

## Jupiter Rising

### Group 17

The main aim of the project was to understand how the data centres of Google evolved with the developments in hardware, by knowing the topologies behind them.

The topologies implemented were based on Clos networking. The five topologies implemented are as follows:

1. Firehose 1.0:

It was one of the very first topologies developed by Google, with the goal to deliver 1Gbps of non blocking bandwidth to each of the 10K servers.

The building blocks used were 8x10G for the fabric and 4x10G for the TORs(top of the rack switches). TOR was divided into 24x1G down for servers and 2x10G up to the aggregation block. Aggregation block consisted of 16 switches, with  $n^2$  type connections in groups of 8. Overall its configuration turned out to be 2x32x10G blocking. One aggregation block connected to 32 spine blocks, which is a 2 stage non blocking system, having 32x10G on one side only.

Overall the fabric speed was 10G, with host speed being 1G and bisection bandwidth of 10T.

2. Firehose 1.1:

The major changes from 1.0 to 1.1 were the change in TORs and the internal connectivity of the aggregation blocks. The TORs now being used were 4x10G+24x1G, and they were connected side by side by two links of 10G each into a buddy TOR.

Overall, now each TOR had 2x10G up, 2x10G side and 48x1G down.

The two disjoint blocks were cabled together in an aggregation block in a configuration similar to flat neighbourhood network.

These changes yet didn't make any difference to the blocking nature of the aggregation block, also the capacity of the network remained the same.

3. Watchtower:

It involved the development of a switch chassis using merchant silicon switches of 16x10G capacity. The TORs had 4x10G+48x1G configuration. The chassis had 8 line cards, with 3 switches in each having 8x8 configuration, and were connected to the backplane for port to port connectivity. This led to a 128x10G non blocking chassis to be used in stage 2 and stage 3 switches. The spine block was also 128x10G non blocking system.

The fabric same remained the same as the previous two topologies i.e. 10G, the host speed became nx1G and the bisection bandwidth 82T.

4. Saturn:

The change from Watchtower to Saturn was the use of 24x10G merchant silicon building blocks with 12 line cards in chassis, making it a 4x288x10G non blocking system. Also the TORs now used a Pluto switch which had 24x10G ports. The spine block was now

288x10G non blocking. The host speeds were now 10G and the bisection bandwidth 207T.

5. Jupiter:

The basic building block used here was a Centauri, consisting of two line cards, each with two 16x40G merchant silicon switch chips. The TORs were made with Centauris, each chip configured to have 48x10G to servers and 16x10G to fabric having dual redundant 10G links to compensate for failure of any node.

The aggregation block comprised of 8 middle blocks, each having 4 Centauris, with 256x10G down connecting to 32 TORs, and 64x40G up, in total making 512x40G connecting to 256 spine blocks. It was a blocking architecture.

The spine block comprised of 6 Centauris making 128x40G down to 64 aggregation blocks.

The fabric was now a combination of both 10G and 40G links, the host speeds could be modelled as 10G or 40G links, and these changes led to a bisection bandwidth of 1.3P.