

# Principles of Computer Systems

## Midterm Exam

1-Nov-2018

This exam has 7 questions, totaling 100 points. You have 105 minutes to answer them, which means you earn about 1 point per minute of work – please consider spending on each question no more minutes than the number of points attributed to it.

If you exit the room during the exam, you will have to turn in your exam, and you will not be permitted to return to the room until the end of the exam. Please plan accordingly.

You are allowed to have any amount of printed material you like (books, papers, notes) but no laptops, tablets, cellphones, etc. are permitted during the exam. You must take the seat assigned by the course staff and present your CAMIPRO card to the staff upon request.

**Do not open the exam until instructed to do so.**

Your name: \_\_\_\_\_ SCIPER: \_\_\_\_\_

### Question 1 (8 points)

Most RPC designs handle the no-response case by choosing one of three strategies: at-least-once, at-most-once, exactly-once. For the following scenarios decide which strategy is the most appropriate. Put exactly one checkmark on each row, in the column corresponding to the most likely answer.

Scenario	At-least-once	At-most-once	Exactly-once
An RPC that increments a counter			
An RPC that invalidates an entry in a distributed caching system			
A read request from a key-value store that acts as a caching layer to some back-end storage			
An RPC that retrieves content for your Facebook feed			

## Question 2 (12 points)

One advantage of a microkernel over a monolithic kernel is that it reduces the load on the translation lookaside buffer (TLB), and thereby increases the TLB hit rate, which in turn improves performance. True or False? Explain in max. 1 paragraph.

### Question 3 (8 points)

DNS is used extensively in DDoS attacks. Provide some reasoning behind why DNS would be a favorite for attackers. (Maximum 2 paragraphs).

## Question 4 (20 points)

### Question 4.A (10 points)

Provide three key properties of a good naming system, and then describe how they are achieved in Lampson's Global Name Service (GNS)<sup>1</sup>. Max. 1 paragraph per property.

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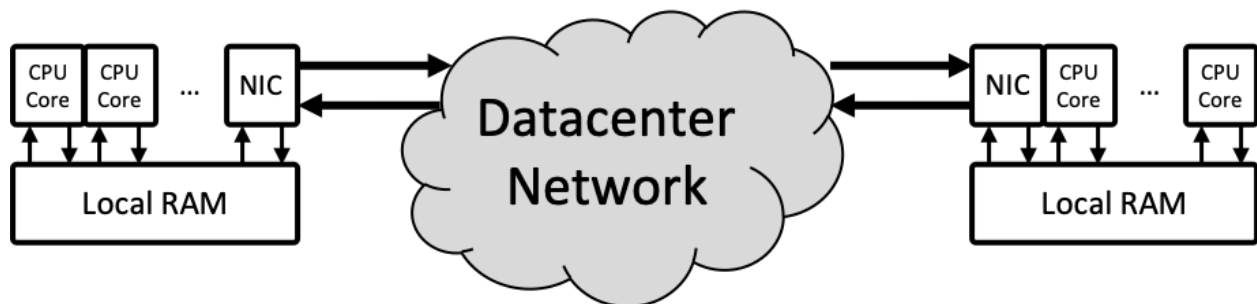
<sup>1</sup> "Designing a global name service" by Butler W. Lampson, PODC 1986

Question 4.B (10 points)

Consider the case where you have a global, flat namespace which is managed by multiple administrative entities. Does the flat namespace provide any challenges in managing the namespace? Describe how a client can identify the server/directory that resolves a particular name. (Maximum 1 paragraph)

### Question 5 (32 points)

You are the CTO of *REMLink*, a hardware startup that has prototyped a next-generation NIC that can access the memory of other servers in a datacenter without requiring the use of an RPC. The NIC is integrated into the server motherboard as an architectural block and is allowed to read/write local memory pages, as well as inject network packets destined for remote NICs, which in turn access their local memory and return the values across the network. The following diagram conceptually shows the *REMLink* platform.



#### Question 5.A (12 points)

Using the virtual memory system discussed in class (x86\_64), describe a method by which REMLink can provide complete transparency to applications, i.e., enable a program to use both local and remote memory in the same way, without doing anything special.

### Question 5.B (20 points)

In order to not corrupt data in remote memory or receive partial data in responses, any remote accesses must be performed exactly once. Your networking team has proposed that this guarantee can be met by providing a reliable link layer. Is this true? If so, describe a way to ensure that network packets/frames are reliably transmitted across links. If you think the statement is not true, then design a protocol to be implemented in the NIC that accomplishes the exactly-once semantics. Describe the protocol as precisely as you can.



### **Question 6** *(10 points)*

An important principle of successful systems is to make the common case fast and the uncommon case merely correct. Lampson refers to this as the “separate the normal case from the worst case” idea, and then advocates handling them separately. Explain one way in which virtual machine monitors employ this principle.

**Question 7 (10 points)**

VxLAN is a technology that encapsulates Ethernet frames in UDP datagrams. Analyze VxLAN from a layering perspective (i.e., discuss which layer(s) it concerns and whether you would view it as a layering violation) and provide a use-case where this technology is applicable.