

# Networking Qualifying Examination

## Computer Sciences

Fall 2015

Please answer all parts of all six questions below.

### 1) The Domain Name System

The Domain Name System (DNS) was invented by Paul Mockapetris in 1983 as a service for translating alphanumeric strings (domain names) into IP addresses that are required by Internet protocols in the transmission of packets. Since its release, DNS has become one of the most important services in the Internet today.

- a) Describe the process for invoking DNS from the client perspective. Name all of the components of DNS that may be used during this process.
- b) Describe the role played by DNS in the transition from IPv4 to IPv6.
- c) Content delivery networks (CDNs) are distributed server infrastructures that are used to cache replicas of popular content. Describe how DNS might play a role in routing client requests to content in CDNs.

### 2) Managing Wide Area Networks

Managing a large, wide area network is a complex and multi-faceted set of activities. Service providers typically have large teams that manage their infrastructures and ensure that they are operating within acceptable bounds.

- a) Give three examples of management challenges *within* the boundaries of a service provider's infrastructure and describe the mechanisms that might be used to address these challenges.
- b) Describe how connectivity between service provider networks is enabled.
- c) Give two examples of management challenges that arise due to connectivity *between* service provider networks and describe the mechanisms that might be used to address these challenges.

### **3) Wireless networking**

a) MACAW was a precursor to the popular WiFi standard used widely today. MACAW, as well as the WiFi standard, proposes the use of RTS-CTS for data exchange. Yet, this mechanism is not quite popular today. Explain why?

b) The layered architecture of TCP/IP stacks was conceived to provide modularity and isolation between different layers. Yet, a number of mechanisms have been proposed over the years that violate strict layering. Describe two examples and how they have been deemed beneficial.

### **4) Transport Protocols**

TCP, the dominant transport protocol in the Internet today, has gone through many transitions over the years.

a) How does classic TCP (TCP Reno) implement: a) Reliability, b) Congestion Control, and c) Flow Control.

b) TCP's congestion control mechanism pioneered the idea of Additive Increase and Multiplicative Decrease (AIMD). Why is this approach of congestion control better than other alternatives, e.g., Multiplicative Increase Multiplicative Decrease (MIMD), or Multiplicative Increase Additive Decrease (MIAD)?

c) What have been the key objectives in the development of new TCP versions of the protocol over the years and what might one expect in future versions of TCP?

### **5) Border Gateway Protocol**

Suppose two end-points/ASes A and B want to communicate with each other over the wide-area Internet using BGP routes. Which of the following properties can the end-points ensure for their routes? What mechanisms would they need to use to ensure these properties? Answer both sets of questions for each:

a) Reachability - i.e., there will be a path that A can use to communicate with B and vice versa

b) Blackhole-safe: when A sends traffic to B, it eventually reaches the intended

destination (a server legitimately owned by B)

c) Interception-safe: a malicious adversary C cannot intercept and sniff the above traffic from A to B.

## **6) Architecture and Mobile**

a) State the end-to-end principle and then give three examples of how it has had an impact on design and implementation of protocols and systems deployed in the Internet today.

b) If one were to strictly follow this principle, where would it be best to implement: (i) Duplicate message suppression (ii) Mobility handling. Give a clear explanation of how adhering to the end-to-end principle leads to your answer.

c) Wearable devices are an important segment in the emerging Internet Of Things. Is the end-to-end principle relevant to these devices and if so, how might it inform their design?