

Lab4 – Cloudlab

Summary

In this lab, we learn about using Cloud lab, setting up, and running experiments. The lab teaches us to remotely log in to a cloud server and interact with the nodes. In exercise 3, we experiment with using multiple TCP connections parallelly and assessing their performance. We go on further to assess if each of the ports on the servers(eth0, eth1, and lo) are accessible by the client, as well as systems on the world wide web/internet.

Note: Throughout the lab, I ran different experiments since the old ones terminated, so the IP addresses are not fixed throughout my report.

Exercise 1

The screenshot shows the CloudLab Experiment Status page in a web browser. The URL is cloudlab.us/status.php?uid=cdd3ff62-6408-11ee-9f39-e4434b2381fc. The page has a navigation bar with 'Experiments', 'Storage', and 'News!' tabs. A message box says 'Sign up to join our user feedback group here via this short form'. Below this, a green box indicates 'Your experiment is ready'. A summary box shows the following details:

- Name: Nihaal
- State: ready
- Profile: CPRE489-lab4
- Creator: nihaal7
- Project: CPRE489
- Started: Oct 6, 2023 12:25 AM
- Expires: Oct 6, 2023 4:25 PM (in 16 hours)

Buttons for 'Logs', 'Portal Log', 'Create Disk Image', 'Copy', 'Extend', and 'Terminate' are present. Below the summary is a table with tabs for 'Topology View', 'List View', 'Manifest', and 'Graphs'. The 'List View' tab is active, showing a table of nodes:

ID	Node	Type	Cluster	Status	Startup	Image	SSH command (if you provided your own key)		
client	amdvm220-1	pcvm	Utah	ready	Finished	n/a	ssh -p 27010 nihaal7@amd220.utah.cloudlab.us	<input type="checkbox"/>	
server	amdvm220-2	pcvm	Utah	ready	Finished	n/a	ssh -p 27011 nihaal7@amd220.utah.cloudlab.us	<input type="checkbox"/>	
amd220	amd220	c6525-25g	Utah	n/a	n/a	n/a	ssh nihaal7@amd220.utah.cloudlab.us	<input type="checkbox"/>	

At the bottom, a footer contains the URL <https://www.cloudlab.us/status.php?uid=cdd3ff62-6408-11ee-9f39-e4434b2381fc#listview>, a link to the Help Forum, and support information: 'Supported by NSF © 2023 The University of Utah'. The system tray shows a temperature of 9°C and the time 12:48 AM on 10/6/2023.

List view

Exercise 2

```
[nzaheer@cpre587-f23-07 ~]$ ssh -i ~/.ssh/id_cloudlab_rsa nihaal7@amd220.utah.cloudlab.us -p 27011
Welcome to Ubuntu 22.04.2 LTS (GNU/Linux 5.15.0-69-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:       https://ubuntu.com/advantage

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https://ubuntu.com/pro

The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

nihaal7@server:~$
```

```
nihaal@Nihaal:~$ ssh nzaheer@cpre587-f23-07.ece.iastate.edu
nzaheer@cpre587-f23-07.ece.iastate.edu's password:
Activate the web console with: systemctl enable --now cockpit.socket

Register this system with Red Hat Insights: insights-client --register
Create an account or view all your systems at https://red.ht/insights-dashboard
Last login: Fri Oct  6 00:53:01 2023 from 10.48.95.234
[nzaheer@cpre587-f23-07 ~]$ ssh -i ~/.ssh/id_cloudlab_rsa nihaal7@amd220.utah.cloudlab.us -p 27010
The authenticity of host '[amd220.utah.cloudlab.us]:27010 ([128.110.219.131]:27010)' can't be established.
ECDSA key fingerprint is SHA256:BB4TBZMIEhrtJN2mb/Mzn8fvSRUBUC+UamxqkhCU7HA.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '[amd220.utah.cloudlab.us]:27010,[128.110.219.131]:27010' (ECDSA) to the list of known hosts.
Welcome to Ubuntu 22.04.2 LTS (GNU/Linux 5.15.0-69-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
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https://ubuntu.com/pro

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individual files in /usr/share/doc/*/copyright.

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

nihaal7@client:~$
```

Client and Server Login page

Exercise 3

```
nihaal7@server:~$ ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 172.17.220.2 netmask 255.240.0.0 broadcast 172.31.255.255
    inet6 fe80::64:20ff:fe06:d424 prefixlen 64 scopeid 0x20<link>
    ether 02:64:20:06:d4:24 txqueuelen 1000 (Ethernet)
    RX packets 188651 bytes 38921931 (38.9 MB)
    RX errors 0 dropped 3136 overruns 0 frame 0
    TX packets 2564 bytes 234980 (234.9 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

eth1: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 10.10.1.2 netmask 255.255.255.0 broadcast 10.10.1.255
    inet6 fe80::6c:a6ff:fe45:d286 prefixlen 64 scopeid 0x20<link>
    ether 02:6c:a6:45:d2:86 txqueuelen 1000 (Ethernet)
    RX packets 24 bytes 1460 (1.4 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 11 bytes 1195 (1.1 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 344 bytes 32865 (32.8 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 344 bytes 32865 (32.8 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

nihaal7@server:~$

nihaal7@client:~$ ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 172.17.220.1 netmask 255.240.0.0 broadcast 172.31.255.255
    inet6 fe80::7a:81ff:fe61:17d4 prefixlen 64 scopeid 0x20<link>
    ether 02:7a:81:61:17:d4 txqueuelen 1000 (Ethernet)
    RX packets 190471 bytes 39009674 (39.0 MB)
    RX errors 0 dropped 3150 overruns 0 frame 0
    TX packets 3183 bytes 273233 (273.2 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

eth1: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 10.10.1.1 netmask 255.255.255.0 broadcast 10.10.1.255
    inet6 fe80::cb:23ff:fe64:2db1 prefixlen 64 scopeid 0x20<link>
    ether 02:cb:23:64:2d:b1 txqueuelen 1000 (Ethernet)
    RX packets 41 bytes 2993 (2.9 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 9 bytes 1035 (1.0 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 346 bytes 32927 (32.9 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 346 bytes 32927 (32.9 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

nihaal7@client:~$
```

Ifconfig

Server IP: 172.17.220.2

Client IP: 172.17.220.1

```
nihaal7@server:~$ iperf -s
-----
Server listening on TCP port 5001
TCP window size: 128 KByte (default)
-----
[  1] local 10.10.1.2 port 5001 connected with 10.10.1.1 port 34256
[  2] local 10.10.1.2 port 5001 connected with 10.10.1.1 port 34272
[ ID] Interval           Transfer     Bandwidth
[  1] 0.0000-10.0803 sec   108 MBytes  90.0 Mbits/sec
[  2] 0.0000-10.0945 sec    6.38 MBytes  5.30 Mbits/sec
[SUM] 0.0000-10.0945 sec   115 MBytes  95.2 Mbits/sec
```

```
-P, --parallel n
        number of parallel client threads to run
```

man page of iperf

```

nihaal7@client:~$ iperf -c server -P 2
[ 1] local 10.10.1.1 port 34256 connected with 10.10.1.2 port 5001
[ 2] local 10.10.1.1 port 34272 connected with 10.10.1.2 port 5001
-----
Client connecting to server, TCP port 5001
TCP window size: 136 KByte (default)
-----
[ ID] Interval      Transfer    Bandwidth
[ 1] 0.0000-10.0893 sec  108 MBytes  89.9 Mbits/sec
[ 2] 0.0000-10.1059 sec   6.38 MBytes   5.29 Mbits/sec
[SUM] 0.0000-10.0843 sec  115 MBytes  95.2 Mbits/sec
[ CT] final connect times (min/avg/max/stdev) = 0.678/0.713/0.748/0.049 ms (tot/err)
) = 2/0

```

-p 2

```

^Cnihaal7@server:~$ iperf -s
-----
Server listening on TCP port 5001
TCP window size: 128 KByte (default)
-----
[ 1] local 10.10.1.2 port 5001 connected with 10.10.1.1 port 37890
[ 2] local 10.10.1.2 port 5001 connected with 10.10.1.1 port 37898
[ 3] local 10.10.1.2 port 5001 connected with 10.10.1.1 port 37914
[ 4] local 10.10.1.2 port 5001 connected with 10.10.1.1 port 37928
[ ID] Interval      Transfer    Bandwidth
[ 2] 0.0000-10.0981 sec  21.9 MBytes  18.2 Mbits/sec
[ 4] 0.0000-10.1446 sec  27.0 MBytes  22.3 Mbits/sec
[ 3] 0.0000-10.2677 sec  12.1 MBytes   9.91 Mbits/sec
[ 1] 0.0000-10.3709 sec  57.1 MBytes  46.2 Mbits/sec
[SUM] 0.0000-10.3709 sec  118 MBytes  95.5 Mbits/sec

```

```

nihaal7@client:~$ iperf -c server -P 4
[ 1] local 10.10.1.1 port 37890 connected with 10.10.1.2 port 5001
[ 3] local 10.10.1.1 port 37914 connected with 10.10.1.2 port 5001
[ 4] local 10.10.1.1 port 37928 connected with 10.10.1.2 port 5001
[ 2] local 10.10.1.1 port 37898 connected with 10.10.1.2 port 5001
-----
Client connecting to server, TCP port 5001
TCP window size: 170 KByte (default)
-----
[ ID] Interval      Transfer    Bandwidth
[ 2] 0.0000-10.1109 sec  21.9 MBytes  18.1 Mbits/sec
[ 4] 0.0000-10.1593 sec  27.0 MBytes  22.3 Mbits/sec
[ 3] 0.0000-10.2716 sec  12.1 MBytes   9.90 Mbits/sec
[ 1] 0.0000-10.3849 sec  57.1 MBytes  46.1 Mbits/sec
[SUM] 0.0000-10.1598 sec  118 MBytes  97.5 Mbits/sec
[ CT] final connect times (min/avg/max/stdev) = 0.417/0.525/0.625/0.089 ms (tot/err)
) = 4/0

```

-p 4

```

nihaal7@client: $ iperf -c server -P 2
[ 1] local 10.10.1.1 port 43864 connected with 10.10.1.2 port 5001
[ 2] local 10.10.1.1 port 43872 connected with 10.10.1.2 port 5001

Client connecting to server, TCP port 5001
TCP window size: 85.0 KByte (default)

[ ID] Interval      Transfer      Bandwidth
[ 2] 0.0000-0.0749 sec  9.38 MBytes  7.81 Mbits/sec
[ 1] 0.0000-0.1075 sec  105 MBytes  87.1 Mbits/sec
[SUM] 0.0000-0.0166 sec  114 MBytes  95.8 Mbits/sec
[CT] final connect times (min/avg/max/stddev) = 0.519/0.554/0.589/0.049 ms (tot/err) = 2/0
nihaal7@client: $ iperf -c server -P 4
[ 1] local 10.10.1.1 port 33842 connected with 10.10.1.2 port 5001
[ 3] local 10.10.1.1 port 33866 connected with 10.10.1.2 port 5001
[ 4] local 10.10.1.1 port 33878 connected with 10.10.1.2 port 5001
[ 2] local 10.10.1.1 port 33858 connected with 10.10.1.2 port 5001

Client connecting to server, TCP port 5001
TCP window size: 476 KByte (default)

[ ID] Interval      Transfer      Bandwidth
[ 2] 0.0000-0.1896 sec  14.0 MBytes  11.5 Mbits/sec
[ 1] 0.0000-0.2219 sec  78.0 MBytes  64.0 Mbits/sec
[ 4] 0.0000-0.2542 sec  10.5 MBytes  8.59 Mbits/sec
[ 3] 0.0000-0.3679 sec  15.5 MBytes  12.5 Mbits/sec
[SUM] 0.0000-0.2318 sec  118 MBytes  96.7 Mbits/sec
[CT] final connect times (min/avg/max/stddev) = 0.366/0.460/0.540/0.074 ms (tot/err) = 4/0
nihaal7@client: $ iperf -c server -P 20
[ 1] local 10.10.1.1 port 44124 connected with 10.10.1.2 port 5001
[ 3] local 10.10.1.1 port 44142 connected with 10.10.1.2 port 5001
[ 4] local 10.10.1.1 port 44152 connected with 10.10.1.2 port 5001
[ 7] local 10.10.1.1 port 44169 connected with 10.10.1.2 port 5001
[ 9] local 10.10.1.1 port 44179 connected with 10.10.1.2 port 5001
[ 8] local 10.10.1.1 port 44209 connected with 10.10.1.2 port 5001
[13] local 10.10.1.1 port 44239 connected with 10.10.1.2 port 5001
[15] local 10.10.1.1 port 44236 connected with 10.10.1.2 port 5001
[17] local 10.10.1.1 port 44262 connected with 10.10.1.2 port 5001
[19] local 10.10.1.1 port 44284 connected with 10.10.1.2 port 5001
[20] local 10.10.1.1 port 44298 connected with 10.10.1.2 port 5001
[22] local 10.10.1.1 port 44136 connected with 10.10.1.2 port 5001
[ 6] local 10.10.1.1 port 44156 connected with 10.10.1.2 port 5001
[11] local 10.10.1.1 port 44210 connected with 10.10.1.2 port 5001
[14] local 10.10.1.1 port 44232 connected with 10.10.1.2 port 5001
[18] local 10.10.1.1 port 44279 connected with 10.10.1.2 port 5001
[ 5] local 10.10.1.1 port 44159 connected with 10.10.1.2 port 5001
[12] local 10.10.1.1 port 44226 connected with 10.10.1.2 port 5001

Client connecting to server, TCP port 5001
TCP window size: 85.0 KByte (default)

[10] local 10.10.1.1 port 44184 connected with 10.10.1.2 port 5001
[16] local 10.10.1.1 port 44252 connected with 10.10.1.2 port 5001
[ ID] Interval      Transfer      Bandwidth
[13] 0.0000-0.1223 sec  7.00 MBytes  5.80 Mbits/sec
[17] 0.0000-0.1543 sec  5.38 MBytes  4.44 Mbits/sec
[18] 0.0000-0.1704 sec  5.88 MBytes  4.85 Mbits/sec
[14] 0.0000-0.1871 sec  6.25 MBytes  5.15 Mbits/sec
[16] 0.0000-0.1867 sec  4.25 MBytes  3.50 Mbits/sec
[ 8] 0.0000-0.2032 sec  5.38 MBytes  4.42 Mbits/sec
[ 9] 0.0000-0.2198 sec  6.13 MBytes  5.03 Mbits/sec
[20] 0.0000-0.2189 sec  3.50 MBytes  2.87 Mbits/sec
[19] 0.0000-0.2519 sec  6.13 MBytes  5.01 Mbits/sec
[ 3] 0.0000-0.2523 sec  5.63 MBytes  4.60 Mbits/sec
[ 1] 0.0000-0.2686 sec  5.25 MBytes  4.29 Mbits/sec
[10] 0.0000-0.2843 sec  6.00 MBytes  4.89 Mbits/sec
[ 2] 0.0000-0.3651 sec  6.50 MBytes  5.26 Mbits/sec
[11] 0.0000-0.3969 sec  5.00 MBytes  4.03 Mbits/sec
[ 5] 0.0000-0.3974 sec  6.00 MBytes  4.84 Mbits/sec
[12] 0.0000-0.4722 sec  7.13 MBytes  5.71 Mbits/sec
[ 6] 0.0000-0.4775 sec  7.63 MBytes  6.10 Mbits/sec
[ 7] 0.0000-0.5097 sec  10.1 MBytes  8.08 Mbits/sec
[15] 0.0000-0.5255 sec  3.88 MBytes  3.09 Mbits/sec
[ 4] 0.0000-0.5263 sec  7.00 MBytes  5.58 Mbits/sec
[SUM] 0.0000-0.5169 sec  120 MBytes  95.7 Mbits/sec
[CT] final connect times (min/avg/max/stddev) = 0.459/0.893/1.320/0.261 ms (tot/err) = 20/0

```

-p 20

This is what we get by changing the number of parallel connections.

We notice that for 2 parallel connections, the throughput is 95.8Mbps and the connection speed is between 7.81 Mbps and 87.1Mbps. Increasing the number of parallel connections initially improves throughput. This is seen when the number of parallel connections is made to 4. Here we see that the throughput is 96.7Mbps and the connection speed ranges from 11.5Mbps to 64Mbps. As we considerably increase the number of parallel connections, the returns diminish. As seen, when the number of parallel connections is 20, throughput decreases to 95.7Mbps, and individual connections range from 2.87Mbps to 8.08Mbps.

So we can infer that an initial increase in parallel connections improves performance, after which it plateaus and doesn't increase further.

5)

The 3 interfaces for the server machine

```
nihaal7@server:~$ ifconfig
eth0: flags=4163<UP,BROADCAST,
      inet 172.17.234.2
```

```
eth1: flags=4163<UP,BROADCAST,
      inet 10.10.1.2
```

```
lo: flags=73<UP,LOOPBACK,
     inet 127.0.0.1
```

For eth0:

I. Interface with the client

```
nihaal7@client:~$ ping 172.17.234.2
PING 172.17.234.2 (172.17.234.2) 56(84) bytes of data.
64 bytes from 172.17.234.2: icmp_seq=1 ttl=64 time=0.734 ms
64 bytes from 172.17.234.2: icmp_seq=2 ttl=64 time=0.277 ms
```

```
nihaal7@server:~$ sudo tcpdump -i eth0 icmp
tcpdump: verbose output suppressed, use -v[v]... for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), snapshot length 262144 bytes
10:29:33.351545 IP amdvm234-1.utah.cloudlab.us > amdvm234-2.utah.cloudlab.us: ICMP echo request, id 4, seq 27, length 64
10:29:33.351561 IP amdvm234-2.utah.cloudlab.us > amdvm234-1.utah.cloudlab.us: ICMP echo reply, id 4, seq 27, length 64
```

II. Interface with the World wide Web

```
nihaal7@server:~$ ping google.com
PING google.com (142.250.105.102) 56(84) bytes of data.
64 bytes from yt-in-f102.1e100.net (142.250.105.102): icmp_seq=1 ttl=50 time=63.8 ms
64 bytes from yt-in-f102.1e100.net (142.250.105.102): icmp_seq=2 ttl=50 time=63.8 ms
```

```
nihaal@Nihaal:~$ ping 172.17.234.2
PING 172.17.234.2 (172.17.234.2) 56(84) bytes of data.
^C
--- 172.17.234.2 ping statistics ---
5 packets transmitted, 0 received, 100% packet loss, time 4183ms
```

For the eth1:

I. Interface with the client

```
nihaal7@client:~$ ping 10.10.1.2
PING 10.10.1.2 (10.10.1.2) 56(84) bytes of data.
64 bytes from 10.10.1.2: icmp_seq=1 ttl=64 time=0.672 ms
64 bytes from 10.10.1.2: icmp_seq=2 ttl=64 time=0.224 ms
```

```
nihaal7@server:~$ sudo tcpdump -i eth1 icmp
tcpdump: verbose output suppressed, use -v[v]... for full protocol decode
listening on eth1, link-type EN10MB (Ethernet), snapshot length 262144 bytes
10:31:12.007445 IP client-link-0 > server-link-0: ICMP echo request, id 5, seq 24, length 64
10:31:12.007463 IP server-link-0 > client-link-0: ICMP echo reply, id 5, seq 24, length 64
```

II. Interface with the World wide Web

```
nihaal@Nihaal:~$ ping 10.10.1.2
PING 10.10.1.2 (10.10.1.2) 56(84) bytes of data.
^C
--- 10.10.1.2 ping statistics ---
2 packets transmitted, 0 received, 100% packet loss, time 1025ms
```

For lo:

I. Interface with the client

```
nihaal7@client:~$ ping 127.0.0.1
PING 127.0.0.1 (127.0.0.1) 56(84) bytes of data.
64 bytes from 127.0.0.1: icmp_seq=1 ttl=64 time=0.014 ms
64 bytes from 127.0.0.1: icmp_seq=2 ttl=64 time=0.010 ms
```

```
nihaal7@server:~$ sudo tcpdump -i lo icmp
tcpdump: verbose output suppressed, use -v[v]... for full protocol decode
listening on lo, link-type EN10MB (Ethernet), snapshot length 262144 bytes
```


The client is not able to ping the server on port 'lo'.

II. Interface with the World wide Web

Since 127.0.0.1 is a generic local IP address, it will work on every computer. This does not mean that we are receiving the ping sent via the 'lo' port. This can be justified by running traceroute on the 'World wide Web PC', in this case, my personal computer.

```
nihaal@Nihaal:~$ traceroute 127.0.0.1
traceroute to 127.0.0.1 (127.0.0.1), 30 hops max, 60 byte packets
 1 localhost (127.0.0.1)  0.047 ms  0.005 ms  0.004 ms
nihaal@Nihaal:~$
```

Explanation for 'Interface with World wide Web'

In the past, for cloudlab, eth0 was given a public IP address, but after the update, all ports only have a local IP. When we ping google.com, this works, but when we try to ping the cloudlab server from any PC on the internet, this fails. The reason as mentioned before, is since the server does not have a public IP address.

Exercise 4

The screenshot shows a web interface with a dark header. A white modal dialog is centered, asking "Are you sure you want to terminate this experiment? Click on the button below if you are really sure." with "Terminate" and "Cancel" buttons. Below the dialog, a status bar shows "experiment is ready". The footer contains navigation links: Experiments, Storage, News!, Docs, and a user profile "nihaal7". A light blue banner invites users to join a feedback group. A usage statistics bar shows "Current Usage: 0 Node Hours, Prev Week: 49.27, Prev Month: 49.27 (30 day rank: 886 of 1308 users)". A bottom navigation bar lists: Experiments, Profiles, Project Profiles, Datasets, Reservations, Membership, Usage, and Account. A message at the bottom states: "You do not have any active experiments. Click [here](#) to create one."