

# Programming and Experimenting with Ethernet

Hui Chen  
Computer Science  
Virginia State University, Virginia 23806

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The objective of this assignment is to gain familiarity with Ethernet addresses including unicast, broadcast, and multicast addresses, Ethernet frame formats, and socket APIs pertinent to programming with Ethernet.

Using the provided example as your basis, you shall complete the tasks in this document and *prepare a report*. In the report, describe *concisely* your activities, observations, and answers.

## 1 Programming and Experiment Environment

Students are to use Linux virtual machines. See the additional document entitled “Setting up Virtual Machines for Network Programming and Experiment” for detail.

Unless explicitly stated otherwise, all the operations shown in this document are command line operations.

## 2 Example Programs

The instructor provides 4 example programs, `ethercap`, `etherinj`, `ethersend`, and `etherrecv`. The programs are hosted on a code repository at [Github.com](https://github.com/huichen-cs/ethernet). Upon log in a Linux virtual machine, you can obtain the source code of the program by cloning the code repository using `git` as follows,

```
git clone https://github.com/huichen-cs/ethernet.git
```

To compile the example programs, go to the directory where the cloned repository resides and issue the command `make`, i.e., provided that you cloned the repository under your home directory, do the following,

```
cd ~/ethernet
make
```

To learn how to use the programs, run the programs from the command line without giving any command line arguments and follow the brief instruction the programs display.

## 3 Tasks

### 3.1 Ethernet Frame Capture and Injection

To make the description of the exercise easier, assume that two individuals, Alice and Bob, are communicate with each other on *two virtual machines*.

*Be aware that your Ethernet interface's name may not be the same as the instructions below.* To determine which Ethernet interface to use is a part of the exercise.

1. Find out available Ethernet interfaces and their status on the two computers Bob and Alice are using the command `ip` and determine an Ethernet adaptor on each computer and the adaptors are on the same Ethernet.
2. Assume that the Ethernet interfaces in both Alice and Bob computers are `eth0`. Be aware that `eth0` is *incorrect* for the provided virtual machines. To determine which Ethernet interface to use is a part of the exercise.
3. Check if the adapters are up using the command `ip`. If an adaptor is down, you can turn it on using the `ip` command. For example, to turn on `eth0`, we run

```
sudo ip link set eth0 up
```

4. Bob starts capturing frames and saving the captured frames to the file `frame_captured.txt` by,

```
sudo ./ethercap eth0 | tee -a frame_captured.txt
```

Note that you may name the captured frame file differently.

5. Alice injects a frame to the link, for example,

```
sudo ./etherinj -s 10:22:33:44:55:66 -d 60:55:44:33:22:11 -m "Hello, World" eth0
```

where 10:22:33:44:55:66 is the Ethernet address of interface `eth0` on Alice's computer, 60:55:44:33:22:11 is the Ethernet address of interface `eth0` on Bob's computer, and the message that Alice transmits to Bob is "Hello, World".

6. After Alice finishes injecting the frame, Bob may stop frame capturing by press `CTRL-C`.
7. Examine the captured frame file to verify the message is successfully transmitted.

Answer the questions,

1. Locate the frame transmitted from `etherinj` and list the values of all fields of the captured Ethernet frame that carries the "Hello, World" message using Table 1 ,
2. Can you run `etherinj` and `ethercap` without using `sudo`?
3. Explain from the computer security perspective, why does Linux require you to run such programs using a special permission, such as using `sudo`?

Table 1: Table for captured frame

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Captured frame in hexadecimals and printable characters:

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Frame Header: destination address:  
Frame Header: source address:  
Frame Header: type or length of frame:  
Body of Frame:

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### 3.2 Unicast, Broadcast, and Multicast

Using the `ethercap` and `etherinj` programs, send and receive a message using `unicast` address, `broadcast` address, and `multicast` address.

Describe the examples and observations in the report.

### 3.3 Extending Programs for Unicast, Broadcast, and Multicast

You are given two other programs, `ethersend` and `etherrecv`. First, figure out how to run the programs. At present, the `etherrecv` program only receives the frames with unicast addresses. Revise the program (or the programs) so that `ethersend` can transmit to `etherrecv` using unicast, broadcast, and multicast addresses.

The instructor suggests that you make a copy of the programs and work on the copy.

Prepare a test procedure and how you test the programs.

### 3.4 Extending Programs for Duplex Communication

The communication achieved via the two programs `ethersend` and `etherrecv` is one way, i.e., `ethersend` can only send message and `etherrecv` can only receive message. In other words, these two programs can send and receive messages on two computers on Ethernet, however, only in simplex fashion.

Extend the programs so that both of the programs must be able to send and receive messages, i.e., in half-duplex or full-duplex fashion. It is simpler to extend the two programs to communicate in the half-duplex fashion than in the full-duplex fashion.

The instructor suggests that you make a copy of the programs and work on the copy.

Prepare a test procedure and how you test the programs.

## 4 Submission

Upload the report, along with the extended programs to Blackboard October 5, 2016.