

**New York University**  
**Computer Science Department**  
**Courant Institute of Mathematical Sciences**

**Course Title:** Data Communication & Networks  
**Instructor:** Jean-Claude Franchitti

**Course Number:** g22.2662-001  
**Session:** 3

**Assignment #3**

**I. Due**

Thursday October 7, 2021 at the beginning of class.

**II. Objectives**

1. Learn application layer concepts.
2. Learn about various protocols such as HTTP, SMTP, P2P etc.
3. Experiment with Data Encoding and Transmission.
4. Program using sockets.

**III. References**

1. Slides and handouts posted on the course Web site
2. Textbook chapters 1 and 2

**IV. Software Required**

1. Microsoft Word
2. Win Zip as necessary

**V. Assignment**

1. Problem 1:
  - a. What transport layer protocol SMTP uses and why?
  - b. Research and describe the protocols used in WhatsApp and iMessage?
  - c. Briefly describe two different server placement approaches in CDN.
  - d. Explain the meaning of HTTP response codes:
    - 1) 201
    - 2) 404
    - 3) 500
  - e. Describe the difference between download-and-delete mode vs. download-and-keep mode in POP3.
  - f. Name two benefits of P2P over client-server architecture.
  - g. Visit <http://www.ibm.com> in your favorite browser. Which protocols are used in application layer and transport layer? Provide proof via screenshot(s) using WireShark.
2. Problem 2:

Are the following statements true or false?

- a. In order to communicate with a process in a host, one only needs the IP address of the host.
  - b. SSL is a transport layer protocol.
  - c. Both UDP and TCP guarantee the delivery of the packet from source to destination.
  - d. If an application uses UDP, that means that application does not need reliable data transfer.
3. Problem 3:
- If you download a HTML file which references to 5 images, how many RTTs are needed?
- a. Your browser uses non-persistent HTTP?
  - b. Your browser uses persistent HTTP?
4. Problem 4:
- a. Consider the following HTTPS request:

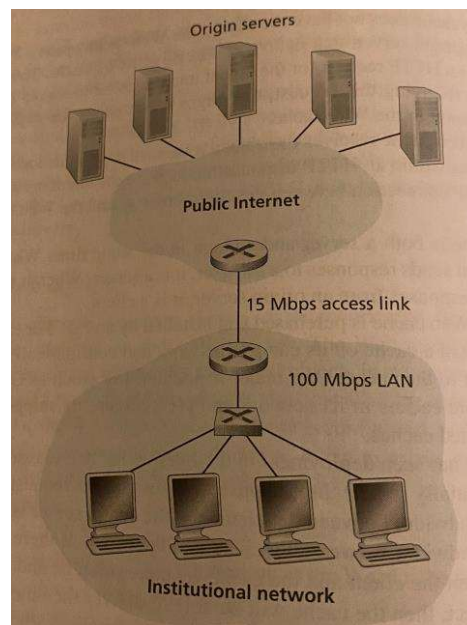
```
authority: www.google.com
method: GET
path: /
scheme: https
accept:
text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,image/apng,*/*
accept-encoding: gzip, deflate, br
accept-language: en-US,en;q=0.9,tr-TR;q=0.8,tr;q=0.7
user-agent: Mozilla/5.0 (Macintosh; Intel Mac OS X 10_15_3) AppleWebKit/537.36
(KHTML, like Gecko) Chrome/79.0.3945.130 Safari/537.36
```

- 1) What method is used?
  - 2) What is the path that is requested?
  - 3) What type of response is accepted?
  - 4) Why multiple user agents are listed?
- b. Consider the following HTTPs response:
- ```
content-length: 66708
content-type: text/html; charset=UTF-8
date: Thu, 27 Feb 2020 02:24:24 GMT
server: gws
set-cookie: 1P_JAR=2020-02-27-02; expires=Sat, 28-Mar-2020 02:24:24 GMT; path=/;
domain=.google.com; Secure; SameSite=none
status: 200
```
- 1) Was the request successful?
  - 2) What is the returned content type?

- 3) Explain what is set-cookie header is used for?
- 4) Is the document last modified at Thu, 27 Feb 2020 02:23:23 GMT? (Yes or No)

5. Problem 5:

Consider Figure 2.12 from the course textbook (shown below). Assume that the average object size is 250Kbits, and the average requests rates from institutional browsers to origin servers are 60 requests per second. Moreover, suppose that the time it takes for the router on the access link side to receive the object from its request is 2 seconds. Also ignore the delay of the outgoing traffic from the institutional network to origin servers.



Answer the following questions:

- a. What is the traffic intensity at the access LAN?
- b. What is the traffic intensity at the access link (from Internet router to institutional router)?
- c. List two solutions to mitigate the delay in the access link?
- d. If cache is deployed with a 0.4 hit rate within the institutional network, what would be the total delay (if less than 0.8 traffic intensity assume 0.01 sec delay)?

6. Problem 6:

Consider distributing a file of size 25Gbits to  $N$  peers. The server has an upload rate of  $u_s=50\text{Mbps}$  and each peer has a download rate of  $d_i=5\text{Mbps}$  and upload rate  $u$ . For  $N= 10, 100, 1000$  and  $u= 250\text{Kbps}, 750\text{Kbs}, 2.5\text{Mbps}$ , calculate the minimum distribution time for each of the combinations of  $N$  and  $u$  for both client-server distribution and P2P distribution. Hint: use the formula presented in class and in the slides).

7. Problem 7:

Develop algorithms for generating each of the codes of NRZI, Bipolar-AMI, Pseudoternary, Manchester, Differential Manchester, B8ZS, and HDB3 from NRZ-L.

8. Problem 8:

The following describes a signal encoding technique.

Binary data is represented as input  $a_m$  for  $m = 1, 2, 3, \dots$

A new set of binary numbers is then produced as follows:

$$b_0 = 0$$

$$b_m = (a_m + b_{m-1}) \bmod 2$$

These numbers are then encoded as:

$$c_m = b_m - b_{m-1}$$

On reception, the original data is recovered via

$$a_m = c_m \bmod 2$$

- a. Confirm that the received values of  $a_m$  are equal to the transmitted values of  $a_m$ .
- b. What kind of encoding is this?

9. Problem 9:

One positive side effect of bipolar encoding is that a bipolar violation (i.e., two consecutive + pulses or two consecutive – pulses separated by any number of zeros) indicates to the receiver that an error occurred in transmission. However, upon receipt of such a violation, the receiver does not know which bit is in error (i.e., the receiver only knows that an error has occurred).

For the received bipolar sequence  $+ - 0 + - 0 - +$ , which has one bipolar violation, construct two scenarios that will produce this same received bit pattern. Each of the two scenarios should involve a different transmitted bit stream with one transmitted bit being converted via an error.

10. Problem 10:

- a. Considering the bit pattern 01100, encode this data using ASK, BFSK, and BPSK.
- b. Assuming a required bit error rate of  $10^{-6}$ , what SNR ratio is required to achieved a bandwidth efficiency of 1.0 for ASK, FSK, PSK, and QPSK?
- c. Consider an audio signal with spectral components in the range 300 to 3000 Hz. Assume that a sampling rate of 7000 samples per second is used to generate a PCM signal.
  - 1) For SNR = 35 dB, what is the number of uniform quantization levels needed?
  - 2) What is the required data rate?

11. Save the file as a Word document.

12. Name the file as follows:

**“firstname\_lastname\_hw\_#.docx”** (e.g., “john\_doe\_hw\_3.docx”).

13. Submit your assignment electronically via NYU Classes by the due date.

Use the following naming convention in the subject line of the eMail:

**“DCN - firstname lastname - homework #”** (e.g.: "DCN – John Doe - homework 3").

In the case source code is submitted, include your name as a comment at the top of each file (Note: all files submitted should include your name).

## **VI. Deliverables**

1. Electronic:

Your assignment file must be submitted via NYU Brightspace. The file must be created and sent by the beginning of class. After the class period, the homework is late. The email clock is the official clock.

2. Cover page and other formatting requirements:

The cover page supplied on the next page must be the first page of your assignment file.

Fill in the blank area for each field.

**NOTE:**

**The sequence of the electronic submission is:**

- 1. Cover sheet**
- 2. Assignment Answer Sheet(s)**

**VII. Sample Cover Sheet:**

Name \_\_\_\_\_ Date: \_\_\_\_\_  
(last name, first name)  
Section: \_\_\_\_\_

### **Assignment 3**

#### **Assignment Layout:**

- Assignment is neatly assembled on 8 1/2 by 11 layout.
- Cover page with your name (last name first followed by a comma then first name), username and section number with a signed statement of independent effort is included.
- Answers to Questions V.1 to V.10 are correct.
- File name is correct.

#### **Answers to Individual Questions:**

**(100 points total, all questions weighted equally)**

- Assumptions provided when required.

**Total in points** (100 points total): \_\_\_\_\_

#### **Professor's Comments:**

**Affirmation of my Independent Effort:** \_\_\_\_\_  
(Sign here)