Experimental Study. 1st Laboratory Practice

Layered architecture. Laboratory familiarization. Basic tools.

Experimental study

The experimental study of this practice consists of eight parts. In each one of them all the steps that the student must carry out are described. **If you have any questions, consult the teacher in charge of the practical session.** In the case of not completing all the parts of the experimental study, before leaving the laboratory you must perform the point **¡Error! No se encuentra el origen de la referencia.**.

(DO NOT TURN ON THE PC UNTIL INSTRUCTED BY THE TEACHER)

Part One: Power On, Restore, Boot Up, and Identify the PC

1. Turn on the PC. When starting up, a screen with a white background will be displayed with a menu titled " Menú del Aula G1.31" (or G1.33, depending on where we are). If this screen does not appear, you must notify the teacher.
2. Select the option " Restaurar Windows 7" from the menu. The restoration process takes about five minutes, so while it is running, you can take the opportunity to start reading the second part of the practice and making the points 8 and 9.
3. When the same screen with the classroom menu reappears, select the option "Iniciar sesión Windows 7
4. Wait for the Windows 7 OS to load, log in with the practice key, and then disable Windows Firewall by entering "Iniciar" > "Panel de control" > "Firewall de Windows" > "Activar o Desactivar Firewall de Windows" and checking the boxes corresponding to the two types of networks.
5. The steps of the 1 to the 4 You will have to do them in all the laboratory practices of this subject.
6. Note that your PC has an identification label on the side which, depending on the laboratory you are in, has a different format.
   The G1.31 laboratory labels are RED-X type text.
   The G1.33 laboratory labels are COM-X type text.
   Write down the identification label of your PC here.

7. If you have already made the points 8 and 9 from the second part, continue with the point 10 of the second part.

Second part: Identification of elements of the physical layer of the Internet access network

This laboratory has different characteristics than the computer classrooms that are usually used in the ETSII. On the one hand, this laboratory behaves like a computer classroom with Internet access and, on the other hand, it allows connection to an Intranet designed by the teacher, as will be seen later.

Next you will identify elements of the physical level (cables, connectors, ...) that are used by your PC to connect to the Internet access network of the University (ETSII network).

8. Look on the back of your PC for the cable that connects it to the school network and it can be yellow, green or white. Follow it from your PC and check that it ends up in a wall-mounted connector near your table. The connector is half a meter above the ground and just below there are one or two red power plugs. This connector, externally, looks like those used in fixed telephony. The cable that you have located is colloquially called a LAN cable, it measures a few meters and is terminated at both ends by two male RJ-45 connectors (similar to RJ-11, which are used in landlines). In order for your PC to start up without problems, it is important to check before starting any of the practices that this patch cord is connected to the ETSII network. Check that you are indeed connected to the ETSII network.
9. The connector where you are connected is a double, it has two connection points. Each connection point is labeled with a unique code that serves to identify this physical level element and differentiate it from the other connection points. Be careful as the label is sometimes hidden by the wall socket. Write down the code on the label of your connection point here and check that it is different from the code of the other connection point of your network jack.
10. To disconnect from your PC, you must press on a tab that has the connector on one of its sides and pull it out without using force. Now disconnect from the wall socket. Look at the LAN cable and you can see that there are 8 different metal contacts. Each of these contacts is attached to a wire that connects it to a contact in the connector at the other end. Later in the course you will learn how this physical interface works. The cable used internally in the patch cord is the same as the piece of cable without connectors provided by the teacher. What physical medium is being used in the ETSII network?

11. Reconnect your patch cord with the code noted in point 9.

12. What type of Internet access network is used in the classroom?

13. What network technology is used in this type of access?

14. According to the nomenclature seen in class, what are the classroom PCs called?

Third part: Checking the TCP / IP Internet access network configuration (ipconfig)

The ETSII network follows the Internet architecture (TCP / IP). In this architecture, an end system (PC) requires to have configured, at least, the following three network level parameters:

- Its own network-level address (IP address, specifically IPv4) that uniquely identifies it on the Internet.
- The network-level address of a border router that provides access to the Internet (in Windows is the default gateway).
- A subnet mask.

(Note: the meaning and use of these parameters will be seen later in the course):

15. The above parameters, and a few more, are part of what is known as TCP / IP configuration. The TCP / IP configuration of a PC can be entered manually or can be obtained automatically by the PC itself. If done automatically, the TCP / IP settings are generally obtained from a DHCP server using the DHCP protocol. To see how your PC is configured, follow these instructions: Right-click on the Network icon on the desktop and select the Propiedades option from the context menu. In the new window that appears, click on the **Conexión de área local** text and in the window that will appear, titled **Estado de Conexión de área local**, click the **Propiedades** button. In the new window that appears, find, at the end of a list, the **Protocolo de Internet versión 4 (TCP/IP v4)** item, select it and click on the **Propiedades** button. How is TCP / IP configured on your PC? When you finish, close all the windows that have appeared.

16. To view the TCP / IP configuration parameters of your PC, you can use the **ipconfig** command, available in most Windows OS. Open a **Command Prompt** window and run the command **ipconfig /all** in it to see all the TCP / IP settings on your PC. You can open a **Command Prompt** window by double clicking on an icon on the desktop or by using "Inicio"> "Todos los programas"> "Accesorios"> " Símbolo del sistema ". Note that the only information in the ipconfig command that we will be interested in is the **Adaptador de Ethernet Conexión de área local**, so you should not pay attention to the information for the other two adapters labeled as **Adaptador de túnel**. On the other hand, keep in mind that the ipconfig command with no options offers a summary with the most important information of the TCP/IP configuration, but that to see it all the information you need to type the ipconfig /all command.

17. What is the IPv4 address assigned to your PC? Note that the fourth number that appears in the IP address matches the number that appears on the identification label of your PC (the one you wrote down in point 5).

18. What is the subnet mask?

19. What is the IP address of your default gateway (border router)?

20. What is the IP address of the DHCP server?

21. The TCP / IP configuration obtained automatically from a server is valid for a certain period of time. The server grants us a "license" of use that expires after a time (although we can renew this "license" of use). How many hours or minutes of "license" of use does your PC have on the current TCP / IP configuration?

22. Run the **ipconfig /release** command in a **Command Prompt** window. Then, **after at least 10 seconds**, also run the **ipconfig /all** command and note what happened when you "released" the configuration. Write down the current value of the three basic parameters of your TCP / IP configuration. The IPv4 address should start with 169.254, the subnet mask should be 255.255.0.0, and you shouldn't have a gateway. This is so because when automatic configuration is given by DHCP and having run out of IP configuration (since we have "released" the IP address assigned by the DHCP server**), the PC has automatically configured this type of special address that begins with 169.25**4 and that it is only valid to communicate with other computers on the same network. It is not possible to communicate with other networks because we do not have the default gateway configured. If in this or another practice you observe that your address begins with 169.254, you should be aware that there is some kind of problem related to the DHCP server and you should try to solve it.

23. Indicate what happens when you run the **ipconfig /renew command** (pay close attention to the three basic parameters of your TCP / IP configuration). Then also run the **ipconfig /all** command and think about what you accomplished by doing the "renew" of the configuration.

24. There is an icon in the notification area of the taskbar  which reports on the status of the Local Area Connection, sometimes changing its appearance. If you click on that icon and then click on **Abrir Centro de redes y recursos compartidos** and then Clicking on the **Conexión de área local** text, a window titled **Estado de Conexión de área local** will appear in which you can see the connection status. What is the bandwidth (R) of your connection?

25. Disconnect the LAN wire from the wall socket and observe that the icon  changes its appearance. Furthermore, if you move the mouse over the icon, a message will appear and if you click on it, you will also see a message. Take a good look at those informational messages and what the icon looks like.
26. Reconnect the LAN wire and observe that the icon  changes its appearance again. Furthermore, if you move the mouse over the icon, a message will appear and if you click on it, you will also see a message. Take a good look at those informational messages and what the icon looks like.
27. Is it possible to know if the cable is connected / disconnected by looking at this icon  ? This would be a physical layer function test, known as "physical layer connectivity."

Part Four: Level 3 Connectivity. Round Trip Delay (Ping)

The ping command is used to test that two computers that have the network level implemented (end systems and routers) can exchange PDUs of that level (N_PDU) between them, that is, it allows to perform a network level connectivity test. When executing this command from a source computer to a destination computer, the source sends a special N_PDU (echo request) to the destination, which when it receives it is forced to respond to the origin with another special N_PDU (echo response).

28. The ping command must be run in a Command Prompt window and requires the IP address or name of the target computer as a mandatory parameter. Ping from your PC using your border router as the destination (see point 19). By default, the Windows7 ping command sends four N_PDUs to the target computer, that is, it performs four network-level connectivity tests. The ping command shows a line of information on the screen for each of the four echo requests sent. If you have received an echo response from an echo request, the information line begins with "Response from" and then the IP of the equipment that sent us the N_PDU appears. How many responses from the border router has the ping command you just executed received?

29. Is it mandatory for a network-level peer entity to exist at the other end (destination computer) for the ping command to receive a response?

30. Does the ping command use services at some level to send the N_PDU? if so, indicate the name of the level and why.

31. Ping the computer 8.8.8.8. Notice how the information provided by the ping command when it receives the response for each of the echo requests reports the time elapsed since the sending of the N_PDU began on the source computer until the echo response R_PDU was received. Check if the four requests have received a response and if they have done so in the same time.

32. The N_PDU on its round trip goes through several intermediate nodes (routers), each of which contributes with its nodal delay to the delay shown by the ping command. What delay sources contribute to the nodal delay?

Fifth part: Identification of elements of the physical level of the laboratory intranet

The laboratory intranet, LAB_DTE, is a network that behaves the same as the Internet but in a controlled environment. We can find the same hardware elements (wired and wireless links, routers, ...) and software (protocols, network applications, ...) that we can find on the Internet. The technology used to connect to the Intranet is the same as that used in an Institutional or Business access network. Ethernet technology is used.

The laboratory's Intranet follows current regulations regarding structured cabling. It follows the correct way in which cables must be laid to install a network in a building. All of these aspects are tasks that belong to the physical level in the layered architecture. One objective of structured cabling is to centralize in one or more points of a building (interconnection cabinets) all the network electronics (devices of different levels of the OSI model that allow to perform a set of well-known

functions), which are normally mounted in a rack. The other objective is to centralize access to network cabling, so that from patch panels located in the interconnection cabinets, cables are distributed throughout the building,

On the laboratory intranet, we can see the wall sockets on the wall closest to our table. It is a surface mount double wall socket located at a height well above the edge of the table where our PC is located. Two cables run from each of the wall sockets, hidden by the horizontal channel that can be seen in the wall, to a pair of patch panels located on one of the walls of the laboratory. Note that there are two cables because the wall socket has two connection points. Near the patch panels there is a rack in which the network electronics are mounted.

Next, you are going to identify physical level elements (patch panels, wall sockets, LAN cables) that are used to connect your PC to the laboratory intranet.

33. On the wall closest to your table, higher than the edge of the table, you will find several cream-colored square wall sockets. Each wall socket is double and has two connection points, accessible from the bottom. On the front of the wall socket there are two identification labels, one for each of the two connection points. The identifier on the left label follows the format "A XX" and the identifier on the right is "B XX". Choose a square wall sockets to carry out the practice and write down the code that appears on the label on the left, in the format "A XX". As a general rule, the connection point labeled "A XX" is to be used to connect to the laboratory intranet and the connection point labeled "B XX" is used for other network electronics configuration tasks. As we have already said, hidden cables start from the wall sockets to the patch panels on the wall. A patch panel is a physical level device that allows many connection points scattered throughout the laboratory to be grouped into a single point. From an external point of view we can see "n" connection points identical to those that we can see in the wall sockets. Each patch panel connection point is known as a port and each has an identifying label identical to the one that appears at the connection point at the other end of the cable (on the wall sockets).
34. Look on the wall of the lab (entering it, on the right hand side) for the patch panels that are there. Take a good look at the port numbering. How many patch panels are there and how many ports does each have?
35. Locate in one of the patch panels the port labeled with an identifier that follows the format "A XX" and that is the same as the one you noted in the section 33.
36. You will be able to see, near the patch panels, a rack with various equipment, some of which are connected to the patch panels. Depending on which lab you are in, the equipment you will find in the rack will be different.
    In the laboratory rack G1.31 you will find a device labeled HUB_ASIA, while
    In the laboratory rack G1.33 you will find a piece of equipment labeled HUB_NORTEAMERICA.

37. Locate the HUB_ASIA or HUB_NORTEAMERICA in the rack. Note that this device has many ports on its front, similar to those on the patch panel, and some LED indicators, one for each port. The LED associated with a port will only light up if there is a cable connected to that port and, in addition, the device detects that there is connectivity at a physical level with a device located at the other end. A normal PC usually also has an LED for the same purpose, right next to the connector in which we plug the patch cord that connects us to the network. In the laboratory PCs, this functionality is implemented by the lower LED that appears to the right of the connector, in this case it only lights up in green or orange if the R is 100 Mbps or 1Gbps, when R that 10 Mbps does not light up. The HUB is a physical level device, later in the course you will learn how it works.

38. What LEDs are lit on the HUB you located in the previous section?

39. Locate in the laboratory the identification label (RED-X or COM-X format) pasted on the side of the PC that is connected to port 16 of the HUB that you located in the section 37. Make a note of the text of that label here.

Part six: Connection to the laboratory intranet

40. Disconnect your LAN cord from the wall socket (the one under the table, from the ETSII network).
41. Connect the LAN cord to the wall socket you chose in the section 33, remember to use the socket labelled “A XX”
42. Use the notification icon  to check if there is connectivity at physical layer. Explain if it is possible, under these conditions, that another computer can reply to a ping sent from your computer.
43. Ask your teacher for a new patch cord and connect one end to the patch panel. Use the same port you have chosen in section **¡Error! No se encuentra el origen de la referencia.**.
44. Connect the other end of the patch cord to any free port on HUB_ASIA or HUB_NORTEAMERICA.
45. In which ways can you verify that there is physical connectivity between your PC and the HUB in the previous section?

46. In the laboratory intranet, as well as in an Internet access network, the PCs connected require a specific TCP / IP configuration that is obtained automatically from a DHCP server. Take the appropriate steps to automatically obtain the new TCP / IP configuration of your PC (Hint: review what you did in the sections 22 and 23 to "release" and

"renew" the TCP / IP configuration). Check that the TCP / IP configuration of your PC is different from the one it had in the third part of the practice. (Let the teacher know if it does match). If a new window called “Establecer ubicación de red” (Choose a network type) pops-up, double-click on the “Red de trabajo” (work network) icon and close the window.

47. What is the bandwidth (R) of your connection now?

48. Why do you think the current bandwidth does not match that of the section 24?

Part seven[1]: Hop-by-hop delay (tracert)

Tracert is a command used to trace the path (routers) that a R_PDUs takes from a source computer to a destination computer. The tracert command is run on the source computer in a Command Prompt window. As with the ping command, the IP address of the target computer is required to run the program.

The output of the tracert command shows us a line for each of the routers in the path from source to destination. The first router (the one closest to the source computer) appears on the first line. Each line associated with a router shows the round-trip delays (in ms) of three R_PDUs that have reached that router and returned to the source computer. That is why there are three columns with numbers.

The last line is different, because it shows information from the target computer itself and not from a router.

The tracert command uses more complex techniques to obtain all this information than those used by the ping command, which we will see later in the course.

49. If your computer is labelled such as RED-X, type “tracert com-101.nam.lab” in the command prompt.
    If your computer is labelled such as COM-X, type “tracert red-10.nam.lab” in the command prompt.
    Note: com-101.nam.lab and red-10.as.lab are end systems connected to the Intranet.
    It's a good idea to run the tracert command at least twice and take a photo or screenshot of the results for future reference.

50. Look at the output of the tracert command and tell how many routers are on the path from your PC to the target machine. Make a diagram representing the two end systems and the intermediate routers as if they were connected each other using wired communications links. In the diagram you should indicate the minimum round trip delay between the originating end system and each of the routers, as well as the minimum round trip delay from the originating end system to the destination. Ask the teacher to review your diagram.

[1]If you do not have time to finish this part of the experimental study in the laboratory, you can do it at home. You only need to de a tracert directed to 8.8.8.8. If you want to check if your results are correct, you may check them with your teacher in his/her consulting hours.

51. Explain why the round-trip delays to the routers shown in the diagram in section **¡Error! No se encuentra el origen de la referencia.** increase as we move away from the origin.

52. Using the diagram that you have made in the section **¡Error! No se encuentra el origen de la referencia.**, estimate the round-trip delay between the first router and the second router, the second and the third, and so on until reaching the destination end system. Write it down in the diagram you have made in the section **¡Error! No se encuentra el origen de la referencia.**.

53. Let's assume that the most influential factor in the round-trip delay between two adjacent computers is the bandwidth of the link between them. Order the bandwidth of the links write them down in the diagram. Use R1 to indicate the lowest bandwidth and Rn the highest, where n is the number of links. Notify the teacher to review the diagram.

Part eight[2]: Using Wireshark

Wireshark is a program that can capture all the network traffic received or sent by a network interface. It means that it captures the frames or E_PDUs arriving or leaving the network interface. It is a very useful tool, because it is also capable of analysing the network traffic and show the user detailed information on the protocols of each of the layer (from the data link level to the application level). That is why it is called a protocol analyzer.

54. Double click on the icon on the desktop to start the Wireshark protocol analyzer. Figure 1 shows the initial screen that appears when Wireshark starts up and Table 1 shows a summary of the most used icons in Wireshark.

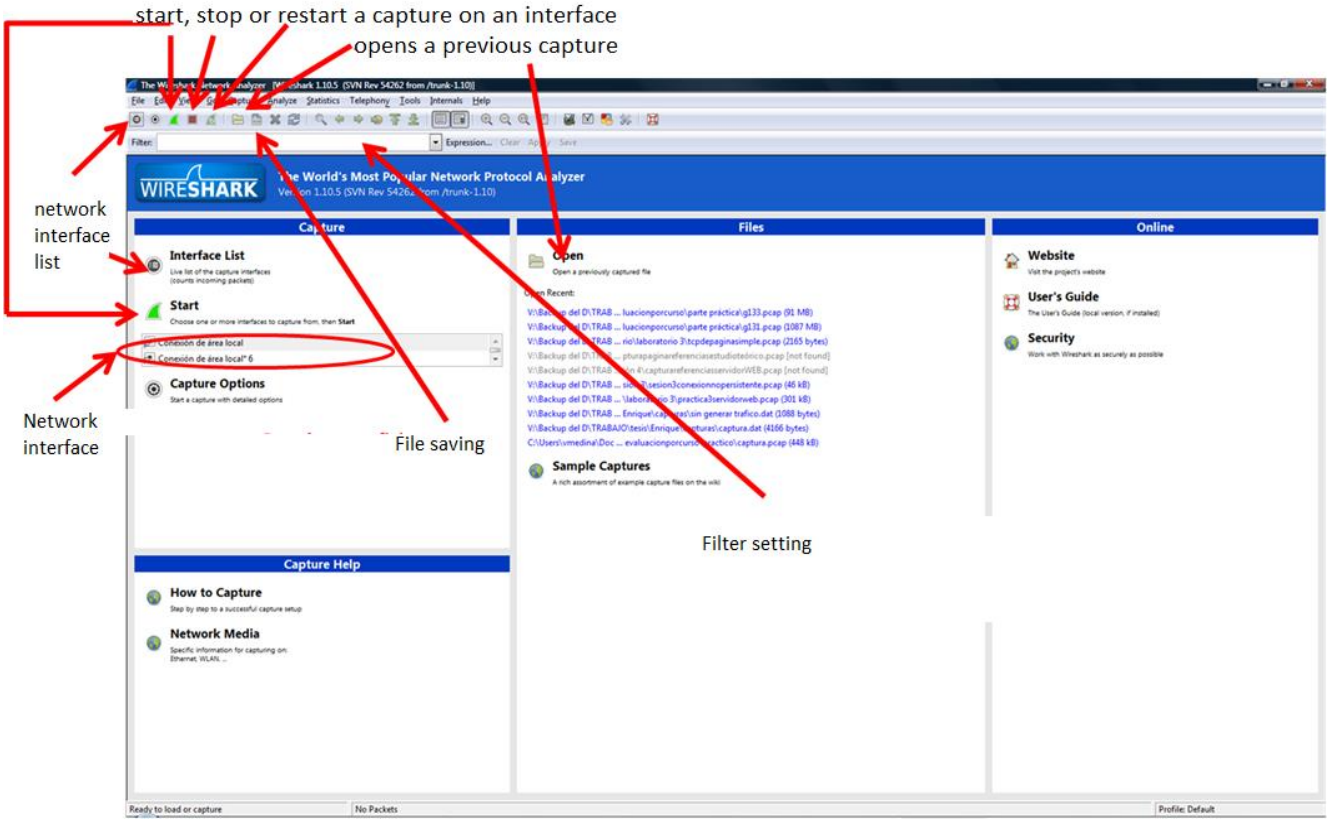

Figure 1

[2]If you do not have time to finish this part of the experimental study in the laboratory, you can do it at home. Just install Wireshark on your computer and open the following web page: http://www.dte.us.es/personal/smartin/lab3/paginasimple.html from the Internet instead of the one indicated in the experimental study. If you want to check if your results are correct, you may check them with your teacher in his/her consulting hours..

	Shows the interfaces available for capturing		Restart a capture (stop the current one and start a new one).
	Stop a capture		Start a capture
	Open a file with a previous capture		Save a file with the current capture

Table 1

55. You can start a capture in several ways. The first way is, from the initial screen of Wireshark, select (if it is not already selected), the “Conexión de área local” (Local Area Connection) and then click Start. Another way is to click on the icon that appears in the menu. And the other way is to click the icon from the menu to open a window which shows all network interfaces that can be used. Then, select the one we are looking for “Conexión de área local” (the Local Area Connection) and then press the Start button. Using whatever method you prefer, start capturing traffic. If everything has been done correctly, the frames that are currently being captured will appear in a window. Notify the teacher before continuing.

56. Open Internet Explorer or Mozilla Firefox and use the browser to access the page at http://www.redes.lab (this webpage is located on a web server in the Intranet).

57. Wait a few seconds and stop capturing by clicking on the icon. Save the capture to a file so you can take it with you when this lab session is over. To do this, click on the icon, enter the name of the file and then save. To load a previously captured file, you only need to open it by clicking on the icon and look for the location of the file.

58. A Wireshark window consist of three panels (list of frames, details of frame and hexadecimal dump of the frame).

59. In the upper panel, go through the list of frames and, using the information that appears in the "Protocol" column, look for frames that encapsulate PDUs of the protocols you discovered in the last section of the theoretical study (HTTP, DNS, TCP, UDP, and IP). Notice that if you click on the name of the column "Protocol" it will sort the list of frames by this field. Also, keep in mind that at the data-link layer all captured frames use the Ethernet protocol.

60. Click on a frame in the list of frames that encapsulates HTTP or DNS. Using the information shown in the "frame detail" panel, draw here a diagram showing, one above the other, the layers of the TCP / IP architecture that are being used. Start with the highest level and end in the data-link layer. Indicate the protocol used for each layer.

61. Close wireshark and the browser, or and any other windows that are open on your PC.
Disconnect your PC from the laboratory intranet.
Connect your PC to the Internet access network (ETSII network) at the same connection point and socket in the section 9.
Copy the capture file that you have saved in the section **¡Error! No se encuentra el origen de la referencia.**.
Turn off the PC.
Put the patch cord that you connected to HUB_ASIA or HUB_NORTEAMÉRICA back in place.
Return the piece of cable without connectors that was given to you and leave it on the teacher's desk.