

# Networking Qualifying Examination

## Computer Sciences

### Spring 2017

Please answer all parts of all six questions below.

#### 1) End-to-end principle

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, how an end-host-only implementation can be achieved for services which are implemented in the network today, and how a host- and network-implementation can co-exist; And, (2) To identify the pros and cons of the alternative implementations relative to the current implementations.

(A) Loss recovery for reliability

(B) Video bit rate adaptation

(C) Routing

(D) Duplicate suppression

#### 2) TCP and congestion control

A) Van Jacobson's paper on Congestion Avoidance and Control argues that if TCP connections obeyed the "packet conservation principle" then congestion collapses become highly unlikely and the network operates at optimal efficiency. Name three ways in which a network transfer can violate the packet conservation principle. Briefly outline the mechanisms incorporated in TCP to ensure that these conditions do not arise in the common case.

B) TCP's congestion control and avoidance mechanisms ensure fair and efficient use of network bandwidth. How can a TCP sender exploit the fair sharing property to obtain a significantly higher share of network bandwidth? Outline three different mechanisms in which a TCP sender can receive  $N$  times the fair share bandwidth. Explain your answers.

C) What benefits does the use of delayed acknowledgments offer in TCP? What are the downsides?

### 3) IPv6

Version 6 of the Internet Protocol was developed in anticipation of the exhaustion of IPv4 address space, and was standardized in RFC 2460 in 1998. While initial adoption was very slow, recent reports put world-wide adoption of IPv6 at about 20%.

- A) Why is the transition between IPv4 and IPv6 difficult?
- B) Give two examples of capabilities that have been developed to enable the transition between IPv4 and IPv6.
- C) Give two examples of methods or capabilities that have delayed the adoption of IPv6.
- D) Give one example of a new challenge that will emerge when IPv6 becomes the norm.

### 4) Mobility support

- A) Mobile IP is a network layer mechanism that can be used to provide mobility support in the Internet. A possible design in Mobile IP is to "route" the incoming traffic (from the Correspondent Host to the Mobile Host) via the home network, while sending the outgoing traffic directly (from the Mobile Host to the Correspondent Host) without having to go through the home network. Explain the considerations behind such a design.
- B) What are main reasons to justify an end-to-end approach to support host mobility instead of doing it at the network layer.
- C) If we had the opportunity to re-design Internet protocols from scratch, how could mobility support be best provided.

### 5) Wireless systems

- A) Random access protocols for channel contention are popular in many Internet technologies, e.g., Ethernet, WiFi, etc., and are very different from an alternative such as Time Division Multiple Access (TDMA). Describe traffic characteristics for which 1) random access protocols are most suitable and 2) TDMA-style channel access protocols are most suitable.
- B) The 802.11 standard proposes the use of RTS-CTS mechanism for channel access. Yet most implementations tend to not employ this mechanism consistently. Explain why.
- C) The 802.11 standard has constantly evolved to using faster data rates some of which are being achieved in part by the use of wider channel bandwidths (e.g., from 20 Mhz in 802.11a/g to 80 Mhz channels in 802.11ac). If all other factors, such as traffic demand, remain constant, do you expect the amount of interference to increase or decrease as we progress to the newer standards. Justify your answer.

## 6) Network Security

Over the years, many types of malicious threats have emerged in the Internet. Despite significant efforts to address these threats, malicious activity in the Internet continues unabated (e.g., claims of “Russian hacking” in recent US election).

A) Give three examples of threats that can have a significant impact on network-connected devices.

B) Describe three ways in which a network can be made secure against the threats/attack that you described in part A.

C) It has been argued that new network architectures are needed to address today’s threats. What is meant by this? Give an example of a capability that might be available in a new network architecture that would improve security. Is it feasible to deploy such a capability?