**[CIIC4070 / ICOM5026] Computer Networks**

**Project 2 – Protocol Analysis, Design, and Testing**

**Overview**

* This project is an **individual** project.
* In this project, you will need to **analyze, design, and test** protocol.
* In this project, the design of protocol shall be based on layer modeling.
* In this project, you will also learn how to use programming tools: Python and Jupyter Notebook (see details below).
* In this project, you must submit a zip file that contains a Jupyter notebook file and a report.
  + **The plagiarism check is not enabled for this project.**

**Required Steps**

1. Set up a Python environment using Jupyter Notebook
   1. Download and install the latest version of Python from site:
      1. <https://www.python.org/downloads/>
   2. Download and install Jupyter Notebook from site:
      1. <https://jupyter.org/>
   3. Download the notebook file from course Moodle site (see References)
      1. Python code for a Stop-and-Wait protocol with retransmission
      2. To use ipywidgets, follow instructions in
         1. <https://ipywidgets.readthedocs.io/en/latest/user_install.html>
2. Analyze the protocol developed by the professor.
   1. Start Jupyter Notebook in your computer.
   2. Run all cells in the notebook, making sure all threads are alive.
   3. In the textbox of “Alice”, type “Alice to Bob” and press Enter.
   4. Then, in the textbox of “Bob”, type “Bob to Alice” and press Enter.
   5. Based on the printed message, explain how one message can be send from Alice to Bob via multiple entities in different layers.
3. Emulate a different physical layer.
   1. **Revise** the loop\_Tx function in the PLE\_TR class, such that:
      1. The transmission will be delay after a random amount of time
         1. In range 0 second to 2 seconds
      2. The transmission will be lost with probability 10%
      3. The transmission will be duplicated with probability 5%
   2. Using the same steps in (2), explain the impacts of the new physical layer entity.
4. Design and use a measurement layer.
   1. Following the design style of the given protocol, design a class MLE\_TR for measurement.
   2. When constructing an MLE\_TR object, create a ipywidgets.Button object
   3. Define a call back function to handle the click event
      1. In the callback function, send **100 messages** by calling a low layer interface.
      2. Each packet shall indicate experiment ID, message ID, and current time with accuracy to millisecond.
         1. You shall use time.time\_ns() function
   4. Design a loop\_Rx function to receive messages from another entity
      1. Using the Experiment ID, message ID, and the transmission time to measure
         1. The average delay
         2. The average message loss rate
         3. The average message duplication rate
   5. In one experiment, create a system with two nodes and two layers.
      1. MLE\_TR object is the upper layer of PLE\_TR object.
      2. Measure the node-to-node performance.
   6. In one experiment, create a system with two nodes and three layers.
      1. MLE\_TR object is the upper layer of DLE\_TR object.
      2. DLE\_TR object is the upper layer of PLE\_TR object.
      3. Measure the node-to-node performance.
5. Record a video.
   1. Use OBS to record screen and your explanation for all illustration in previous steps in (2), (3), and (4)
   2. Upload a video to YouTube using your upr account
      1. Set its access to private
      2. Share it to me: [kejie.lu@upr.edu](mailto:kejie.lu@upr.edu)
   3. **Include the link of your video in the reference of the report.**
6. Submit a zip file that include you Jupyter notebook file (i.e., your source code) and a report (See more instructions below)

**Content in the report**

* Cover page with the following information:
  + Logo of UPRM
  + Title
  + Course
  + Name of student with Student IDs
  + Name of Professor
  + Department
* Table of content
* Section 1: Introduction
  + Overview of the project
  + Outline of the rest of this report
* Section 2: The Layer Model used in the given protocol.
  + Describe the layer model.
    1. Use a figure to illustrate entities in all layers.
* Section 3: The finite state machine in the data layer
  + Describe all states.
  + Describe all events.
  + Describe the state transition.
    1. Use a figure to illustrate the state transition diagram.
* Section 4: The design of a measurement layer
  + Design of the constructor
  + Design of the loop\_Rx function
  + Design a method to generate measurement output.
    1. You will need to specify when the output shall be generated because the lower layer can be unreliable.
* Section 5: Conclusions
* References
  + Need **at least 10 references** for software used, standards, research papers, **link to your video**, etc. (**IEEE Style**)