Computer Networks Quiz 3

Spring Semester 2018

Answer Sheet

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<td>5.74 / 9 points</td>
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Total points distribution

ECDF of score
Q1: Based on the following routing table, through which interface will the router forward a packet destined for 192.168.5.65?

(a) eth0
(b) eth1
(c) eth2
(d) eth3

Solution: By longest prefix matching.

Q2: A large IP packet that is sent over a link with a low MTU is fragmented. Mark all the IP packet-header fields that must be the same among the fragmented IP packets:

(a) Total Length

Solution: Each fragment is a different IP packet (belonging to the initial larger packet) and therefore has (potentially) a different length than the other fragments.

(b) Header Checksum

Solution: Since the header fields of the fragments are different, their checksums will also be different.
(c) Identification
(d) Protocol
(e) Fragment Offset

**Solution:** The Fragment Offset is used to identify the position of a fragment within the original packet and is therefore unique among the packet fragments.

(f) Source Address

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**Q3:** Mark all the benefits of using Network Address Translation (NAT).

(a) **It enhances privacy because internal hosts are not advertised.**

(b) It accelerates the forwarding process because no modifications are made on the packets.

**Solution:** NATs change the source address and port of outgoing/incoming packets. This processing is not particularly heavyweight, but can definitely not accelerate the forwarding process.

(c) **It relieves the problem of IPv4 address exhaustion.**

(d) It makes the deployment of multiple servers easier.

**Solution:** It makes it harder. Usually servers listen on well-known ports, but the NAT can associate a well-known port only to one server. Thus, it is not possible to have multiple servers listening on the same well-known port.
Q4: In link-state routing, after sending link-state packets, the routes are computed using the ...

(a) Distributed Bellman-Ford algorithm

**Solution:** Bellman-Ford is used in distributed settings and is used in distance-vector routing protocols, where each node does not learn the whole topology.

(b) Border Gateway Protocol

**Solution:** BGP is also used in a distributed setting and is today’s inter-domain routing protocol. It belongs to the family of path-vector routing protocols (similar to distance-vector, but with path information in routing advertisements).

(c) Dijkstra’s algorithm

(d) Spanning Tree Protocol

**Solution:** The STP is used to form a spanning tree of routers at Layer 2.
Q5: Which statement(s) are true about distance-vector routing?

(a) Each router maintains a vector with the next hop and the distance to destination.

(b) Each router learns the entire topology of the network.

Solution: Each router only learns paths from its immediate neighbors. The entire topology is not known to routers, in contrast to link-state routing.

(c) It detects cycles by explicitly indicating each node on the path.

Solution: Path-vector indicates each node on the path. Distance-vector algorithms can implement split horizon with poison reverse and use a maximum number of hops to counter the “count-to-infinity” problem.

(d) The Bellman-Ford algorithm can be used to compute paths.
Q6: Mark all concepts that help in improving routing scalability.

(a) The flat address space of MAC addresses.

**Solution:** A flat address space degrades scalability, because paths to individual addresses must be computed and stored. The optimization of computing a path for multiple addresses through aggregation is not possible. As a sidenote, the term “routing” typically refers to the process of discovering paths at Layer 3 (both intra- and inter-domain) and not Layer 2. However, this is not a strict convention and the term “routing” can be used for Layer 2 (esp. for more sophisticated protocols (e.g., TRILL), which is out of the scope of this lecture).

(b) Hierarchical routing by routing to network regions rather than single hosts.

(c) Aggregating multiple IP blocks into a larger subnet.

(d) Using multiple paths towards the same destination.

**Solution:** This also degrades scalability since there is additional computational effort to compute multiple paths for the same destination. There is also more storage space required to store paths and potentially an increased volume of routing messages (more messages or longer messages).

Q7: We are interested in discovering shortest paths from node A using Dijkstra’s algorithm. In Step 0 of the algorithm, node A “visits” itself and “explores” its neighbors (B, C, F). In Step 1, node A “visits” node B and “explores” B’s neighbors. Mark all sentences that are correct:

(a) In Step 2, node A “visits” node D.

(b) In Step 2, node A “visits” node C.
Solution: The order in which A discovers the other nodes is: B, D, E, C, F.

(c) In Step 3, node A “visits” node C.

Solution: The order in which A discovers the other nodes is: B, D, E, C, F.

(d) In Step 3, node A “visits” node E.

![Network topology with annotated costs on each edge.](image)

Figure 3: Network topology with annotated costs on each edge.

Q8: Which of the following are true?

(a) Queuing delay is the delay that packets experience waiting in a buffer to be processed or to be transmitted onto a link.

(b) Every router implements the network and the transport layer.

(c) There can be only one router acting as gateway for the same IP subnet.

Solution: Most Routers only look at the network header.

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**Solution:** Multiple entry/exit points can exist for an IP subnet, and the router at those points can all serve as gateways.

(d) When the IP address in the destination address field of the IP header is not found in the forwarding table of the router, the incoming packet is forwarded to all links except the link it is received.

**Solution:** In such a case, the packet is dropped and an ICMP message is sent to the source.

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**Q9:** Which of the following are true?

(a) A simplified BGP protocol without policies and in which routes would be selected based on the AS-PATH length would be guaranteed to converge.

**Solution:** It is a simple path vector protocol (i.e., without policy), which is guaranteed to converge.

(b) A BGP route between two hosts may not be the shortest path possible in terms of router hops.

**Solution:** BGP route selection depends on many factors (i.e., routing policies) and distance is only one of the metrics. Hence, a BGP router may prefer a longer path over the shortest path.

(c) BGP policies often lead to asymmetric routing. Yet, the forward and reverse paths will always have the same length in terms of number of AS hops.
(d) By sending the same prefix p to multiple providers, multi-homed BGP networks increase the size of the forwarding table of all routers in the Internet.

**Solution:**
Assume A is a multi-homed AS that has two provider ASes, B and C. Also assume that B and C have the same provider AS D. In such a case, even if A makes two announcements for its prefix (one to B and the other two C), D will choose one of the two announcements. Hence, routers that receive announcements from D will only receive one announcement for the prefix of A.