

# 15-213: Introduction to Computer Systems

## Written Assignment #8

This written homework covers Networking and Concurrency

### Directions

Complete the question(s) on the following pages with single paragraph answers. These questions are not meant to be particularly long! Once you are done, submit this assignment on Canvas.

Below is an example question and answer.

Q: Please describe benefits of two's-complement signed integers versus other approaches.

A: Other representations of signed integers (ones-complement and sign-and-magnitude) have two representations of zero (+0 and -0), which makes testing for a zero result more difficult. Also, addition and subtraction of two's complement signed numbers are done exactly the same as addition and subtraction of unsigned numbers (with wraparound on overflow), which means a CPU can use the same hardware and machine instructions for both.

### Grading

Assignments are graded via *peer review*:

1. Three other students will each provide short, constructive feedback on your assignment, and a score on a scale of 1 to 20. You will receive the maximum of the three scores.
1. You, in turn, will provide feedback and a score for three other students (not the same ones as in part 1). We will provide a *rubric*, a document describing what good answers to each question look like, to assist you. You receive five additional points for completing all of your peer reviews.

### Due Date

This assignment is due on Wednesday, August 3, 2022 by 11:59pm Pittsburgh time (currently UTC-4). Remember to convert this time to the timezone you currently reside in.

Peer reviews will be assigned roughly 12 hours later, and are due a week after that.

# Question 1 (3 points)

Explain the stacked (layered) architecture of the internet protocols. List an advantage and a disadvantage of this architecture.

The architecture contains 7 layers, they are, from bottom to top, physical, data link, network, transport, session, presentation, and application.

## Internet Model

Application	HTTP	SMTP	SSH	DNS
Security	TLS			
Transport	TCP			UDP
Addressing	IP			
Physical Link	Ethernet	WiFi	SDH	

One advantage is that all layers are separated from each other so changes in one layer does not affect the other layers. This also makes scaling the network model easier.

One disadvantage is that there is additional overhead from encapsulating layers.

## Question 2 (3 points)

Linux provides the functions *getaddrinfo* and *getnameinfo* to convert between `struct sockaddr` objects and string representations of addresses. Since every network-layer protocol has its own `struct sockaddr_PROTO`, different from all the others, how does *getaddrinfo* arrange things so its caller doesn't need to know which structs to use?

The `addrinfo` struct written by `getaddrinfo()` contains a `sockaddr` struct. This struct is defined as an array of bytes that can hold either ipv4 or ipv6's version of `sockaddr`. Therefore it can be directly used to call `connect()`, `bind()`, `getnameinfo()`, and other APIs, regardless of internet protocols. Thus, the caller doesn't need to choose from protocol-specific `sockaddr` structs.

## Question 3: Get RICH! :) or poor? :( (4 points)

The year is 1969. ATMs have just been invented. Thanks to ATMs, people don't have to go to banks anymore to deposit and withdraw money. But wait! Some people start complaining about their bank account not showing the correct balance. The bank hires a professional debugger. That's where you come in with your hat, pipe, magnifying glasses and a teddy bear (for debugging purposes only).

The bank tells you that the issue has mostly been seen in situations where a person was trying to withdraw money from the ATM and someone else was paying this person by depositing money to the same account from another ATM.

The ATM has 2 functions: Deposit and Withdraw.

Deposit has 5 steps:

- D1 Count money to be deposited.
- D2 Read the amount currently in the bank account.
- D3 Add current balance and money to be deposited.
- D4 Set amount to the amount calculated in step D3.
- D5 Display success message.

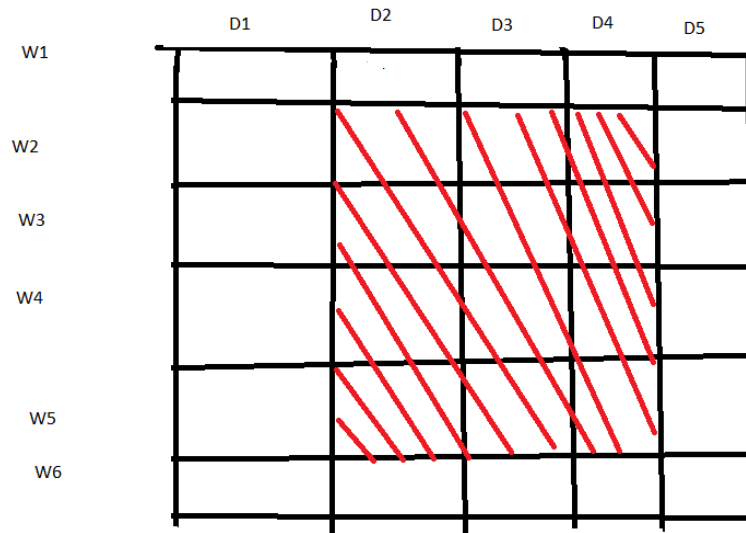
Withdraw has 6 steps:

- W1 Get amount to be withdrawn.
- W2 Read amount currently in the bank account.
- W3 If amount to be withdrawn > current balance. Exit with a failure message.
- W4 Subtract amount to be withdrawn from the current amount.
- W5 Set amount to the amount calculated in step W4.
- W6 Display success message.

Answer the following questions:

- A. What could be causing the issue?
- B. Give a sequence of operations that would make someone richer than they should be.
- C. Draw a progress graph of events when one person is withdrawing money from an account, and another depositing money to the same account, simultaneously. Indicate the critical region that must not be entered.
- D. What synchronization primitive should be used to fix the bug?

- A. Data race
- B. D1 W1 W2 W3 D2 W4 W5 W6 D3 D4 D5
- C. The red lines mark the critical region



- D. Binary semaphore