Universidad de León
Ingeniería en Electrónica Industrial y Automática
Course on Industry Telecoms

Homework No. 1 (HW_1)

Submission via the agora virtual campus

--- Study Guide ---

1. At all times, have the textbook by P&D at hand. Most of the material that we have taught so far belongs in book chapters 1 and 2. Find the book, here:

   https://github.com/SystemsApproach/book/releases/download/v6.1/book.pdf

2. A key resource as you study the lessons contained in the assigned presentations is the Questionnaires, which you can find at the following link under section titled "Questionnaires, study guides and homework":

   http://paloalto.unileon.es/it/

3. Check out the Questionnaires that are to be solved this week and which are listed in the deliverables section, below. By this time, all the course topics needed for these questionnaires have been taught in the Lectures or proposed for self-study. Try to resolve the relevant exercises on your own; only after working your solutions is it acceptable to consult the solutions published in paloatlo.unileon.es/cn. I may ask you to submit your personal solution to some exercise from some Q in which case I expect that you add some value to the solution already published by me.

4. If you need assistance, contact me via the email given above or on the class forum (chat). Send me your comments and suggestions for improving the course.

Homework HW_1

Exercises about presentation for Chapter 2

http://paloalto.unileon.es/it/lect/TEL-Ch2-2018.pdf

*This section **is** to be included in your homework submission. These exercises will be assessed and will count to your Term 1 supplementary grade (Not toward the pass grade). You must submit your original work via the agora and cite sources in case you used some.*

1. Name the types of networking equipment you can recall from the lectures and the lab sessions

2. Regarding the concept of value of a network (Metcalf's Law), what role do you think scalability plays in this context?

3. The network architectures relevant to this course (CN), are they organized into layers or otherwise?

4. What do you think is the most significant difference between the OSI and the Internet (TCP/IP) architectures?

5. Consult the lecture presentation mentioned above to determine what the network layer does

6. Which of the Internet applications mentioned in the lecture presentation you think is the most challenging for the network?

7. In which units is the bandwidth of your internet access specified: bits, bytes, bits per sec or bytes per sec?

8. Calculate the maximum potential connectivity of a network comprised of 10 IP routers.

9. The current scale of Internet is about 4000M of hosts1. According to the scalable connectivity slide in the presentation used in the lecture (Ch. 1, section 2), which protocol is responsible for this huge scale? Explain your answer.

10. How many networks result when a number of switches are connected?

11. What's the network equipment used for interconnecting networks?

12. Depict a diagram that establishes the correspondence between the layers of the OSI and the Internet (TCP/IP) Architectures

13. Beyond the fact that the OSI and TCP/IP architectures have different numbers of layers, what do you think is the most important difference between them?

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[1] According to http://www.internetlivestats.com/

14. Execute ping against an Internet host that does respond to ICMP echo messages (For example, www.cisco.com), then, start a Wireshark trace of the messages interchanged by your host and the remote host. You may want to display the ICMP messages only by specifying the following protocol name within the textbox: "icmp". After capturing a few frames, stop the trace and select any one of them and, according to the results you see on the screen, depict a protocol stack containing all the protocols involved. You have an example of real a protocol stacks on the section 2 of the presentation on chapter 1.

15. Consider the TCP/IP architecture for this question; in TCP/IP, any layer exports two interfaces, one to its upper layer and the other to its remote counterpart, what are the technical names of these two interfaces?

16. Conceptually, which TCP/IP layers are implemented in a host? And, which are implemented by a LAN switch and by an IP router? Many network devices implement all the architecture layers, but for purposes other than the core responsibility played by the device: we ask you to tell the layers implemented by a device which are necessary for fulfilling its role.

17. Explain what is multiplexing and encapsulation and what role each concept plays in the network architectures reviewed in the lectures

18. What international institution is responsible for the TPC/IP architecture (Internet Architecture)?

19. Study and solve ch.1 ex. 4.a and 4.b? Check the pdf document mentioned above about Network Performance:

    http://paloalto.unileon.es/cn/ComplNotesCN.Ch1.pdf

    and study all the exercises solved in it. We already worked 4.a and 4.b in the lectures.

20. There exist a number of PCM line encoding techniques, among them, we note the importance of NRZ, which you used in the Digital Electronics lab, however, in this course on Computer Networks, we are only interested in PCM signals such as NRZ-i and Manchester. Provide a brief explanation about why we don't use NRZ in Computer Networks.

21. Briefly explain the voltage levels used at the output of a CMOS NOT gate for representing a 0 and a 1. Observe that all CMOS NOT gates must follow these specifications, in particular, we want to note that each binary value is represented by a continuous range of voltages and that in between them, there exists a region in which no signal should remain for a long time.

22. By contrast to logic gates, line encoders (NRZi, Manchester, etc.) don't have such a stringent specification but the receiver keeps the average value of the input signals it has seen so far and decodes a 1 when the input signal's value is greater than the average voltage and 0 otherwise. What adverse effect is derived when a signal stays on the same level for a long number of bit times? What's the name of this effect?

23. Assume a 4B/5B + NRZ-I encoder for this exercise. We want to transmit the following sequence of 20 binary symbols: 0100 0000 0000 0000 0001

    a. What's the length of the longest string of bits 0 present in the sequence?

    b. What's the length of the longest string of bits 0 present in the output of the 4B/5B encoder? Is this result consistent with the 4B/5B encoder's mission?

    c. What's the length of the longest string of bits 1 present in the output of the 4B/5B encoder? Now, carry out the NRZ-I line encoding, then, count the longest string of bit times in which the signal stays on the high level and also count the longest string of bit times in which the signal stays on the low level. Contrast each of the results obtained with the results obtained in a) and in b).

    d. Assume the encoder is using a bit time $\tau = 0.1\mu s$. Calculate the transmitting clock frequency corresponding to this value of τ.

    e. Estimate the sampling clock derived by the receiver by calculating the average distance between signal level changes.

24. Assume, now a Manchester encoder:
    a. Encode the same bit sequence used in the preceding exercise

    b. Assume the encoder is using a bit time $\tau=0.1\mu s$. Calculate the transmitting clock frequency corresponding to this value of τ.

    c. Estimate the sampling clock derived by the receiver by calculating the average distance between signal level changes.

25. Which Internet Architecture layer is this chapter focused on? Briefly list the functions of this layer and the name and the structure of its PDU (Protocol Data Unit) in the case of the Ethernet technology.

26. Observe the network diagram of slide no. 6 of presentation http://paloalto.unileon.es/cn/lect/CN-Ch1-2018-Section4.pdf, then, respond to the following questions related to it:

    a. Is the physical layer implemented in all the network elements?

Explain why it is

b. Switches have no IP, try to justify this on the basis of the board discussions we held in the labs as we were evolving the lab practicals

c. Why do routers have IP?

d. Try to justify the great variety of link layer protocols that appear on the net diagram

27. We can digitize the variables that represent a real-world process like the surrounding sound by turning time, which is considered continuous, into a discrete variable, then, at each discrete-time value we must quantize the sound which consists of assigning the correct discrete value to its sound power (Air pressure). Nyquist established an important result known as the Nyquist rate or criterion:

    a. We want to find out whether Nyquist rate applies to the discretization process (continuous time to discrete time) or the quantization process (Continuous air-pressure to discrete air-pressure)

    b. Is the Nyquist rate a sufficient condition or a necessary condition for obtaining the original signal from the digitized samples?

    c. We are digitizing music at a 8Ksamples/sec, then, when converting the samples back into real sound, what will that sound bandwidth be?

28. Over a communication channel, can we transmit at a speed as high as we wish? Carefully discuss this question according to Shannon-Hartley theorem.

29. Compute the Shannon capacity of a channel with a 2MHz bandwidth whose SNR=500. In order to increase the channel capacity in this case, you can choose to double either the bandwidth or the SNR: which one would you choose? Explain why.

30. Calculate the even, 1's parity of each of the following two 7-bit blocks: 110 0100, 1100 000 (Slide no. 77)

31. Assume a datalink protocol that uses bidimensional parity in which each 7-bit block is appended one bit of horizontal parity and, for each 6-byte block a 1-byte vertical parity is computed (The same scheme employed in the textbook example at slide no. 78). The data which bidimensional parity is to be calculated are the following:

Calculate the parity bit of each of the preceding six 7-bit blocks and, finally, calculate the vertical parity byte.

32. Solve the CRC calculation of the example in pg. 101 and 102 of the textbook, which is also explained in slide 92 and on. Checkpoint yourselves as you compute each row by checking you obtain the correct result per the table in slide 95.

33. A layer-2 protocol uses the CRC generator following polynomial: $C(x)=1+x+x^3$. We want to transmit the message $M(x)=x^3+x^2+1$.

34. Respond to the following questions derived from the lecture given on Error Detection:

    a. Check that Manchester encoding is derived from computing (Clock XOR DataBit) at each bit time

    b. Do an example about HDLC's transparency mechanism which name is *bit-stuffing*

    c. Identify the ASCII table section dedicated to representing the control characters such as ESC (Escape), XON, XOFF, DC1, DLE, etc.

35. What is the essential difference between a bit-oriented protocol and a byte-oriented one? State the difference in a precise manner.

36. HDLC is bit-oriented protocol that uses the following sentinel whose name is *flag:* 01111110. The flag marks the start of a new HDLC frame and is also used to mark the end a the frame, much in the style of the quotation mark used for the start and the end of constant string in the C language. Ethernet is also a bit-oriented protocol since it allows a payload of any size, not necessarily a multiple of 8 (One byte). Let's recall the structure of an Ethernet frame (Consult slide no. 64 in the presentation mentioned above):

    [Preamble][Dest MAC][Src MAC][Ethertype][PAYLOAD][CRC]

    The preamble is a 64-bit pattern much like HDLC's flag, but longer; the preamble is the Ethernet's sentinel that marks the start of a new frame.

    a. What field in the Ethernet frame constitutes the sentinel marking its end?

    b. If you can't identify the end of frame sentinel in the Ethernet frame, can you speculate how the receiver discovers the end of the received frame?

37. Explain the transparency mechanism at use in the HDLC protocol

38. One of the stations that comprise an HDLC point-to-point link wishes to transmit the bit-string 10111011011111010101010 to the station on the other end. Explain what the transmitter sends on the line and what the receiver's behavior is.

39. Explain the transparency mechanism at use in the BiSync protocol

40. One of the stations that comprise a BiSync link wishes to send the following Byte-string (Each bracket space contains a Byte): [H][E] [L] [L] [O][ETX][!][SYN]. Explain what the transmitter sends on the line and the receiver's behavior is.

For all the following questions, assume an original Ethernet System network (Shared media Ethernet)

41. How many communications can take place in an shared-medium Ethernet? Consequently, is it half-duplex, or full-duplex or simplex?

42. What are the three types of Ethernet addresses? Explain the purpose of each one.

43. Explain Ethernet's access algorithm (CSMA/CD) in your own words:
    a. CS
    b. MA
    c. CD

44. What's the minimum length of an Ethernet frame? Why is it necessary that a minimum frame length be specified?

45. How long is Ethernet's IFG?

46. What negative effect happens if an Ethernet transmitter sends a frame length that is shorter than 512 bits?

47. Explain the responsibilities of the Transceiver and the NIC in the Ethernet technology. Which one is responsible for computing Ethernet's CRC-32?

48. What does Shared Link mean in the context of the Ethernet system? Then, what does Switched Ethernet mean?

49. What is the Rtt of a maximally shared-medium Ethernet (2500m)?

50. The transmission speed of the original Ethernet system is 10Mbps. Calculate how many bits fit the Rtt of a maximally-configured Ethernet.

51. Assume a number of hosts (H1, H2,…) are connected to an original Ethernet; host H1 transmits a frame and wishes to prevent other hosts from receiving the frame. Is this possible? Make some suggestion.

52. What topology is implemented by the network based on coaxial cable used in 10BASE-2 and 10BASE-5? What is the topology used in 10BASE-T? What's is the acronym that represents the access protocol in the three cases?

53. Ethernet's datalink frame structure is explained in slide no. 64, then, what's the minimum size of the payload field that honors that complies with Ethernet's *minimum frame size*? In other words, considering the other fields's sizes <u>except the preamble</u>, what's the resulting **minimum size of the Ethernet frame**? Is there also a maximum Ethernet frame's size? (Updated 4th-june-2019)

54. Does there exist an Ethernet MAC address that represents all the hosts belonging to one network? What's the bit pattern of that special MAC address? What's its name?

55. What's the sentinel that marks the *end of frame* in the Ethernet system?

56. Host H1 in an Ethernet has a number of frames to transmit. Assume no other hosts on the same network want to transmit for the time being, only H1 wants to transmit a frame now, therefore no carrier will be present in the medium when H1 checks CS (Carrier Sense). After H1 finishes transmitting the first of the backlog of frames it wishes to transmit the second frame: How long after the first is finished? (Skim slide no. 113).

57. The 32-bit Jamming Sequence sent by a host when it determines that a collision took place is a fixed bit pattern? Discuss this.

58. Why does the Ethernet system specify that minimum frame length is 512 bits? Consider the number of bits that fit the Rtt that you calculated above (Skim slides 120:123).

59. In slide no. 123, observe the behavior of node D, which detects a collision earlier than node B. When the collision's wavefront arrives at D (Marked as "collision detect/abort time") it makes sure a collision is taking place: recall D (a transmitter) <u>*continuously*</u> monitors the average signal power as it transmits, it convinces itself that a collision is taking place since the power associated with the yellow/red wavefront is much higher than that of the red wavefront (Its own transmitted wavefront). What does D do after the "collision detect/abort time"? Indicate where in the diagram is D's Jamming Sequence sent.

60. An institution has a maximally configured original Ethernet whose length is 2500m and needs to extend it to 3000m. Calculate the minimum Ethernet frame length that allows the access algorithm (CSMA/CD) to function correctly.

61. Explain the collision timing diagram in slide no. 52. Provide a substantial explanation that allows to check whether the idea you have about collisions is correct. We seek your writing about collisions, whether it is an accurate or simply approximate explanation.