

## CSE278: Introduction to Systems Programming (Systems I)

### Homework #4

**Due: Wednesday March 11 2020 before 11:59 PM**

**Email-based help Cutoff: 5:00 PM on Tue, March 10, 2020**

**Maximum Points: 50**

#### Submission Instructions

This part of the homework assignment must be turned-in electronically via Canvas. Ensure you name this document *HW4\_MUID.docx*, where *MUID* is your Miami University unique ID. (Example: HW4\_ahmede.docx)

Copy pasting from online resources is **Plagiarism**. Instead you should read, understand, and use your own words to respond to questions.

#### Submission Instructions:

Once you have completed answering the questions save this document as a PDF file (**don't just rename the document; that is not the correct way to save as PDF**) and upload it to Canvas.

**General Note:** Upload each file associated with homework (or lab exercises) individually to Canvas. Do not upload archive file formats such as zip/tar/gz/7zip/rar etc.

#### Objective

The objective of this homework is to:

- Review basic concepts of data communication networks from lecture slides

### Required reading

Prior to answering the questions in this homework briefly review the following chapters from the E-book titled "Computer and Communication Networks" (all students have free access to the electronic book):

- Chapter 1: Packet-switched networks
- Section 4.1 (LAN and Basic Topologies) & 4.2 (LAN Protocols)
- Section 8.1 (Overview of Transport Layer), Section 8.2 (UDP), Section 8.3 (TCP)

1. Data communication networks are comparable to telephone systems. Briefly (1 sentence each, no more) describe 2 similarities between the two, in the table below [2 points].

Telephone systems	Data communication networks
A telephone system uses a phone number and extensions to reach people	Data communication networks use an IP address and port numbers to connect between programs
There is a caller who initiates the conversation and the person who picks up on the other end and listens to the person and responds	There is a client who attempts to connect to the server, who would then listen to the client and respond appropriately.

2. What is the key difference between a *Circuit* switched and *Packet* switched network? [1 points]

The key difference between Circuit and Packet switched networks are that for a Circuit switched network, resources for both users on each end must be allocated and reserved before data can be transmitted. Whereas with Packet switched networks, data can be sent much more efficiently and contains robust routing protocols to adapt to the changing network demands. This means Packet switches don't need pre-allocated resources or paths and can change paths as needed.

3. What is the difference between a "Packet" and "Frame"? [1 points]

A frame is a packet that's been broken down or partitioned further, where a packet is the formatted unit of data.

4. What is the difference between "Connection-less" and "Connection-oriented" communication/networking? [1 points]

In a connection-oriented network, an established and verified connection is required between the client and server before sending packets over the network. Whereas with connection-less network, packets of data can be broken up and sent in separate paths across the network to reach the same destination not requiring a pre-established connection route.

5. Write the expansion of the following acronyms [**0.5×10 = 5 points**]:

a. OSI	Open System Interconnection
b. IP	Internet Protocol
c. TCP	Transmission Control Protocol
d. MAC	Media Access Control
e. NIC	Network Interface Card
f. LAN	Local Area Network
g. UDP	User Datagram Protocol
h. CIDR	Classless Inter-Domain Routing
i. NAT	Network Address Translation
j. IETF	Internet Engineering Task Force

6. Briefly (1 sentence each) state the 5 key layers in a network and their key functionality (in order starting with closest to hardware) in the 5-layer model [**5 points**]

The first layer of the network is the Physical Layer that deals with the physical hardware of the computer and exchanging electronic bits.

The second layer is the Data Link Layer and provides an interface for the computer to connect with the network. This layer provides a NIC and unique MAC address for the computer. At this level it is also able to create a LAN.

The third layer is the Network Layer which provides basic management through ICMP. At this stage an IP address can be created for the computer and a WAN can be created.

The fourth layer is the Transport Layer and it provides communications between programs. The communication is in the form of Sockets and UDP/TCP protocols are used to send data across the network.

The fifth layer is the Application layer and it contains all of the programs that interact with the Internet such as the WWW.

7. Write the expansion for the following application-layer protocols and the "well known port numbers" for each [**0.5×4 = 2 points**]

Protocol	Port	Expansion
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	Number	
SMTP	25	Simple Mail Transfer Protocol
DNS	53	Domain Name Service
HTTP	80	Hypertext Transfer Protocol
SSH	22	Secure Shell

8. Briefly describe the 3-way handshake used to establish a TCP connection between two hosts. What is the benefit of the TCP three-way handshake mechanism? [6 points]

In order to establish a TCP connection between host A and host B

Step 1: The client sends a SYN and a random sequence number to the server

Step 2: Then, the server replies with the SYN and an incremented sequence number one higher. The server also replies with an ACK and a random acknowledgement number.

Step 3: Finally, the client replies with the sequence number, the ACK and an incremented acknowledgement number

Benefits: Using TCP ensures that a secure and reliable connection is established. This would help prevent the loss of data and data that is out of order. A three-way handshake also makes DDoS attacks harder.

9. Tabulate 3 significant differences between UDP and TCP [3 points]

UDP	TCP
UDP is unreliable, packets could get lost in the transfer process and this failure wouldn't be reported.	TCP is much more reliable; it retrieves sending packets to ensure that the information is received and reports data transfer failures.
UDP is unordered, data packets are not always going to be delivered the same way they are sent.	TCP ensures that all of the data arrives in the same order that it was sent. It maintains a buffer that allows it to act like a stream in order to do so.
UDP doesn't focus on connection and therefore there isn't any initial handshake to establish a connection	TCP is very connection oriented and uses a 3-three way handshake to establish a connection.

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10. Explain the purpose/behavior of the commands from the SMTP Protocol

Command	Purpose
HELO	This starts the SMTP handshake between the client and the server (typically a mail server)
DATA	Allows the user to enter the Subject and body of the mail message. The user is able to type multiple lines.
. (on a line by itself)	This indicates that you are finished typing in the body of the email and exits the editing phase and prepares to send the email.

11. What are the two components of an endpoint? Why are both needed? [3 points]

The two components of an endpoint are an IP address/Host name and a port number. These are required because in order to communicate across the internet, first an IP address is required to establish a connection with a certain server and then a port address indicates the protocol that is being used and therefore how the data will be processed.

12. How is a *well-known* port different from an *ephemeral* port?

Almost all well-known ports are numbered below 1023 and are well-defined by the computer. One instance is port 22 is a known port for SSH and can only be used for that process. Whereas ephemeral ports are high numbered (>1024) and are used by client applications to connect and send data on the network. Ephemeral ports can have different protocols and programs connected based on how they are assigned.

13. What is meant by saying that HTTP is a *stateless* protocol?

HTTP is a stateless protocol because previous HTTP calls won't affect future HTTP calls. This means that's when a request is made, it isn't stored on the server or locally and if you make another request, the previous request doesn't affect it at all.

14. Do port addresses need to be unique? Why or why not? Why are port addresses shorter than IP addresses?

If the IP address is the same for the port numbers, then they need to be unique because each port number represents a specific protocol or program running on that machine associated with the IP address; Therefore, having two different protocols on the same port would on the same port would cause confusion between programs on which protocol to use.

Whereas if the IP addresses are different then the port numbers can be the same since port numbers with different IP addresses can still point to their respective protocol or program running on each unique machine.

Port numbers are shorter than IP addresses because there only needs to be enough free port numbers for protocols or programs on a local machine, which is much less than the number of computers that would need a unique IP address, allowing for port addresses to be shorter than IP addresses.

15. Consider an HTTP client that wants to retrieve a Web document at a given URL. The IP address of the HTTP server is initially unknown. What transport and application-layer protocols besides HTTP are needed in this scenario?

You would need the DNS protocol to retrieve the IP address from the given URL. After you retrieve the IP address, you would need a TCP or UDP protocol to establish a connection with the server to use the HTTP protocol.

16. Suppose you purchase a wireless router and connect it to your cable modem. Also suppose that your ISP dynamically assigns your connected device (that is, your wireless router) one IP address. Also suppose that you have five PCs at home that use 802.11 to

wirelessly connect to your wireless router. How are IP addresses assigned to the five PCs? Does the wireless router use NAT? Why or why not?

The router uses the Dynamic Host Control Protocol (DHCP) to automatically assign a unique IP address to each computer, meaning all five computers will have a unique IP address on the local area network. Then the router uses NAT to convert all of the unique routers on the local area network into the dynamic IP that is given by the ISP that will allow the router to connect to the internet. This allows all of the devices to connect to the internet using the same dynamic IP given by the ISP.

## Submission

- No late assignments will be accepted!
- This work is to be done individually
- The submission file will be saved with the name ***HW4\_yourMUID.pdf***
- Assignment is due before Midnight Wednesday March 11, 2020.
- On or before the due time, drop the *electronic copy* of your work in the *canvas*
- **Don't forget to Turn in the file! HW4\_yourMUID.pdf**