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Study Guides on Computer Networks and Distributed Systems

UDP and TCP transport protocols

Motivation

SD study guides contain diverse resources for your preparing this course such as proposed and solved exercises, illustrating examples and recommendations for study. I recommend that you work them in synchrony with the course, that way, you will not be swamped with too much material to prepare as the term exam date approaches. At specific times in the semester, I will request that you submit specific questions contained in these study guides, which entails your keeping a record of your solutions.

I encourage you to produce your own outline of each lesson, particularly by examining sections of the textbook other than those explicitly explained. As to specific concepts that you might find difficult to grasp, I recommend that you consider Cal Newport advice, which he provides in his book *How to become a straight-A student*:

"The most effective way to imprint a concept is to first review it and then try to explain it, unaided, in your own words. If you can close your eyes and articulate an argument from scratch, or stare at a blank sheet of paper and reproduce a solution without a mistake, then you have fully imprinted the concept"

Basic References

This section contains a listing of recommended resources you can consult to solve the questions and exercises. Note that in this course about Distributed Systems we use two essential textbooks: Computer Networks (Peterson & Davie) and Distributed Systems (Coulouris, Dollimore, Kindberg, etc). You can find both textbooks in the School Library, however, I recommend that you get the pdf document to each one, since they will allow you to carry out your searches and, if necessary, you can print them out. In this Study Guide we used only the textbook by P&D alongside with my PPT lecture presentation:

- Chapter 5 of Computer Networks by Peterson & Davie, Ed. 5
- PPT Presentations
    - UDP & TCP Protocol
        - http://paloalto.unileon.es/ds/Lec/BasicTCP-1.pdf
        - http://paloalto.unileon.es/ds/Lec/BasicTCP-2.pdf
- Commented past exams at paloalto.unileon.es/ds

Questionnaire

1. The Internet is a great communication and collaboration medium, its capabilities are impressive; however, looking at it with a sufficient level of detail, we discover that the services it provides result somewhat imperfect and must be complemented by the intervening hosts so that the application programs running in those hosts offer some guarantees to their users. Explain the IP Service Model, also known as *Best Effort Model*, which constitutes a brief summary of the raw Internet capabilities and shortcomings.

2. Explain the purpose of Transport Protocols. Transport protocols belong to OSI architecture layer 4 and have specific missions to accomplish, which are completely different than those of the other OSI layers, then, recall those layers and their main functions and highlight the Transport Protocols.

3. The UDP protocol is one of the constituent protocols of the TCP/IP architecture

    a. Which TCP/IP layer does UDP reside on?

    b. Why is UDP known as the *simple* multiplexer? Consequently, is there a *complex* multiplexer?

    c. What UDP fields constitute its multiplexing key?

    d. What RFC number specifies the UDP protocol?

4. What is the protocol number assigned to UDP in an IP packet's multiplexing key?

5. Explain why UDP offers a non-reliable service

6. Briefly comment on the correctness of this statement: *UDP's demux key is comprised of the Source and Destination ports.*

7. List the fields of a UDP Datagram that constitute its multiplexing key.

8. Briefly discuss the following statement: The DNS protocol (Domain Name System) can be run over UDP or TCP, depending on specific technical circumstances, this is due to the fact that UDP is not reliable, i.e., when reliability is needed, DNS will use TCP.

9. For broadcast communications on a single network, which protocol would you use, UDP or TCP?

10. What does UDP communicate, computers, networks, internet hosts or processes running in those hosts? Explain your answer.

11. Same question as the preceding one, but, this time we want to consider TCP.

12. What is the protocol number assigned to TCP in an IP packet's multiplexing key?

13. List the three main functions of TCP

14. A TCP segment uses a multiplexing key, list its fields and comment whether all those fields span other protocol units (The IP packet that encapsulates the TCP segment). Note the radical differences between demultiplexing TCP segments' payloads and UDP datagrams'.

15. What does "stream service" mean when applied to TCP?

16. List the segments exchanged by a TCP client and a TCP server when they establish a TCP connection (3-way handshake); in each of the segments, highlight the flags that are activated alongside with their meaning. Also, highlight an essential TCP options set in the segments interchanged.

17. Continuing with TCP's 3-way handshake, do the Initial Sequence Numbers set by each of the two parties (The client and the server) have to be the same integer?

18. A TCP Client (C) runs in a host located at 8 hops from a Server with which it has established a TCP connection. C is connected to the network by Wi-Fi NIC transmitting at 54 Mbps and the average Rtt is 71 ms. Calculate the 2BD product (Bandwidth x Delay). Later, we'll build upon this example an illustration of the significance of the 2BD product in TCP connections.

19. Is TCP a secure communication protocol?

20. Is it true that there are two types of TCP segments: Data Segments and Control Segments?

21. What's the *technical term* used to refer to the fact that TCP segments contain data sent in a direction (A->B) alongside with acknowledgements to data received in the other direction (B->A). Beyond recalling the term just requested, it's important that you successfully grasp the concept.

22. A new TCP segment has been received by TCP, explain how the receiving process is identified so that it can effectively read the segment's payload?

23. When does a TCP module send a segment that has the SYN flag set?

24. When does a TCP module send a segment that has the ACK flag set?

25. TCP receives a segment with ACK set and the ACK number field contains 1000. Explain what interpretation should the receiver apply to that segment ACK fields.

26. An IP packet arrives at host A whose protocol field contains 4, when its payload is deencapsulated, which protocol module is it delivered to?

27. Host A's TCP module receives a segment which Src Port field contains 15882 and which Dst Port field contains 80: explain how TCP is able to make the decision regarding what is the final destination for the payload contained within this segment.

28. What can we state that TCP connects: computers, networks, internet hosts or processes running in these hosts?

29. "ACKs are a special type of TCP segment totally separated from data segments", explain whether this statement is correct or not.

30. A process writes a block of 10 bytes on an open Java Socket, how many of these bytes will be immediately

transmitted over the underlying TCP connection in a single segment? We are not seeking an exhaustive answer to this question, your comments will suffice.

31. [Español, Pregunta de examen] El host de un extremo de una conexión TCP envía un segment con el flag ACK activado y con ACK number = 10000 ¿**Cuál** de las siguientes opciones es la caracterización más apropiada de la conexión TCP?
    - El último segmento recibido por el host contenía datos hasta el número de secuencia 9999 inclusive
    - El host ha recibido segmentos hasta el número de secuencia 10000 y el siguiente número de secuencia esperado es el 10001
    - El ultimo segmento recibido por el host tenía un número de secuencia 9999
    - El ultimo segmento recibido por el host contenía datos hasta el número de secuencia 9999 inclusive y el siguiente número de secuencia esperado es el 10000
    - El ultimo segmento recibido por el host incluía datos hasta el número de secuencia 10000 inclusive

Comentarios: En este tipo de pregunta tendréis que elegir la mejor de las opciones ofrecidas, esto significa que puede haber otras opciones correctas aparte de la major, pero, se os pide que decidáis, de acuerdo con vuestros conocimientos y vuestro criterio cuál es la mejor. La pregunta se evalúa con un esquema pasa/no-pasa, es decir, recibís la puntuación completa de la pregunta, cualquiera que ésta sea, o bien, recibís 0 puntos; en ningún caso esta pregunta resta.

32. A TCP transmitter receives 3 duplicate ACKs for some ACK number, what should the transmitter do now?

33. "*ACKs are a special type of TCP segment totally separated from data segments*", explain whether this statement is correct or not.

34. Every time TCP receives a new segment it reacts by sending an ACK corresponding to it. Please, comment the preceding statement according to the explanation we provided on the lecture.

35. Use the result obtained in exercise no. 18 above to explain the significance of the 2BD product in TCP connections.

36. Estimate the value of the 2BD product (Bandwidth x RTT) of a Gigabit Ethernet (Gbe) network with RTT=0,6 ms?

37. In a Gbe network, a TCP connection is established between two hosts. Calculate a reasonable value for the TCP's sliding window size. Discuss whether that value for the sliding window size can be represented in TCP's segment WS field and how this can be solved.

38. Use Wireshark to determine the AWS value of a few TCP connections over a Gbe network like that in the preceding question (You may want to use Lab B6's Gbe LAN). Test with different TCP/IP stacks: Linux, BSD, Windows, etc.

39. What does a TCP sender do to know what size of the Flow Control window it can use when transmitting segments to the other party of the TCP connection?

40. Read textbook section 5.2.5 *Triggering Transmission,* then, explain what timer is referred to in the closing lines of this section where it speaks about the push operation.

41. How many simultaneous TCP connections can a web server have? We do not want an exhaustive calculation but a simple estimation and discussion of the involved factors.

42. A new TCP segment has been received by TCP, explain how the receiving process is identified so that it can actually read the segment's payload?

43. What's the fundamental difference between Slow Start and Congestion Avoidance?

44. What *network element* informs a TCP sender that there is congestion and that, consequently, the Congestion Window must be closed?

45. What is a network power curve, what does it represent?

46. What situations cause a TCP sender to enter Slow Start? Is Fast Retransmit one of them?

47. An IP packet arrives at host A whose protocol field contains 4, when its payload is deencapsulated, which protocol module is it delivered to?

48. Host A's TCP module receives a segment which Src Port field contains 15882 and which Dst Port field contains 80: explain how TCP makes the decision regarding which is the final destination for the payload contained within this segment?

49. Two hosts, A and B, have an active TCP connection. Tell in which TCP state is each host if none of the two has closed the connection yet. Consult the TCP state diagram in the textbook.

50. For each of the following events happening during the evolution of a TCP connection, mark its corresponding TCP state transition on the State Diagram (You can find it on the last slide of the BasicTCP-1.pdf at paloalto.unileon.es or in the Textbook by P&D).

    a. Welcome socket is created
    b. Active open by the client
    c. Bidirectional data transfer is taking place, now (Mark a state, not a transition, in this case)
    d. Server affirmatively responds to client's active open
    e. Server starts shutdown
    f. Client sends active open to server, which hasn't created a Welcome Socket

51. Host A carries out a TCP active open. Explain how an active open is executed in Java and in C with Berkeley Sockets.

52. Same as preceding question, this time we ask you about a passive open.

53. Is it possible to implement a distributed system based on the C/S model, using the UDP protocol?

54. Explain the meaning of acronyms Rtt and RTO in the context of the TCP protocol.

55. The present value of SRTT in a TCP connection (In the direction A -> B) is 100ms. What time length will TCP

program the RTO with?

56. Explain the Nagle algorithm.

57. The transmission buffer of a TCP connection (A FIFO) at a host has the following *blocks* of bytes to transmit:
    First: 10 bytes
    Second: 1 MSS
    Third: 1 MSS
    Comment how TCP deals with this situation and what's going to happen next.

58. Assume a TCP connection has an SRTT value of 100ms in the direction from host A to host B. The next three samples of of the Rtt are the following: {250, 95, 110}. Calculate the resulting SRTT and the value of the RTO if the Karn-Partridge statistics is used.
