Fall 2014 Networking Qualifying Examination

1. Answer all FOUR questions
2. Write your answers legibly
3. Please state all assumptions clearly.

1. Transport protocols

TCP is the dominant transport protocol in the Internet today. Its operation is end-to-end in nature, i.e., all adaptation decisions are made solely by the endpoints.
However, an alternative design could have been to make intermediate points (such as, routers) more stateful. This question explores some of the tradeoffs in such designs.

A) Consider a long-running FTP transfer between two endhosts (A and B) separated by a multi-hop Internet path with many routers (R1, R2, ..., Rn). Compare the end-to-end throughput achievable for this FTP transfer when using the following two transport mechanisms:

i) End-to-end TCP transport between A and B as it exists today in the Internet, and
ii) A hop-by-hop variant, where we run a separate instance of TCP across each hop. More specifically, the flow is a composition of n+1 TCP flows,
A - R1, R1 - R2, R2 - R3, ..., Rn - B.

Please focus on specific properties and path parameters that allow you to explain which of the two methods achieve a higher throughput in general.

B) Consider a short web content download, where end-to-end download latency is the critical metric of optimization. Among end-to-end TCP and the above described hop-by-hop variant, which method will lead to a lower end-to-end latency for such short downloads.

2. Wireless medium access

A) Carrier sensing is not considered to be a useful method in wireless environments. Why?

B) Does the 802.11 standard solve the exposed terminal problem? If yes, explain how it solves the problem. If no, explain how exposed terminals are prevented from simultaneous communication.

C) In the Opportunistic Auto Rate adaptation protocol, if the achievable data rates of two backlogged clients, A and B, are 11 Mbps and 1 Mbps respectively, what is the actual data throughputs achieved by each client when they are the only active wireless transmitters in the system. Make any necessary simplifying assumptions. Why is this an improvement over the basic 802.11standard?

3. Quality-of-Service

1. QoS mechanims such as IntServ/RSVP did not fly because they relied heavily on fair queueing, and consequently, on the ability of routers to maintain expensive per flow state. You goal is to answer whether the following performance guarantees can be provided to network flows, *without* any inherent support for fair queueing *anywhere* inside the network. Provide explanations for your answers.

A) flow jitter < x ms always
B) flow jitter < x ms with probability > p. With probability 1-p, the flow may observe worse jitter.
C) flow throughput > x Mbps always
D) flow throughput > x Mbps with probability > p. With probability 1-p, the flow may obtain worse throughput.

2. CSFQ relies of employing fair queueing at the *network edges*. Which of the above guarantees can CSFQ provide? Why?

4. Network Architecture and Protocols

The End-to-End principle is widely realized in the network architecture and protocols today. Driven in part by this principle, many crucial services are implemented purely on end-hosts for correctness and completeness. Yet, arguments can be made that a fraction of these services are better off with a purely network-based or a network-assisted implementation. At the same time, there are other crucial services that are solely implemented within the network because they apply generally to all (or most) end-to-end transfers. Yet, a case can be made for an end-host-only or a end-hosted-assisted implementation.

Listed below are a few services which are implemented predominantly in end-hosts (or close to network-edges, perhaps using special devices) or predominantly in the network (i.e. within all or most network elements) today. For each service, your goal is: (1) To briefly sketch how a network-only implementation can be achieved for services which are implemented in end-hosts today, and how an end-host-only implementation can be achieved for services which are implemented in the network today; And, (2) To identify the pros and cons of the alternative implementations relative to the current implementations.

(A) Security, broadly defined

(B) Reliable content delivery

(C) Quality of Service