

**Based on**  
**Mastering Networks - An Internet Lab Manual**  
**by Jörg Liebeherr and Magda Al Zarki**

*Adapted for*  
*'Labo Computernetwerken'*  
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## Lab 2

# Single-Segment IP Networks

What you will learn in this lab:

- How to capture and filter network traffic
- How to configure a network interface for IP networking
- How to access IP statistics and settings with the netstat command
- How ARP works
- How hackers snoop passwords from the network

## 2.1 Prelab 2

### New commands

Read the manual pages of the following commands at <http://manpages.ubuntu.com/> for the operating system version “trusty 14.04 LTS”:

- arp
- ifconfig
- netstat
- tcpdump

### IP Addresses

Read the article “Understanding IP Addressing: Everything You Ever Wanted To Know” by Chuck Semeria, at <http://holdenweb.com/static/docs/3comip.pdf>

### Wireshark capture and display filters

Go to the Wireshark website and read about capture filters and display filters for Wireshark:

- <http://wiki.wireshark.org/CaptureFilters>
- [http://www.wireshark.org/docs/wsug\\_html\\_chunked/ChWorkBuildDisplayFilterSection.html](http://www.wireshark.org/docs/wsug_html_chunked/ChWorkBuildDisplayFilterSection.html).

## Prelab Questions

### Question 1)

Write the syntax for an `ifconfig` command that sets the IP address of the interface `eth0` to 128.143.2.3/16 with broadcast address 128.143.255.255.

`ifconfig eth0 128.143.2.3 netmask 255.255.0.0 broadcast 128.143.255.255`

### Question 2)

Write the syntax of a `tcpdump` command that captures packets containing IP datagrams with source or destination IP address equal to 10.0.1.12.

`tcpdump host 10.0.1.12`

### Question 3)

Write the syntax of a `tcpdump` command that captures packets containing ICMP messages with source or destination IP address equal to 10.0.1.12.

`tcpdump icmp and host 10.0.1.12 tcpdump [expression]`

### Question 4)

Write the syntax of a `tcpdump` command that captures packets containing IP datagrams between two hosts with IP addresses 10.0.1.11 and 10.0.1.12, both on interface `eth1`.

`tcpdump -i eth1 host 10.0.1.11 and 10.0.1.12`

### Question 5)

Write a `tcpdump` filter expression that captures packets containing TCP segments with source or destination IP address equal to 10.0.1.12.

`tcp and host 10.0.1.12`

### Question 6)

Write a `tcpdump` filter expression that, in addition to the constraints in Question 5, only captures packets using port number 23.

`tcp and host 10.0.1.12 and tcp port 23`

### Question 7)

Write the syntax for a `wireshark` command with capture filter so that all IP datagrams with source or destination IP address equal to 10.0.1.12 are recorded.

`wireshark -f "host 10.0.1.12"`

### Question 8)

Write the syntax for a Wireshark display filter that shows IP datagrams with destination IP address equal to 10.0.1.50 and frame sizes greater than 400 bytes.

`ip.dst == 10.0.1.50 and frame.len > 400`

### Question 9)

Write the syntax for a Wireshark display filter that shows packets containing ICMP messages with source or destination IP address equal to 10.0.1.12 and frame numbers between 15 and 30.

`icmp and ip.host == 10.0.1.12 and frame.number >= 15 and frame.number <= 30`

### Question 10)

Write the syntax for a Wireshark display filter that shows packets containing TCP segments with source or destination IP address equal to 10.0.1.12 and using port number 23.

`ip.host == 10.0.1.12 and tcp.port == 23`

### Question 11)

Write a Wireshark capture filter expression for Question 10.

`tcp and host 10.0.1.12 and port 23`

## 2.2 Lab 2

In Lab 2 you become acquainted with IP configuration issues on a single Ethernet segment. The lab also exposes you to advanced use of `tcpdump` and Wireshark.

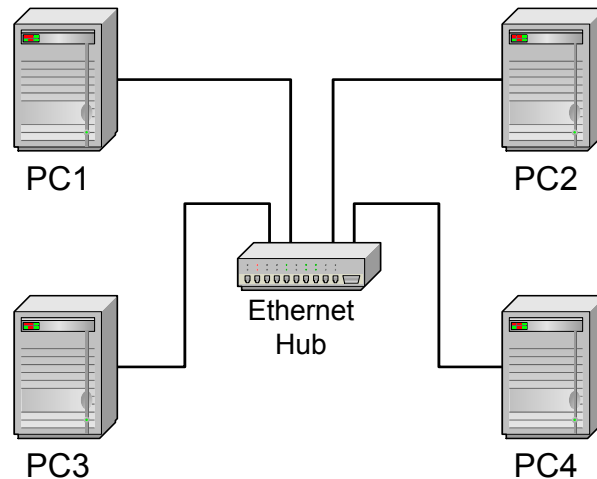


Figure 2.1: Network configuration for Lab 2.

The setup for this lab is identical as in Lab 1. All Linux PCs are connected to the same Ethernet segment by an Ethernet hub as shown in Figure 2.1. The IP addresses for the Linux PCs are configured as shown in Table 2.1 below. Configure `eth0` for each of the PCs. e.g. for PC1 use the following command.

```
PC1% ifconfig eth0 10.0.1.11 netmask 255.255.255.0 broadcast 10.0.255 up
```

As an alternative, you can use the `ip` command:

```
PC1% ip addr add 10.0.1.11/24 dev eth0
PC1% ip link set dev eth0 up
```

Linux PC	IP Addresses of Ethernet Interface eth0
PC1	10.0.1.11/24
PC2	10.0.1.12/24
PC3	10.0.1.13/24
PC3	10.0.1.14/24

Table 2.1: IPv4 addresses for Lab 2

## Part 1. Using filters in tcpdump

In the first part of the lab, you explore `tcpdump` in more detail. In particular, you learn how to write filter expressions so that `tcpdump` monitors only selected traffic flows on the network. See 2.1 for more details on the use of filters in `tcpdump`.

### Exercise 1. Writing filter expressions for tcpdump

In this exercise, you explore the use of simple filter expressions with the `tcpdump` command. Save the output for your lab report.

1. On PC1, execute a `tcpdump` command with a filter that prints all packets with PC2 as source or destination. This command is the answer to Question 2 from the Prelab. Save the output of this `tcpdump` session to a file using the `tee` or `tail` commands discussed in Lab 1.



*As in Lab 1, always use the `-n` option (i.e. `tcpdump -n`) to avoid that `tcpdump` tries to resolve hostnames.*

2. In another terminal, issue a ping command to PC2 by typing `ping -c 5 10.0.1.12` on PC1 and observe the output. Recall that the ping command to a host triggers the transmission of an ICMP Echo Request. The destination host responds with an ICMP Echo Reply message.
3. Repeat steps 1 - 2 above. In addition to the existing filter, set the filter so that only ICMP messages are captured. This command is the answer to Question 3 from the Prelab.



***Make sure to include the saved data in your lab report as they are part of your evaluation!***

## Part 2. Using filters in Wireshark

In this part of the lab, you experiment with filter expressions using the `wireshark` command. Recall that Wireshark has two types of filters: capture filters and display filters.



*There are several command line options that can be assigned when starting the `wireshark` command:*

- **Capture Filters:** A capture filter specifies the traffic to be captured by the Wireshark tool. A capture filter expression can be specified from the command line using the `-f` option or using the Wireshark GUI, under the “Capture:Start” menu. The syntax for specifying the filter expression is the same syntax as used by `tcpdump`.
- **Display Filters:** By default, Wireshark displays all captured packets. With a display filter, just those packets, which meet the requirements of the filter, are displayed. The display filter cannot be set from the command line. It must be entered in the “Filter” window at the bottom of the GUI. The syntax for setting the display filter is different from the syntax for setting a capture filter.
- **Setting an interface:** When you run Wireshark on a host with multiple network interfaces, you may specify the interface with the `-i` argument. For example, to start Wireshark to capture traffic on interface `eth1`, type

```
| wireshark -i eth1
```

If you do not specify an interface, the default is `eth0`. Alternatively, you can change the interface using the Wireshark GUI, under the “Capture:Start” menu.

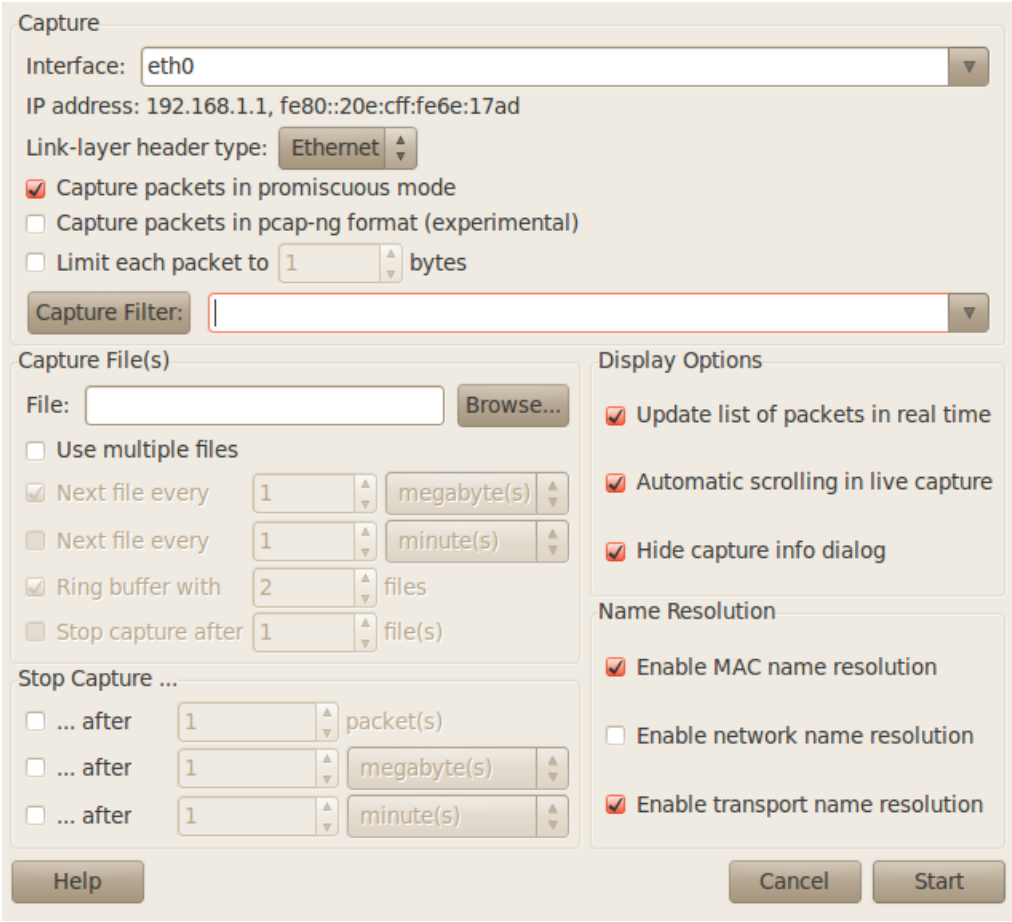
### Exercise 2-A. Setting capture filters in Wireshark

This exercise is a review of the traffic capture capabilities of Wireshark. As a new feature, you are introduced to the notion of capture filters.

1. Start Wireshark on PC1 and set the same capture preferences as in Lab 1 and as shown again in Figure 2.2 for your convenience. You should always set these same preferences for all your experiments.



**Selecting capture preferences in wireshark**



- Select *eth0* in “Interface”.
- Select “Capture packets in promiscuous mode”.
- Select “Update list of packets in real time”.
- Select “Automatic scrolling in live capture”.
- Unselect “Enable MAC name resolution”.
- Unselect “Enable network name resolution”.
- Unselect “Enable transport name resolution”.

Figure 2.2: General capture settings for Wireshark

2. Setting a capture filter: In the window “Capture Preferences”, set a filter so that all packets that contain the IP address of PC2 are recorded. The filter is set in the “Filter” box under “Capture Preferences” (see Figure 2.2). The required filter expression is the answer to Question 7 from the Prelab.
3. Start the capture by clicking “OK” in the “Capture Preferences” window.
4. In another terminal window of PC1, issue a `ping` command to PC2

```
| PC1% ping -c 2 10.0.1.12
```

5. Stop the capture process of Wireshark.
6. Save the results of the capture. This is done by selecting “Print” in the “File” menu as described in Lab 1. (As instructed in Lab 1, unless asked to save the details of captured frames, selecting the summary option is usually sufficient.)



***Make sure to include the saved data in your lab report as they are part of your evaluation!***

### Exercise 2-B. Working with display filters

Next you set display filters, which allow you to select a subset of the captured data for display in the main window of Wireshark.

1. In the Wireshark main window on PC1 from Exercise 2-A, set the display options as listed below. You can find the display options in the “Capture Options” window (select “Start” in the “Capture” menu)(see Figure 2.2):
  - Select “Update list of packets in real time”.
  - Select “Automatic Scrolling in live capture”.
  - Unselect “Enable MAC name resolution”.
  - Unselect “Enable network name resolution”.
  - Unselect “Enable transport name resolution”.
2. Setting a display filter: Type the desired display filter in the field next to the “Filter” box, which is located at the bottom of the Wireshark main window, as shown in Figure 2.3. Click the “Reset” button next to the “Filter” box to clear any existing filter:



Figure 2.3: Filter box for setting display filters.

Enter a display filter so that all IP datagrams with destination IP address 10.0.1.12 are shown. Refer to Question 8 from the Prelab.

3. Observe the changes in the display panel of Wireshark. Only packets with 10.0.1.12 in the IP destination address field are now being displayed.
4. Save the displayed data, by selecting “File:Print”. Note that the “Print” command only saves packets that are currently being displayed. If a display filter is used, the saved data is limited to the packets that match the display filter.
5. Repeat the above exercise with a display filter that lists only IP datagrams with source IP address equal to 10.0.1.12. Save the results.



***Make sure to include the saved data in your lab report as they are part of your evaluation!***

**Exercise 2-C. More complex capture and display filters**

In this exercise, you learn how to use more sophisticated filters to restrict the packets being captured and displayed.

1. Start Wireshark on PC1 and start to capture traffic using the same settings as in Exercise 2-A. Do not set any capture or display filters!

2. From a new terminal on PC1, execute the `ping` command for PC2

```
| PC1% ping -c 5 10.0.1.12
```

3. At the same time, start a Telnet session from PC1 to PC2 in another terminal by typing

```
| PC1% telnet 10.0.1.12
```

and log in as *telecomlabo*. After you logged in successfully to PC2, logout with the command `exit`.

4. Stop the traffic capture of wireshark.
5. Apply a set of display filters to the captured traffic and save the output to a text file. Select the option "Print summary" in the "Print" window.
  - Display packets that contain ICMP messages with the IP address of PC2 either in the IP destination address or IP source address. Refer to Question 9 from the Prelab. Save the output.
  - Display packets that contain TCP traffic with the IP address of PC2 either in the IP destination address or IP source address. Refer to Question 10 from the Prelab. Save the output.
  - Display packets that, in addition to the constraints in the previous filter expression, use the port number 23. Refer to Question 10 from the Prelab. Save the output.



***Make sure to include the saved data in your lab report as they are part of your evaluation!***

### Part 3. ARP - Address Resolution Protocol

This part of the lab explores the operation of the Address Resolution Protocol (ARP) which resolves a MAC address for a given IP address. The lab exercises use the Linux command `arp` for displaying and manipulating the contents of the ARP cache. The ARP cache is a table that holds entries of the form <IP address, MAC address>.



*The most common uses of the `arp` command are as follows:*

`arp -a`

*Displays the content of the ARP cache.*

`arp -d <IPAddress>`

*Deletes the entry with IP address `IPAddress`.*

`arp -s <IPAddress><MAC_Address>`

*Adds a static entry to the ARP cache which is never overwritten by network events. The MAC address is entered as a 6 hexadecimal bytes separated by colons.*

*Example: `arp -s 00:02:2D:0D:68:C1`*



#### **Time-outs in the ARP cache:**

*The entries in an ARP cache have a limited lifetime. Entries are deleted unless they are refreshed. The typical lifetime of an ARP entry is 2 minutes, but much longer lifetimes (up to 20 minutes) have been observed. You may want to verify when your Linux system does remove ARP entries automatically after a certain amount of time.*



#### **Refreshing the ARP cache:**

*In Linux, you will observe that occasionally, a host sends out ARP requests to interfaces that are already in the ARP cache. Example: Suppose that a host with IP address 10.0.1.12 has an ARP cache entry: "<10.0.1.11>is-at <00:02:83:39:2C:42>". Then, this host occasionally sends a unicast ARP Request to MAC address 00:02:83:39:2C:42 of the form "Who has 10.0.1.11? Tell 10.0.1.12" to verify that the IP address 10.0.1.11 is still present before deleting the entry from the ARP cache.*

### Exercise 3-A. A simple experiment with ARP

1. On PC1, view the ARP cache with `arp -a` and delete all entries with the `-d` option.
2. Start Wireshark on PC1 with a capture filter set to the IP address of PC2.
3. Issue a ping command from PC1 to PC2:

```
| PC1% ping -c 2 10.0.1.12
```

Observe the ARP packets in the Wireshark window. Explore the MAC addresses in the Ethernet headers of the captured packets. Direct your attention to the following fields:

- The destination MAC address of the ARP Request packets.
  - The Type field in the Ethernet headers of ARP packets and ICMP messages.
4. View the ARP cache again with the command `arp -a`. Note that ARP cache entries get refreshed/ deleted fairly quickly (approx. 2 minutes).
  5. Save the results of Wireshark to a pcap dump file.

Use the saved data to answer to the following questions:

**Question 3.A.1)**

What is the destination MAC address of an ARP Request packet?

"ff:ff:ff:ff:ff:ff" This is the broadcast MAC address, which corresponds with the working of an ARP-request. (send to everyone)

**Question 3.A.2)**

What are the different values of the Type field in the Ethernet headers that you observed?

Both ARP-request and response have 0x0806 as type value, which stands for ARP. The ping request and responses both have 0x0800 (IP) as type.

**Question 3.A.3)**

Use the captured data to discuss the process in which ARP acquires the MAC address for IP address 10.0.1.12.

The request is broadcasted through its own protocol (ARP) to all available ethernet receivers. IP is not usable as protocol as we are searching for the IP - MAC. On receipt of the request, the computer with 10.0.1.12 responds to the src mac address of the request with its own MAC address.

**Exercise 3-B. Matching IP addresses and MAC addresses**

Identify the MAC addresses of all interfaces connected to the network, and enter them in Table 2.2. You can obtain the MAC addresses from the ARP cache of each PC. You can fill up the ARP cache at a host, by issuing a ping command from that host to every other host on the network. Alternatively, you can obtain the MAC addresses from the output of the `ifconfig -a` command explained in Part 5.

Linux PC	IP Address of eth0	MAC Address of eth0
PC1	10.0.1.11/24	
PC2	10.0.1.12/24	
PC3	10.0.1.13/24	
PC3	10.0.1.14/24	

Table 2.2: IP and MAC addresses.

**Question 3.B.1)**

Include the completed Table 2.2 in your lab report.

Linux PC	IP Address of eth0	MAC Address of eth0
PC1	10.0.1.11/24	68:05:ca:36:33:a0
PC2	10.0.1.12/24	68:05:ca:36:31:f0
PC3	10.0.1.13/24	68:05:ca:36:39:c7
PC3	10.0.1.14/24	68:05:ca:36:e1:2f

Table 2.3: solutions IP and MAC addresses.

**Exercise 3-C. ARP requests for a non-existing address**

Observe what happens when an ARP Request is issued for an IP address that does not exist.

1. On PC1, start Wireshark with a capture filter set to capture packets that contain the IP address of PC1:

```
| PC1% wireshark -f 'host 10.0.1.11'
```

2. Establish a Telnet session from PC1 to 10.0.1.10 (Note that this address does not exist on this network)

```
| PC1% telnet 10.0.1.10
```

Observe the time interval and the frequency with which PC1 transmits ARP Request packets. Repeat the experiment a number of times to discover the pattern.

3. Save the captured output.

**Question 3.C.1)**

Using the saved output, describe the time interval between each ARP Request packet issued by PC1. Describe the method used by ARP to determine the time between retransmissions of an unsuccessful ARP Request. Include relevant data to support your answer.

The time interval is 1 second between requests, 6 requests are sent.

```
No. Time Source Destination Protocol Length Info 1 0.000000000 68:05:ca:36:39:c7 ff:ff:ff:ff:ff:ff
ARP 42 Who has 10.0.1.10? Tell 10.0.1.11 2 0.998636000 68:05:ca:36:39:c7 ff:ff:ff:ff:ff:ff
ARP 42 Who has 10.0.1.10? Tell 10.0.1.11 3 1.998631000 68:05:ca:36:39:c7 ff:ff:ff:ff:ff:ff
ARP 42 Who has 10.0.1.10? Tell 10.0.1.11 4 2.998653000 68:05:ca:36:39:c7 ff:ff:ff:ff:ff:ff
ARP 42 Who has 10.0.1.10? Tell 10.0.1.11 5 3.998634000 68:05:ca:36:39:c7 ff:ff:ff:ff:ff:ff
ARP 42 Who has 10.0.1.10? Tell 10.0.1.11 6 4.998629000 68:05:ca:36:39:c7 ff:ff:ff:ff:ff:ff
ARP 42 Who has 10.0.1.10? Tell 10.0.1.11
```

**Question 3.C.2)**

Why are ARP Request packets not transmitted (i.e. not encapsulated) as IP packets? Explain your answer.

Because they are used to resolve IP-addresses to their corresponding MAC-address. IP routing would not work.

## Part 4. The netstat command

The Linux command `netstat` displays information on the network configuration and activity of a Linux system, including network connections, routing tables, interface statistics, masquerade connections, and multicast memberships. The following exercise explores how to use the `netstat` command to extract different types of information about the network configuration of a host.



*The most common uses of the `netstat` command are as follows:*

`netstat -i`

*Displays a table with statistics of the currently configured network interfaces.*

`netstat -rn`

*Displays the kernel routing table. The `-n` option forces `netstat` to print the IP addresses. Without this option, `netstat` attempts to display the hostnames.*

`netstat -an; netstat -tan; netstat -uan`

*Displays the active network connections. The `-a` option displays all active network connections, the `-ta` option displays only information on TCP connections, and the `-ua` option displays only information on UDP traffic. Omitting the `-n` options prints hostnames and names of servers, instead of IP addresses and ports numbers.*

`netstat -s`

*Displays summary statistics for each protocol that is currently running on the host.*

### Exercise 4. Basic usage of the netstat command

On PC1, try the different variations of the `netstat` command listed above and save the output to a file.

1. Display information on the network interfaces by typing

```
| PC1% netstat -in
```

2. Display the content of the IP routing table by typing

```
| PC1% netstat -rn
```

3. Display information on TCP and UDP ports that are currently in use by typing

```
| PC1% netstat -a
```

4. Display the statistics of various networking protocols by typing

```
| PC1% netstat -s
```



*The values of the statistics displayed by some of the `netstat` commands are reset each time a host is rebooted.*

#### Question 4.1)

Attach the saved output to your report. Using the saved output, answer the following questions.

Kernel Interface table Iface MTU Met RX-OK RX-ERR RX-DRP RX-OVR TX-OK TX-ERR

```

TX-DRP TX-OVR Flg eth0 1500 0 52819 0 0 0 52760 0 0 0 BMRU lo 65536 0 956 0 0 0 956 0
0 0 LRU Kernel IP routing table Destination Gateway Genmask Flags MSS Window irtt Iface
10.0.1.0 0.0.0.0 255.255.255.0 U 0 0 0 eth0 Active Internet connections (servers and estab-
lished) Proto Recv-Q Send-Q Local Address Foreign Address State tcp 0 0 *:ftp *: LISTEN
tcp 0 0 *:ssh *: LISTEN tcp 0 0 localhost:ipp *: LISTEN tcp 0 0 *:telnet *: LISTEN tcp6 0 0
[:]:ssh [:]: LISTEN tcp6 0 0 ip6-localhost:ipp [:]: LISTEN tcp6 1 0 ip6-localhost:46681 ip6-
localhost:ipp CLOSE_WAIT udp00* : 60385* : *udp00* : bootpc* : *udp00* : ipp* : *udp00* :
mdns* : *udp00* : 30159* : *udp600[:]: 48348[:]: *udp600[:]: 13209[:]: *udp600[:]:
mdns[:]: *ActiveUNIXdomainsockets(serversandestablished)ProtoRefCntFlagsTypeStateI-
NodePathunix2[ACC]STREAMLISTENING14898@/tmp/.ICE-unix/2049unix2[ACC]STREAMLISTENING14898@/tmp/.ICE-unix/2049unix2[ACC]STREAMLISTENING13951/tmp/.X11-unix/X0unix2[ACC]STREAMLISTENING14637/var/run/cups/cups.sockunix2[ACC]STREAMLISTENING15435/run/user/1000/keyring-n5bKb6/pkcs11unix2[ACC]STREAMLISTENING857/var/run/dbus/system_bus_socketunix2[ACC]STREAMLISTENING10861/var/run/uml-utilities/uml_switchctlunix2[ACC]STREAMLISTENING15331@/com/ubuntu/upstart-session/112/2402unix2[ACC]STREAMLISTENING14975/run/user/1000/pulse/nativeunix2[ACC]STREAMLISTENING16545@/com/ubuntu/upstart-session/1000/2155unix2[ACC]STREAMLISTENING12830@/tmp/dbus-OAyeDpuWXbunix19[DGRAM]PGSuh9PnQTunix2[ACC]STREAMLISTENING14836/run/user/1000/keyring-n5bKb6/controlunix3[ACC]STREAMCONNECTED15730unix3[ACC]STREAMCONNECTED14601/var/run/dbus-OAyeDpuWXbunix3[ACC]STREAMCONNECTED15553unix3[ACC]STREAMCONNECTED19198@/tmp/dbus-OAyeDpuWXbunix3[ACC]STREAMCONNECTED16476unix3[ACC]STREAMCONNECTED15440@/com/ubuntu/session/1000/1934unix3[ACC]STREAMCONNECTED15157/var/run/dbus/system_bus_socketunix3[ACC]STREAMCONNECTED12962unix3[ACC]STREAMCONNECTED18989/var/run/dbus/system_bus_socketunix3[ACC]STREAMCONNECTED13000@/tmp/.ICE-unix/2049unix3[ACC]STREAMCONNECTED15547unix3[ACC]STREAMCONNECTED12945/var/run/dbus/system_bus_socketunix3[ACC]STREAMCONNECTED16459unix3[ACC]STREAMCONNECTED15676/run/user/1000/X11-unix/X0unix3[ACC]STREAMCONNECTED19261unix3[ACC]STREAMCONNECTED14803/var/run/dbus/system_bus_socketunix3[ACC]STREAMCONNECTED14870unix3[ACC]STREAMCONNECTED14361unix3[ACC]STREAMCONNECTED14849/var/run/dbus/system_bus_socketunix3[ACC]STREAMCONNECTED15516@/tmp/.X11-unix/X0unix3[ACC]STREAMCONNECTED13007unix3[ACC]STREAMCONNECTED15241@/tmp/.ICE-unix/2049unix3[ACC]STREAMCONNECTED16409unix3[ACC]STREAMCONNECTED15460unix3[ACC]STREAMCONNECTED20726@/dbus-vfs-daemon/socket-ckMYcNJwunix3[ACC]STREAMCONNECTED16540unix3[ACC]STREAMCONNECTED16426@/tmp/.X11-unix/X0unix3[ACC]STREAMCONNECTED13048unix3[ACC]STREAMCONNECTED15065unix3[ACC]STREAMCONNECTED15659unix3[ACC]STREAMCONNECTED12872/var/run/dbus/system_bus_socketunix3[ACC]STREAMCONNECTED15763unix3[ACC]STREAMCONNECTED15544@/tmp/.X11-unix/X0unix3[ACC]STREAMCONNECTED10850/var/run/dbus/system_bus_socketunix3[ACC]STREAMCONNECTED15457unix3[ACC]STREAMCONNECTED14124unix3[ACC]STREAMCONNECTED15171unix3[ACC]STREAMCONNECTED15175@/tmp/dbus-OAyeDpuWXbunix3[ACC]STREAMCONNECTED16623@/tmp/dbus-OAyeDpuWXbunix3[ACC]STREAMCONNECTED897unix3[ACC]STREAMCONNECTED13115unix3[ACC]STREAMCONNECTED15532unix3[ACC]STREAMCONNECTED12983unix3[ACC]STREAMCONNECTED15490unix3[ACC]STREAMCONNECTED11226@/com/ubuntu/session/1000/1934unix3[ACC]STREAMCONNECTED20686unix3[ACC]STREAMCONNECTED10849/var/run/dbus-OAyeDpuWXbunix2[ACC]STREAMCONNECTED21787unix3[ACC]STREAMCONNECTED12997@/tmp/.ICE-unix/2049unix3[ACC]STREAMCONNECTED25782@/tmp/.X11-unix/X0unix3[ACC]STREAMCONNECTED892unix3[ACC]STREAMCONNECTED17179unix3[ACC]STREAMCONNECTED12985unix3[ACC]STREAMCONNECTED11238unix3[ACC]STREAMCONNECTED23036@/tmp/dbus-PGSuh9PnQTunix3[ACC]STREAMCONNECTED15161/var/run/sdpunix3[ACC]STREAMCONNECTED10226/var/run/dbus/system_bus_socketunix3[DGRAM]997

```



```

v fs-daemon/socket-Ar7V7Shuunix3[]STREAMCONNECTED15167/var/run/dbus/systembus_socketun
O AyeDpuWXbunix3[]STREAMCONNECTED12485unix3[]STREAMCONNECTED22168@/tmp/dbus-
O AyeDpuWXbunix3[]STREAMCONNECTED22143unix3[]STREAMCONNECTED19182@/dbus-
v fs-daemon/socket-mO3Q1TcUunix3[]STREAMCONNECTED16517unix3[]STREAMCONNECTED
O AyeDpuWXbunix3[]STREAMCONNECTED13118@/dbus-v fs-daemon/socket-
QO5OKfs4unix3[]STREAMCONNECTED14634/var/run/dbus/systembus_socketunix3[]STREAMCON
O AyeDpuWXbunix3[]STREAMCONNECTED13034@/tmp/dbus-O AyeDpuWXbunix3[]STREAMCON
unix/X0unix3[]STREAMCONNECTED15469@/tmp/.X11-unix/X0unix3[]STREAMCONNECTED20
unix/X0unix3[]STREAMCONNECTED15596/var/run/dbus/systembus_socketunix3[]STREAMCONNE
v fs-daemon/socket-kPxvkJE6unix3[]STREAMCONNECTED16483unix3[]STREAMCONNECTED1
O AyeDpuWXbunix3[]STREAMCONNECTED13106/var/run/dbus/systembus_socketunix3[]STREAMCO
O AyeDpuWXbunix3[]STREAMCONNECTED15548@/tmp/dbus-O AyeDpuWXbunix3[]STREAMCON
O AyeDpuWXbunix3[]STREAMCONNECTED10211/var/run/dbus/systembus_socketunix3[]STREAMCO
O AyeDpuWXbunix3[]STREAMCONNECTED14871unix3[]STREAMCONNECTED12162unix3[]STRE
unix/X0unix3[]STREAMCONNECTED19981unix3[]STREAMCONNECTED13041@/tmp/dbus-
O AyeDpuWXbunix3[]STREAMCONNECTED15594@/tmp/dbus-O AyeDpuWXbunix3[]STREAMCON
unix/2049unix2[]DGRAM14264unix3[]STREAMCONNECTED12163unix3[]STREAMCONNECTED1
O AyeDpuWXbunix3[]STREAMCONNECTED15597unix3[]STREAMCONNECTED15441@/com/ubun
session/1000/1934unix3[]STREAMCONNECTED15094@/tmp/dbus-O AyeDpuWXbunix3[]STREAMCO
n5bKb6/pkcs11unix3[]STREAMCONNECTED11127/var/run/dbus/systembus_socketunix3[]STREAMCO
unix/2049unix3[]STREAMCONNECTED12944unix3[]STREAMCONNECTED13093/var/run/dbus/sy
unix/X0unix3[]STREAMCONNECTED15586@/tmp/dbus-O AyeDpuWXbunix3[]STREAMCONNECT
unix/2049unix3[]STREAMCONNECTED16432unix3[]STREAMCONNECTED14874unix2[]DGRAM1
unix/X0unix3[]STREAMCONNECTED14979unix3[]STREAMCONNECTED13012@/tmp/.X11-
unix/X0unix3[]STREAMCONNECTED12980@/tmp/dbus-O AyeDpuWXbunix3[]STREAMCONNECT
unix/X0unix3[]STREAMCONNECTED12844@/tmp/dbus-O AyeDpuWXbunix3[]STREAMCONNECT
O AyeDpuWXbunix3[]STREAMCONNECTED15623/var/run/dbus/systembus_socketunix3[]STREAMCO
O AyeDpuWXbunix3[]STREAMCONNECTED15095@/tmp/dbus-O AyeDpuWXbunix3[]STREAMCON
O AyeDpuWXbunix3[]STREAMCONNECTED15043@/tmp/dbus-O AyeDpuWXbunix3[]STREAMCON
unix/X0unix3[]STREAMCONNECTED13050@/tmp/dbus-O AyeDpuWXbunix3[]STREAMCONNECT
O AyeDpuWXbunix3[]STREAMCONNECTED16408unix3[]STREAMCONNECTED22144@/tmp/.X11
unix/X0unix3[]STREAMCONNECTED10751unix3[]STREAMCONNECTED24816@/dbus-
v fs-daemon/socket-p9go0eNPunix2[]DGRAM17290unix3[]STREAMCONNECTED13112unix3[]STRE
O AyeDpuWXbunix3[]STREAMCONNECTED9942unix3[]STREAMCONNECTED14877/var/run/dbu
O AyeDpuWXbunix3[]STREAMCONNECTED12843unix3[]STREAMCONNECTED12593/var/run/dbu
O AyeDpuWXbunix3[]STREAMCONNECTED22156unix3[]STREAMCONNECTED12868@/tmp/.X11
unix/X0unix3[]STREAMCONNECTED14876/var/run/dbus/systembus_socketunix3[]STREAMCONNE
O AyeDpuWXbunix3[]STREAMCONNECTED12996@/tmp/.ICE-unix/2049unix3[]STREAMCONNE
O AyeDpuWXbunix3[]STREAMCONNECTED16413@/tmp/dbus-O AyeDpuWXbunix3[]STREAMCON
unix/X0unix3[]STREAMCONNECTED15179unix2[]DGRAM12384unix3[]STREAMCONNECTED248
v fs-daemon/socket-sQ94RQHxunix3[]STREAMCONNECTED18426unix3[]STREAMCONNECTED
O AyeDpuWXbunix3[]STREAMCONNECTED12882@/tmp/.X11-unix/X0unix3[]STREAMCONNEC
session/1000/1934unix3[]STREAMCONNECTED24169@/tmp/dbus-O AyeDpuWXbunix3[]STREAMCO
v fs-daemon/socket-Klqa6Af4unix3[]STREAMCONNECTED15160unix3[]STREAMCONNECTED1
O AyeDpuWXbunix3[]STREAMCONNECTED12871@/tmp/dbus-O AyeDpuWXbunix3[]STREAMCON
O AyeDpuWXbunix3[]STREAMCONNECTED15515unix2[]DGRAM896unix3[]STREAMCONNECTED
unix/X0unix2[]DGRAM873unix3[]STREAMCONNECTED19257@/tmp/dbus-O AyeDpuWXbunix3[]ST
O AyeDpuWXbunix3[]STREAMCONNECTED13105Ip : 53549totalpacketsreceived2withinvalidaddresses
52988ICMPmessagesreceived9inputICMPmessagefailed.ICMPinputhistogram : destinationunreachable
352echorequests : 352echoreplies : 5262352993ICMPmessagesent0ICMPmessagesfailedICMPoutputhisto
destinationunreachable : 352echorequest : 52628echoreplies : 13IcmpMsg : InType0 :
52623InType3 : 352InType8 : 13OutType0 : 13OutType3 : 352OutType8 : 52628Tcp :
67activeconnectionsopenings34passiveconnectionopenings33failedconnectionattempts0connectionresetsrece
504packetsreceived8packetstounknownportreceived.0packetreceiveerrors483packetsentIgnoredMulti :

```

12UdpLite : TcpExt : 34TCPsocketsfinishedtimewaitinfasttimer4delayedackssent2delayedacksfurtherdel  
 21TCPspuriousRtxHostQueues : 1TCPSynRetrans : 1TCPOrigDataSent : 264IpExt :  
 InMcastPkts : 489OutMcastPkts : 130InBcastPkts : 14InOctets : 4637350OutOctets :  
 4516426InMcastOctets : 166812OutMcastOctets : 26326InBcastOctets : 5108InNoECTPkts :  
 53549

**Question 4.1.a)**

What are the network interfaces of PC1 and what are the MTU (Maximum Transmission Unit) values of the interfaces?

eth0 and loopback (lo) interfaces with respectively 1500 and 65536 as MTU.

**Question 4.1.b)**

How many IP datagrams, ICMP messages, UDP datagrams, and TCP segments has PC1 transmitted and received since it was last rebooted?

53549+53518 IP, 52988+52993 ICMP, 504+483 UDP datagrams and 596+597 TCP segments were received+sent.

**Question 4.2)**

Explain the role of interface lo, the loopback interface. In the output of "netstat -in", why are the values of RX-OK (packets received) and TX-OK (packets transmitted) different for interface "eth0" but identical for interface lo?

The loopback interface is the interface used by hosts to communicate with themselves. Therefore, every packet sent to the loopback interface is also received by the loopback interface.

## Part 5. Configuring IP interfaces in Linux

The `ifconfig` command is used to configure parameters of network interfaces on a Linux system, such as enabling and disabling of interfaces and setting the IP address. The `ifconfig` command is usually run when a system boots up. In this case, the parameters of the commands are read from a file. Once the Linux system is running, the `ifconfig` command can be used to modify the network configuration parameters.



*The most common uses of the `ifconfig` command to query the status of network interfaces are as follows:*

`ifconfig`

*Displays the configuration parameters of all active interfaces.*

`ifconfig -a`

*Displays the configuration parameters of all network interfaces, including the inactive interfaces.*

`ifconfig <interface>`

*Displays the configuration parameters of a single interface. For example, `ifconfig eth0` displays information on interface `eth0`.*



*There are numerous options for configuring a network interface with `ifconfig`. The following example shows how to enable and disable an interface and how to change the IP configuration.*

`ifconfig eth0 down`

*Disables the `eth0` interface. No traffic is sent or received on a disabled interface.*

`ifconfig eth0 up`

*Enables the `eth0` interface.*

`ifconfig eth0 10.0.1.8 netmask 255.255.255.0 broadcast 10.0.1.255`

*Assigns interface `eth0` the IP address 10.0.1.8/24 and a broadcast address of 10.0.1.255. The interface should be disabled before a new IP address is assigned, and should be enabled after the IP address has been modified.*

`ifconfig eth0 down 10.0.1.8 netmask 255.255.255.0 broadcast 10.0.1.255 up`

*Performs all three commands above in sequence. Interface `eth0` is disabled, an IP address and a broadcast address are assigned, and the interface is enabled.*

`ifconfig eth0 mtu 500`

*Sets the MTU of interface `eth0` to 500 bytes.*

### Exercise 5. Changing the IP address of an interface

Use the `ifconfig` command to modify the IP address of the `eth0` interface of PC4.

1. On PC4, run `ifconfig -a` and save the output.
2. Change the IP address of interface `eth0` of PC4 to 10.0.1.11/24.
3. Run `ifconfig -a` again and save the output.

**Question 5.1)**

Attach the saved files to your report and explain the fields of the `ifconfig` output.

Link encap:Ethernet HWaddr MAC address

inet addr:IPv4 address Bcast:Broadcast IP address Mask:Subnet-mask

inet6 addr: IPv6 address Scope: IPv6 scope

UP BROADCAST RUNNING MULTICAST MTU:Maximum Transmission unit Metric: Priority of the device.

RX packets: Received packets through this interface errors: Number of errors with incoming packets. dropped: Number of incoming packets dropped. overruns: Number of incoming packets dropped because capacity of interface exceeded frame:0

TX packets: Transmitted packets through this interface errors: Number of errors with outgoing packets. dropped: Number of outgoing packets dropped. overruns: Number of outgoing packets dropped because capacity of interface exceeded carrier:0

collisions: of collisions txqueuelen: Length of the transmission-queue

RX bytes: bits received TX bytes: bits transmitted

Interrupt: The interrupt line used by the interface. Memory: Memory used by this device

## Part 6. Duplicate IP addresses

In this part of the lab, you observe what happens when two hosts have identical IP addresses.

### Exercise 6. Duplicate IP addresses

1. After completing Exercise 5, the IP addresses of the Ethernet interfaces on the four PCs are as shown in the Table 2.4. Note that PC1 and P4 are assigned the same IP address.

Linux PC	IP Addresses of Ethernet Interface eth0
PC1	10.0.1.11/24
PC2	10.0.1.12/24
PC3	10.0.1.13/24
PC3	10.0.1.11/24

Table 2.4: IP addresses for Part 6

2. Delete all entries in the ARP cache on all PCs.
3. Run Wireshark on PC3 and capture the network traffic to and from the duplicate IP address 10.0.1.11
4. From PC3, start a Telnet session to the duplicate IP address, 10.0.1.11, by typing  

```
| PC3% telnet 10.0.1.11
```

and log in as *telecomlabo* user, using the *mvkbf1n* password.
5. Once you have logged in, determine the name of the host to which you are connected. The name of the host can be determined in several ways: (1) issue the command `hostname`, (2) inspect the ARP cache on PC3, or (3) interpret the captured Wireshark packets.
6. Stop the traffic capture in Wireshark.
7. Save all ARP packets and the first few TCP packets captured by Wireshark. Also save the ARP cache of PC3 using the `arp -a` command.
8. When you are done with the exercise, reset the IP address of PC4 to its original value as given in Table 2.1.

#### Question 6.1)

Explain why the Telnet session was established to one of the hosts with the duplicate address and not the other. Explain why the Telnet session was established at all, and did not result in an error message. Use the ARP cache and the captured packets to support your explanation.

In the PCAP dump we see that the ARP request gets duplicate replies. However, the first host who replies has its MAC address saved in the local ARP table and used for further IP routing.

## Part 7. Changing netmasks

In this part of the lab you test the effects of changing the netmask of a network configuration. In the table below, two hosts (PC2 and PC4) have been assigned different network prefixes.



*If you are having difficulties understanding the concept of netmasks, try using a subnet calculator tool. You can find one at <http://subnet-calculator.com> or most operating systems have native tools or widgets that can do the same.*

### Exercise 7.

1. Setup the interfaces of the hosts as shown in Table 2.5. Note that the netmasks of the hosts are different.

Linux PC	IP Addresses of eth0	Netmask
PC1	10.0.1.100/24	255.255.255.0
PC2	10.0.1.101/28	255.255.255.240
PC3	10.0.1.120/24	255.255.255.0
PC3	10.0.1.121/28	255.255.255.240

Table 2.5: IP addresses for Part 7

2. Run Wireshark on PC1 and capture the packets for the following ping commands
  - a. From PC1 to PC3:  

```
| PC1% ping -c 1 10.0.1.120
```
  - b. From PC1 to PC2:  

```
| PC1% ping -c 1 10.0.1.101
```
  - c. From PC1 to PC4:  

```
| PC1% ping -c 1 10.0.1.121
```
  - d. From PC4 to PC1:  

```
| PC1% ping -c 1 10.0.1.100
```
  - e. From PC2 to PC4:  

```
| PC1% ping -c 1 10.0.1.121
```
  - f. From PC2 to PC3:  

```
| PC1% ping -c 1 10.0.1.120
```
3. Save the Wireshark output, and save the output of the ping commands. Note that not all of the above scenarios are successful. Save all output, including any error messages.
4. When you are done with the exercise, reset the interfaces to their original values as given in Table 2.1.

### Question 7.1)

Use your output data and ping results to explain what happened in each of the ping commands. Which ping operations were successful and which were unsuccessful? Why?



**You get credits for answering the 'why?' question, not for stating the obvious.**

Successful: a,b Unsuccessful:c,d,e,f

## Part 8. Static mapping of IP addresses and hostnames

Since it is easier to memorize names than IP addresses, there are mechanisms to associate a symbolic name, called *hostname*, with an IP address. On the Internet, the resolution between hostnames and IP addresses is generally done by the Domain Name System (DNS), which will not be discussed in this course. This experiment illustrates another, simpler method to map IP addresses and domain names using the host file `/etc/hosts`.

Before DNS became available, the `/etc/hosts` file was the only method to resolve hostnames in the Internet. All hosts on the Internet had to occasionally synchronize with the content of other `/etc/hosts` files.

### Exercise 8. Associating names with IP addresses

In this exercise, you manipulate the static mapping of hostnames and IP addresses using the `/etc/hosts` file.

1. On PC1, inspect the content of file `/etc/hosts` with a text editor.

2. On PC1, issue a `ping` command to PC2

```
| PC1% ping 10.0.1.12
```

3. Repeat Step 2, but use symbolic names instead of IP addresses (e.g., PC2 instead of 10.0.1.12). You should see that the symbolic name is unreachable at this point.

4. On PC1, edit the file `/etc/hosts` and associate hostnames with the IP addresses and save the changes. Use the names PC1, PC2, etc., as used throughout this lab to refer to the PCs.

5. Repeat Step 3. You should now be able to ping directly using the hostnames "PC2", "PC3", "PC4", as in:

```
| PC1% ping PC2
| PC1% ping PC3
| PC1% ping PC4
```

6. Reset the `/etc/hosts` file to its original state. That is, remove the changes you have made in this exercise, and save the file.

#### Question 8.1)

Explain why a static mapping of names and IP addresses is impractical when the number of hosts is large.

#### Question 8.2)

What will be the result of the hostname resolution when multiple IP addresses are associated with the same hostname in the `/etc/hosts` file?

## Part 9. Experiments with FTP and Telnet

A severe security problem with the file transfer protocol (FTP) is that the login and password information are transmitted as plain text (not encrypted). Sometimes malicious users exploit this by snooping passwords on the network.

Here you learn how easy it is to crack passwords by snooping traffic from FTP and Telnet sessions.



***The use of applications that do not encrypt passwords, such as FTP and Telnet, is strongly discouraged. On the Internet, you should use protocols such as Secure Shell (SSH) tools for file transfers and remote login.***

### Exercise 9-A. Snoop Passwords from an FTP session

Capture traffic from an FTP session between two hosts.

The ftp server installed on the lab PC's is vsftpd, which is not started by default. Use the following command to start it on PC2:

```
| PC2% service vsftpd start
```

1. On PC1, run the Wireshark command with capture filters set to capture traffic between PC1 and PC2. The capture filter is

```
| host 10.0.1.11 and host 10.0.1.12
```

2. On PC1, initiate a FTP session to PC2 by typing

```
| PC1% ftp 10.0.1.12
```

3. Log in as *telecomlabo* user.
4. Inspect the payload of packets with FTP payload that are sent from PC1 to PC2. FTP sessions use TCP connections for data transfer.



*In Wireshark, there is a simple method to view the payload sent in a TCP connection. Simply select a packet that contains a TCP segment in the main window of Wireshark, and then click on "Follow TCP Stream" in the "Tools" menu of the Wireshark window. This will create a new window that displays only the payload of the selected TCP connection.*

5. Save the details of the packets, i.e., select "Print details" in the "Print" window of Wireshark, which transmit the login name and password. As a hint, you can set the display filter in Wireshark to show only the desired packet(s). Refer to Question 9 from the Prelab.

### Question 9.A.1)

Using the saved output, identify the port numbers of the FTP client and the FTP server.

```
No. Time Source Destination Protocol Length Info 1 0.000000000 10.0.1.11 10.0.1.12 TCP
74 41694 > 21 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM = 1 TSval =
2924482 TSecr = 0 WS = 128
```

Frame 1: 74 bytes on wire (592 bits), 74 bytes captured (592 bits) on interface 0 Interface id: 0 Encapsulation type: Ethernet (1) Arrival Time: Feb 19, 2016 16:34:05.834370000 CET



[Time shift for this packet: 0.000000000 seconds] Epoch Time: 1455896045.834370000 seconds [Time delta from previous captured frame: 0.000000000 seconds] [Time delta from previous displayed frame: 0.000000000 seconds] [Time since reference or first frame: 0.000000000 seconds] Frame Number: 1 Frame Length: 74 bytes (592 bits) Capture Length: 74 bytes (592 bits) [Frame is marked: False] [Frame is ignored: False] [Protocols in frame: eth:ip:tcp] [Coloring Rule Name: TCP SYN/FIN] [Coloring Rule String: tcp.flags 0x02 || tcp.flags.fin == 1] Ethernet II, Src: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0), Dst: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Destination: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0. .... = IG bit: Individual address (unicast) Source: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0. .... = IG bit: Individual address (unicast) Type: IP (0x0800) Internet Protocol Version 4, Src: 10.0.1.11 (10.0.1.11), Dst: 10.0.1.12 (10.0.1.12) Version: 4 Header length: 20 bytes Differentiated Services Field: 0x00 (DSCP 0x00: Default; ECN: 0x00: Not-ECT (Not ECN-Capable Transport)) 0000 00.. = Differentiated Services Codepoint: Default (0x00) .... ..00 = Explicit Congestion Notification: Not-ECT (Not ECN-Capable Transport) (0x00) Total Length: 60 Identification: 0xa42f (42031) Flags: 0x02 (Don't Fragment) 0... .... = Reserved bit: Not set .1.. .... = Don't fragment: Set ..0. .... = More fragments: Not set Fragment offset: 0 Time to live: 64 Protocol: TCP (6) Header checksum: 0x8076 [validation disabled] [Good: False] [Bad: False] Source: 10.0.1.11 (10.0.1.11) Destination: 10.0.1.12 (10.0.1.12) [Source GeoIP: Unknown] [Destination GeoIP: Unknown] Transmission Control Protocol, Src Port: 41694 (41694), Dst Port: 21 (21), Seq: 0, Len: 0 Source port: 41694 (41694) Destination port: 21 (21) [Stream index: 0] Sequence number: 0 (relative sequence number) Header length: 40 bytes Flags: 0x002 (SYN) 000. .... = Reserved: Not set ...0. .... = Nonce: Not set .... 0... .... = Congestion Window Reduced (CWR): Not set .... .0.. .... = ECN-Echo: Not set .... ..0. .... = Urgent: Not set .... ..0. .... = Acknowledgment: Not set .... .... 0... = Push: Not set .... .... .0.. = Reset: Not set .... .... .1. = Syn: Set [Expert Info (Chat/Sequence): Connection establish request (SYN): server port 21] [Message: Connection establish request (SYN): server port 21] [Severity level: Chat] [Group: Sequence] .... .... ..0 = Fin: Not set Window size value: 29200 [Calculated window size: 29200] Checksum: 0x1645 [validation disabled] [Good Checksum: False] [Bad Checksum: False] Options: (20 bytes), Maximum segment size, SACK permitted, Timestamps, No-Operation (NOP), Window scale Maximum segment size: 1460 bytes Kind: MSS size (2) Length: 4 MSS Value: 1460 TCP SACK Permitted Option: True Kind: SACK Permission (4) Length: 2 Timestamps: TSval 2924482, TSecr 0 Kind: Timestamp (8) Length: 10 Timestamp value: 2924482 Timestamp echo reply: 0 No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) Window scale: 7 (multiply by 128) Kind: Window Scale (3) Length: 3 Shift count: 7 [Multiplier: 128]

No. Time Source Destination Protocol Length Info 2 0.000596000 10.0.1.12 10.0.1.11 TCP 74 21 > 41694 [SYN, ACK] Seq=0 Ack=1 Win=28960 Len=0 MSS=1460 SACK<sub>PERM</sub> = 1 TSval = 8497110 TSecr = 2924482 WS = 128

Frame 2: 74 bytes on wire (592 bits), 74 bytes captured (592 bits) on interface 0 Interface id: 0 Encapsulation type: Ethernet (1) Arrival Time: Feb 19, 2016 16:34:05.834966000 CET [Time shift for this packet: 0.000000000 seconds] Epoch Time: 1455896045.834966000 seconds [Time delta from previous captured frame: 0.000596000 seconds] [Time delta from previous displayed frame: 0.000596000 seconds] [Time since reference or first frame: 0.000596000 seconds] Frame Number: 2 Frame Length: 74 bytes (592 bits) Capture Length: 74 bytes (592 bits) [Frame is marked: False] [Frame is ignored: False] [Protocols in frame: eth:ip:tcp] [Coloring Rule Name: TCP SYN/FIN] [Coloring Rule String: tcp.flags 0x02 || tcp.flags.fin == 1] Ethernet II, Src: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0), Dst: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Destination: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0. .... = IG bit: Individual address (unicast) Source: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) .... ..0. .... = LG bit: Globally unique address

(factory default) .... 0 .... = IG bit: Individual address (unicast) Type: IP (0x0800) Internet Protocol Version 4, Src: 10.0.1.12 (10.0.1.12), Dst: 10.0.1.11 (10.0.1.11) Version: 4 Header length: 20 bytes Differentiated Services Field: 0x00 (DSCP 0x00: Default; ECN: 0x00: Not-ECT (Not ECN-Capable Transport)) 0000 00.. = Differentiated Services Codepoint: Default (0x00) .... 00 = Explicit Congestion Notification: Not-ECT (Not ECN-Capable Transport) (0x00) Total Length: 60 Identification: 0x0000 (0) Flags: 0x02 (Don't Fragment) 0... .... = Reserved bit: Not set .1.. .... = Don't fragment: Set ..0. .... = More fragments: Not set Fragment offset: 0 Time to live: 64 Protocol: TCP (6) Header checksum: 0x24a6 [validation disabled] [Good: False] [Bad: False] Source: 10.0.1.12 (10.0.1.12) Destination: 10.0.1.11 (10.0.1.11) [Source GeoIP: Unknown] [Destination GeoIP: Unknown] Transmission Control Protocol, Src Port: 21 (21), Dst Port: 41694 (41694), Seq: 0, Ack: 1, Len: 0 Source port: 21 (21) Destination port: 41694 (41694) [Stream index: 0] Sequence number: 0 (relative sequence number) Acknowledgment number: 1 (relative ack number) Header length: 40 bytes Flags: 0x012 (SYN, ACK) 000. .... = Reserved: Not set ...0 .... = Nonce: Not set .... 0... .... = Congestion Window Reduced (CWR): Not set .... 0.. .... = ECN-Echo: Not set .... ..0. .... = Urgent: Not set .... ...1 .... = Acknowledgment: Set .... .... 0... = Push: Not set .... .... 0.. = Reset: Not set .... .... ..1. = Syn: Set [Expert Info (Chat/Sequence): Connection establish acknowledge (SYN+ACK): server port 21] [Message: Connection establish acknowledge (SYN+ACK): server port 21] [Severity level: Chat] [Group: Sequence] .... .... 0 = Fin: Not set Window size value: 28960 [Calculated window size: 28960] Checksum: 0x3882 [validation disabled] [Good Checksum: False] [Bad Checksum: False] Options: (20 bytes), Maximum segment size, SACK permitted, Timestamps, No-Operation (NOP), Window scale Maximum segment size: 1460 bytes Kind: MSS size (2) Length: 4 MSS Value: 1460 TCP SACK Permitted Option: True Kind: SACK Permission (4) Length: 2 Timestamps: TSval 8497110, TSecr 2924482 Kind: Timestamp (8) Length: 10 Timestamp value: 8497110 Timestamp echo reply: 2924482 No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) Window scale: 7 (multiply by 128) Kind: Window Scale (3) Length: 3 Shift count: 7 [Multiplier: 128] [SEQ/ACK analysis] [This is an ACK to the segment in frame: 1] [The RTT to ACK the segment was: 0.000596000 seconds]

No. Time Source Destination Protocol Length Info 3 0.000629000 10.0.1.11 10.0.1.12 TCP 66 41694 > 21 [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=2924482 TSecr=8497110

Frame 3: 66 bytes on wire (528 bits), 66 bytes captured (528 bits) on interface 0 Interface id: 0 Encapsulation type: Ethernet (1) Arrival Time: Feb 19, 2016 16:34:05.834999000 CET [Time shift for this packet: 0.000000000 seconds] Epoch Time: 1455896045.834999000 seconds [Time delta from previous captured frame: 0.000033000 seconds] [Time delta from previous displayed frame: 0.000033000 seconds] [Time since reference or first frame: 0.000629000 seconds] Frame Number: 3 Frame Length: 66 bytes (528 bits) Capture Length: 66 bytes (528 bits) [Frame is marked: False] [Frame is ignored: False] [Protocols in frame: eth:ip:tcp] [Coloring Rule Name: TCP] [Coloring Rule String: tcp] Ethernet II, Src: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0), Dst: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Destination: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) .... 0. .... = LG bit: Globally unique address (factory default) .... 0 .... = IG bit: Individual address (unicast) Source: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) .... 0. .... = LG bit: Globally unique address (factory default) .... 0 .... = IG bit: Individual address (unicast) Type: IP (0x0800) Internet Protocol Version 4, Src: 10.0.1.11 (10.0.1.11), Dst: 10.0.1.12 (10.0.1.12) Version: 4 Header length: 20 bytes Differentiated Services Field: 0x00 (DSCP 0x00: Default; ECN: 0x00: Not-ECT (Not ECN-Capable Transport)) 0000 00.. = Differentiated Services Codepoint: Default (0x00) .... 00 = Explicit Congestion Notification: Not-ECT (Not ECN-Capable Transport) (0x00) Total Length: 52 Identification: 0xa430 (42032) Flags: 0x02 (Don't Fragment) 0... .... = Reserved bit: Not set .1.. .... = Don't fragment: Set ..0. .... = More fragments: Not set Fragment offset: 0 Time to live: 64 Protocol: TCP (6) Header checksum: 0x807d [validation disabled] [Good: False] [Bad: False] Source: 10.0.1.11 (10.0.1.11) Destination: 10.0.1.12 (10.0.1.12) [Source GeoIP: Unknown] [Destination GeoIP: Un-

known] Transmission Control Protocol, Src Port: 41694 (41694), Dst Port: 21 (21), Seq: 1, Ack: 1, Len: 0 Source port: 41694 (41694) Destination port: 21 (21) [Stream index: 0] Sequence number: 1 (relative sequence number) Acknowledgment number: 1 (relative ack number) Header length: 32 bytes Flags: 0x010 (ACK) 000. .... = Reserved: Not set ...0 .... = Nonce: Not set .... 0... .... = Congestion Window Reduced (CWR): Not set .... .0.. .... = ECN-Echo: Not set .... .0.. .... = Urgent: Not set .... ..1 .... = Acknowledgment: Set .... .... 0... = Push: Not set .... .... .0.. = Reset: Not set .... .... .0. = Syn: Not set .... .... ..0 = Fin: Not set Window size value: 229 [Calculated window size: 29312] [Window size scaling factor: 128] Checksum: 0x163d [validation disabled] [Good Checksum: False] [Bad Checksum: False] Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) Timestamps: TSval 2924482, TSecr 8497110 Kind: Timestamp (8) Length: 10 Timestamp value: 2924482 Timestamp echo reply: 8497110 [SEQ/ACK analysis] [This is an ACK to the segment in frame: 2] [The RTT to ACK the segment was: 0.000033000 seconds]

No. Time Source Destination Protocol Length Info 4 0.018029000 10.0.1.12 10.0.1.11 FTP 86 Response: 220 (vsFTPD 3.0.2)

Frame 4: 86 bytes on wire (688 bits), 86 bytes captured (688 bits) on interface 0 Interface id: 0 Encapsulation type: Ethernet (1) Arrival Time: Feb 19, 2016 16:34:05.852399000 CET [Time shift for this packet: 0.000000000 seconds] Epoch Time: 1455896045.852399000 seconds [Time delta from previous captured frame: 0.017400000 seconds] [Time delta from previous displayed frame: 0.017400000 seconds] [Time since reference or first frame: 0.018029000 seconds] Frame Number: 4 Frame Length: 86 bytes (688 bits) Capture Length: 86 bytes (688 bits) [Frame is marked: False] [Frame is ignored: False] [Protocols in frame: eth:ip:tcp:ftp] [Coloring Rule Name: TCP] [Coloring Rule String: tcp] Ethernet II, Src: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0), Dst: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Destination: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) .... ..0 .... = LG bit: Globally unique address (factory default) .... ..0 .... = IG bit: Individual address (unicast) Source: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) .... ..0 .... = LG bit: Globally unique address (factory default) .... ..0 .... = IG bit: Individual address (unicast) Type: IP (0x0800) Internet Protocol Version 4, Src: 10.0.1.12 (10.0.1.12), Dst: 10.0.1.11 (10.0.1.11) Version: 4 Header length: 20 bytes Differentiated Services Field: 0x00 (DSCP 0x00: Default; ECN: 0x00: Not-ECT (Not ECN-Capable Transport)) 0000 00.. = Differentiated Services Codepoint: Default (0x00) .... ..00 = Explicit Congestion Notification: Not-ECT (Not ECN-Capable Transport) (0x00) Total Length: 72 Identification: 0xf87d (63613) Flags: 0x02 (Don't Fragment) 0... .... = Reserved bit: Not set .1.. .... = Don't fragment: Set ..0. .... = More fragments: Not set Fragment offset: 0 Time to live: 64 Protocol: TCP (6) Header checksum: 0x2c1c [validation disabled] [Good: False] [Bad: False] Source: 10.0.1.12 (10.0.1.12) Destination: 10.0.1.11 (10.0.1.11) [Source GeoIP: Unknown] [Destination GeoIP: Unknown] Transmission Control Protocol, Src Port: 21 (21), Dst Port: 41694 (41694), Seq: 1, Ack: 1, Len: 20 Source port: 21 (21) Destination port: 41694 (41694) [Stream index: 0] Sequence number: 1 (relative sequence number) [Next sequence number: 21 (relative sequence number)] Acknowledgment number: 1 (relative ack number) Header length: 32 bytes Flags: 0x018 (PSH, ACK) 000. .... = Reserved: Not set ...0 .... = Nonce: Not set .... 0... .... = Congestion Window Reduced (CWR): Not set .... .0.. .... = ECN-Echo: Not set .... .0.. .... = Urgent: Not set .... ..1 .... = Acknowledgment: Set .... .... 1... = Push: Set .... .... .0.. = Reset: Not set .... .... ..0. = Syn: Not set .... .... ..0 = Fin: Not set Window size value: 227 [Calculated window size: 29056] [Window size scaling factor: 128] Checksum: 0x7e5c [validation disabled] [Good Checksum: False] [Bad Checksum: False] Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1)

Timestamps: TSval 8497114, TSecr 2924482 Kind: Timestamp (8) Length: 10 Timestamp value: 8497114 Timestamp echo reply: 2924482 [SEQ/ACK analysis] [Bytes in flight: 20] File Transfer Protocol (FTP) 220 (vsFTPD 3.0.2) Response code: Service ready for new user (220) Response arg: (vsFTPD 3.0.2)

No. Time Source Destination Protocol Length Info 5 0.018085000 10.0.1.11 10.0.1.12 TCP 66 41694 > 21 [ACK] Seq=1 Ack=21 Win=29312 Len=0 TSval=2924486 TSecr=8497114

Frame 5: 66 bytes on wire (528 bits), 66 bytes captured (528 bits) on interface 0 Interface id: 0 Encapsulation type: Ethernet (1) Arrival Time: Feb 19, 2016 16:34:05.852455000 CET [Time shift for this packet: 0.000000000 seconds] Epoch Time: 1455896045.852455000 seconds [Time delta from previous captured frame: 0.000056000 seconds] [Time delta from previous displayed frame: 0.000056000 seconds] [Time since reference or first frame: 0.018085000 seconds] Frame Number: 5 Frame Length: 66 bytes (528 bits) Capture Length: 66 bytes (528 bits) [Frame is marked: False] [Frame is ignored: False] [Protocols in frame: eth:ip:tcp] [Coloring Rule Name: TCP] [Coloring Rule String: tcp] Ethernet II, Src: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0), Dst: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Destination: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) .... 0. .... = LG bit: Globally unique address (factory default) .... 0 .... = IG bit: Individual address (unicast) Source: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) .... 0. .... = LG bit: Globally unique address (factory default) .... 0 .... = IG bit: Individual address (unicast) Type: IP (0x0800) Internet Protocol Version 4, Src: 10.0.1.11 (10.0.1.11), Dst: 10.0.1.12 (10.0.1.12) Version: 4 Header length: 20 bytes Differentiated Services Field: 0x10 (DSCP 0x04: Unknown DSCP; ECN: 0x00: Not-ECT (Not ECN-Capable Transport)) 0001 00.. = Differentiated Services Codepoint: Unknown (0x04) .... 00 = Explicit Congestion Notification: Not-ECT (Not ECN-Capable Transport) (0x00) Total Length: 52 Identification: 0xa431 (42033) Flags: 0x02 (Don't Fragment) 0... .... = Reserved bit: Not set 1... .... = Don't fragment: Set 0. .... = More fragments: Not set Fragment offset: 0 Time to live: 64 Protocol: TCP (6) Header checksum: 0x806c [validation disabled] [Good: False] [Bad: False] Source: 10.0.1.11 (10.0.1.11) Destination: 10.0.1.12 (10.0.1.12) [Source GeoIP: Unknown] [Destination GeoIP: Unknown] Transmission Control Protocol, Src Port: 41694 (41694), Dst Port: 21 (21), Seq: 1, Ack: 21, Len: 0 Source port: 41694 (41694) Destination port: 21 (21) [Stream index: 0] Sequence number: 1 (relative sequence number) Acknowledgment number: 21 (relative ack number) Header length: 32 bytes Flags: 0x010 (ACK) 000. .... = Reserved: Not set ...0 .... = Nonce: Not set .... 0... .... = Congestion Window Reduced (CWR): Not set .... 0.. .... = ECN-Echo: Not set .... 0. .... = Urgent: Not set .... 1 .... = Acknowledgment: Set .... 0... = Push: Not set .... 0.. = Reset: Not set .... 0. = Syn: Not set .... 0 = Fin: Not set Window size value: 229 [Calculated window size: 29312] [Window size scaling factor: 128] Checksum: 0x163d [validation disabled] [Good Checksum: False] [Bad Checksum: False] Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) Timestamps: TSval 2924486, TSecr 8497114 Kind: Timestamp (8) Length: 10 Timestamp value: 2924486 Timestamp echo reply: 8497114 [SEQ/ACK analysis] [This is an ACK to the segment in frame: 4] [The RTT to ACK the segment was: 0.000056000 seconds]

No. Time Source Destination Protocol Length Info 6 5.015520000 68:05:ca:36:33:a0 68:05:ca:36:31:f0 ARP 42 Who has 10.0.1.12? Tell 10.0.1.11

Frame 6: 42 bytes on wire (336 bits), 42 bytes captured (336 bits) on interface 0 Interface id: 0 Encapsulation type: Ethernet (1) Arrival Time: Feb 19, 2016 16:34:10.849890000 CET [Time shift for this packet: 0.000000000 seconds] Epoch Time: 1455896050.849890000 seconds [Time delta from previous captured frame: 4.997435000 seconds] [Time delta from previous displayed frame: 4.997435000 seconds] [Time since reference or first frame: 5.015520000 seconds] Frame Number: 6 Frame Length: 42 bytes (336 bits) Capture Length: 42 bytes (336 bits) [Frame is marked: False] [Frame is ignored: False] [Protocols in frame: eth:arp] [Coloring Rule

Name: ARP [Coloring Rule String: arp] Ethernet II, Src: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0), Dst: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Destination: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0 .... = IG bit: Individual address (unicast) Source: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0 .... = IG bit: Individual address (unicast) Type: ARP (0x0806) Address Resolution Protocol (request) Hardware type: Ethernet (1) Protocol type: IP (0x0800) Hardware size: 6 Protocol size: 4 Opcode: request (1) Sender MAC address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Sender IP address: 10.0.1.11 (10.0.1.11) Target MAC address: 00:00:00:00:00:00 (00:00:00:00:00:00) Target IP address: 10.0.1.12 (10.0.1.12)

No. Time Source Destination Protocol Length Info 7 5.016109000 68:05:ca:36:31:f0 68:05:ca:36:33:a0 ARP 60 10.0.1.12 is at 68:05:ca:36:31:f0

Frame 7: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface 0 Interface id: 0 Encapsulation type: Ethernet (1) Arrival Time: Feb 19, 2016 16:34:10.850479000 CET [Time shift for this packet: 0.000000000 seconds] Epoch Time: 1455896050.850479000 seconds [Time delta from previous captured frame: 0.000589000 seconds] [Time delta from previous displayed frame: 0.000589000 seconds] [Time since reference or first frame: 5.016109000 seconds] Frame Number: 7 Frame Length: 60 bytes (480 bits) Capture Length: 60 bytes (480 bits) [Frame is marked: False] [Frame is ignored: False] [Protocols in frame: eth:arp] [Coloring Rule Name: ARP] [Coloring Rule String: arp] Ethernet II, Src: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0), Dst: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Destination: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0 .... = IG bit: Individual address (unicast) Source: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0 .... = IG bit: Individual address (unicast) Type: ARP (0x0806) Padding: 00000000000000000000000000000000 Address Resolution Protocol (reply) Hardware type: Ethernet (1) Protocol type: IP (0x0800) Hardware size: 6 Protocol size: 4 Opcode: reply (2) Sender MAC address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Sender IP address: 10.0.1.12 (10.0.1.12) Target MAC address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Target IP address: 10.0.1.11 (10.0.1.11)

No. Time Source Destination Protocol Length Info 8 6.633875000 10.0.1.11 10.0.1.12 FTP 80 Request: USER student

Frame 8: 80 bytes on wire (640 bits), 80 bytes captured (640 bits) on interface 0 Interface id: 0 Encapsulation type: Ethernet (1) Arrival Time: Feb 19, 2016 16:34:12.468245000 CET [Time shift for this packet: 0.000000000 seconds] Epoch Time: 1455896052.468245000 seconds [Time delta from previous captured frame: 1.617766000 seconds] [Time delta from previous displayed frame: 1.617766000 seconds] [Time since reference or first frame: 6.633875000 seconds] Frame Number: 8 Frame Length: 80 bytes (640 bits) Capture Length: 80 bytes (640 bits) [Frame is marked: False] [Frame is ignored: False] [Protocols in frame: eth:ip:tcp:ftp] [Coloring Rule Name: TCP] [Coloring Rule String: tcp] Ethernet II, Src: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0), Dst: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Destination: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0 .... = IG bit: Individual address (unicast) Source: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0 .... = IG bit: Individual address (unicast) Type: IP (0x0800) Internet Protocol Version 4, Src: 10.0.1.11 (10.0.1.11), Dst: 10.0.1.12 (10.0.1.12) Version: 4 Header length: 20 bytes Differentiated Services Field: 0x10 (DSCP 0x04: Unknown DSCP; ECN: 0x00: Not-ECT (Not ECN-Capable Transport)) 0001 00.. = Differentiated Services Codepoint: Unknown (0x04) .... ..00 = Explicit Congestion Notification: Not-ECT (Not ECN-Capable Transport) (0x00) Total Length: 66 Identification: 0xa432 (42034) Flags: 0x02 (Don't Fragment) 0... .... = Reserved bit: Not set .1.. .... = Don't fragment: Set ..0. .... = More fragments: Not set Fragment offset: 0 Time to live: 64 Protocol: TCP (6)



Header checksum: 0x805d [validation disabled] [Good: False] [Bad: False] Source: 10.0.1.11 (10.0.1.11) Destination: 10.0.1.12 (10.0.1.12) [Source GeoIP: Unknown] [Destination GeoIP: Unknown] Transmission Control Protocol, Src Port: 41694 (41694), Dst Port: 21 (21), Seq: 1, Ack: 21, Len: 14 Source port: 41694 (41694) Destination port: 21 (21) [Stream index: 0] Sequence number: 1 (relative sequence number) [Next sequence number: 15 (relative sequence number)] Acknowledgment number: 21 (relative ack number) Header length: 32 bytes Flags: 0x018 (PSH, ACK) 000. .... = Reserved: Not set ...0 .... = Nonce: Not set .... 0... .... = Congestion Window Reduced (CWR): Not set .... .0.. .... = ECN-Echo: Not set .... ..0. .... = Urgent: Not set .... ...1 .... = Acknowledgment: Set .... .... 1... = Push: Set .... .... .0.. = Reset: Not set .... ..0. = Syn: Not set .... .... ..0 = Fin: Not set Window size value: 229 [Calculated window size: 29312] [Window size scaling factor: 128] Checksum: 0x164b [validation disabled] [Good Checksum: False] [Bad Checksum: False] Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) Timestamps: TSval 2926140, TSecr 8497114 Kind: Timestamp (8) Length: 10 Timestamp value: 2926140 Timestamp echo reply: 8497114 [SEQ/ACK analysis] [Bytes in flight: 14] File Transfer Protocol (FTP) USER student Request command: USER Request arg: student

No. Time Source Destination Protocol Length Info 9 6.634430000 10.0.1.12 10.0.1.11 TCP 66 21 > 41694 [ACK] Seq=21 Ack=15 Win=29056 Len=0 TSval=8498768 TSecr=2926140

Frame 9: 66 bytes on wire (528 bits), 66 bytes captured (528 bits) on interface 0 Interface id: 0 Encapsulation type: Ethernet (1) Arrival Time: Feb 19, 2016 16:34:12.468800000 CET [Time shift for this packet: 0.000000000 seconds] Epoch Time: 1455896052.468800000 seconds [Time delta from previous captured frame: 0.000555000 seconds] [Time delta from previous displayed frame: 0.000555000 seconds] [Time since reference or first frame: 6.634430000 seconds] Frame Number: 9 Frame Length: 66 bytes (528 bits) Capture Length: 66 bytes (528 bits) [Frame is marked: False] [Frame is ignored: False] [Protocols in frame: eth:ip:tcp] [Coloring Rule Name: TCP] [Coloring Rule String: tcp] Ethernet II, Src: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0), Dst: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Destination: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0 .... = IG bit: Individual address (unicast) Source: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0 .... = IG bit: Individual address (unicast) Type: IP (0x0800) Internet Protocol Version 4, Src: 10.0.1.12 (10.0.1.12), Dst: 10.0.1.11 (10.0.1.11) Version: 4 Header length: 20 bytes Differentiated Services Field: 0x00 (DSCP 0x00: Default; ECN: 0x00: Not-ECT (Not ECN-Capable Transport)) 0000 00.. = Differentiated Services Codepoint: Default (0x00) .... ..00 = Explicit Congestion Notification: Not-ECT (Not ECN-Capable Transport) (0x00) Total Length: 52 Identification: 0xf87e (63614) Flags: 0x02 (Don't Fragment) 0... .... = Reserved bit: Not set .1.. .... = Don't fragment: Set ..0. .... = More fragments: Not set Fragment offset: 0 Time to live: 64 Protocol: TCP (6) Header checksum: 0x2c2f [validation disabled] [Good: False] [Bad: False] Source: 10.0.1.12 (10.0.1.12) Destination: 10.0.1.11 (10.0.1.11) [Source GeoIP: Unknown] [Destination GeoIP: Unknown] Transmission Control Protocol, Src Port: 21 (21), Dst Port: 41694 (41694), Seq: 21, Ack: 15, Len: 0 Source port: 21 (21) Destination port: 41694 (41694) [Stream index: 0] Sequence number: 21 (relative sequence number) Acknowledgment number: 15 (relative ack number) Header length: 32 bytes Flags: 0x010 (ACK) 000. .... = Reserved: Not set ...0 .... = Nonce: Not set .... 0... .... = Congestion Window Reduced (CWR): Not set .... .0.. .... = ECN-Echo: Not set .... ..0. .... = Urgent: Not set .... ...1 .... = Acknowledgment: Set .... .... 0... = Push: Not set .... .... .0.. = Reset: Not set .... .... ..0. = Syn: Not set .... .... ..0 = Fin: Not set Window size value: 227 [Calculated window size: 29056] [Window size scaling factor: 128] Checksum: 0xca75 [validation disabled] [Good Checksum: False] [Bad Checksum: False] Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) No-Operation (NOP)

Type: 1 0... .. = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) Timestamps: TSval 8498768, TSecr 2926140 Kind: Timestamp (8) Length: 10 Timestamp value: 8498768 Timestamp echo reply: 2926140 [SEQ/ACK analysis] [This is an ACK to the segment in frame: 8] [The RTT to ACK the segment was: 0.000555000 seconds]

No. Time Source Destination Protocol Length Info 10 6.634448000 10.0.1.12 10.0.1.11 FTP 100 Response: 331 Please specify the password.

Frame 10: 100 bytes on wire (800 bits), 100 bytes captured (800 bits) on interface 0 Interface id: 0 Encapsulation type: Ethernet (1) Arrival Time: Feb 19, 2016 16:34:12.468818000 CET [Time shift for this packet: 0.000000000 seconds] Epoch Time: 1455896052.468818000 seconds [Time delta from previous captured frame: 0.000018000 seconds] [Time delta from previous displayed frame: 0.000018000 seconds] [Time since reference or first frame: 6.634448000 seconds] Frame Number: 10 Frame Length: 100 bytes (800 bits) Capture Length: 100 bytes (800 bits) [Frame is marked: False] [Frame is ignored: False] [Protocols in frame: eth:ip:tcp:ftp] [Coloring Rule Name: TCP] [Coloring Rule String: tcp] Ethernet II, Src: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0), Dst: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Destination: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0. .... = IG bit: Individual address (unicast) Source: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0. .... = IG bit: Individual address (unicast) Type: IP (0x0800) Internet Protocol Version 4, Src: 10.0.1.12 (10.0.1.12), Dst: 10.0.1.11 (10.0.1.11) Version: 4 Header length: 20 bytes Differentiated Services Field: 0x00 (DSCP 0x00: Default; ECN: 0x00: Not-ECT (Not ECN-Capable Transport)) 0000 00.. = Differentiated Services Codepoint: Default (0x00) .... ..00 = Explicit Congestion Notification: Not-ECT (Not ECN-Capable Transport) (0x00) Total Length: 86 Identification: 0xf87f (63615) Flags: 0x02 (Don't Fragment) 0... .. = Reserved bit: Not set .1.. .... = Don't fragment: Set ..0. .... = More fragments: Not set Fragment offset: 0 Time to live: 64 Protocol: TCP (6) Header checksum: 0x2c0c [validation disabled] [Good: False] [Bad: False] Source: 10.0.1.12 (10.0.1.12) Destination: 10.0.1.11 (10.0.1.11) [Source GeolIP: Unknown] [Destination GeolIP: Unknown] Transmission Control Protocol, Src Port: 21 (21), Dst Port: 41694 (41694), Seq: 21, Ack: 15, Len: 34 Source port: 21 (21) Destination port: 41694 (41694) [Stream index: 0] Sequence number: 21 (relative sequence number) [Next sequence number: 55 (relative sequence number)] Acknowledgment number: 15 (relative ack number) Header length: 32 bytes Flags: 0x018 (PSH, ACK) 000. .... = Reserved: Not set ...0. .... = Nonce: Not set .... 0... .. = Congestion Window Reduced (CWR): Not set .... ..0.. .... = ECN-Echo: Not set .... ..0. .... = Urgent: Not set .... ..1. .... = Acknowledgment: Set .... ..1... = Push: Set .... ..0.. = Reset: Not set .... ..0. = Syn: Not set .... ..0. = Fin: Not set Window size value: 227 [Calculated window size: 29056] [Window size scaling factor: 128] Checksum: 0x832a [validation disabled] [Good Checksum: False] [Bad Checksum: False] Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps No-Operation (NOP) Type: 1 0... .. = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) No-Operation (NOP) Type: 1 0... .. = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) Timestamps: TSval 8498768, TSecr 2926140 Kind: Timestamp (8) Length: 10 Timestamp value: 8498768 Timestamp echo reply: 2926140 [SEQ/ACK analysis] [Bytes in flight: 34] File Transfer Protocol (FTP) 331 Please specify the password.\*Response code: User name okay, need password (331) Response arg: Please specify the password.

No. Time Source Destination Protocol Length Info 11 6.634479000 10.0.1.11 10.0.1.12 TCP 66 41694 > 21 [ACK] Seq=15 Ack=55 Win=29312 Len=0 TSval=2926140 TSecr=8498768

Frame 11: 66 bytes on wire (528 bits), 66 bytes captured (528 bits) on interface 0 Interface id: 0 Encapsulation type: Ethernet (1) Arrival Time: Feb 19, 2016 16:34:12.468849000 CET [Time shift for this packet: 0.000000000 seconds] Epoch Time: 1455896052.468849000 seconds [Time delta from previous captured frame: 0.000031000 seconds] [Time delta from previous

displayed frame: 0.000031000 seconds] [Time since reference or first frame: 6.634479000 seconds] Frame Number: 11 Frame Length: 66 bytes (528 bits) Capture Length: 66 bytes (528 bits) [Frame is marked: False] [Frame is ignored: False] [Protocols in frame: eth:ip:tcp] [Coloring Rule Name: TCP] [Coloring Rule String: tcp] Ethernet II, Src: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0), Dst: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Destination: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) .... 0. .... = LG bit: Globally unique address (factory default) .... 0. .... = IG bit: Individual address (unicast) Source: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) .... 0. .... = LG bit: Globally unique address (factory default) .... 0. .... = IG bit: Individual address (unicast) Type: IP (0x0800) Internet Protocol Version 4, Src: 10.0.1.11 (10.0.1.11), Dst: 10.0.1.12 (10.0.1.12) Version: 4 Header length: 20 bytes Differentiated Services Field: 0x10 (DSCP 0x04: Unknown DSCP; ECN: 0x00: Not-ECT (Not ECN-Capable Transport)) 0001 00.. = Differentiated Services Codepoint: Unknown (0x04) .... 00 = Explicit Congestion Notification: Not-ECT (Not ECN-Capable Transport) (0x00) Total Length: 52 Identification: 0xa433 (42035) Flags: 0x02 (Don't Fragment) 0... .... = Reserved bit: Not set .1.. .... = Don't fragment: Set ..0. .... = More fragments: Not set Fragment offset: 0 Time to live: 64 Protocol: TCP (6) Header checksum: 0x806a [validation disabled] [Good: False] [Bad: False] Source: 10.0.1.11 (10.0.1.11) Destination: 10.0.1.12 (10.0.1.12) [Source GeoIP: Unknown] [Destination GeoIP: Unknown] Transmission Control Protocol, Src Port: 41694 (41694), Dst Port: 21 (21), Seq: 15, Ack: 55, Len: 0 Source port: 41694 (41694) Destination port: 21 (21) [Stream index: 0] Sequence number: 15 (relative sequence number) Acknowledgment number: 55 (relative ack number) Header length: 32 bytes Flags: 0x010 (ACK) 000. .... = Reserved: Not set ...0 .... = Nonce: Not set .... 0... .... = Congestion Window Reduced (CWR): Not set .... 0.. .... = ECN-Echo: Not set .... 0.. .... = Urgent: Not set .... 1 .... = Acknowledgment: Set .... 0... = Push: Not set .... 0.. = Reset: Not set .... 0.. = Syn: Not set .... 0 = Fin: Not set Window size value: 229 [Calculated window size: 29312] [Window size scaling factor: 128] Checksum: 0x163d [validation disabled] [Good Checksum: False] [Bad Checksum: False] Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) Timestamps: TSval 2926140, TSecr 8498768 Kind: Timestamp (8) Length: 10 Timestamp value: 2926140 Timestamp echo reply: 8498768 [SEQ/ACK analysis] [This is an ACK to the segment in frame: 10] [The RTT to ACK the segment was: 0.000031000 seconds]

No. Time Source Destination Protocol Length Info 12 11.640273000 68:05:ca:36:31:f0 68:05:ca:36:33:a0 ARP 60 Who has 10.0.1.11? Tell 10.0.1.12

Frame 12: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface 0 Interface id: 0 Encapsulation type: Ethernet (1) Arrival Time: Feb 19, 2016 16:34:17.474643000 CET [Time shift for this packet: 0.000000000 seconds] Epoch Time: 1455896057.474643000 seconds [Time delta from previous captured frame: 5.005794000 seconds] [Time delta from previous displayed frame: 5.005794000 seconds] [Time since reference or first frame: 11.640273000 seconds] Frame Number: 12 Frame Length: 60 bytes (480 bits) Capture Length: 60 bytes (480 bits) [Frame is marked: False] [Frame is ignored: False] [Protocols in frame: eth:arp] [Coloring Rule Name: ARP] [Coloring Rule String: arp] Ethernet II, Src: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0), Dst: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Destination: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) .... 0. .... = LG bit: Globally unique address (factory default) .... 0. .... = IG bit: Individual address (unicast) Source: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) .... 0. .... = LG bit: Globally unique address (factory default) .... 0. .... = IG bit: Individual address (unicast) Type: ARP (0x0806) Padding: 00000000000000000000000000000000 Address Resolution Protocol (request) Hardware type: Ethernet (1) Protocol type: IP (0x0800) Hardware size: 6 Protocol size: 4 Opcode: request (1) Sender MAC address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Sender IP address: 10.0.1.12 (10.0.1.12) Target MAC address: 00:00:00:00:00:00



(00:00:00:00:00:00) Target IP address: 10.0.1.11 (10.0.1.11)

No. Time Source Destination Protocol Length Info 13 11.640295000 68:05:ca:36:33:a0 68:05:ca:36:31:f0 ARP 42 10.0.1.11 is at 68:05:ca:36:33:a0

Frame 13: 42 bytes on wire (336 bits), 42 bytes captured (336 bits) on interface 0 Interface id: 0 Encapsulation type: Ethernet (1) Arrival Time: Feb 19, 2016 16:34:17.474665000 CET [Time shift for this packet: 0.000000000 seconds] Epoch Time: 1455896057.474665000 seconds [Time delta from previous captured frame: 0.000022000 seconds] [Time delta from previous displayed frame: 0.000022000 seconds] [Time since reference or first frame: 11.640295000 seconds] Frame Number: 13 Frame Length: 42 bytes (336 bits) Capture Length: 42 bytes (336 bits) [Frame is marked: False] [Frame is ignored: False] [Protocols in frame: eth:arp] [Coloring Rule Name: ARP] [Coloring Rule String: arp] Ethernet II, Src: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0), Dst: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Destination: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) .... 0. .... = LG bit: Globally unique address (factory default) .... 0 .... = IG bit: Individual address (unicast) Source: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) .... 0. .... = LG bit: Globally unique address (factory default) .... 0 .... = IG bit: Individual address (unicast) Type: ARP (0x0806) Address Resolution Protocol (reply) Hardware type: Ethernet (1) Protocol type: IP (0x0800) Hardware size: 6 Protocol size: 4 Opcode: reply (2) Sender MAC address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Sender IP address: 10.0.1.11 (10.0.1.11) Target MAC address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Target IP address: 10.0.1.12 (10.0.1.12)

No. Time Source Destination Protocol Length Info 14 11.825979000 10.0.1.11 10.0.1.12 FTP 80 Request: PASS mvkbj1n

Frame 14: 80 bytes on wire (640 bits), 80 bytes captured (640 bits) on interface 0 Interface id: 0 Encapsulation type: Ethernet (1) Arrival Time: Feb 19, 2016 16:34:17.660349000 CET [Time shift for this packet: 0.000000000 seconds] Epoch Time: 1455896057.660349000 seconds [Time delta from previous captured frame: 0.185684000 seconds] [Time delta from previous displayed frame: 0.185684000 seconds] [Time since reference or first frame: 11.825979000 seconds] Frame Number: 14 Frame Length: 80 bytes (640 bits) Capture Length: 80 bytes (640 bits) [Frame is marked: False] [Frame is ignored: False] [Protocols in frame: eth:ip:tcp:ftp] [Coloring Rule Name: TCP] [Coloring Rule String: tcp] Ethernet II, Src: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0), Dst: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Destination: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) .... 0. .... = LG bit: Globally unique address (factory default) .... 0 .... = IG bit: Individual address (unicast) Source: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) .... 0. .... = LG bit: Globally unique address (factory default) .... 0 .... = IG bit: Individual address (unicast) Type: IP (0x0800) Internet Protocol Version 4, Src: 10.0.1.11 (10.0.1.11), Dst: 10.0.1.12 (10.0.1.12) Version: 4 Header length: 20 bytes Differentiated Services Field: 0x10 (DSCP 0x04: Unknown DSCP; ECN: 0x00: Not-ECT (Not ECN-Capable Transport)) 0001 00.. = Differentiated Services Codepoint: Unknown (0x04) .... 00 = Explicit Congestion Notification: Not-ECT (Not ECN-Capable Transport) (0x00) Total Length: 66 Identification: 0xa434 (42036) Flags: 0x02 (Don't Fragment) 0... .... = Reserved bit: Not set .1.. .... = Don't fragment: Set ..0. .... = More fragments: Not set Fragment offset: 0 Time to live: 64 Protocol: TCP (6) Header checksum: 0x805b [validation disabled] [Good: False] [Bad: False] Source: 10.0.1.11 (10.0.1.11) Destination: 10.0.1.12 (10.0.1.12) [Source GeoIP: Unknown] [Destination GeoIP: Unknown] Transmission Control Protocol, Src Port: 41694 (41694), Dst Port: 21 (21), Seq: 15, Ack: 55, Len: 14 Source port: 41694 (41694) Destination port: 21 (21) [Stream index: 0] Sequence number: 15 (relative sequence number) [Next sequence number: 29 (relative sequence number)] Acknowledgment number: 55 (relative ack number) Header length: 32 bytes Flags: 0x018 (PSH, ACK) 000. .... = Reserved: Not set ...0 .... = Nonce: Not set .... 0... .... = Congestion Window Reduced (CWR): Not set .... 0.. .... = ECN-Echo: Not set .... 0.. .... = Urgent: Not set .... ..1 .... = Acknowledgment: Set .... .... 1... = Push: Set .... .... 0.. = Reset: Not set .... .... 0.. = Syn: Not set .... .... 0 = Fin: Not set Window size value: 229 [Calculated window size:

29312] [Window size scaling factor: 128] Checksum: 0x164b [validation disabled] [Good Checksum: False] [Bad Checksum: False] Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) Timestamps: TSval 2927438, TSecr 8498768 Kind: Timestamp (8) Length: 10 Timestamp value: 2927438 Timestamp echo reply: 8498768 [SEQ/ACK analysis] [Bytes in flight: 14] File Transfer Protocol (FTP) PASS mvkby1n Request command: PASS Request arg: mvkby1n

No. Time Source Destination Protocol Length Info 15 11.864114000 10.0.1.12 10.0.1.11 TCP 66 21 > 41694 [ACK] Seq=55 Ack=29 Win=29056 Len=0 TSval=8500076 TSecr=2927438

Frame 15: 66 bytes on wire (528 bits), 66 bytes captured (528 bits) on interface 0 Interface id: 0 Encapsulation type: Ethernet (1) Arrival Time: Feb 19, 2016 16:34:17.698484000 CET [Time shift for this packet: 0.000000000 seconds] Epoch Time: 1455896057.698484000 seconds [Time delta from previous captured frame: 0.038135000 seconds] [Time delta from previous displayed frame: 0.038135000 seconds] [Time since reference or first frame: 11.864114000 seconds] Frame Number: 15 Frame Length: 66 bytes (528 bits) Capture Length: 66 bytes (528 bits) [Frame is marked: False] [Frame is ignored: False] [Protocols in frame: eth:ip:tcp] [Coloring Rule Name: TCP] [Coloring Rule String: tcp] Ethernet II, Src: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0), Dst: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Destination: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0 .... = IG bit: Individual address (unicast) Source: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0 .... = IG bit: Individual address (unicast) Type: IP (0x0800) Internet Protocol Version 4, Src: 10.0.1.12 (10.0.1.12), Dst: 10.0.1.11 (10.0.1.11) Version: 4 Header length: 20 bytes Differentiated Services Field: 0x00 (DSCP 0x00: Default; ECN: 0x00: Not-ECT (Not ECN-Capable Transport)) 0000 00.. = Differentiated Services Codepoint: Default (0x00) .... ..00 = Explicit Congestion Notification: Not-ECT (Not ECN-Capable Transport) (0x00) Total Length: 52 Identification: 0xf880 (63616) Flags: 0x02 (Don't Fragment) 0... .... = Reserved bit: Not set .1.. .... = Don't fragment: Set ..0. .... = More fragments: Not set Fragment offset: 0 Time to live: 64 Protocol: TCP (6) Header checksum: 0x2c2d [validation disabled] [Good: False] [Bad: False] Source: 10.0.1.12 (10.0.1.12) Destination: 10.0.1.11 (10.0.1.11) [Source GeoIP: Unknown] [Destination GeoIP: Unknown] Transmission Control Protocol, Src Port: 21 (21), Dst Port: 41694 (41694), Seq: 55, Ack: 29, Len: 0 Source port: 21 (21) Destination port: 41694 (41694) [Stream index: 0] Sequence number: 55 (relative sequence number) Acknowledgment number: 29 (relative ack number) Header length: 32 bytes Flags: 0x010 (ACK) 000. .... = Reserved: Not set ...0 .... = Nonce: Not set .... 0... .... = Congestion Window Reduced (CWR): Not set .... ..0.. .... = ECN-Echo: Not set .... ..0. .... = Urgent: Not set .... ..1 .... = Acknowledgment: Set .... .... 0... = Push: Not set .... .... ..0.. = Reset: Not set .... .... ..0. = Syn: Not set .... .... ..0 = Fin: Not set Window size value: 227 [Calculated window size: 29056] [Window size scaling factor: 128] Checksum: 0xc017 [validation disabled] [Good Checksum: False] [Bad Checksum: False] Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) Timestamps: TSval 8500076, TSecr 2927438 Kind: Timestamp (8) Length: 10 Timestamp value: 8500076 Timestamp echo reply: 2927438 [SEQ/ACK analysis] [This is an ACK to the segment in frame: 14] [The RTT to ACK the segment was: 0.038135000 seconds]

No. Time Source Destination Protocol Length Info 16 11.937449000 10.0.1.12 10.0.1.11 FTP 89 Response: 230 Login successful.

Frame 16: 89 bytes on wire (712 bits), 89 bytes captured (712 bits) on interface 0 Interface id: 0 Encapsulation type: Ethernet (1) Arrival Time: Feb 19, 2016 16:34:17.771819000 CET [Time shift for this packet: 0.000000000 seconds] Epoch Time: 1455896057.771819000 seconds [Time

delta from previous captured frame: 0.073335000 seconds] [Time delta from previous displayed frame: 0.073335000 seconds] [Time since reference or first frame: 11.937449000 seconds] Frame Number: 16 Frame Length: 89 bytes (712 bits) Capture Length: 89 bytes (712 bits) [Frame is marked: False] [Frame is ignored: False] [Protocols in frame: eth:ip:tcp:ftp] [Coloring Rule Name: TCP] [Coloring Rule String: tcp] Ethernet II, Src: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0), Dst: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Destination: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0 .... = IG bit: Individual address (unicast) Source: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0 .... = IG bit: Individual address (unicast) Type: IP (0x0800) Internet Protocol Version 4, Src: 10.0.1.12 (10.0.1.12), Dst: 10.0.1.11 (10.0.1.11) Version: 4 Header length: 20 bytes Differentiated Services Field: 0x00 (DSCP 0x00: Default; ECN: 0x00: Not-ECT (Not ECN-Capable Transport)) 0000 00.. = Differentiated Services Codepoint: Default (0x00) .... ..00 = Explicit Congestion Notification: Not-ECT (Not ECN-Capable Transport) (0x00) Total Length: 75 Identification: 0xf881 (63617) Flags: 0x02 (Don't Fragment) 0... .... = Reserved bit: Not set .1... .... = Don't fragment: Set ..0. .... = More fragments: Not set Fragment offset: 0 Time to live: 64 Protocol: TCP (6) Header checksum: 0x2c15 [validation disabled] [Good: False] [Bad: False] Source: 10.0.1.12 (10.0.1.12) Destination: 10.0.1.11 (10.0.1.11) [Source GeoIP: Unknown] [Destination GeoIP: Unknown] Transmission Control Protocol, Src Port: 21 (21), Dst Port: 41694 (41694), Seq: 55, Ack: 29, Len: 23 Source port: 21 (21) Destination port: 41694 (41694) [Stream index: 0] Sequence number: 55 (relative sequence number) [Next sequence number: 78 (relative sequence number)] Acknowledgment number: 29 (relative ack number) Header length: 32 bytes Flags: 0x018 (PSH, ACK) 000. .... = Reserved: Not set ...0 .... = Nonce: Not set .... 0... .... = Congestion Window Reduced (CWR): Not set .... .0.. .... = ECN-Echo: Not set .... ..0. .... = Urgent: Not set .... ..1 .... = Acknowledgment: Set .... .... 1... = Push: Set .... .... .0.. = Reset: Not set .... .... ..0. = Syn: Not set .... .... ..0 = Fin: Not set Window size value: 227 [Calculated window size: 29056] [Window size scaling factor: 128] Checksum: 0xde6d [validation disabled] [Good Checksum: False] [Bad Checksum: False] Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) Timestamps: TSval 8500094, TSecr 2927438 Kind: Timestamp (8) Length: 10 Timestamp value: 8500094 Timestamp echo reply: 2927438 [SEQ/ACK analysis] [Bytes in flight: 23] File Transfer Protocol (FTP) 230 Login successful.\*Response code: User logged in, proceed (230) Response arg: Login successful.

No. Time Source Destination Protocol Length Info 17 11.937486000 10.0.1.11 10.0.1.12 TCP 66 41694 > 21 [ACK] Seq=29 Ack=78 Win=29312 Len=0 TSval=2927466 TSecr=8500094

Frame 17: 66 bytes on wire (528 bits), 66 bytes captured (528 bits) on interface 0 Interface id: 0 Encapsulation type: Ethernet (1) Arrival Time: Feb 19, 2016 16:34:17.771856000 CET [Time shift for this packet: 0.000000000 seconds] Epoch Time: 1455896057.771856000 seconds [Time delta from previous captured frame: 0.000037000 seconds] [Time delta from previous displayed frame: 0.000037000 seconds] [Time since reference or first frame: 11.937486000 seconds] Frame Number: 17 Frame Length: 66 bytes (528 bits) Capture Length: 66 bytes (528 bits) [Frame is marked: False] [Frame is ignored: False] [Protocols in frame: eth:ip:tcp] [Coloring Rule Name: TCP] [Coloring Rule String: tcp] Ethernet II, Src: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0), Dst: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Destination: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0 .... = IG bit: Individual address (unicast) Source: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0 .... = IG bit: Individual address (unicast) Type: IP (0x0800) Internet Protocol Version 4, Src: 10.0.1.11 (10.0.1.11), Dst: 10.0.1.12 (10.0.1.12) Version: 4 Header length: 20 bytes Differentiated Services

Field: 0x10 (DSCP 0x04: Unknown DSCP; ECN: 0x00: Not-ECT (Not ECN-Capable Transport)) 0001 00.. = Differentiated Services Codepoint: Unknown (0x04) .... ..00 = Explicit Congestion Notification: Not-ECT (Not ECN-Capable Transport) (0x00) Total Length: 52 Identification: 0xa435 (42037) Flags: 0x02 (Don't Fragment) 0... .... = Reserved bit: Not set .1.. .... = Don't fragment: Set ..0. .... = More fragments: Not set Fragment offset: 0 Time to live: 64 Protocol: TCP (6) Header checksum: 0x8068 [validation disabled] [Good: False] [Bad: False] Source: 10.0.1.11 (10.0.1.11) Destination: 10.0.1.12 (10.0.1.12) [Source GeoIP: Unknown] [Destination GeoIP: Unknown] Transmission Control Protocol, Src Port: 41694 (41694), Dst Port: 21 (21), Seq: 29, Ack: 78, Len: 0 Source port: 41694 (41694) Destination port: 21 (21) [Stream index: 0] Sequence number: 29 (relative sequence number) Acknowledgment number: 78 (relative ack number) Header length: 32 bytes Flags: 0x010 (ACK) 000. .... .... = Reserved: Not set ...0 .... = Nonce: Not set .... 0... .... = Congestion Window Reduced (CWR): Not set .... .0.. .... = ECN-Echo: Not set .... ..0. .... = Urgent: Not set .... ...1 .... = Acknowledgment: Set .... .... 0... = Push: Not set .... .... .0.. = Reset: Not set .... .... ..0. = Syn: Not set .... .... ...0 = Fin: Not set Window size value: 229 [Calculated window size: 29312] [Window size scaling factor: 128] Checksum: 0x163d [validation disabled] [Good Checksum: False] [Bad Checksum: False] Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) Timestamps: TSval 2927466, TSecr 8500094 Kind: Timestamp (8) Length: 10 Timestamp value: 2927466 Timestamp echo reply: 8500094 [SEQ/ACK analysis] [This is an ACK to the segment in frame: 16] [The RTT to ACK the segment was: 0.000037000 seconds]

No. Time Source Destination Protocol Length Info 18 11.937521000 10.0.1.11 10.0.1.12 FTP 72  
Request: SYST

Frame 18: 72 bytes on wire (576 bits), 72 bytes captured (576 bits) on interface 0 Interface id: 0 Encapsulation type: Ethernet (1) Arrival Time: Feb 19, 2016 16:34:17.771891000 CET [Time shift for this packet: 0.000000000 seconds] Epoch Time: 1455896057.771891000 seconds [Time delta from previous captured frame: 0.000035000 seconds] [Time delta from previous displayed frame: 0.000035000 seconds] [Time since reference or first frame: 11.937521000 seconds] Frame Number: 18 Frame Length: 72 bytes (576 bits) Capture Length: 72 bytes (576 bits) [Frame is marked: False] [Frame is ignored: False] [Protocols in frame: eth:ip:tcp:ftp] [Coloring Rule Name: TCP] [Coloring Rule String: tcp] Ethernet II, Src: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0), Dst: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Destination: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0 .... = IG bit: Individual address (unicast) Source: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0 .... = IG bit: Individual address (unicast) Type: IP (0x0800) Internet Protocol Version 4, Src: 10.0.1.11 (10.0.1.11), Dst: 10.0.1.12 (10.0.1.12) Version: 4 Header length: 20 bytes Differentiated Services Field: 0x10 (DSCP 0x04: Unknown DSCP; ECN: 0x00: Not-ECT (Not ECN-Capable Transport)) 0001 00.. = Differentiated Services Codepoint: Unknown (0x04) .... ..00 = Explicit Congestion Notification: Not-ECT (Not ECN-Capable Transport) (0x00) Total Length: 58 Identification: 0xa436 (42038) Flags: 0x02 (Don't Fragment) 0... .... = Reserved bit: Not set .1.. .... = Don't fragment: Set ..0. .... = More fragments: Not set Fragment offset: 0 Time to live: 64 Protocol: TCP (6) Header checksum: 0x8061 [validation disabled] [Good: False] [Bad: False] Source: 10.0.1.11 (10.0.1.11) Destination: 10.0.1.12 (10.0.1.12) [Source GeoIP: Unknown] [Destination GeoIP: Unknown] Transmission Control Protocol, Src Port: 41694 (41694), Dst Port: 21 (21), Seq: 29, Ack: 78, Len: 6 Source port: 41694 (41694) Destination port: 21 (21) [Stream index: 0] Sequence number: 29 (relative sequence number) [Next sequence number: 35 (relative sequence number)] Acknowledgment number: 78 (relative ack number) Header length: 32 bytes Flags: 0x018 (PSH, ACK) 000. .... .... = Reserved: Not set ...0 .... = Nonce: Not set .... 0... .... = Congestion Window Reduced (CWR): Not set .... .0.. .... = ECN-Echo: Not set .... ..0. .... = Urgent: Not set

.... 1... = Acknowledgment: Set .... 1... = Push: Set .... .0.. = Reset: Not set ....  
 ..0. = Syn: Not set .... ..0 = Fin: Not set Window size value: 229 [Calculated window size:  
 29312] [Window size scaling factor: 128] Checksum: 0x1643 [validation disabled] [Good Check-  
 sum: False] [Bad Checksum: False] Options: (12 bytes), No-Operation (NOP), No-Operation  
 (NOP), Timestamps No-Operation (NOP) Type: 1 0... = Copy on fragmentation: No .00. .... =  
 Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) No-Operation (NOP) Type: 1 0...  
 .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation  
 (NOP) (1) Timestamps: TSval 2927466, TSecr 8500094 Kind: Timestamp (8) Length: 10 Times-  
 tamp value: 2927466 Timestamp echo reply: 8500094 [SEQ/ACK analysis] [Bytes in flight: 6]  
 File Transfer Protocol (FTP) SYST Request command: SYST

No. Time Source Destination Protocol Length Info 19 11.938050000 10.0.1.12 10.0.1.11 TCP 66  
 21 > 41694 [ACK] Seq=78 Ack=35 Win=29056 Len=0 TSval=8500094 TSecr=2927466

Frame 19: 66 bytes on wire (528 bits), 66 bytes captured (528 bits) on interface 0 Interface  
 id: 0 Encapsulation type: Ethernet (1) Arrival Time: Feb 19, 2016 16:34:17.772420000 CET  
 [Time shift for this packet: 0.000000000 seconds] Epoch Time: 1455896057.772420000 sec-  
 onds [Time delta from previous captured frame: 0.000529000 seconds] [Time delta from previous  
 displayed frame: 0.000529000 seconds] [Time since reference or first frame: 11.938050000 sec-  
 onds] Frame Number: 19 Frame Length: 66 bytes (528 bits) Capture Length: 66 bytes (528 bits)  
 [Frame is marked: False] [Frame is ignored: False] [Protocols in frame: eth:ip:tcp] [Coloring Rule  
 Name: TCP] [Coloring Rule String: tcp] Ethernet II, Src: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0),  
 Dst: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Destination: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0)  
 Address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) .... ..0. .... = LG bit: Globally unique  
 address (factory default) .... ..0. .... = IG bit: Individual address (unicast) Source:  
 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) .... ..0. ....  
 .... = LG bit: Globally unique address (factory default) .... ..0. .... = IG bit: Individ-  
 ual address (unicast) Type: IP (0x0800) Internet Protocol Version 4, Src: 10.0.1.12 (10.0.1.12),  
 Dst: 10.0.1.11 (10.0.1.11) Version: 4 Header length: 20 bytes Differentiated Services Field: 0x00  
 (DSCP 0x00: Default; ECN: 0x00: Not-ECT (Not ECN-Capable Transport)) 0000 00.. = Differ-  
 entiated Services Codepoint: Default (0x00) .... ..00 = Explicit Congestion Notification: Not-ECT  
 (Not ECN-Capable Transport) (0x00) Total Length: 52 Identification: 0xf882 (63618) Flags: 0x02  
 (Don't Fragment) 0... .... = Reserved bit: Not set .1... .... = Don't fragment: Set ..0. .... = More  
 fragments: Not set Fragment offset: 0 Time to live: 64 Protocol: TCP (6) Header checksum:  
 0x2c2b [validation disabled] [Good: False] [Bad: False] Source: 10.0.1.12 (10.0.1.12) Destina-  
 tion: 10.0.1.11 (10.0.1.11) [Source GeoIP: Unknown] [Destination GeoIP: Unknown] Transmis-  
 sion Control Protocol, Src Port: 21 (21), Dst Port: 41694 (41694), Seq: 78, Ack: 35, Len: 0  
 Source port: 21 (21) Destination port: 41694 (41694) [Stream index: 0] Sequence number: 78  
 (relative sequence number) Acknowledgment number: 35 (relative ack number) Header length:  
 32 bytes Flags: 0x010 (ACK) 000. .... = Reserved: Not set ...0 .... = Nonce: Not set  
 .... 0... .... = Congestion Window Reduced (CWR): Not set .... .0.. .... = ECN-Echo: Not set  
 .... ..0. .... = Urgent: Not set .... ..1 .... = Acknowledgment: Set .... 0... = Push: Not set  
 .... .... .0.. = Reset: Not set .... .... .0. = Syn: Not set .... ..0 = Fin: Not set Window size  
 value: 227 [Calculated window size: 29056] [Window size scaling factor: 128] Checksum: 0xbfcc  
 [validation disabled] [Good Checksum: False] [Bad Checksum: False] Options: (12 bytes), No-  
 Operation (NOP), No-Operation (NOP), Timestamps No-Operation (NOP) Type: 1 0... .... = Copy  
 on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP)  
 (1) No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control  
 (0) ...0 0001 = Number: No-Operation (NOP) (1) Timestamps: TSval 8500094, TSecr 2927466  
 Kind: Timestamp (8) Length: 10 Timestamp value: 8500094 Timestamp echo reply: 2927466  
 [SEQ/ACK analysis] [This is an ACK to the segment in frame: 18] [The RTT to ACK the segment  
 was: 0.000529000 seconds]

No. Time Source Destination Protocol Length Info 20 11.938300000 10.0.1.12 10.0.1.11 FTP 85  
 Response: 215 UNIX Type: L8



Frame 20: 85 bytes on wire (680 bits), 85 bytes captured (680 bits) on interface 0 Interface id: 0 Encapsulation type: Ethernet (1) Arrival Time: Feb 19, 2016 16:34:17.772670000 CET [Time shift for this packet: 0.000000000 seconds] Epoch Time: 1455896057.772670000 seconds [Time delta from previous captured frame: 0.000250000 seconds] [Time delta from previous displayed frame: 0.000250000 seconds] [Time since reference or first frame: 11.938300000 seconds] Frame Number: 20 Frame Length: 85 bytes (680 bits) Capture Length: 85 bytes (680 bits) [Frame is marked: False] [Frame is ignored: False] [Protocols in frame: eth:ip:tcp:ftp] [Coloring Rule Name: TCP] [Coloring Rule String: tcp] Ethernet II, Src: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0), Dst: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Destination: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) Address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0. .... = IG bit: Individual address (unicast) Source: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0. .... = IG bit: Individual address (unicast) Type: IP (0x0800) Internet Protocol Version 4, Src: 10.0.1.12 (10.0.1.12), Dst: 10.0.1.11 (10.0.1.11) Version: 4 Header length: 20 bytes Differentiated Services Field: 0x00 (DSCP 0x00: Default; ECN: 0x00: Not-ECT (Not ECN-Capable Transport)) 0000 00.. = Differentiated Services Codepoint: Default (0x00) .... ..00 = Explicit Congestion Notification: Not-ECT (Not ECN-Capable Transport) (0x00) Total Length: 71 Identification: 0xf883 (63619) Flags: 0x02 (Don't Fragment) 0... .... = Reserved bit: Not set .1... .... = Don't fragment: Set ..0. .... = More fragments: Not set Fragment offset: 0 Time to live: 64 Protocol: TCP (6) Header checksum: 0x2c17 [validation disabled] [Good: False] [Bad: False] Source: 10.0.1.12 (10.0.1.12) Destination: 10.0.1.11 (10.0.1.11) [Source GeoIP: Unknown] [Destination GeoIP: Unknown] Transmission Control Protocol, Src Port: 21 (21), Dst Port: 41694 (41694), Seq: 78, Ack: 35, Len: 19 Source port: 21 (21) Destination port: 41694 (41694) [Stream index: 0] Sequence number: 78 (relative sequence number) [Next sequence number: 97 (relative sequence number)] Acknowledgment number: 35 (relative ack number) Header length: 32 bytes Flags: 0x018 (PSH, ACK) 000. .... = Reserved: Not set ...0 .... = Nonce: Not set .... 0... .... = Congestion Window Reduced (CWR): Not set .... 0.. .... = ECN-Echo: Not set .... ..0. .... = Urgent: Not set .... ..1 .... = Acknowledgment: Set .... .... 1... = Push: Set .... .... 0.. = Reset: Not set .... .... ..0. = Syn: Not set .... .... ..0 = Fin: Not set Window size value: 227 [Calculated window size: 29056] [Window size scaling factor: 128] Checksum: 0x5861 [validation disabled] [Good Checksum: False] [Bad Checksum: False] Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) Timestamps: TSval 8500094, TSecr 2927466 Kind: Timestamp (8) Length: 10 Timestamp value: 8500094 Timestamp echo reply: 2927466 [SEQ/ACK analysis] [Bytes in flight: 19] File Transfer Protocol (FTP) 215 UNIX Type: L8 Response code: NAME system type (215) Response arg: UNIX Type: L8

No. Time Source Destination Protocol Length Info 21 11.975485000 10.0.1.11 10.0.1.12 TCP 66 41694 > 21 [ACK] Seq=35 Ack=97 Win=29312 Len=0 TSval=2927476 TSecr=8500094

Frame 21: 66 bytes on wire (528 bits), 66 bytes captured (528 bits) on interface 0 Interface id: 0 Encapsulation type: Ethernet (1) Arrival Time: Feb 19, 2016 16:34:17.809855000 CET [Time shift for this packet: 0.000000000 seconds] Epoch Time: 1455896057.809855000 seconds [Time delta from previous captured frame: 0.037185000 seconds] [Time delta from previous displayed frame: 0.037185000 seconds] [Time since reference or first frame: 11.975485000 seconds] Frame Number: 21 Frame Length: 66 bytes (528 bits) Capture Length: 66 bytes (528 bits) [Frame is marked: False] [Frame is ignored: False] [Protocols in frame: eth:ip:tcp] [Coloring Rule Name: TCP] [Coloring Rule String: tcp] Ethernet II, Src: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0), Dst: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Destination: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) Address: 68:05:ca:36:31:f0 (68:05:ca:36:31:f0) .... ..0. .... = LG bit: Globally unique address (factory default) .... ..0. .... = IG bit: Individual address (unicast) Source: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0)

Address: 68:05:ca:36:33:a0 (68:05:ca:36:33:a0) .... 0. .... = LG bit: Globally unique address (factory default) .... 0 .... = IG bit: Individual address (unicast)  
 Type: IP (0x0800) Internet Protocol Version 4, Src: 10.0.1.11 (10.0.1.11), Dst: 10.0.1.12 (10.0.1.12) Version: 4 Header length: 20 bytes Differentiated Services Field: 0x10 (DSCP 0x04: Unknown DSCP; ECN: 0x00: Not-ECT (Not ECN-Capable Transport)) 0001 00.. = Differentiated Services Codepoint: Unknown (0x04) .... 00 = Explicit Congestion Notification: Not-ECT (Not ECN-Capable Transport) (0x00) Total Length: 52 Identification: 0xa437 (42039) Flags: 0x02 (Don't Fragment) 0... .... = Reserved bit: Not set .1.. .... = Don't fragment: Set ..0. .... = More fragments: Not set Fragment offset: 0 Time to live: 64 Protocol: TCP (6) Header checksum: 0x8066 [validation disabled] [Good: False] [Bad: False] Source: 10.0.1.11 (10.0.1.11) Destination: 10.0.1.12 (10.0.1.12) [Source GeoIP: Unknown] [Destination GeoIP: Unknown] Transmission Control Protocol, Src Port: 41694 (41694), Dst Port: 21 (21), Seq: 35, Ack: 97, Len: 0 Source port: 41694 (41694) Destination port: 21 (21) [Stream index: 0] Sequence number: 35 (relative sequence number) Acknowledgment number: 97 (relative ack number) Header length: 32 bytes Flags: 0x010 (ACK) 000. .... = Reserved: Not set ...0 .... = Nonce: Not set .... 0... .... = Congestion Window Reduced (CWR): Not set .... 0.. .... = ECN-Echo: Not set .... 0.. .... = Urgent: Not set .... 1 .... = Acknowledgment: Set .... 0... = Push: Not set .... 0.. = Reset: Not set .... 0.. = Syn: Not set .... 0 = Fin: Not set Window size value: 229 [Calculated window size: 29312] [Window size scaling factor: 128] Checksum: 0x163d [validation disabled] [Good Checksum: False] [Bad Checksum: False] Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) No-Operation (NOP) Type: 1 0... .... = Copy on fragmentation: No .00. .... = Class: Control (0) ...0 0001 = Number: No-Operation (NOP) (1) Timestamps: TSval 2927476, TSecr 8500094 Kind: Timestamp (8) Length: 10 Timestamp value: 2927476 Timestamp echo reply: 8500094 [SEQ/ACK analysis] [This is an ACK to the segment in frame: 20] [The RTT to ACK the segment was: 0.037185000 seconds]

### Question 9.A.2)

Identify the login name and the password, shown in plain text in the payload of the packets that you captured.

### Exercise 9-B. Snoop Passwords from a Telnet session

Repeat the above exercise with the `telnet` command instead of `ftp`. On PC1, establish a Telnet session to PC2, and save the Wireshark output of packets used to transmit the login name and password.

### Question 9.B)

Does Telnet have the same security flaws as FTP? Support your answer using the saved output.

### Exercise 9-C. Observing traffic from a Telnet session

This exercise uses the Telnet session established in the previous exercise.

1. Run Wireshark on PC1, and start to capture traffic. If the Wireshark window from the previous exercise is still open, make sure that Wireshark is capturing traffic.

2. If the Telnet session from the previous exercise is still in place, skip to the next step. Otherwise, follow the steps from the previous exercise and log in from PC1 to PC2 with the `telnet` command.
3. Once you are logged in, type a few characters. Observe the number of packets, captured by Wireshark, for each character typed. Observe that for each key you type, there are three packets transmitted. Determine why this occurs.
4. Save the Wireshark output to a text file (using the “Print Summary” option).

**Question 9.C)**

Attach the saved output to your report. Explain why three packets are sent in a telnet session for each character typed on the terminal.