Task 4 - Simple Network

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I. VM Region Allocation

When we setup and create a vm instance, there's an important feature need to be claimed is the region and zones of your compute engine resources. A region is a specific geographical location where you can run your resources. Each region has one or more zones; most regions have three or more zones.Resources that live in a zone, such as instances or persistent disks, are referred to as zonal resources. Other resources, like static external IP addresses, are regional. Regional resources can be used by any resources in that region, regardless of zone, while zonal resources can only be used by other resources in the same zone [1]. Figure 1 shows the available zones and regions:

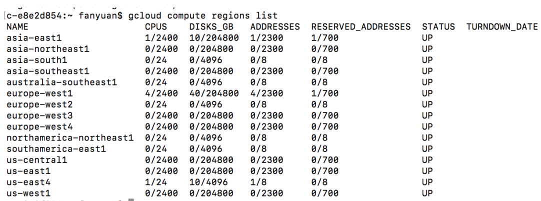

Fig. 1. Region Lists

According to the requirement, we setup 6 different vm instances in the same availability zone,across availability zones and across regions. Figure 2 shows the instance parameters including the external IP address:

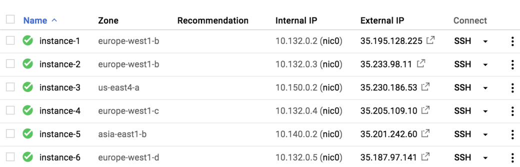

Fig. 2. vm Instance list

II. Benchmark TCP/UDP Communications

As suggested, we use Linux tools *"iperf"* to conduct these experiment. Iperf is a TCP/IP and UDP/IP performance measurement tool that provides network throughput information, as well as statistical information such as jitters, packet loss rate, maximum segments, and maximum transmission unit size; this helps us test network performance and locate networks bottleneck. After installing this tool, we conduct a simple loopback test to study the parameters of the output.

During all the test, instance-1 will be treated as the client which meets all the situation environment. It has the external IP address of 35.195.128.225 and located in "europe-west1" zone "b". Table 1 summarized the necessary commands towards different scenarios. Assign the data format to be MBytes and using the default port 5001.

TABLE I
Command of TCP/UDP testing

	TCP communication	UDP communication
Server	`iperf -s -i 1 -f M`	`iperf -s -u -i 1 -f M`
Client (single)	`iperf -c 10.x.0.y -i 1 -t 10 -f M`	`iperf -c 10.x.0.y -u -i 1 -t 10 -f M -b 1000M.`
Client (parallel)	`iperf -c 10.x.0.y -i 1 -t 10 -f M -P 2.`	`iperf -c 10.x.0.y -u -i 1 -t 10 -f M -b 1000M -P 2`

In UDP transmission, we specifies that the client sends data at a speed of 1000Mbit/s. Because the UDP protocol is connectionless and unreliable, it does not ensure whether the packet is received at the server or not. Therefore, we need to check the service report to determine the current network performance data. Due to our testing circumstances,we tested the parameter from small to large, otherwise it is easy to cause the current bandwidth of the service to be full.

III. Benchmark Results

A. Same availability zone

In this test we create a connection between vm instance-1 and instance-2 where the instance-2 serves as server. The following figures shown the results:

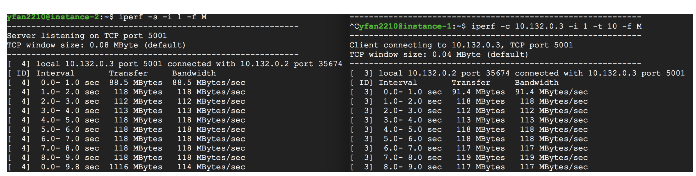

Fig. 3. europe-west1-b Single TCP transmission

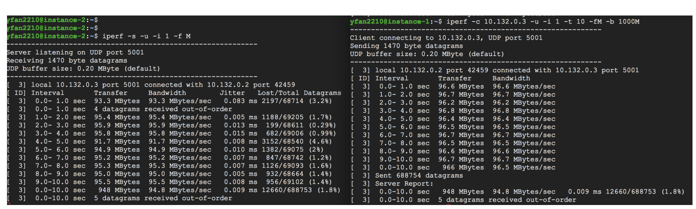

Fig. 4. europe-west1-b Single UDP transmission

Since TCP has a slow start, the very beginning of the transmission the bandwidth is lower than the usual, the steady value of this transmission is 117 MBytes/s. On the other hand, the UDP transmission has the bandwidth of 94.8 MBytes/s and the jitter of 0.009ms with 5 packets out-of-order.

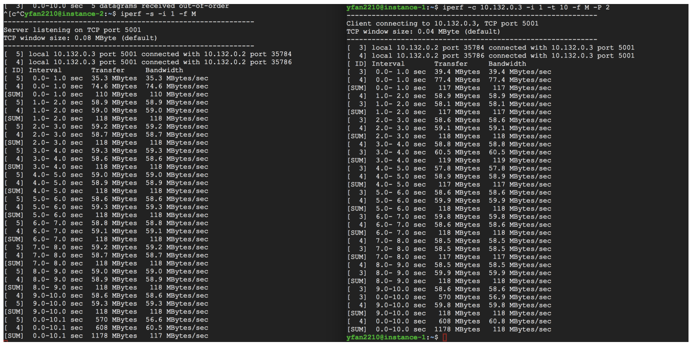

Fig. 5. europe-west1-b Parallel TCP transmission

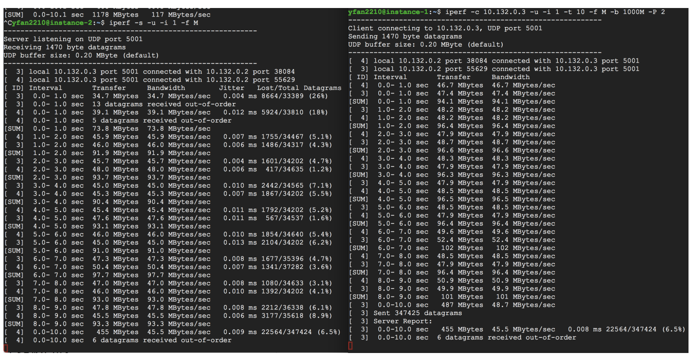

Fig. 6. europe-west1-b Parallel UDP transmission

The parallel transmission indicates us both TCP and UDP communication will share the bandwidth with the each others. And the sum of two bandwidth are quite the same with the single transfer.

B. Across availability zones

As required, we choose *"europe-west1-c"* and *"europe-west1-d* as our server and done the above test again.

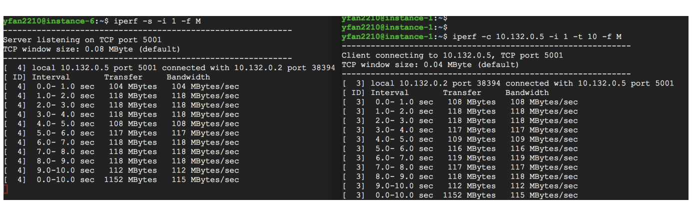

Fig. 7. europe-west1-d Single TCP transmission

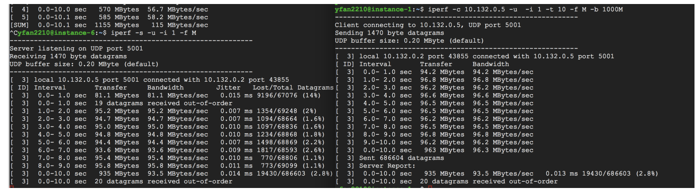

Fig. 8. europe-west1-d Single UDP transmission

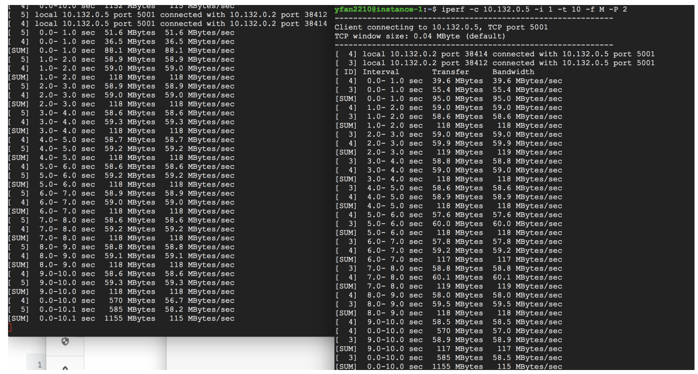

Fig. 9. europe-west1-d Parallel TCP transmission

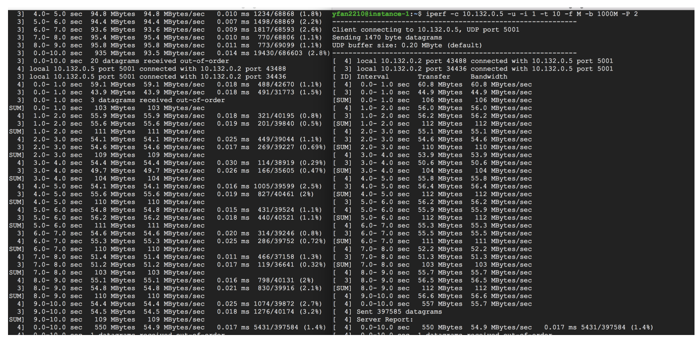

Fig. 10. europe-west1-d Parallel UDP transmission

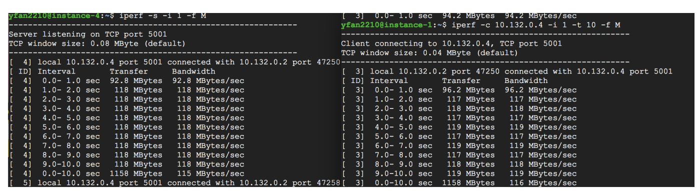

Fig. 11. europe-west1-c Single TCP transmission

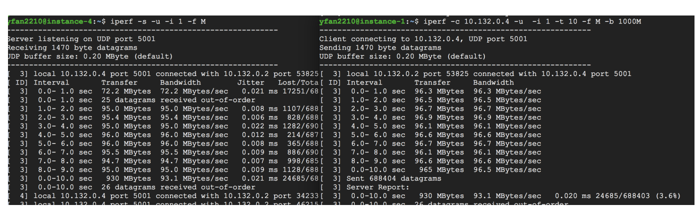

Fig. 12. europe-west1-c Single UDP transmission

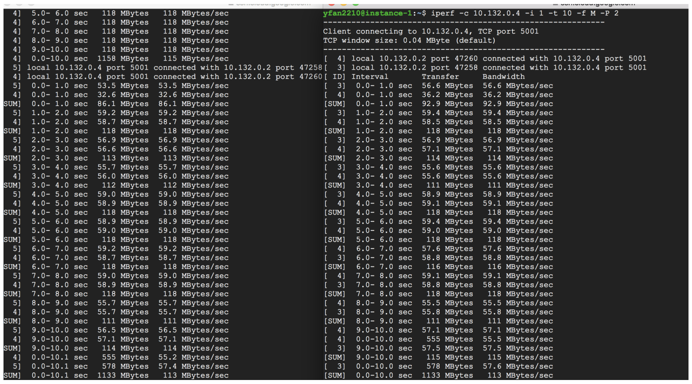

Fig. 13. europe-west1-c Parallel TCP transmission

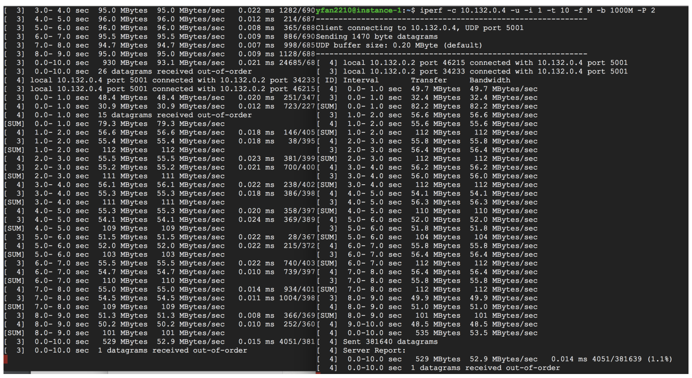

Fig. 14. europe-west1-c Parallel UDP transmission

Across availability zones in the same region test data output is clear, the performance of bandwidth is quite similar with the same zones. However we discovered, during the parallel UDP transmission, the total bandwidth is higher than the single transmission up to 110 MBytes/s. It's likely that during the parallel the UDP connection has the ability to take maximum use of bandwidth.

C. Across regions

We choose 3 regions in this part, they are *"us-east4-a"* and *"asia-east1-b* as our server and done the above test again to find out the differences.

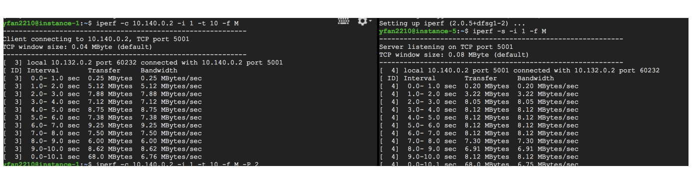

Fig. 15. asia-east1-b Single TCP transmission

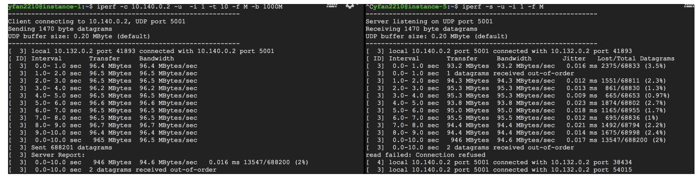

Fig. 16. asia-east1-b Single UDP transmission

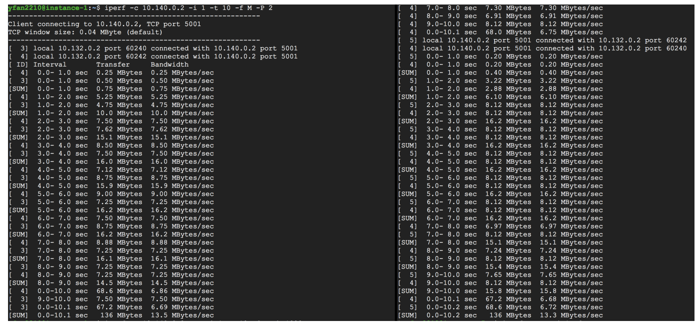

Fig. 17. asia-east1-b Parallel TCP transmission

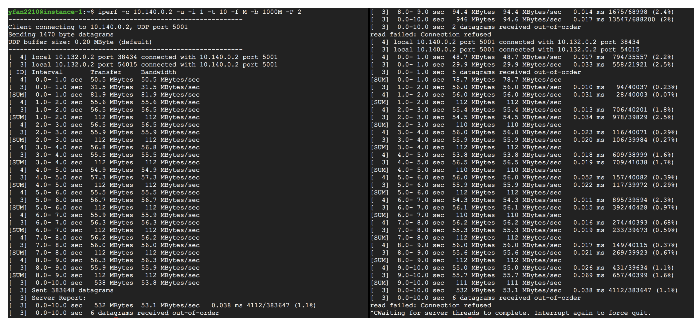

Fig. 18. asia-east1-b Parallel UDP transmission

The connection of TCP flow to Asia region has the same slow start issue with 0.25 MBytes/s in the first second, and due to the long distance there's has a decrease in the bandwidth with the average value around 7.0 MBytes/s. And the data is larger when it's parallel in TCP. While using UDP protocol, the statistics are similar to the same region/zone.

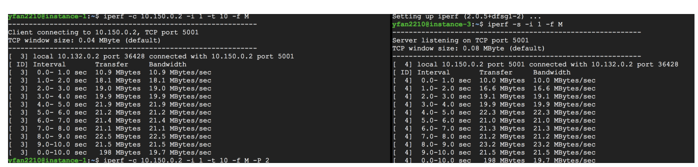

Fig. 19. us-east4-a Single TCP transmission

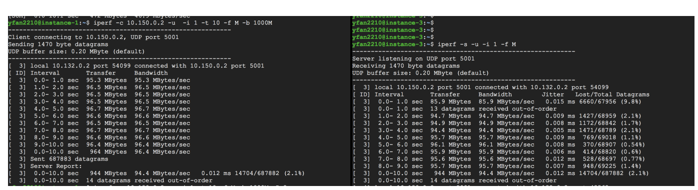

Fig. 20. us-east4-a Single UDP transmission

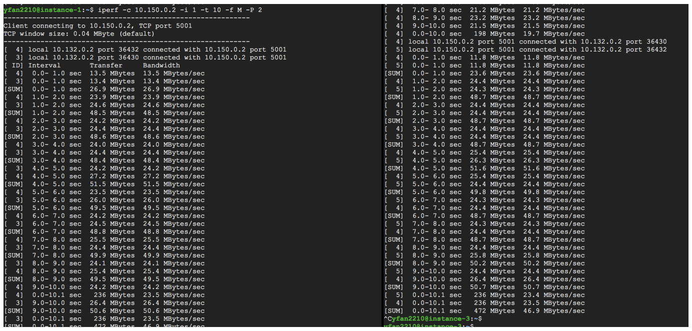

Fig. 21. us-east4-a Parallel TCP transmission

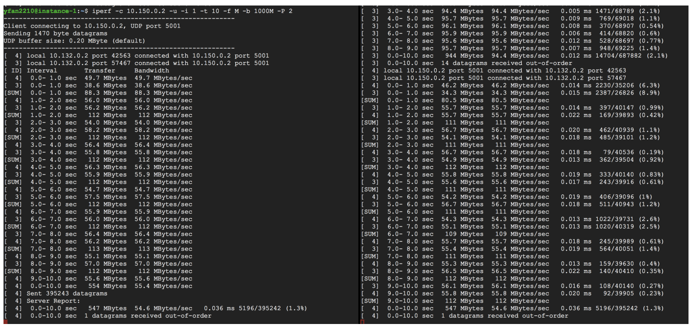

Fig. 22. us-east4-a Parallel UDP transmission

The last pair of experiment were conduct under US region. As we assumed, the result also decreased to 21 MBytes/s, similar to Asia, the parallel testing total bandwidth also result in twice of the bandwidth of the single transmission. As for UDP connection, the single transmission cause more package out-of-order than former cases, other data are quite same with other region.

D. Conclusion

After these experiment, it's right to believe that TCP connection has a certain time to raising to a steady state because of its proprieties, and for UDP connection, the state in different regions, zones, time doesn't vary so much and that thanks to its best-effort feature.

REFERENCES

[1] "Region and zones, google cloud platform document." [Online]. Available: https://cloud.google.com/compute/docs/regions-zones/