Question 1:

With the switches marked with X eliminated, are these two topologies identical? Would they have identical responses to further failures? If not, can you point out one failure scenario where they behave differently? [Figures reproduced with modifications from “A Scalable, Commodity Data Center Network Architecture”, Al-Fares et al., ACM SIGCOMM 2008.]

**Solution:** No, the topologies may respond differently to further failures. In the topology on the left, consider the left-most pod. If the top-left aggregation switch fails, this pod will be disconnected from the network. This is not the case for the other topology. Note that the failures are identical in terms of available bandwidth to the end hosts.

Question 2:

How does the number of cables in a fat-tree topology scale with the port-count of the individual switches used to build it, i.e., the parameter $k$? Ignore constant factors; is it $O(k)$, $O(k^2)$, $O(k^3)$, $O(k^2 \log k)$ ...?

**Solution:** $O(k^3)$.

Each of the $k$ pods has 2 layers of $k/2$ k-port switches. Therefore, number of switches in the pods is $O(k^2)$. As, the number of core layer k-port switches is $(k/2)^2$, the total number of switches is $O(k^2)$. Hence the total number of ports and links: $O(k^3)$.

Question 3:

What are the limitations of the big switch approach?

**Solution:** Here are some limitations (not complete)
Throughput is limited by bisection bandwidth of “big switch”.

- Cost of switch.
- Single point of failure.
- Practically it is not possible to build a switch “big” enough to handle all the traffic of today’s datacenters.

**Question 4:**

What is the number of network hops between two racks in a fat-tree topology? Comment your answer.

**Solution:** The number of network hops does not depend on the value of k in a k-ary fat tree. Rather it depends on the number of layers of switches in the hierarchical switching fabric. The number of hops between 2 racks in 2 different pods is 4, between 2 racks in the same pod is 2.

**Question 5:**

Intuitively, why should a topology with small average shortest path length have high throughput?

**Solution:** The end-to-end throughput of a topology does not only depend on the capacity of the network, but is also inversely proportional to the network capacity consumed to deliver each byte, i.e. the average path length. [1]. Further, for small flows RTT plays an important role.

**References**