-10.0264 sec 645 KBytes 527 Kbits/sec 0.032 ms 0/449 (0%)
[ 4 ] local 10.6.1.2 port 5001 connected with 10.6.1.1 port 60385

```

Figure 8: iPerf with 512 Mbps (After Link Failure)