Team Project (20%)

The students form their own teams with no more than 4 members. The graded deliverables of all projects include:

- **Demo** (20%, week 14): 30 minutes. Research project teams run the demo of their implementation with test cases.

Description.

Objective: The hands-on project aims to develop system implementation skills. The students embody their understandings of network security concepts with demonstrable artifacts which reciprocally deepens their understandings. The implementation can be done with any language including C, Java and Python.

Network Description: The project is to use software to emulate simplified IP over Ethernet with add-on security features. The topology of the network to emulate is depicted below. It consists of three network nodes: Node1, Node2 and Node3; and one router R.

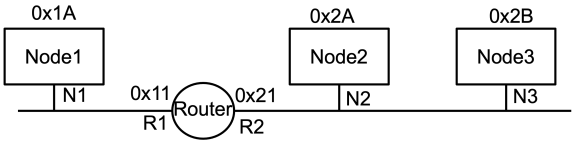

Figure 1. The topology of an emulated IP-over-Ethernet network.

(1) Ethernet emulation: Use the network API provided by the programming language to emulate Ethernet communications. The MAC addresses are defined as two ASCII characters. Specifically, “N1” for Node1, “N2” for Node2, “N3” for Node3; and “R1”, “R2” for Router’s two interfaces.
   a. Use the networking API (e.g., sockets) to emulate the effect of Ethernet broadcast. For example, when Router communicates with Node2, the frame will also be received by Node3.
   b. Emulate the MAC behavior so that a network interface will drop the datagram if it is not the intended receiver. In the previous example, Node3 drops the frame sent from Router to N2.

The emulated Ethernet frame has the following format:

2 bytes	2 bytes	1 byte	up to 256 bytes
Source	Destination	DataLength	Data

For example: Node1 sends an Ethernet frame to R.

N1	R1	7	MY DATA

(2) IP emulation: The emulated IP addresses of Node1, Node2 and Node3 are 0x1A, 0x2A, and 0x2B respectively. The IP addresses assigned for Router's are 0x11 for R1 and 0x21 for R2. The emulated IP packet has the following format:

1 byte	1 byte	1 byte	1 byte	up to 256 bytes
Source	Destination	Protocol	DataLength	Data

For example: Node1 sends an IP datagram to Node2.

0x1A	0x2A	0	5	HELLO

"Protocol" in the packet can be:

- 0: ping protocol. The recipient replies to the sender with the same data.
- ~~1: kill protocol. The recipient exits (dropped from requirement).~~

Project Requirements and Rubrics:

- Basic network emulation and Three protocols (7%): Please implement the emulation of IP over Ethernet of the network in Figure 1. Each node has its own console to print out the emulated IP packets, Ethernet frames it receives and sends.
  - Ethernet: 2%
  - IP: 3%
  - ~~two protocols: 1% each~~ Ping protocol: 2%
- IP Spoofing (2%). Node1 is malicious. It impersonates Node3 to ping Node1.
- Sniffing attack (1%). Node3 is malicious. It sniffs Node2's communications.
- Firewall (2%). Node3 has a packet filter. The firewall needs to support user configuration. For instance, a user can add a rule that blocks all packets from Node2 and accept all others.
- Open category (8%). Design and implement other security functions or attacks. Grades given in three levels: A (8,6), B (5,3), C (2,1) according to the *correctness*, *novelty* and *difficulty* in implementation.

Individual Grade: Each team will be given a team grade. The team members' individual grades will be adjusted according to peer evaluation within the team and the instructor's evaluation.