

Name_____ Student ID_____ Department/Year_____

1st Examination

Introduction to Computer Networks (Online)

Class#: EE 4020, Class-ID: 901E31110

Fall 2023

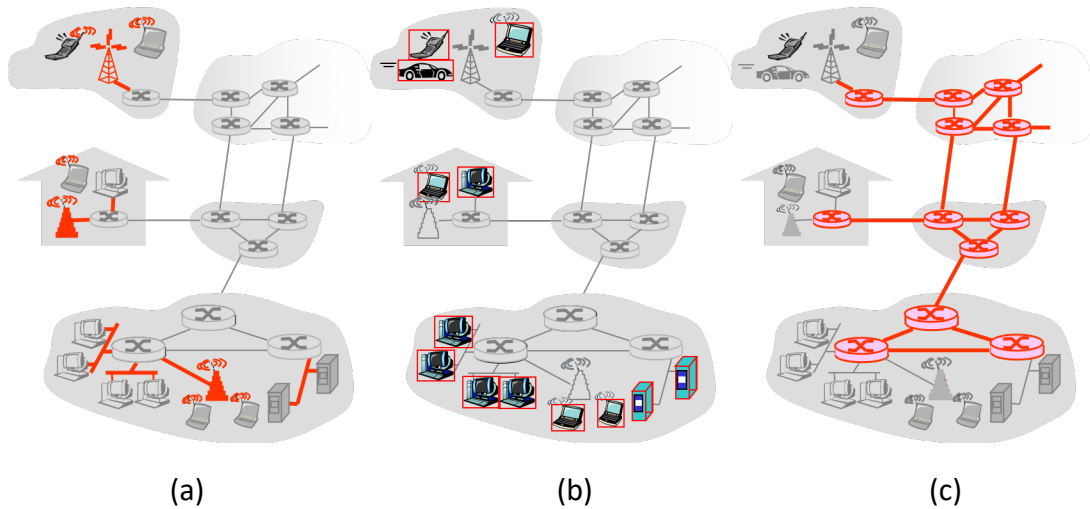
10:20-12:10 Thursday

October 12, 2023

Cautions

1. There are in total 100 points to earn. You have 90 minutes to answer the questions. Skim through all questions and start from the questions you are more confident with.
2. Use only English to answer the questions. Misspelling and grammar errors will be tolerated, but you want to make sure with these errors your answers will still make sense.

1. (ch11, 3pt) Consider the 3 figures below that highlight different parts of the mini-Internet we've seen several times in class. (3pt)



- (1) Which highlights the edge part of the mini-Internet? (1pt)
- (2) Which highlights the access network part of the mini-Internet? (1pt)
- (3) Which highlights the core part of the mini-Internet? (1pt)

Sample Solution:

(b)(a)(c)

2. (ch12, 4pt) Consider these devices on the Internet today. Tell the part of the Internet each of them belongs – (a) edge, (b) access network, or (c) core?

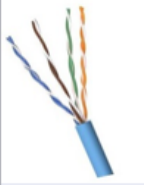

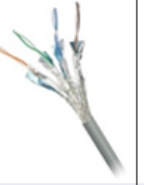

- (1) Smartphone (1pt)
- (2) Smartphone with the mobile hotspot on (1pt)
- (3) Starlink modem (1pt)
- (4) IXP router (1pt)

Sample Solution:

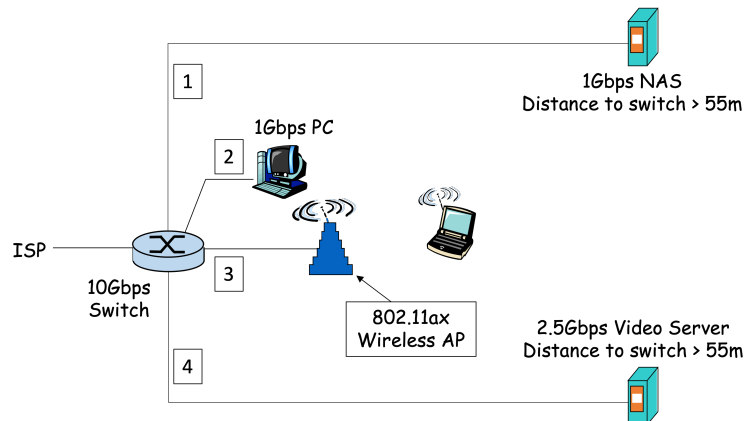
(a), (a)(b), (b), (c)

3. (ch12, 8pt). 10Gbps Ethernet switches and 2.5Gbps Ethernet network cards are growingly popular. As we connect these high-speed Ethernet devices into the network, we want to be careful about the Ethernet cables we use to take advantage of the full speed.

There are generations of the CAT cables (i.e., the Ethernet cables) these days. They differ in (1) the modulation frequency, (2) the shielding mechanism, and (3) the price. A higher modulation frequency gives a more reliable or higher transmission rate. More elaborated shielding allows more reliable transmission over a longer distance. A more advanced cable, on the other hand, costs more.

	Cat5e	Cat6	Cat6a	Cat7	Cat7a	Cat8
Frequency	100MHz	250MHz	500MHz	600MHz	1GHz	2GHz
Shielding	UTP	UTP	FTP/SFTP	SFTP	SFTP	SFTP
					Similar to Cat7	Similar to Cat7
Capacity	1Gbps	10Gbps	Up to 10Gbps	10Gbps	10Gbps+	25-40Gbps
Distance	100m	Up to 55m	100m	100m	100m	30m

The figure below depicts a small enterprise network. Suggest the cable for each of the 4 links connected to the 10Gbps switch. The goal is to make sure the link won't limit the transmission rate and to keep the cost as low as possible.



- (1) Which cable for link 1? (1pt)
- (2) Continue from (1). Why? (1pt)
- (3) Which cable for link 2? (1pt)
- (4) Continue from (3). Why? (1pt)
- (5) Which cable for link 3? (1pt)
- (6) Continue from (5). Why? (1pt)
- (7) Which cable for link 4? (1pt)

(8) Continue from (7). Why? (1pt)

Sample Solution:

(1) Cat5e

(2) 1Gbps is all that's needed.

(3) Cat5e

(4) 1Gbps is all that's needed.

(5) Cat6

(6) 802.11ax can run at 9Gbps+. The cheapest cable to accommodate the transmission is Cat6.

(7) Cat6a

(8) The cheapest cable to accommodate the transmission of 2.5Gbps and longer than 55m distance is Cat6a

4. (ch13, 4pt) Based on your understanding of circuit switching and packet switching principle, compare and contrast the two public transportation networks in Taipei city: the bus network and the Metropolitan Rapid Transit (MRT) network.

(1) Is the bus network more circuit switching or packet switching? (0pt)

(2) Continue from (1). Why? (2pt)

(3) Is the MRT network more circuit switching or packet switching? (0pt)

(4) Continue from (3). Why? (2pt)

Sample Solution:

Justify your answer.

5. (ch14, 10pt) `ping` provides another way to investigate the round-trip time (RTT) to a remote machine. The way it works is very simple – sending a request to the remote machine and the remote machine sending back a response. By calculating the difference in the timestamp of the request and response, `ping` shows the measured RTT on the screen. Using the `-c` flag, one can limit the number of request-response probes.

Let's `ping` to NCCU, NCHU, and NCKU's Web servers. These 3 universities are located in northern, central, and southern TW respectively. Let's see if the machines that are geographically closer give also a shorter RTT.

(1) Login to the PA workstation with your exam account. Create a directory "exam1" and

move to the directory. (2pt)

(2) `ping` to `www.nccu.edu.tw` and create a file `nccu.txt` to contain the output as follows. You should see 5 RTT measurements in the output file. Leave the file there for grading. (2pt)

```
$ ping -c 5 www.nccu.edu.tw > nccu.txt
```

(3) Tell the average RTT from the PA workstation to www.nccu.edu.tw according to `nccu.txt`. (1pt)

(4) `ping` to `www.nchu.edu.tw` and create a file `nchu.txt` to contain the output and leave the file there for grading. (1pt)

(5) Tell the average RTT from the PA workstation to www.nchu.edu.tw according to `nchu.txt`. (1pt)

(6) `ping` to `www.ncku.edu.tw` and create a file `ncku.txt` to contain the output and leave the file there for grading. (1pt)

(7) Tell the average RTT from the PA workstation to www.ncku.edu.tw according to `ncku.txt`. (1pt)

(8) According to the 3 `.txt` files, are the machines geographically closer to the PA workstation showing shorter RTTs? (1pt)

Sample Solution:

Will check what the `.txt` files in your `exam1` directory say

6. (ch15, 6pt) Internet protocols are sorted into layers and people refer to this as a layered service model.

(1) Give the 2 benefits of the layered model. (2pt)

(2) Give 1 drawback of the layered model. (1pt)

(3) We used air travel as an example of the layered model. Give another example that operates in the layered model. (1pt)

(4) Justify your example. (2pt)

Sample Solution:

(1) ease of management, lowered communication overhead

(2) Sub-optimal performance/efficiency, hard to debug inter-layer errors, steep learning curve

(3) Think of one.

(4) Justify your example.

7. (ch21, 6pt) There are three types of sockets an app designer can choose to transmit the app's data – TCP, UDP, or TLS. Tell for each of the following application, which socket you think is more appropriate and why.
- (1) Which type of socket you would choose for online banking (e.g., eTrade)? (0pt)
 - (2) Continue from (1). Why? (2pt)
 - (3) Which type of socket you would choose for short video sharing (e.g., Tiktok)? (0pt)
 - (4) Continue from (3). Why? (2pt)
 - (5) Which type of socket you would choose for hostname to IP address lookup (i.e., DNS)?
 - (6) Continue from (5). Why? (2pt)

Sample Solution:

Take your pick and justify.

8. (ch22, 9pt) Consider these connection modes one can implement in HTTP –
- (a) non-persistent + no parallel connections
 - (b) non-persistent + 2 parallel connections max
 - (c) persistent connection without pipelining + no parallel connections
 - (d) persistent connection without pipelining + 2 parallel connections max
 - (e) persistent connection with pipelining + no parallel connections
 - (f) persistent connection with pipelining + 2 parallel connections max

Let's download a Web page of 1 base html and 4 reference objects. In that, the base html is in one server, 1 of the reference objects in another server, and the remaining 3 reference objects in yet another server. Assume the transmission time is negligible and the RTT to these 3 servers are the same for simplicity.

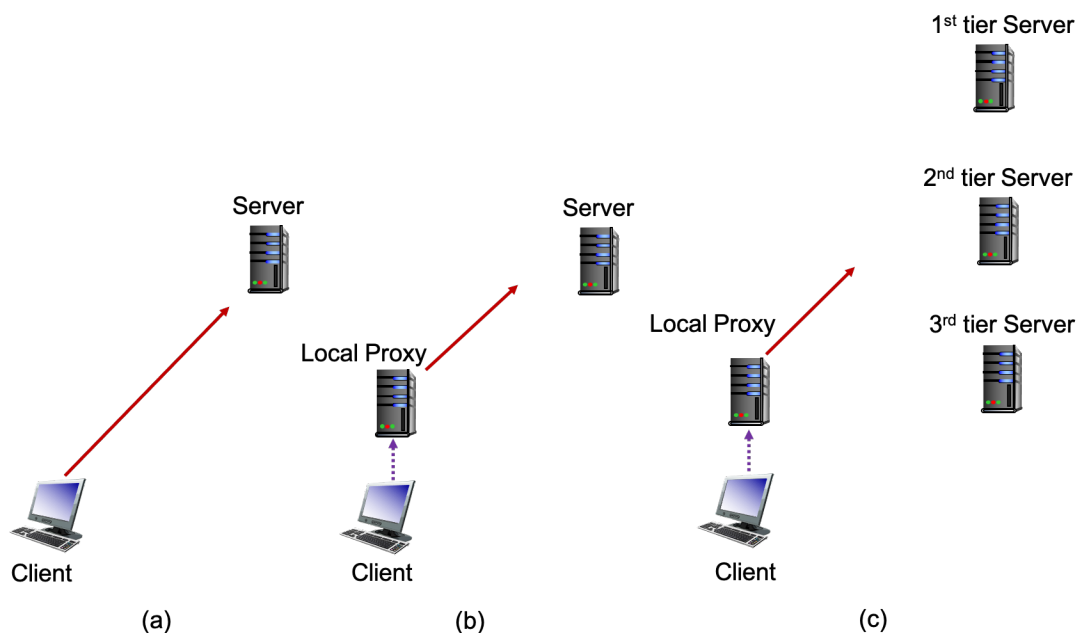
- (1) Tell the response time in RTT and show the derivation using mode (a). (1pt)
- (2) Tell the response time in RTT and show the derivation using mode (b). (1pt)
- (3) Tell the response time in RTT and show the derivation using mode (c). (1pt)
- (4) Tell the response time in RTT and show the derivation using mode (d). (2pt)
- (5) Tell the response time in RTT and show the derivation using mode (e). (1pt)
- (6) Tell the response time in RTT and show the derivation using mode (f). (2pt)
- (7) Among the 6 modes, which one would you use and why? (1pt)

Sample Solution:

- (1) $2RTT$ for the base. $4 \cdot 2RTT$ for each of the subsequent ref objects. Total = $10RTT$
- (2) $2RTT$ for the base. $2RTT$ for 2 parallel connections to get 2 ref objects and $2RTT$ for another 2 parallel connections to get 2 ref objects. Total = $6RTT$

- (3) 2RTT for the base. 2RTT for one object in one server. 2RTT+RTT+RTT for the other three objects in another server. Total = 8RTT
- (4) 2RTT for the base. 2RTT for one object in one server. 2RTT+RTT+RTT for the three objects in another server. The two connections run in parallel. The time to download the 4 ref objects is the max of the two. Total = 6RTT
- (5) 2RTT for the base. 2RTT for one object in one server. 2RTT for the other three objects in another server. Total = 6RTT
- (6) 2RTT for the base. 2RTT for the objects in two other servers in parallel. Total = 4RTT
- (7) Take your pick and justify.

9. (ch22-24, 4pt) These are the major design choices of an application layer protocol – the architecture, the socket type, and the message formats. Among the 3 system architectures we have observed so far (depicted below) – (a) client-server model without expansion, (b) client-server model with client-end expansion, (c) client-server model with both client- and server-end expansion, which one is used by the following protocols:



- (1) HTTP without proxy server (1pt)
- (2) HTTP with proxy server (1pt)
- (3) SMTP (1pt)
- (4) DNS (1pt)

Sample Solution:
 (a)(b)(b)(c)

10. (ch24, 6pt) You are introduced 4 types of DNS resource records (RRs) in the lectures – (a) A, (b) MX, (c) NS, and (d) CNAME. We know smtp.gmail.com is the mail server of gmail.com and ns1.google.com is the authoritative DNS server for google.com. Tell which type each of the following RRs is.

- (1) (gmail.com, smtp.gmail.com) (1pt)
- (2) (smtp.gmail.com, tsa01s11-in-f4.1e100.net) (1pt)
- (3) (tsa01s11-in-f4.1e100.net, 108.177.125.10) (1pt)
- (4) (google.com, ns1.google.com) (1pt)
- (5) (ns1.google.com, 216.239.32.10) (1pt)
- (6) (b.root-servers.net, 199.9.14.201) (1pt)

Sample Solution:

(b)(d)(a)(c)(a)(a)

11. (ch24, 6pt) Continue from Problem Set 10. There are 4 types of DNS servers – (a) local DNS, (b) root DNS, (c) TLD DNS, and (d) authoritative DNS server. Tell which server(s) we might see each of the following 6 RRs stored.

- (1) (gmail.com, smtp.gmail.com) (1pt)
- (2) (smtp.gmail.com, tsa01s11-in-f4.1e100.net) (1pt)
- (3) (tsa01s11-in-f4.1e100.net, 108.177.125.10) (1pt)
- (4) (google.com, ns1.google.com) (1pt)
- (5) (ns1.google.com, 216.239.32.10) (1pt)
- (6) (b.root-servers.net, 199.9.14.201) (1pt)

Sample Solution:

- (1) (a)(d)
- (2) (a)(d)
- (3) (a)(d)
- (4) (a)(c)
- (5) (a)(c)
- (6) (a)

12. (ch25, 4pt) Emma joins a BT torrent and connects to 4 peers – Alice, Bob, Cindy, and Danny. The file Emma likes to download is divided into 4 chunks. Each peer tracks its

availability of chunks using a vector of 4 bits. When the bit value is 1, the peer holds the chunk on the disk. When the bit value is 0, the chunk is not on the peer's disk. For example, (1, 0, 1, 0) indicates chunk 1 and 3 are available at this particular peer.

Provided the vectors of Alice, Bob, Cindy, and Danny below.

Alice: (0, 1, 1, 1)

Bob: (1, 1, 0, 1)

Cindy: (0, 1, 0, 1)

Danny: (1, 0, 0, 1)

Assume that Alice, Bob, Cindy, and Danny are not interested in the file anymore and stop downloading the remaining chunks. Tell the chunks in the order of Emma's request to complete the file download. (4pt)

Sample Solution:

3, 1, 2, 4

13. (PA2, 15pt) Please go on the PA workstation and work under the exam1 directory for this problem set. Create the exam1 directory if you have not yet done so. Grading policy: pt for latter sub-problems will be given only when the former ones are completed.
- (1) You should see two text files in your home directory – win-test.txt and unix-test.txt. Move the two files to the exam1 directory. (1pt)
 - (2) Develop exam1-p13-1.go such that it (1) prompts the user for a filename, (2) reads the file and (3) prints the file size on screen. (2pt)
 - (3) Develop exam1-p13-2.go such that it (1) prompts the user for a filename, (2) reads the file and (3) prints the exact file on screen. (3pt)
 - (4) Develop exam1-p13-3.go such that it (1) prompts the user for a filename, (2) reads the file, (3) prints the file character by character when the character is not '\r', and (4) when the character is '\r', prints a visible string "\r" instead. (3pt)
 - (5) Develop exam1-p13-4.go such that it (1) prompts the user for a filename, (2) reads the file, (3) prints the file character by character when the character is not '\r' or '\n', (4) when the character is '\r', prints a visible string "\r" instead, and (5) when the character is '\n', prepend a string "\n" before printing the character '\n'. (4pt)
 - (6) Test your exam1-p13-4.go using win-test.txt and unix-test.txt. Tell if you see any difference. (2pt)

Sample Solution:

Whatever that works.

14. (PA3, 15pt) Please go on the PA workstation and work under the exam1 directory for this problem set. Create the exam1 directory if you have not yet done so. Grading policy: pt for latter sub-problems will be given only when the former ones are completed.
- (1) Develop exam1-p14-1.go such that it connects to the server running on port 11991 and then close the connection. (3pt)
 - (2) Develop exam1-p14-2.go such that it connects to the server running on port 11992, sends "hey!\n" and then closes the connection. (3pt)
 - (3) Develop exam1-p14-3.go such that it connects to the server running on port 11993, sends "hey!\n", prints the response from the server, and then closes the connection. (4pt)
 - (4) Run your exam1-p14-3.go again and send "Testing123...\n" this time. Tell the response from the server. (2pt)
 - (5) Run your exam1-p14-3.go again and send an arbitrary string until you figure out what the server on port 11993 is doing. Tell what the server on port 11993 is doing. (3pt)

Sample Solution:

Whatever that works.