Report

Preliminaries

After starting tun device, we can see the interface in Figure 1.

```
swwind@ubuntu (main)×% ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host noprefixroute
       valid_lft forever preferred_lft forever
2: host0@if6: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP group default qlen 1000
    link/ether e2:d0:da:9c:1c:0c brd ff:ff:ff:ff:ff:ff link-netnsid 0
    inet 192.168.26.87/24 metric 1024 brd 192.168.26.255 scope global dynamic host0
       valid_lft 41841sec preferred_lft 41841sec
    inet6 fd8b:182d:cc2:0:e0d0:daff:fe9c:1c0c/64 scope global mngtmpaddr noprefixroute
       valid_lft forever preferred_lft forever
    inet6 fe80::e0d0:daff:fe9c:1c0c/64 scope link
       valid_lft forever preferred_lft forever
4: tun144: <NO-CARRIER,POINTOPOINT,MULTICAST,NOARP,UP> mtu 1500 qdisc fq_codel state DOWN group default qlen 500
    link/none
    inet 169.254.144.1/24 scope global tun144
       valid_lft forever preferred_lft forever
    inet6 fe80::83ab:ec04:2a3a:5c55/64 scope link stable-privacy
       valid_lft forever preferred_lft forever
swwind@ubuntu (main)×%
```

Figure 1: Tun Device

Running `check_webget` just passed without any problem, as shown in Figure 2.

```
swwind@ubuntu (main)×% cmake --build build --target check_webget
Test project /home/swwind/cs144/minnow/build
    Start 1: compile with bug-checkers
1/2 Test #1: compile with bug-checkers ........   Passed    0.34 sec
    Start 2: t_webget
2/2 Test #2: t_webget .........................   Passed    1.18 sec

100% tests passed, 0 tests failed out of 2

Total Test time (real) =   1.52 sec
Built target check_webget
swwind@ubuntu (main)×%
```

Figure 2: Check Webget

Next, we try to analyze data from `www.usa.gov`, we first using `mtr` to test link route, the result is shown in Figure 3.

Analyze data

We pinged `www.usa.gov` for about 2 hours.

1. We have sent total 41270 requests, while 1358 were lost and 39912 were received.

```
                                                My traceroute  [v0.95]
ubuntu (192.168.26.87) -> www.usa.gov (18.154.144.37)                                      2024-11-07T21:57:00+0800
Keys:  Help   Display mode   Restart statistics   Order of fields   quit
                                                              Packets               Pings
Host                                                          Loss%   Snt   Last   Avg  Best  Wrst StDev
 1. 192.168.26.1                                               0.0%    10    0.1   0.1   0.1   0.2   0.0
 2. ImmortalWrt                                                0.0%    10    1.0   1.0   0.8   1.1   0.1
 3. 10.11.168.1                                                0.0%    10    7.0   6.1   3.4   7.8   1.5
 4. (waiting for reply)
 5. 221.183.47.5                                              88.9%    10    5.0   5.0   5.0   5.0   0.0
 6. 221.183.89.21                                             66.7%    10   12.0  12.0  12.0  12.1   0.1
 7. 221.183.89.34                                              0.0%    10   11.2  11.2  10.7  12.1   0.3
 8. (waiting for reply)
 9. 223.120.12.177                                             0.0%    10  184.2 184.6 184.2 185.5   0.3
10. 223.120.6.218                                             10.0%    10  196.5 197.1 196.1 200.8   1.5
11. 99.83.117.125                                              0.0%    10  194.7 196.6 194.3 209.6   4.6
12. 150.222.234.77                                            10.0%    10  183.1 184.6 183.1 190.9   2.4
13. 54.239.102.210                                             0.0%    10  184.2 186.1 184.2 193.4   2.8
14. (waiting for reply)
15. (waiting for reply)
16. (waiting for reply)
17. (waiting for reply)
18. (waiting for reply)
19. (waiting for reply)
20. 150.222.232.119                                           33.3%     9  190.6 190.6 189.9 191.6   0.6
21. server-18-154-144-37.lax50.r.cloudfront.net                0.0%     9  183.7 184.0 183.5 184.8   0.4
```

Figure 3: MyTraceroute to target website

The overall delivery rate were $39912/41270 = 96.71\%$.

2. The longest consective successful pings were 592.

3. The longest burst of losses were 3.

4. We have Pr[success|success] = 96.75%, and Pr[success|loss] = 95.58%. They are almost the same comparing to overall delivery rate.

5. Minimum RTT is 182.0 ms.

6. Maximum RTT is 373.0 ms.

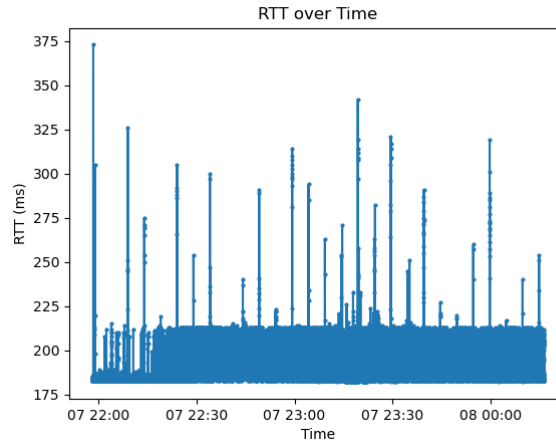7. The graph of RTT over time was shown in Figure 4.

Figure 4: RTT vs Time

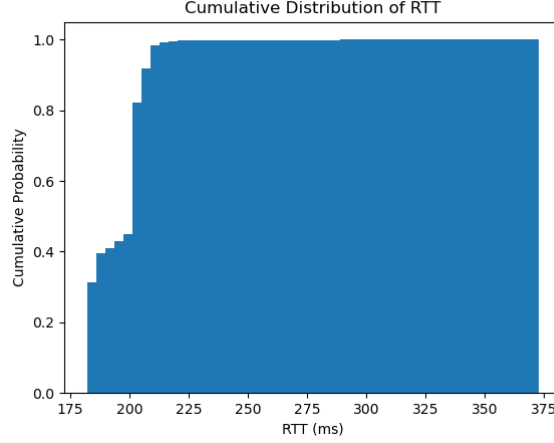8. The graph of cumulative distribution function of RTT is shown in Figure 5.

Figure 5: Cumulative Distribution of RTT

9. The graph of correlation of RTT is shown in Figure 6.

10. By observing the RTT over Time graph, we find that the majority of the RTT values are tightly clustered between 175 ms and 225 ms, indicating that the usual latency is relatively stable within this range. This narrow range shows a consistently low RTT under typical network conditions. Besides, there are intermittent spikes reaching up to 375 ms. These spikes occur throughout the time period but are not frequent. The spikes suggest occasional latency increases, possibly due to transient network congestion or routing changes.

By observing the cumulative distribution of RTT graph, we find that the cumulative probability reaches nearly 100% by the time RTT values reach around 250 ms. This indicates that almost all RTT measurements are below 250 ms, with only a small fraction extending beyond this point.

By observing the correlation of RTT graph, we find that the densest cluster of points lies around the 200 ms mark for both axes. This suggests that when RTT is low for one ping, it tends to be low for the subsequent ping as well, indicating stable network conditions with low latency for consecutive pings. Besides, there is a noticeable diagonal trend where points align roughly along the line $y = x$. This indicates that when a ping has a higher-than-average RTT, it's likely that the following ping will also have a higher RTT. This pattern suggests a level of correlation between consecutive RTTs, meaning that network conditions affecting one ping (like temporary congestion) often persist long enough to affect the next.
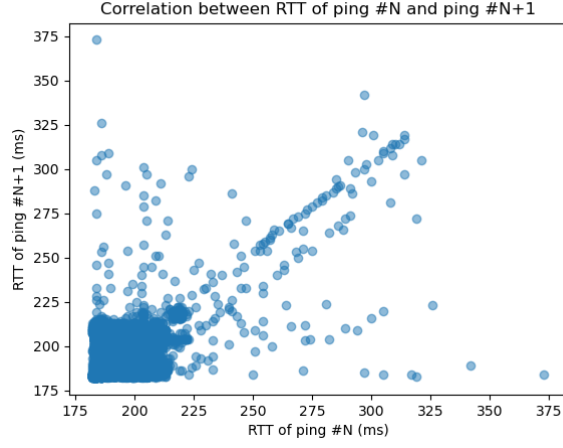
Figure 6: Correlation of RTT

In conclusion, the network is generally stable with a high delivery rate (96.71%) and low, consistent RTT (~200 ms). Occasional, brief spikes in RTT (up to 375 ms) indicate rare, transient delays. RTT values show moderate correlation over consecutive pings, suggesting short-lived bursts of latency without prolonged issues.