

**MET CS 625 Business Data Communication and Networks  
Assignment 2**

There are three parts to this assignment. Please make sure to complete all parts.

**Part 1: Data Rate Calculations**

In the last module, you learned a formula for calculating the bit rate,  $R = b/t$ , that is, the number of bits divided by the time. This formula expresses the number of bits that are transmitted over a circuit in a given period of time. In practice, however, we are not only concerned with the number bits transmitted, but also with the number of *data bits* transmitted over a circuit. The data bits are those that the sender decides to send to the receiver, and do not include the overhead bits used by the networking protocols involved. Recall that the protocols that send messages on a circuit use some of the available bits to store metadata (overhead) for protocol communication. From a data perspective, the bit rate on a circuit can be termed the *maximum data rate* because it calculates the theoretical maximum number of data bits that can be sent over a network circuit if the protocols were to use no overhead bits. *Effective data rate* is a rate that takes into account the overhead of the protocols involved.

In this part, you will perform effective data rate calculations with two scenarios. Each scenario gives you the maximum data rate of the circuit, along with details of the protocol(s) involved and asks you to calculate the transmission efficiency and effective data rate. For full credit, the calculations you use to derive the answers must be shown.

***Scenario 1: 19,500 ASCII characters are transmitted over a 3 Mbps circuit. The protocol uses 8-bits to encode each ASCII character, and adds an additional parity bit to help detect errors.***

***a. Calculate the transmission efficiency of this protocol.***

Application bits = 8  
Overhead bits = 1  
Transmission efficiency =  $8 / (8+1) = 88.9\%$

***b. Determine the effective data rate of sending these characters over the circuit using the above-defined protocol.***

Transmission efficiency = 88.9%  
Effective data rate = Transmission efficiency \* Maximum Data Rate =  $0.889 * 3\text{Mbps} = 2.667\text{Mbps}$

**Scenario 2: A person types a plaintext email consisting of 350 characters into their email client, and the characters are encoded with 16-bit Unicode. When the person hits the Send button, the email client uses the SMTP protocol to transmit the message, with an SMTP header of 100 bytes. SMTP is running over TCP over IP over Ethernet, and the Ethernet link is running at 1Gbps.**

***a. Calculate the size of the email message in bytes.***

Information bits =  $350 * 16 / 8 = 700$  bytes

- b. Calculate the transmission efficiency of sending this email, using the nominal overhead sizes for the TCP and IP protocols, and the standard Ethernet II overhead size.**

SMTP: 100 bytes

TCP header: 20 bytes (not includes option field)

IP header: 20 bytes (use IPv4 and not includes option field)

Ethernet II: 26 bytes

Information bits: 700 bytes

Transmission efficiency:  $700 / (100 + 20 + 20 + 26 + 700) = 80.83\%$

- c. Determine the effective data rate of sending this email.**

Effective data rate = Transmission efficiency \* Maximum Data Rate =  $0.8083 * 1\text{Gbps} =$

$0.8083\text{Gbps} = 808.3\text{ Mbps}$

## Part 2: Error Correction

In this module, you learned that some communication protocols implement error correction, which is a mechanism that both detects and corrects errors that occur between the sender and receiver of a message. You also learned that one common method of error correction is automatic repeat request (ARQ), in which the sender and receiver detect potential errors in each protocol data unit (PDU) sent and retransmit them when appropriate.

In this part, you are given different scenarios for which the sender initially transmits some PDUs, and different situations occur after initial transmission. Continuous ARQ is being used with a sliding window of 3.

For each scenario, indicate a complete and numbered series of steps which describe exactly how the receiver ultimately successfully receives all transmitted PDUs. Recall that continuous ARQ is capable of retransmitting PDUs when necessary. In your steps, the sender should successfully receive acknowledgment (ACK) from the receiver for all transmitted PDUs. The final step for each scenario will thus be receipt of the last ACK.

Follow the example below when giving your series of steps. If the scenario were to be “the sender transmits a single PDU without error”, the numbered of steps would be something like this:

1. Sender transmits PDU1
2. Receiver receives PDU1 and transmits an ACK
3. Sender receives the ACK

Below are the scenarios for which you should give numbered steps.

- **Scenario 1: The sender transmits only two PDUs; the first PDU is affected by an error, and the second PDU is transmitted error-free.**

1. Sender sends PDU1 and PDU2
2. Receiver receives PDU1 with errors and send NACK1. It receives PDU2 without errors and

send ACK2.

3. Sender receives NACK1 and ACK2 and resends PDU1
4. Receiver receives PDU1 without error and sends ACK1.
5. Sender receives ACK1.

- **Scenario 2: The sender transmits three PDUs without error.**

1. Sender sends PDU1, PDU2, PDU3
2. Receiver receives PDU1, PDU2, PDU3 and detects no errors.
3. Receiver sends ACK1, ACK2, ACK3
4. Sender receives ACK1, ACK2, ACK3

- **Scenario 3: The sender transmits a single PDU without error, but the PDU is lost before it arrives at the receiver.**

1. Sender sends PDU.
2. PDU lost.
3. After timeout, sender resends PDU.
4. Receiver receives PDU without error.
5. Receiver sends ACK.
6. Sender receives ACK.

- **Scenario 4: Four PDUs are transmitted by the sender without error. However, the acknowledgment (ACK) of the third PDU sent by the receiver is lost before it arrives at the sender.**

1. Sender send PDU1, PDU2, PDU3
2. Receiver receives PDU1, PDU2, PDU3 without error and sends ACK1, ACK2, ACK3
3. ACK3 lost.
4. After timeout, Sender resends PDU3
5. Senders sends PDU4 after it receives ACK1 and ACK2. (*Because sliding window is 3*)
6. Receiver receives PDU3 (duplicate) and PDU4 and detects no errors.
7. Receiver sends ACK3, ACK4.
8. Sender receives ACK3, ACK4.

### **Part 3: Transport Protocols**

An organization has many satellite offices with Internet connections slower than the typical data speeds available on the market. The organization also employs many people that work from home. The organization has developed a streaming application that allows employees to watch videos, such as training videos, new product videos, meeting recordings, etc., that are posted by other employees. The application was written to use the TCP transport protocol.

The employees complain that the videos often stall and buffer while they are watching them. Sometimes the stalls are short, and sometimes they stall for longer periods of time. Eventually they can watch through the entire video, if they persist, but the stalls make the videos difficult to watch.

The project manager is considering what could be done to remedy these issues. Answer the following questions to help the project manager decide.

**a. What might be causing the application to exhibit the stalls the employees complain about?**

- The reasons which cause the application to exhibit the stalls is because of using a connection-oriented service via TCP protocol. This mean that before the first packet is sent, the transport layer first sands a SYN segment to establish a session (also known as the three-way handshake).
- When data is in motion from server to the client, TCP will transmit each packet and engages in many error check mechanisms, acknowledgement process. If the data sequences get corrupted, TCP will restart the connection all over again and require the server to send and receive and acknowledgment.
- So, the main reason of stalling is timeout re-transmissions.

**b. Would switching the application to UDP protocol reduce or eliminate these stalls? Explain your answer.**

- Yes. It would reduce or eliminate stalls if application is switched to UDP protocol. Because UDP is a connectionless protocol, so it does not need an established connection to start sending packets, also no need to put packets in sequence or send and wait to receive acknowledgments.
- UPD protocol does not offer delivery/reliability or quality of service. No guaranteed packet delivery so packets are not acknowledged, and they may get lost or corrupted packet and then moves on to the next one, making it significantly more efficient.
- Because video broadcasting deals with sending large number of pixels, so if small number of pixels get loss or erroneous will not result in significantly change in the end user viewing experience.

**c. Would switching the application to UDP introduce problems that would not occur if the application stayed with TCP? Identify the problems, explain what they are, and tie them in to this scenario.**

- The first problem is reliable. UDP is unreliable, no guarantee in delivery data, UDP does not check for lost messages. TCP is more reliable; it guarantees delivery of the data so application does not have to worry.
- The second problem is that UPD does not care if packets arrive out of order at destination (in order) while TCP ensures ordering.
- In this scenario, because UDP does not guarantee on delivery data, it could result few frames could be missing or errored. Therefore, some important information might be missing in the videos or glitch in the video, audio.

**d. What inherent benefits might UDP have over TCP in relation to this video streaming scenario?**

- UDP is more efficient in terms of bandwidth, UDP does not check errors and waiting for acknowledgement.
- When the loss of a few pixel (packets) does not matter, so it is ideal for videos transmissions.
- The process is faster than TCP, because UDP does not need an established connection

to start sending packets.

- TCP cannot be used for multicast, but UDP can be multicast to multiple hosts.
- UDP overhead is small, so it improves the transmission efficiency, while TCP overhead is big.

**e. With this information in mind, would you recommend to the project manager that the application switch to UDP? Explain your reasoning.**

Yes, I would recommend to the project manager to switch to UDP to address the stalls problem because the organization already has slower internet connection than the typical data speed available in the market. The employee's watching experience will be improved even though some small information might be missing, but this can be addressed by contacting to the employee who posts the videos to get that information if they really need them. Despite its inherently unreliable of PDU, a lost packet will only skip a few frames and UDP will continues to send the subsequent data packets. However, TCP will restart connection, retransmit the data and waiting for acknowledgement if there is an error. UDP overhead is small, so it also improves the transmission efficiency

Your submission will be evaluated according to the following grading rubric.

	Grade	Qualities Demonstrated by the Assignment Submission	Grade Assigned
Content (70%) Measures the quality of the content in the assignment	A+ ➔ 100	The content demonstrates exceptional understanding of all relevant subject matter and its inter-relationships. All major relevant issues are thoroughly covered, and all content is very focused and on-topic. There is no known way to improve the content, and there are absolutely no technical or coverage errors present..	
	A ➔ 96	The content demonstrates exceptional understanding of all relevant subject matter and its inter-relationships. All major relevant issues are thoroughly covered, and all content is very focused and on-topic. At most one insignificant technical or coverage error may be present	
	A- ➔ 92	The content demonstrates deep understanding of all relevant subject matter and its inter-relationships. All major relevant issues are covered, and all content is on-topic.	
	B+ ➔ 88	The content demonstrates understanding of all relevant subject matter and its inter-relationships. Almost all major relevant issues are covered, and the content is at least reasonably on-topic.	
	B ➔ 85	The content demonstrates understanding of most relevant subject matter and its inter-relationships. Almost all major relevant issues are covered, and all content is at least reasonably on-topic.	
	B- ➔ 82	The content demonstrates moderate understanding of much relevant subject matter and its inter-relationships. There is reasonable coverage of major relevant issues, and the content is at least reasonably on-topic.	
	C+ ➔ 78	The content demonstrates some understanding of relevant subject matter and its inter-relationships. Some major relevant issues are covered, and at least some content is on-topic.	
	C ➔ 75	The content demonstrates understanding of a small portion of the relevant subject matter and its inter-relationships. Some major relevant issues are covered, and at least a small portion of the content is on-topic.	
	C- ➔ 72	The content demonstrates little understanding of and insight into the relevant subject matter and its inter-relationships. A small portion of the major relevant issues are covered. The focus of the content may be off topic or on insubstantial or secondary topics	
	D ➔ 67	The content demonstrates almost no understanding of or insight into the relevant subject matter and its inter-relationships. Almost none of the major relevant issues are covered, and the content may be almost entirely off-topic.	
	F ➔ 0	The content demonstrates no understanding of or insight into the relevant subject matter and its inter-relationships. No major relevant issues are covered, and the content is entirely off-topic.	
Exposition (30%) Measures how well the content is expressed	A+ ➔ 100	The presentation of all ideas and designs is exceptionally clear and persuasive; the entire submission is exceptionally organized. There is no known way to improve the clarity or organization of the submission.	
	A ➔ 96	The presentation of all ideas and designs is exceptionally clear and persuasive; the entire submission is exceptionally organized. There may be at most one insignificant way to improve the clarity or organization of the submission.	
	A- ➔ 92	The presentation of all ideas and designs is very clear and persuasive; the entire submission is very organized.	
	B+ ➔ 88	The presentation of all ideas and designs is clear and persuasive; the entire submission is organized.	
	B ➔ 85	The presentation of most ideas and designs is clear and persuasive; most of the submission is organized.	
	B- ➔ 82	The presentation of most ideas and designs is generally clear; most of the submission is reasonably organized.	
	C+ ➔ 78	Some parts of the submission are hard to understand; some parts are disorganized.	
	C ➔ 75	About half of the submission is hard to understand; about half is disorganized.	
	C- ➔ 72	Most parts of the submission are hard to understand; most parts are disorganized.	
	D ➔ 67	Almost all of the submission is hard to understand and disorganized.	
	F ➔ 0	The entire submission is hard to understand and disorganized.	
Overall Assignment Grade:			

Use the **Ask the Facilitators Discussion Board** if you have any questions regarding how to approach this assignment.

Save your assignment as ***lastnameFirstname\_assignment2.doc*** and submit it in the *Assignments* section of the course.

For help uploading files please refer to the *Technical Support* page in the syllabus.