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Faculty of Engineering

School of Electrical Engineer
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Course: CEG3185
Semester: Summer 2021

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Lab 3 (3%)

Socket Programming and the IP protocol v4

Work in groups of two or individually

Week of June 7 and June 14.

Deadline: June 22nd before midnight

Objectives: (1) to know the importance of IP protocol; and (2) to get familiar with Network Socket programming, which will be needed in subsequent labs.
In this lab, students are required to make two programs using sockets to transmit IP packets from a client to a server.

What to submit (In a zip file named StudentID1_StudentID2.zip):

- Your code (two Java/Python source code files) **before Tuesday, June 22nd.**
- Submit a README file indicating how to run your code.
- Submit a screenshot showing both the client and server consoles when the example below is executed.

The Scenario:
Client's IP: 192.168.0.3 (in this example, it will vary based on your client's IP).
Server's IP: 192.168.0.1 (in this example, it will vary based on your server's IP).

USER
User call the program as follows (if Python is used):
*python packet_sender.py -server 192.168.0.1 -payload "**COLOMBIA 2 - MESSI 0**"*

CLIENT PROGRAM (Encoder - packet_sender.py)

Converts the string to HEX:

434f 4c4f 4d42 4941 2032 202d 204d 4553 5349 2030

Encapsulates the data into an IP datagram (packet) and initializes the checksum to 0000.

4500 0028 1c46 4000 4006 **0000** C0A8 0003 C0A8 0001 **434f 4c4f 4d42 4941 2032 202d 204d 4553 5349 2030**

Calculates the checksum:

4500 0028 1c46 4000 4006 **9D35** C0A8 0003 C0A8 0001 **434f 4c4f 4d42 4941 2032 202d 204d 4553 5349 2030**

and sends it to the client.

SERVER PROGRAM (Decoder - packet_receiver.py)

> *Receives the data stream and prints to the screen the data received with the following message:*
> *The data received from 192.168.0.3 is COLOMBIA 2 - MESSI 0*
> *The data has 160 bits or 20 bytes. Total length of the packet is 40 bytes.*
> *The verification of the checksum demonstrates that the packet received is correct.*

If the packet received is corrupted, the following message should be printed:

> *The verification of the checksum demonstrates that the packet received is corrupted. Packet discarded!*

More details

Consider the stream used in our scenario above:

4500 0028 1c46 4000 4006 9D35 C0A8 0003 C0A8 0001 **434f 4c4f 4d42 4941 2032 202d 204d 4553 5349 2030**

- **45** corresponds to the first two fields of the header. 4 means IPv4 and 5 corresponds to the header length. Since header length is described in 4 byte words, the actual header length comes out to be 5×4=20 bytes. [fixed]
- **00** corresponds to TOS or the type of service. This value of TOS indicated normal operation. [fixed]
- **0028** corresponds to the total length field of the IP header. So, in this case the total length of the IP packet is 40 bytes. The header is made of 20 bytes, the payload includes 20 bytes. [variable]
- **1c46** corresponds to the identification field. ~~[variable]~~ fixed for this lab
- **4000** can be divided into two bytes. These two bytes correspond to the flags and fragment offset of IP header fields. [fixed for this lab]
- **4006** can be divided into ’40’ and ’06’. The first byte ’40’ corresponds to the TTL field and the byte ’06’ corresponds to the protocol field of the IP header. ’06’ indicates that the protocol is TCP. [fixed]
- **9D35** corresponds to the checksum which is set at the source end (which sent the packet) [variable]
- The next set of bytes **C0A8 0003** (192.168.0.3) and **C0A8 0001** (192.168.0.1) correspond to the source IP address and the destination IP address in the IP header. [**variable** - it will depend on the address of the client and the server]
- 434f 4c4f 4d42 4941 2032 202d 204d 4553 5349 2030 corresponds to the payload (20 bytes in this case).[**variable**]

For simplicity: All fields marked as [fixed] will be hardcoded. No options are included in the packet.
The payload length + header length must be divisible by 8. If this is not the case, padding must be performed (add zeros to the payload).

How the checksum (16 bits) is calculated - ENCODING:

If we consider the header checksum field to be 0 and calculate the total of all 16 bits, it will be:

4500 + 0028 + 1c46 + 4000 + 4006 + **0000** + C0A8 + 0003 + C0A8 + 0001 = 262C8

Calculating further, adding carry: 2+62C8 = 62CA.

One's complement represented in hex: 9D35 (FFFF-62CA)

Note that the checksum is calculated using only the header fields. That is, the payload bytes are not included in the calculation.

How the checksum (16 bits) is verified - DECODING:

4500 + 0028 + 1c46 + 4000 + 4006 + 9D35 + C0A8 + 0003 + C0A8 + 0001 = 2FFFD

Calculating further, adding carry: 2+FFFD = FFFF

One's complement represented in hex: 0000 (No error)

Additional instructions:

- **You need to implement two programs,** a client and a server and two functions (methods), one to encode (at the client side), one to decode (at the server side).

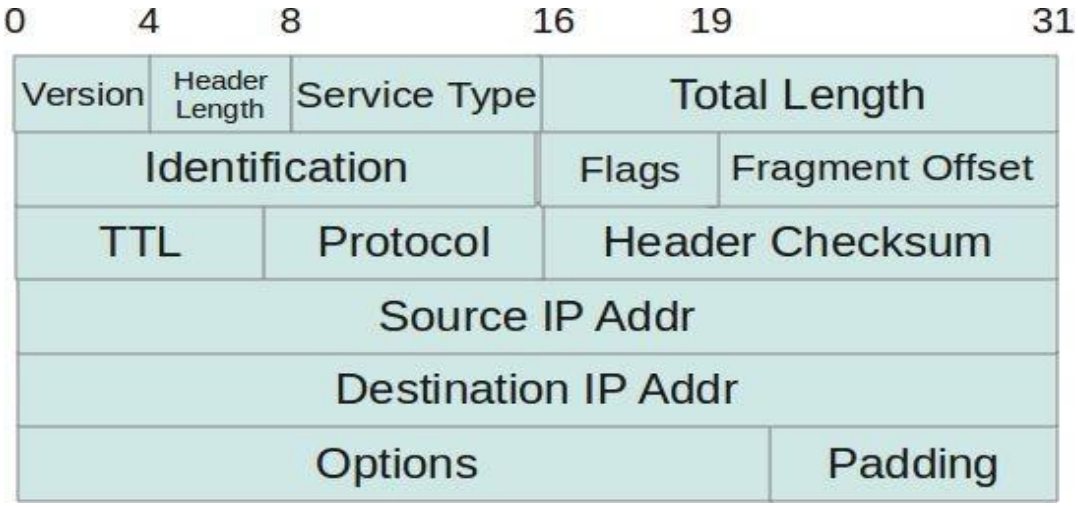
  The Client: PacketSender.java or packet_sender.py
  - Encodes the data.
  - Sends the encoded stream to the server through socket

  Server: PacketReceiver.java or packet_receiver.py
  - Acknowledges the client that the encoded stream has been received
  - Decodes the stream and prints it on the screen

You can code the two programs using Java or Python 3.

Use any necessary built-in functions for the ASCII->HEX conversions.

For more info:



Python Sockets:
https://docs.python.org/2/howto/sockets.html

Java Sockets:
https://docs.oracle.com/javase/tutorial/networking/sockets/clientServer.html

The following will be marking scheme used by the TA:

Component	**Grade**
1. Client communicates to a server through a **Socket**	20 points
2. **Encoding** operation works correctly	10 points*
3. **Decoding** operation works correctly	10 points*
4. **README** describes how to run the code	5 points
5. At the client side, user can send any desired message.	5 points
Total	**50 points**

* The TA will run five different test cases. Using different payloads. Make sure that the provided example works.