Week 2 Quiz

22 questions

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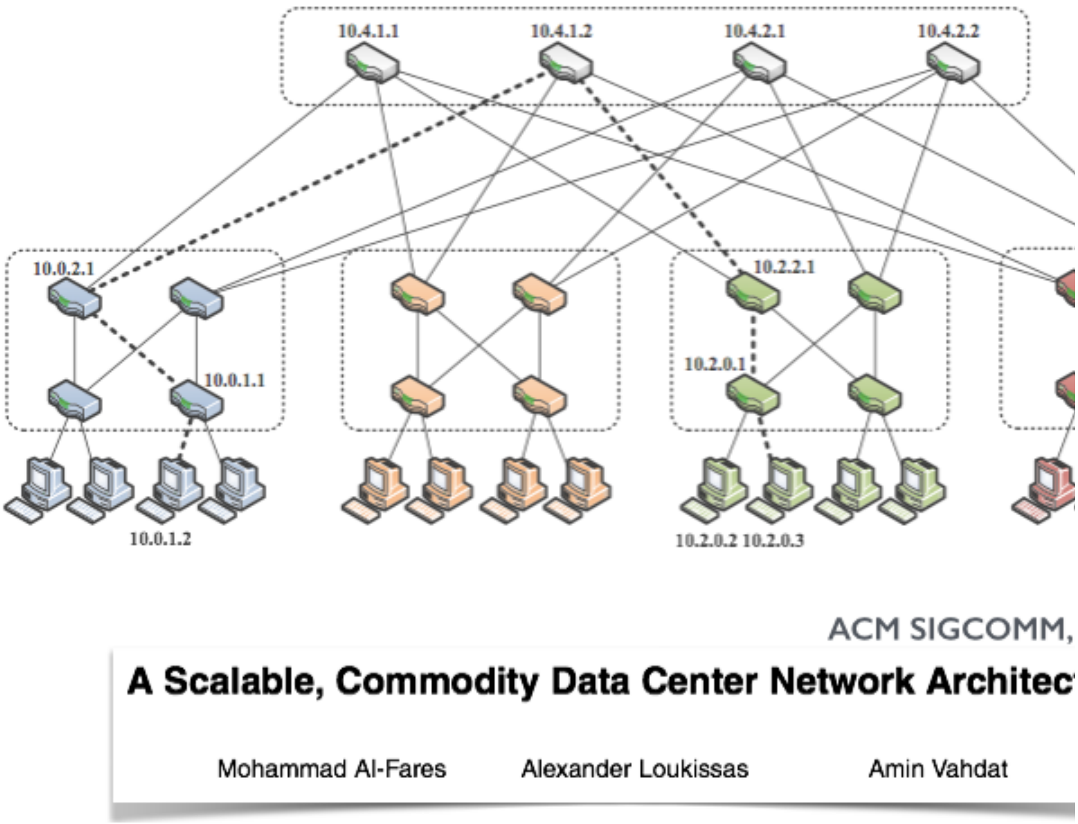
1.

The fat-tree network below has a total of 32 switch-switch links. (Verify that this is true.) these links will be used by a tree spanning all the switches? Remember: we're excluding links in both counts and are counting cables, not directed edges.



- ( ) 24
- ( ) 26
- (•) 19
- ( ) 32

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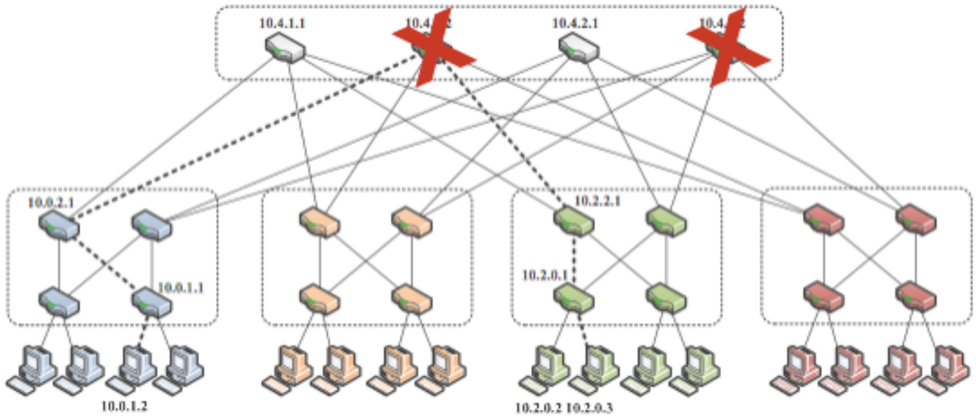
2.

Assuming that there's no other traffic in the network, how much aggregate bandwidth is available from the left-most pod (the left-most four servers) to any other pod in the fat-tree below with the switches marked with **X** having failed? Count only bandwidth in the direction from the left-most pod to the other; assume links are all unit capacity and that we have perfect multipath routing.



ACM SIGCOMM, 2008

A Scalable, Commodity Data Center Network Architecture

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- (selected) 2 units
- Depends on what the destination pod is
- 1 unit
- 4 units

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3.

How does TRILL enable the use of all the links in the network?

- ◯ By simply flooding packets on all outgoing links
- ◯ Every packet is sent to a controller that decides the routes
- ◉ By running a link-state protocol between the switches

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4.

In BGP, the path announcements nodes make to neighbors contain:

- ◯ Only the next hop autonomous system towards the destination
- ◯ The entire network topology as seen by the node
- ◯ Only the path length to the destination
- ◉ The autonomous system-level path from the node to the destination

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5.

How does ECMP avoid packet reordering?

- ◯ By consistently using the same path for packets of the same flow
- ◯ By adding delays to packets sent on different paths in such a way that reordering is unlikely
- ◉ By only using one path between the same source and destination servers

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6.

Between a specific pair of servers, how many ECMP paths can be set up for the fat-tree topology (as in this paper: A Scalable, Commodity Data Center Network Architecture) built with switches with 10 ports each, i.e., k = 10? Ignore any switch hardware constraints on ECMP; we're only looking for the number of equal-cost shortest paths.

- (selected) 25
- 100
- 50
- 20

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7.

How does CONGA do forwarding on multiple paths?

- (selected) It uses a link state protocol across all the switches.
- It uses a centralized controller to direct all traffic.
- It's the same as ECMP.
- Congestion is monitored on the various paths between pairs of leaf switches, with the least congested paths being chosen.

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8.

What are flowlets?

- ( ) Flowlets are the same as flows except they have fewer packets. Different flowlets must always belong to different flows.
- (•) Flowlets are packet-groups in the same flow that are separated by large enough gaps from other packet-groups such that sending them along different paths has a reasonably small likelihood of reordering a flow’s packets.
- ( ) Flowlets are cute little flows with fur.

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9.

How do containers (for example, with Docker) typically differ from virtual machines?

- ( ) Each virtual machine runs its own operating system, while containers may depend on the underlying system’s kernel and other resources.
- ( ) Applications can be packaged into containers needing much smaller disk and memory footprint than with virtual machines.
- ( ) Containers can be instantiated much faster than virtual machines.
- (•) All of the above

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10.
At 100Gbps, with all packets being 100 Bytes in size (including the preamble, etc.), how much time can we afford to spend on processing each packet to be able to process packets at line-rate, sequentially?

- ( ) 67 nanoseconds
- ( ) 1 nanosecond
- ( ) 10 nanoseconds
- (•) 8 nanoseconds

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11.
How does SR-IOV help with the difficulty of packet processing at line rates?

- ( ) It uses a simple fast packet classifier on the NIC itself.
- (•) All of the above
- ( ) Each virtual machine has hardware resources on the NIC from where it reads packets meant for it.
- ( ) Packets are passed to a VM's memory from the NIC using direct memory access, without invoking the hypervisor.

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12.

What are some drawbacks of SR-IOV’s approach?

- ( ) A. It cannot achieve anywhere near line-rate performance.
- ( ) B. Migration of VMs is trickier because their network state is tied to the NIC.
- ( ) C. The simple on-NIC packet classifier does not provide general purpose packet forwarding logic.
- ( ) D. Options A, B, and C
- (•) E. Options B and C but not A
- ( ) F. Options A and C but not B

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13.

Which of these design decisions enables Open vSwitch to provide fast-enough performance for common workloads while allowing general purpose packet forwarding logic?

- ( ) Division of user-space and kernel-space tasks: user-space handles network state updates and processes the first packet of flows, while kernel-space is optimized for fast forwarding of future packets.
- ( ) The kernel-space packet classifier is a simplified, collapsed version of rules applicable to packets seen recently, thus making processing faster.
- ( ) An even simpler cache allows constant-time lookups mapping incoming packets to the applicable forwarding entry in the kernel-space classifier.
- (•) All of the above

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14.

Assuming that TCP is in the additive increase phase and the congestion window is *X* bytes, what will the congestion window be after the sender detects a single packet loss?

- ○ *X*
- ○ *X*/4
- ○ 2 packets
- ● *X*/2

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15.

What problems does TCP's reaction to loss pose?

- ○ Loss is a poor signal of persistent congestion. Losses can also occur due to other transient factors.
- ○ Multiplicative decrease can be too aggressive – perhaps the sender's rate is only marginally larger than the available capacity.
- ○ Waiting until a loss before reacting to congestion means waiting until buffer occupancy is large. This increases queuing latencies.
- ● All of the above

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16.

Assume that data travels over fiber at a speed of $2c/3$, where c is the speed of light in a vacuum. What is the (one-way) propagation delay across 300 meters of fiber running across a data center floor? (This might seem annoying, but the point of such questions is to make sure you have a better sense of these timescales.)

- (x) 1.5 microseconds
- ( ) 30 microseconds
- ( ) 200 microseconds
- ( ) 200 nanoseconds

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17.

Assuming a line rate of 10Gbps, what time elapses between a packet arriving in a buffer with five packets already queued (each packet being 9000 bytes in size), and reaching the head of the queue (i.e., just before its bytes start to get sent across the wire)?

- ( ) 108 microseconds
- (x) 36 microseconds
- ( ) 4.5 microseconds
- ( ) 45 microseconds

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18.

In data centers, queuing delay caused by just a few packets can exceed the propagation delay. What problem(s) does this pose?

- ○ Large buffer occupancies can inflate end-to-end latencies by orders of magnitude.
- ○ It doesn't matter; we are still talking about microseconds.
- ● It leads to excessive packet reordering.
- ○ None of the above

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19.

Suppose that to address TCP incast, we reduce the TCP connection timeout value. Which of the following is true?

- ○ It doesn't increase throughput or decrease queuing latency.
- ● While this helps decrease latencies, throughput can still be very small.
- ○ While this may help increase throughput if some of the TCP connections were timing out due to losses, latencies can still be high and variable because of large buffer occupancies.

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20.
How does DCTCP try to provide both low latency (i.e., keeping buffer occupancies small) and high throughput?

- ( ) It marks packets with congestion signals as the buffer starts to fill beyond a threshold. If the threshold is low, this signals congestion much before the buffer is full.
- ( ) The senders adjust their rate in proportion to the number of congestion markings they receive, unlike TCP's multiplicative decrease.
- ( ) Small buffer occupancies also allow buffers to absorb traffic bursts, thus reducing packet losses and helping maintain high throughput.
- (•) All of the above

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21.
If the congestion window at a sender is *X* bytes and it receives congestion markings based on which fraction of marked packets is updated to 0.4 (i.e., the α calculated per equation (1) in the DCTCP paper – Data Center TCP (DCTCP) is 0.4), what is the congestion window adjusted to?

- (•) 0.8 *X*
- ( ) 0.6 *X*
- ( ) 0.5 *X*
- ( ) None of the above

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22.

What considerations govern the setting of DCTCP's congestion marking threshold, *K*?

- A. If it's too large, buffer occupancy will still be high.
- B. If it's too small, throughput can be low because congestion is signaled more often than necessary.
- C. Both A and B
- D. Neither A nor B

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