

CN Assignment 3

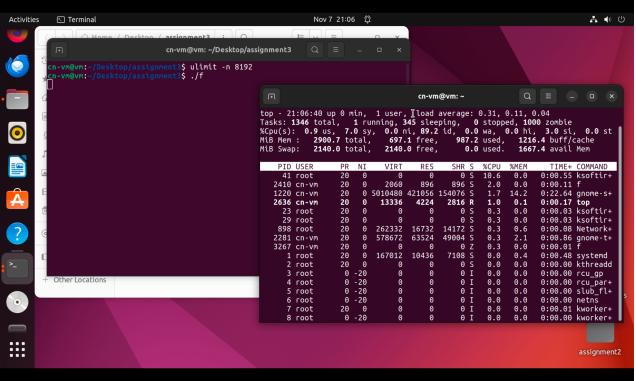
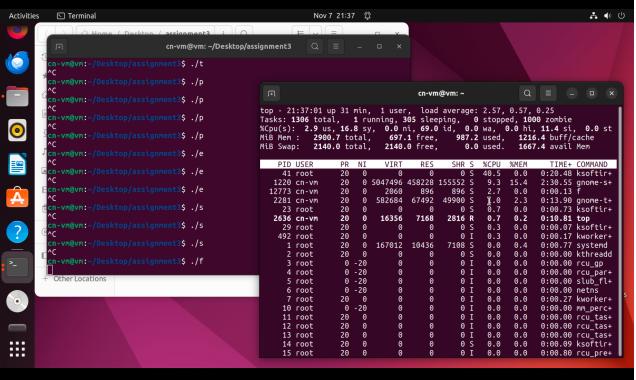
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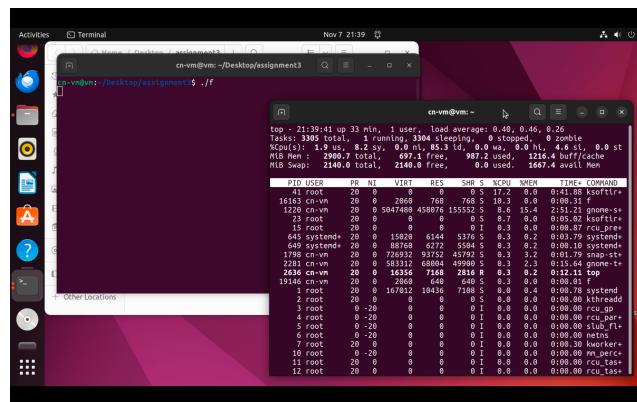
System: M1 Macbook Pro (using VM ware fusion)

Abstract: Server codes for handling multiple concurrent clients are made using different techniques involving fork(), thread(), poll(), epoll() and select(). Key takeaway from this assignment is fork() and thread() have simple implementations but are resource intensive, use higher CPU and memory and are not scalable. Whereas poll(), epoll() and select() can efficiently manage a high number of clients and use less resources as compared to fork() and thread(), they are suitable to use for large scale servers. However, select() is not as efficient as poll() and epoll() and also has an upper limit on FD i.e. 1024.

Ip_address:port - 172.16.40.128:8189

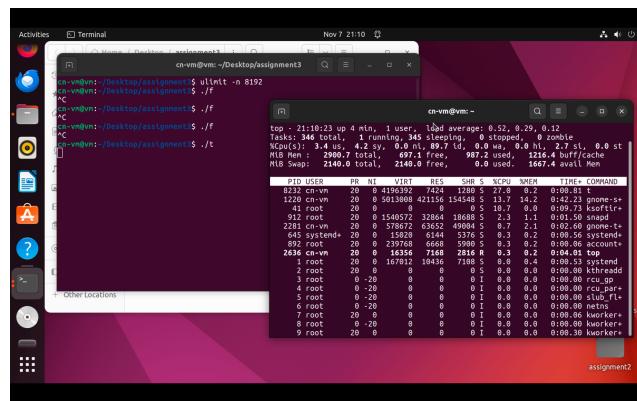
Fork with 500 concurrent connections		Peak CPU Usage: 2% Peak Memory: 0% (Parent Process)
Fork with 1000 concurrent connections		Peak CPU Usage: 2.7% Peak Memory: 0%

Fork with
3000
concurrent
connections



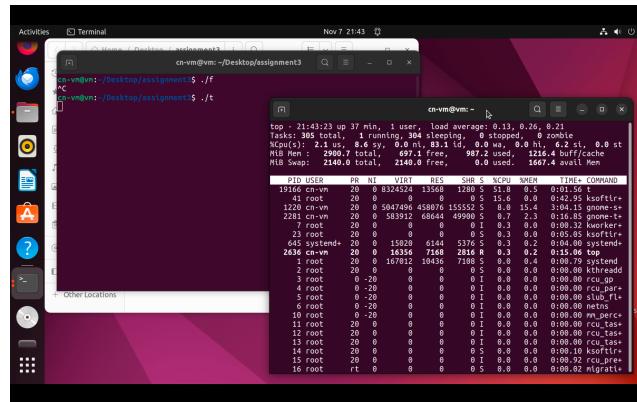
Peak CPU Usage:
10.3%
Peak Memory: 0%

Thread with
500
concurrent
connections



Peak CPU Usage: 27%
Peak Memory: 0.2%

Thread with
1000 concurrent
connections



Peak CPU Usage:
51.8%
Peak Memory: 0.5%

Thread with
3000
concurrent
connections

Peak CPU Usage:
84.1%
Peak Memory usage:
1.3%

Poll with
500
concurrent
connections

```
Activites Terminal cn-vm@vm:~$ ps aux | sort -r -n CPU | head -10
cn-vm@vm:~$ ps aux | sort -r -n CPU | head -10
cn-vm@vm:~$ top
top - 21:12:24 up 6 min, 1 user, load average: 0.92, 0.56, 0.24
Tasks: 305 total, 1 running, 304 sleeping, 0 stopped, 0 zombie
CPU(s): 0.00%us, 0.00%sy, 0.73%ni, 9.00%id, 8.00%wa, 0.00%hi, 8.66%st
HDD: 0.00%util, 0.00%avg
Mem: 2140.0 total, 2140.0 free, 0 used, 0 available
Swap: 2140.0 total, 2140.0 free, 0 used, 0 available
          PID USER      PR  NI    VIRT    RES    SHW S %CPU %MEM TIME+ COMMAND
 17246 cn-vn-g  20   0  20868 1024 R  0.0  0.0  0.0 0.00:00.20 p
 15336 cn-vn-g  20   0  20868 1024 R  0.0  0.0  0.0 0.00:00.20 p
 2636 cn-vn    20   0 16356 7168 R  0.7  0.2  0.0 0.04:42.60 top
10413 cn-vn    20   0  38932 11356 R  0.7  0.2  0.0 0.00:43 lbusd-de
22820 cn-vn    20   0  20868 1024 R  0.0  0.0  0.0 0.00:00.00 p
 1 root      20   0 167812 10436 S  0.0  0.4  0.0 0.00:59 sysvinit
 2 root      20   0  20868 1024 R  0.0  0.0  0.0 0.00:00.00 p
 3 root      20   0  20868 1024 R  0.0  0.0  0.0 0.00:00.00 p
 4 root      20   0  20868 1024 R  0.0  0.0  0.0 0.00:00.00 rcpu_parallel
 5 root      20   0  20868 1024 R  0.0  0.0  0.0 0.00:00.00 rcpu_parallel
 6 root      20   0  20868 1024 R  0.0  0.0  0.0 0.00:00.00 netns
 10 root     20   0  20868 1024 R  0.0  0.0  0.0 0.00:00.00 kworker/u0:0
 11 root     20   0  20868 1024 R  0.0  0.0  0.0 0.00:00.00 rcpu_tas
 12 root     20   0  20868 1024 R  0.0  0.0  0.0 0.00:00.00 rcpu_tas
 13 root     20   0  20868 1024 R  0.0  0.0  0.0 0.00:00.00 rcpu_tas
 14 root     20   0  20868 1024 R  0.0  0.0  0.0 0.00:00.00 ksfttr[
```

Peak CPU Usage: 4%
Peak Memory usage:
0%

Poll with
1000
concurrent
connections

Peak CPU Usage: 5%
Peak Memory usage:
0%

Poll with
3000
concurrent
connections

```

Activities Terminal Nov 7 21:15
cn-vm@vm: ~/Desktop/assignment3
top - 21:15:13 up 9 min, 1 user, load average: 0.14, 0.35, 0.28
Tasks: 306 total, 1 running, 304 sleeping, 0 stopped, 0 zombie
CPU(s): 9.9 us, 3.4 sy, 0.0 id, 0.0 wa, 0.0 hi, 0.1 st
Mem: 2990.7 total, 697.1 free, 987.2 used, 1216.4 buff/cache
Mib Swap: 2140.0 total, 2140.0 free, 0.0 used. 1667.4 avail Mem

PID USER PR NI VIRT RES SHRS S %CPU %MEM TIME+ COMMAND
12720 cn-vn 20 0 5612408 443144 154676 S 5.3 14.9 1:15.74 gnome-sess
12720 cn-vn 20 0 5632408 443144 154676 S 5.3 14.9 1:15.74 gnome-sess
41 root 20 0 1048576 1048576 1048576 S 3.7 0.4 0:00:00 ksoftirqd
2213 cn-vn 20 0 579992 64932 49008 S 3.3 0.4 0:00:00 rcu_bh
23 root 20 0 0 0 0 0 I 0.0 0.0 0:00:00 ksoftirqd
445 root 20 0 15856 6512 3272 S 0.3 0.0 0:00:00 ksoftirqd
2636 cn-vn 20 0 16556 7148 2816 R 0.2 0.2 0:05:06 top
1 root 20 0 167812 10436 7108 S 0.0 0.4 0:00:00 systemd
1 root 20 0 167812 10436 7108 S 0.0 0.4 0:00:00 systemd
3 root 0 -20 0 0 0 I 0.0 0.0 0:00:00 rCU_bp
4 root 0 -20 0 0 0 I 0.0 0.0 0:00:00 rCU_bp
5 root 0 -20 0 0 0 I 0.0 0.0 0:00:00 rCU_bp
6 root 0 -20 0 0 0 I 0.0 0.0 0:00:00 netns
7 root 0 -20 0 0 0 I 0.0 0.0 0:00:00 rCU_bp
10 root 0 -20 0 0 0 I 0.0 0.0 0:00:00 rCU_bp
11 root 0 -20 0 0 0 I 0.0 0.0 0:00:00 rCU_bp
12 root 20 0 0 0 0 I 0.0 0.0 0:00:00 rCU_bp

```

Peak CPU Usage:
16.6%
Peak Memory usage:
0%

Epoll with
500
concurrent
connections

```

Activities Terminal Nov 7 21:16
cn-vm@vm: ~/Desktop/assignment3
top - 21:16:13 up 10 min, 1 user, load average: 0.18, 0.30, 0.19
Tasks: 306 total, 1 running, 305 sleeping, 0 stopped, 0 zombie
CPU(s): 9.9 us, 3.4 sy, 0.0 id, 0.0 wa, 0.0 hi, 0.4 st
Mem: 2990.7 total, 697.1 free, 987.2 used, 1216.4 buff/cache
Mib Swap: 2140.0 total, 2140.0 free, 0.0 used. 1667.4 avail Mem

PID USER PR NI VIRT RES SHRS S %CPU %MEM TIME+ COMMAND
12720 cn-vn 20 0 5617688 443144 154676 S 4.9 14.9 1:21.05 gnome-sess
12720 cn-vn 20 0 5637688 443144 154676 S 4.9 14.9 1:21.05 gnome-sess
12751 cn-vn 20 0 2868 1824 1024 S 4.7 0.4 0:00:00 rCU_bp
41 root 20 0 1048576 1048576 1048576 S 3.3 0.4 0:00:00 ksoftirqd
1641 cn-vn 20 0 389312 11356 3272 S 0.3 0.4 0:00:01 libus-ds
1743 cn-vn 20 0 349388 26244 15488 S 0.3 0.9 0:01:15 libus-ex*
1811 cn-vn 20 0 167812 10436 7108 S 0.0 0.4 0:00:00 rCU_bp
2 root 20 0 0 0 0 I 0.0 0.0 0:00:00 kthreadd
3 root 0 -20 0 0 0 I 0.0 0.0 0:00:00 rCU_bp
4 root 0 -20 0 0 0 I 0.0 0.0 0:00:00 rCU_bp
5 root 0 -20 0 0 0 I 0.0 0.0 0:00:00 slab_fl
6 root 0 -20 0 0 0 I 0.0 0.0 0:00:00 netns
7 root 0 -20 0 0 0 I 0.0 0.0 0:00:00 rCU_bp
10 root 0 -20 0 0 0 I 0.0 0.0 0:00:00 rCU_bp
11 root 0 -20 0 0 0 I 0.0 0.0 0:00:00 rCU_bp
12 root 20 0 0 0 0 I 0.0 0.0 0:00:00 rCU_bp
13 root 20 0 0 0 0 I 0.0 0.0 0:00:00 rCU_bp

```

Peak CPU Usage:
4.7%
Peak Memory usage:
0%

Epoll with
1000
concurrent
connections

```

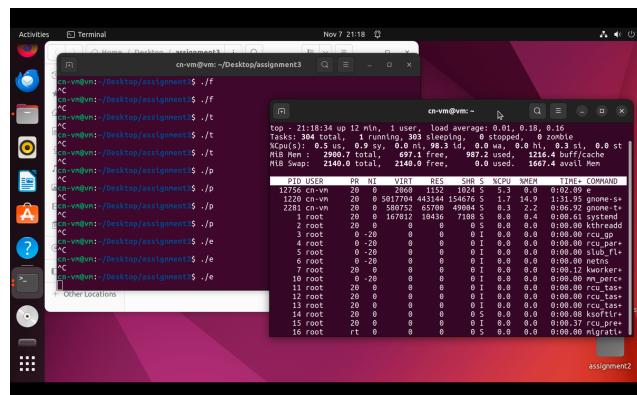
Activities Terminal Nov 7 21:17
cn-vm@vm: ~/Desktop/assignment3
top - 21:17:13 up 11 min, 1 user, load average: 0.03, 0.23, 0.18
Tasks: 305 total, 1 running, 304 sleeping, 0 stopped, 0 zombie
CPU(s): 0.4 us, 0.8 sy, 0.0 id, 0.0 wa, 0.0 hi, 0.4 st
Mem: 2990.7 total, 697.1 free, 987.2 used, 1216.4 buff/cache
Mib Swap: 2140.0 total, 2140.0 free, 0.0 used. 1667.4 avail Mem

PID USER PR NI VIRT RES SHRS S %CPU %MEM TIME+ COMMAND
12752 cn-vn 20 0 2068 1824 1024 S 5.3 0.0 0:01:37 e
12752 cn-vn 20 0 5617688 443144 154676 S 1.1 14.9 1:21.05 gnome-sess
12753 cn-vn 20 0 5637688 443144 154676 S 1.1 14.9 1:21.05 gnome-sess
645 systemd+ 20 0 15820 6144 3376 S 0.2 0.0 0:00:13 systemd
1 root 20 0 167812 10436 7108 S 0.0 0.4 0:00:00 rCU_bp
2 root 20 0 0 0 0 I 0.0 0.0 0:00:00 kthreadd
3 root 0 -20 0 0 0 I 0.0 0.0 0:00:00 rCU_bp
4 root 0 -20 0 0 0 I 0.0 0.0 0:00:00 rCU_bp
5 root 0 -20 0 0 0 I 0.0 0.0 0:00:00 rCU_bp
6 root 0 -20 0 0 0 I 0.0 0.0 0:00:00 netns
7 root 0 -20 0 0 0 I 0.0 0.0 0:00:00 rCU_bp
10 root 0 -20 0 0 0 I 0.0 0.0 0:00:00 rCU_bp
11 root 0 -20 0 0 0 I 0.0 0.0 0:00:00 rCU_bp
12 root 20 0 0 0 0 I 0.0 0.0 0:00:00 rCU_bp
13 root 20 0 0 0 0 I 0.0 0.0 0:00:00 rCU_bp
14 root 20 0 0 0 0 S 0.0 0.0 0:00:00 ksoftirqd
15 root 20 0 0 0 0 S 0.0 0.0 0:00:00 rCU_bp
16 root rt 0 0 0 0 S 0.0 0.0 0:00:00 rCU_bp

```

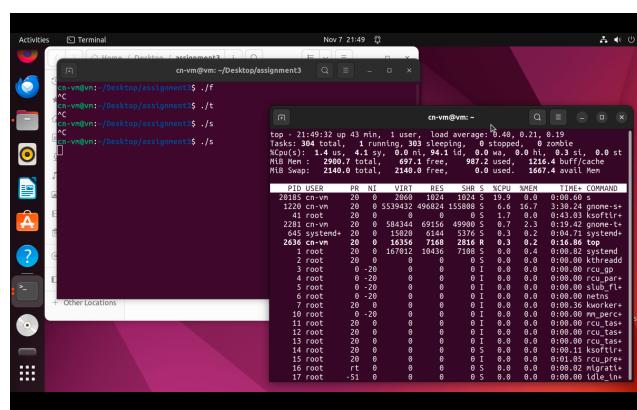
Peak CPU Usage:
5.3%
Peak Memory usage:
0%

Epoll with 3000 concurrent connections



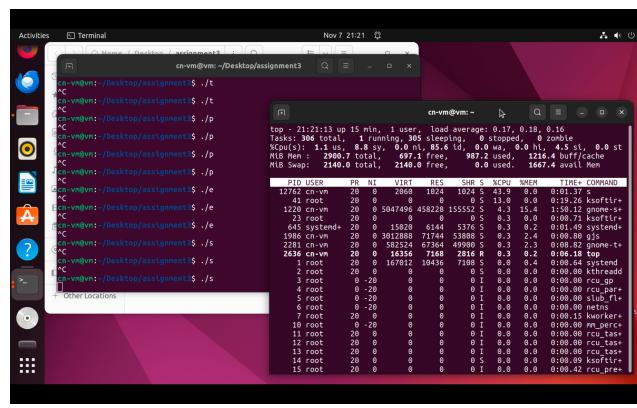
Peak CPU Usage: 5.3%
Peak Memory usage: 0%

Select with 500 concurrent connections



Peak CPU Usage: 19.9%
Peak Memory usage: 0%

Select with 1000 concurrent connections



Peak CPU Usage: 43.9%
Peak Memory usage: 0%

Select with
1024
concurrent
connections

```
cn-vm@vm:~$ top
Tasks: 21 up, 14 min, 1 user, load average: 0.24, 0.19, 0.17
Memory: 1.4 MiB, 7.5 MiB available, 0.0 MiB swapped
      0.0 MiB free, 987.2 used, 2126.4 buff/cache
      2980.7 total, 697.4 free, 987.2 used, 1687.4 avail Mem

PID USER PR NI VIRT RES SHS S NCPU NMEM TIME+ COMMAND
1259 root 20 0 2080 1024 0 0 0 0 0:00.00 0:00.00 [ksoftirqd]
41 root 20 0 0 0 0 0 0 0 0 0:18.54 [ksoftirqd]
1220 cn-vn 20 0 5032792 458228 155552 5 5.3 15.3 0:00.00 [phone-svc]
2313 cn-vn 20 0 16356 7148 7316 R 0.3 0.2 0:05.97 [top]
2636 cn-vn 20 0 16356 7148 7316 R 0.3 0.2 0:05.97 [top]
459 root 20 0 10780 1040 7308 0 0 0 0:00.00 [kthreadd]
2 root 20 0 0 0 0 0 0 0 0:00.00 [kthreadd]
3 root 0 -20 0 0 0 0 0 0 0:00.00 [rcu_gp]
4 root 0 -20 0 0 0 0 0 0 0:00.00 [rcu_par]
5 root 0 -20 0 0 0 0 0 0 0:00.00 [slub_rl]
6 root 0 -20 0 0 0 0 0 0 0:00.00 [netns]
7 root 20 0 0 0 0 0 0 0 0:00.00 [rcu_bh]
10 root 20 0 -20 0 0 0 0 0 0:00.00 [rcu_bh]
11 root 20 0 0 0 0 0 0 0 0:00.00 [rcu_bh]
12 root 20 0 0 0 0 0 0 0 0:00.00 [rcu_bh]
13 root 20 0 0 0 0 0 0 0 0:00.00 [rcu_bh]
14 root 20 0 0 0 0 0 0 0 0:00.00 [rcu_bh]
15 root 20 0 0 0 0 0 0 0 0:00.41 [rcu_prep_migrat]
16 root rt 0 0 0 0 0 0 0 0:00.00 [migration]
17 root 53 0 0 0 0 0 0 0 0:00.00 [migration]
19 root 20 0 0 0 0 0 0 0 0:00.00 [cpuhp/0]
```

Peak CPU Usage:
35.9%
Peak Memory Usage:
0%

References:

<https://www.softprayog.in/programming/io-multiplexing-select-poll-epoll-in-linux>

<https://www.ibm.com/docs/en/i/7.1?topic=designs-using-poll-instead-select>

<https://www.ibm.com/docs/en/i/7.1?topic=designs-example-nonblocking-io-select>

Stackoverflow.com

Google.com