

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

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Lab 2: Introduction to iPerf3

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- Using iPerf3 (client and server commands)
 - Test duration
 - Reporting interval
 - Bytes to transmit
 - Transport-layer protocol
 - Port number
 - Export results to JSON
 - Handle one client

Section 1: Bandwidth and iPerf3

Bandwidth

- Bandwidth is a physical property of a transmission media that depends on factor such as the construction and length of wire or fiber
- To network engineers, bandwidth is the maximum data rate of a channel, a quantity measured in bits per second (bps)

Bandwidth

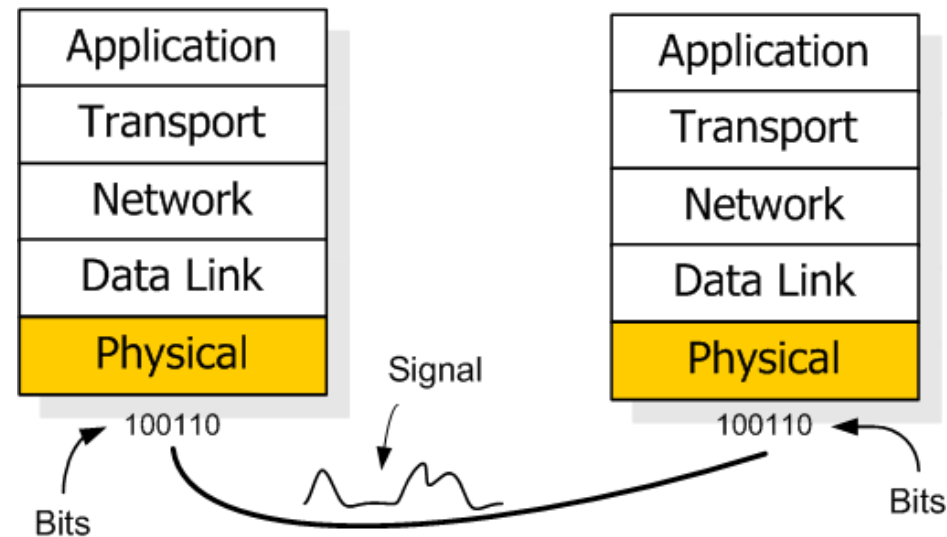
- Principal metric prefixes (common in data rate and time):

Exp.	Explicit	Prefix	Exp.	Explicit	Prefix
10^{-3}	0.001	milli	10^3	1,000	Kilo
10^{-6}	0.000001	micro	10^6	1,000,000	Mega
10^{-9}	0.000000001	nano	10^9	1,000,000,000	Giga
10^{-12}	0.0000000000001	pico	10^{12}	1,000,000,000,000	Tera
10^{-15}	0.0000000000000001	femto	10^{15}	1,000,000,000,000,000	Peta
10^{-18}	0.0000000000000000001	atto	10^{18}	1,000,000,000,000,000,000	Exa
10^{-21}	0.0000000000000000000001	zepto	10^{21}	1,000,000,000,000,000,000,000	Zetta
10^{-24}	0.000000000000000000000001	yocto	10^{24}	1,000,000,000,000,000,000,000,000	Yotta

- Examples: milliseconds (msec), micro (μ sec), nanoseconds (nsec); Kilobits/sec (Kbps), Megabits/sec (Mbps), Gigabits/sec (Gbps)

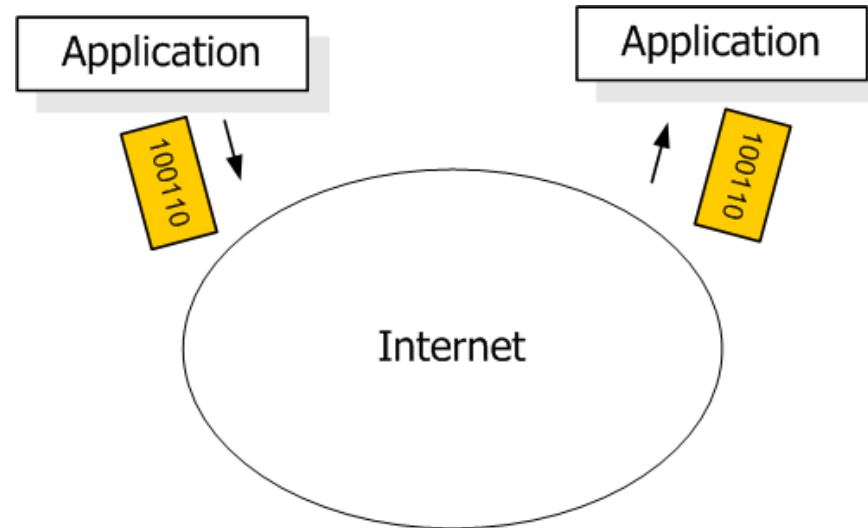
Bandwidth

- Media include wires, fiber optics, wireless
- Each medium has properties that impact signal propagation, which in turn impact the bandwidth, delay, packet loss rate (e.g., attenuation, noise)



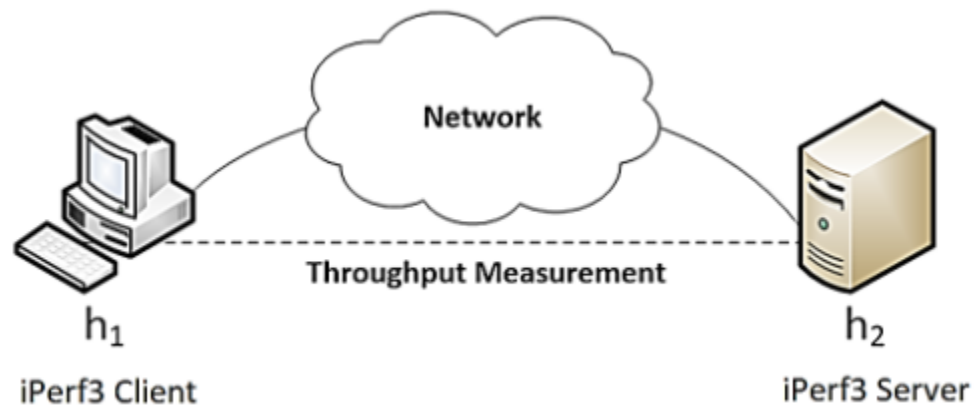
Throughput

- Throughput is the rate in bps at which the sending process can deliver bits to the receiving process
- The available throughput can fluctuate with time because sessions will be sharing the bandwidth



iPerf3

- iPerf3 is a real-time network throughput measurement tool
- It is an open source, cross-platform client-server application that can be used to measure the throughput between the two end devices
- A typical iPerf3 output contains a timestamped report of the amount of data transferred and the throughput measured
- Measuring throughput is particularly useful when experiencing network bandwidth issues such as delay, packet loss, etc.



iPerf3

- iPerf3 can operate on TCP, UDP, and SCTP, unidirectional or bidirectional way
- In iPerf3, the user can set *client* and *server* configurations via options and parameters
- iPerf3 outputs a timestamped report of the amount of data transferred and the throughput measured

```
Connecting to host 10.0.0.2, port 5201
[ 13] local 10.0.0.1 port 59414 connected to 10.0.0.2 port 5201
[ ID] Interval          Transfer    Bitrate      Retr  Cwnd
[ 13]  0.00-1.00      sec  5.18 GBytes  44.5 Gbits/sec    0   843 KBytes
[ 13]  1.00-2.00      sec  5.21 GBytes  44.7 Gbits/sec    0   1.11 MBytes
[ 13]  2.00-3.00      sec  5.20 GBytes  44.7 Gbits/sec    0   1.18 MBytes
[ 13]  3.00-4.00      sec  5.21 GBytes  44.7 Gbits/sec    0   1.24 MBytes
[ 13]  4.00-5.00      sec  5.19 GBytes  44.6 Gbits/sec    0   1.24 MBytes
[ 13]  5.00-6.00      sec  5.22 GBytes  44.8 Gbits/sec    0   1.30 MBytes
[ 13]  6.00-7.00      sec  5.24 GBytes  45.0 Gbits/sec    0   1.44 MBytes
[ 13]  7.00-8.00      sec  5.22 GBytes  44.9 Gbits/sec    0   1.44 MBytes
[ 13]  8.00-9.00      sec  5.21 GBytes  44.8 Gbits/sec    0   1.45 MBytes
[ 13]  9.00-10.00     sec  5.22 GBytes  44.8 Gbits/sec    0   1.52 MBytes
-----
[ ID] Interval          Transfer    Bitrate      Retr
[ 13]  0.00-10.00     sec  52.1 GBytes  44.8 Gbits/sec    0      sender
[ 13]  0.00-10.04     sec  52.1 GBytes  44.6 Gbits/sec    0      receiver

iperf Done.
root@admin-pc:~#
```

Section 2: Using iPerf3 (client and server commands)

iPerf3

- The user interacts with iPerf3 using the *iperf3* command
- The basic iperf3 syntax used on both the client and the server is as follows
 - *iperf3 [-s|-c] [options]*
- To launch iPerf3 in server mode, run the command *iperf3 -s*
- To launch iPerf3 in client mode, run the command *iperf3 -c 10.0.0.2*

```
root@admin-pc:~# iperf3 -s
-----
Server listening on 5201
-----
```

Server

```
root@admin-pc:~# iperf3 -c 10.0.0.2
Connecting to host 10.0.0.2, port 5201
[ 13] local 10.0.0.1 port 59414 connected to 10.0.0.2 port 5201
[ ID] Interval      Transfer    Bitrate      Retr  Cwnd
[ 13]  0.00-1.00    sec  5.18 GBytes  44.5 Gbits/sec  0    843 KBytes
```

Client

Useful Options (Test Duration)

- To change the default transmission time, use the `-t` option followed by the number of seconds on the client
- E.g., `iperf3 -c 10.0.0.2 -t 5`

```
root@admin-pc:~# iperf3 -c 10.0.0.2 -t 5
Connecting to host 10.0.0.2, port 5201
[ 13] local 10.0.0.1 port 59418 connected to 10.0.0.2 port 5201
[ ID] Interval      Transfer    Bitrate      Retr  Cwnd
[ 13]  0.00-1.00    sec  5.17 GBytes  44.4 Gbits/sec  0    860 KBytes
[ 13]  1.00-2.00    sec  5.19 GBytes  44.6 Gbits/sec  0    949 KBytes
[ 13]  2.00-3.00    sec  5.20 GBytes  44.6 Gbits/sec  0    1.02 MBytes
[ 13]  3.00-4.00    sec  5.19 GBytes  44.6 Gbits/sec  0    1.25 MBytes
[ 13]  4.00-5.00    sec  5.17 GBytes  44.4 Gbits/sec  0    1.25 MBytes
-----
[ ID] Interval      Transfer    Bitrate      Retr
[ 13]  0.00-5.00    sec  25.9 GBytes  44.5 Gbits/sec  0
[ 13]  0.00-5.04    sec  25.9 GBytes  44.2 Gbits/sec
sender
receiver

iperf Done.
root@admin-pc:~#
```

Useful Options (Reporting Interval)

- The `-i` option allows setting the reporting interval time in seconds
- E.g., `iperf3 -c 10.0.0.2 -i 2`

```
root@admin-pc:~# iperf3 -c 10.0.0.2 -i 2
Connecting to host 10.0.0.2, port 5201
[ 13] local 10.0.0.1 port 59430 connected to 10.0.0.2 port 5201
[ ID] Interval          Transfer      Bitrate      Retr  Cwnd
[ 13] 0.00-2.00 sec    8.69 GBytes  37.3 Gbits/sec    0   4.33 MBytes
[ 13] 2.00-4.00 sec   10.3 GBytes  44.3 Gbits/sec    0   4.33 MBytes
[ 13] 4.00-6.00 sec   10.3 GBytes  44.3 Gbits/sec    0   4.33 MBytes
[ 13] 6.00-8.00 sec   10.4 GBytes  44.8 Gbits/sec    0   4.33 MBytes
[ 13] 8.00-10.00 sec  10.4 GBytes  44.8 Gbits/sec    0   4.33 MBytes
-----
[ ID] Interval          Transfer      Bitrate      Retr
[ 13] 0.00-10.00 sec    50.2 GBytes  43.1 Gbits/sec    0
[ 13] 0.00-10.05 sec    50.2 GBytes  42.9 Gbits/sec    0
sender
receiver

iperf Done.
root@admin-pc:~#
```

Useful Options (Bytes to Transmit)

- By default, iPerf3 performs the throughput measurement for 10 seconds
- Using the -n option, the client will send packets until all the bytes specified by the user were sent

```
root@admin-pc:~# iperf3 -c 10.0.0.2 -n 16G
Connecting to host 10.0.0.2, port 5201
[ 13] local 10.0.0.1 port 59434 connected to 10.0.0.2 port 5201
[ ID] Interval          Transfer      Bitrate      Retr  Cwnd
[ 13]  0.00-1.00    sec  4.96 GBytes  42.6 Gbits/sec  0    800 KBytes
[ 13]  1.00-2.00    sec  5.31 GBytes  45.6 Gbits/sec  0    881 KBytes
[ 13]  2.00-3.00    sec  5.20 GBytes  44.6 Gbits/sec  0    1.01 MBytes
[ 13]  3.00-3.11    sec   548 MBytes  40.0 Gbits/sec  0    1.01 MBytes
-----
[ ID] Interval          Transfer      Bitrate      Retr
[ 13]  0.00-3.11    sec  16.0 GBytes  44.1 Gbits/sec  0
[ 13]  0.00-3.15    sec  16.0 GBytes  43.5 Gbits/sec
iperf Done.
root@admin-pc:~#
```

Useful Options (Specifying transport-layer protocol)

- In order to change the protocol to UDP, the option `-u` on the client side is used
- Similarly, the option `-sctp` is used for the SCTP protocol

```
root@admin-pc:~# iperf3 -c 10.0.0.2 -u
Connecting to host 10.0.0.2, port 5201
[ 13] local 10.0.0.1 port 45368 connected to 10.0.0.2 port 5201
[ ID] Interval          Transfer      Bitrate      Total Datagrams
[ 13] 0.00-1.00 sec      129 KBytes   1.05 Mbits/sec  91
[ 13] 1.00-2.00 sec      127 KBytes   1.04 Mbits/sec  90
[ 13] 2.00-3.00 sec      129 KBytes   1.05 Mbits/sec  91
[ 13] 3.00-4.00 sec      127 KBytes   1.04 Mbits/sec  90
[ 13] 4.00-5.00 sec      129 KBytes   1.05 Mbits/sec  91
[ 13] 5.00-6.00 sec      129 KBytes   1.05 Mbits/sec  91
[ 13] 6.00-7.00 sec      127 KBytes   1.04 Mbits/sec  90
[ 13] 7.00-8.00 sec      129 KBytes   1.05 Mbits/sec  91
[ 13] 8.00-9.00 sec      127 KBytes   1.04 Mbits/sec  90
[ 13] 9.00-10.00 sec     129 KBytes   1.05 Mbits/sec  91
-----
[ ID] Interval          Transfer      Bitrate      Jitter      Lost/Total Datagrams
[ 13] 0.00-10.00 sec     1.25 MBytes   1.05 Mbits/sec  0.000 ms    0/906 (0%) sender
[ 13] 0.00-10.04 sec     1.25 MBytes   1.04 Mbits/sec  0.010 ms    0/906 (0%) receiver

iperf Done.
root@admin-pc:~#
```


Useful Options (Port Number)

- If the user wishes to measure throughput on a specific port, the `-p` option is used

```
"Host: h2"  
root@admin-pc:~# iperf3 -s -p 3250  
-----  
Server listening on 3250  
-----  
█
```

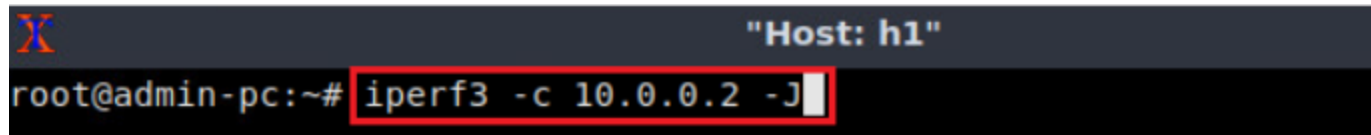
Server

```
"Host: h1"  
root@admin-pc:~# iperf3 -c 10.0.0.2 -p 3250  
Connecting to host 10.0.0.2, port 3250  
[ 13] local 10.0.0.1 port 59676 connected to 10.0.0.2 port 3250  
[ ID] Interval      Transfer    Bitrate      Retr  Cwnd  
[ 13]  0.00-1.00    sec  5.23 GBytes  44.9 Gbits/sec  0  1.02 MB
```

Client

Useful Options (Export Results to JSON)

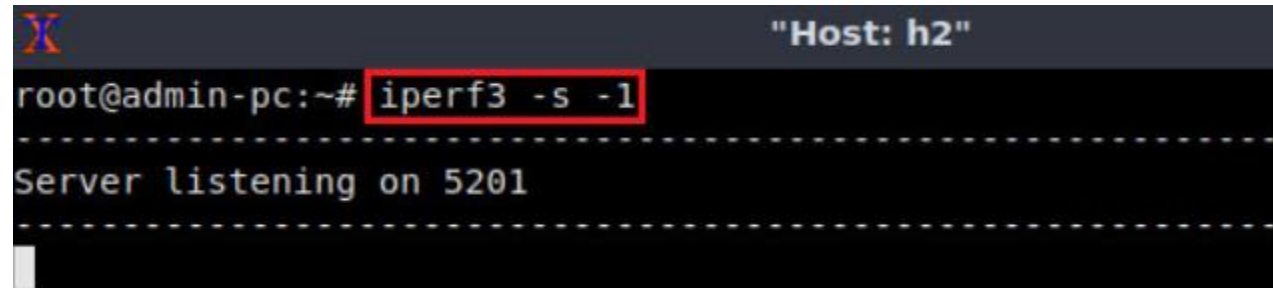
- JSON (JavaScript Object Notation) is a lightweight data-interchange format
- iPerf3 allows exporting the test results to a JSON file, which makes it easy for other applications to parse the file and interpret the results



```
X "Host: h1"  
root@admin-pc:~# iperf3 -c 10.0.0.2 -J
```

Useful Options (Handle One Client)

- By default, an iPerf3 server keeps listening to incoming connections
- To allow the server to handle one client and then stop, the `-1` option is added to the server



```
X "Host: h2"
root@admin-pc:~# iperf3 -s -1
-----
Server listening on 5201
-----
```