Sample Solution for Exercise Communication Networks I

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General Remarks

Welcome to the exercise for Communication Networks I. Please adhere to the following general remarks regarding the organization of the exercise during this summer term.

- One week before the tutorial, a new exercise will be published at the Exercise area of the KN1 Moodle (`https://moodle.tu-darmstadt.de/course/view.php?id=5268`)
- The exercise serves as your hands-on experience in addition to the lecture and as a preparation for the exam
- The questions in the exercise can be discussed at the tutorial date
- The sample solution for the exercise is available at the Exercise area of KN1 Moodle in addition to the corresponding tutorial. Nevertheless, we encourage students to try to solve the exercise themselves before the tutorial date without looking into the solution as a good practice to understand the subject of the lecture

Problem 1 - Multiple Choice

a) Which data entity does the network layer deal with?

A) Frame
B) Byte
C) Packet
D) NLDDU
E) Bit

Solution: Answer C

b) Which of the following statements is true?

I) In a packet switched connection each datagram holds the address of the destination.
II) In a circuit switched connection each datagram holds the address of the destination.
III) In a virtual circuit each datagram holds the address of the destination.

A) Only I
B) I and II
C) I, II and III
D) Only II
E) II and III

Solution: Answer A

c) Which of the following is not a type of switching?

A) Router Switching
B) Circuit switching
C) Message switching
D) Packet switching
E) Switching by virtual circuit

Solution: Answer A

d) Which of the following statements is false?

I) Connectionless services have more overhead than connection-oriented services
II) It is easier to implement flow control in connection-oriented services than in connectionless services
III) Internet Protocol IP is a connection-oriented protocol
IV) Transmission Control Protocol TCP is a connectionless protocol

A) Only I
B) I and II
C) I, II and III
D) Only II
E) I, III and IV

Solution: Answer E

Problem 2 - Switching, Connectionless and Connection-oriented Services

a) Briefly explain the four types of switching. Why is message switching not recommended at all?

Solution:

- Circuit switching: switching a physical connection
- Message switching: message is stored and passed on by one hop
- Packet switching: store-and-forward, but transmissions packets limited in size
- Switching by virtual circuit: packets (or cells) over a pre-defined path

Message switching is not recommended because of:

- High memory requirements at the node (switching centers),
  - because message may be of any size
  - usually stored on secondary repository (hard disk)
- node may be used to its full capacity over a longer period of time by one message,
  - i. e. better if packets are of limited size (packet switching)

b) Briefly compare connection oriented to connectionless services. Give an application scenario for each one of them.

Solution:

- Connection oriented
  - error free communication channel
  - usually error control: L3 (or network)
    - flow control, ...
  - usually duplex communication
  - more favorable for real-time communications
  - telephone and telecommunication companies:
    - X.25, ATM, in mobile systems
  - Example: In mobile voice communications where a certain amount of bandwidth should be guaranteed for each user, a connection-oriented approach is used.
- Connectionless
  - unreliable communication
    - hardly any error control: left to L4 or higher layers
  - maintaining sequence not ensured, ...
  - simplex communication
  - more favorable for simple data communication:
    - SEND-PACKET, RECEIVE-PACKET
  - Internet community: IP
  - Example: Video streaming can be realized as a connectionless service where losing a number of packets does not affects the whole stream and does not make it impossible to view the stream at the receiver side.

c) What is the main difference between circuit switching and virtual circuit switching?

Solution: Virtual circuit switching is still a packet-switching technology. No physical connection is actually reserved in virtual circuit switching but only a logical path where the traffic has to pass through certain nodes. In circuit switching, a physical communication line is reserved for the whole connection duration like in classical telephony service.

d) What is the difference between full-duplex, half-duplex and simplex operations? Why is a duplex connection required in the context of connection-oriented services?

Solution:

- Full-duplex: Communications in both directions from the sender to the receiver and the other way around are possible at the same time.
- Half-duplex: Communications in both directions from the sender to the receiver and the other way around are possible but not at the same time.
- Simplex: Communication in only one direction from the sender to the receiver is possible.

Connection-oriented services are based on the fact that the receiver can also communicate with the sender for the purpose of quality of service negotiation. Therefore a two-way connection needs to be established between the sender and the receiver which mains a duplex connection.

e) User Datagram Protocol UDP is an L4 connectionless transmission protocol. Give an application scenario where UDP is used as a transmission protocol.

Solution: Video Streaming

Problem 3 - Congestion Avoidance

a) What is the meaning of the word "isarithmic" in the context of isarithmic congestion control? Explain it based on the operations of isarithmic congestion control.

Solution: Isarithmic means constant. The name refers to the fact that the number of permits in the network is limited and **CONSTANT**

b) For congestion control, the algorithms Leaky Bucket and Token Bucket are used.

I) Classify these algorithms within the methods of congestion control.

Solution: Avoindace of congestions (vs. adjustment) and herewith traffic shaping (vs. e.g. buffer reservation)

II) Briefly state the difference between the two algorithms. Which one is better suited for Internet as we have it today?

Solution: Leaky Bucket does not allow a burst larger than the maximal data rate. When using Token Bucket, the Sender can accumulate tokens and send at a very high rate for a short time. The network must be able to deal with this bursts, which might cause congestion control problems. Therefore the Token Bucket must have the maximum filling quantity. Leaky Bucket relieves the network from the burden to manage bursts at the cost that bursts are delayed.

c) Does the isarithmic congestion control approach avoid congestion completely? Explain why?

Solution: No it does not. Due to the changing topology it is impossible to equally distribute the permits. Furthermore, since computers crash often, permits might get lost. Another example where isarithmic congestion control fails is when the congestion occurs at one node which happens when quite a large number of nodes tries to transmit packets to this single node. Congestion at one node can not be handled by isarithmic congestion control.

d) The network connection of a computer to a 10 Mbit/s network is regulated by a Token Bucket algorithm. The bucket is filled with a rate of 1 Mbit/s and initialized with tokens for 9 Mbit. How long can the computer send with the full rate of 10 Mbit/s?

Solution: Equation: Capacity / (network speed - filling speed)
$9/(10-1) = 1sec$

Problem 4 - Congestion Control – Reaction and Correction

a) Why is it critical to drop an acknowledgement packet?

Solution: In the connection-oriented approach when a node sends a packet, it keeps this packet stored in its outgoing buffer until it receives an ACK for it. When we drop an ACK packet, the node will have to maintain the packet acknowledged by this ACK and then retransmit it after a time-out which affects the network performance.

b) Why is the Content-related packet dropping not recommended?

Solution: Because it contradicts with the privacy principle. In order to drop packets based on their content, the router has to inspect the content which is not acceptable by the users.

c) How could an end system be disadvantaged in the context of Choke Packets algorithm?

Solution: The sender is not obliged to cope with the choke packets of the receiver. This means the sender might or might not reduce its transmission rate. When one sender responds to choke packets by reducing its transmission rate and some other senders do not, then this sender will be disadvantaged.

d) Why is a duplex connection with a connection-oriented service a prerequisite for Random Early Detection (RED)?

Solution: In RED, one router or intermediate system can mark a packet passing through it to warn against congestion. When the receiver gets this packet, it should be able to inform the sender that this packet has been marked by a router which implies a possible congestion in the network. Therefore, a duplex connection is required between the sender and the receiver.

e) Internet is based on a best effort service. Explain why is it called best effort and give a reason why it is realized this way?

Solution: Internet is a best effort service because it is based on IP protocol which is a connectionless protocol and which does not provide any guarantee with regard to the data transmission. It is implemented this way because it is very complicated to provide quality of service guarantees to millions of nodes which might lead to a scalability problem. Moreover, the Internet as a best effort service seems to be providing quite a good quality of service which explains why there was no strong attempt to change this best-effort approach.