COSC 465 Capstone Project Proposal

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Project Objective and Motivation

- **Objective:** We aim to develop a router simulation using Python and sockets to facilitate communication between devices on a simulated network. Initially, the router will utilize ARP protocol to collect MAC addresses and build a routing table for devices within the same network, enabling packet forwarding. We will focus on direct links and multiple hops protocols. We won't use any networking Python libraries to connect to actual routers but rather create classes.

- **Motivation:** By building a router simulation, we aim to understand networking fundamentals, including packet routing and communication protocols. This project offers a practical learning experience that bridges theoretical knowledge and real-world implementation, preparing us for future network engineering and system administration challenges.

Project Plan

1. Define Router and Network Device and Packet Classes

   a. Creating a class that simulates a router, including attributes for routing tables, ARP tables, and interfaces.

   b. Create a class that simulates network devices (e.g., computers) that can send and receive packets.

   c. Create a class that pretends to be a packet, including specific variables such as the IP of the source and destination.

2. Implement ARP Simulation

   a. To implement ARP, we must include a method to manage an ARP table mapping IP addresses (subnet of router IP) to MAC addresses. Implement functions to simulate sending and receiving ARP requests and replies to populate the ARP table.

3. Implementing Basic Routing Capabilities

a. For the first milestone, we should have our "routers" topology predefined so that we can test sending packets from clients to other destinations. This would involve creating a static routing table that defines fixed routes between nodes. Run test cases to see if we are able to 'send' packets over the network created by us.

4. Implementing Dynamic Routing Capabilities

a. Incorporate a Protocols class that includes dynamic routing protocols such as Link State (OSPF), etc. Will have to rework on the Router class.

What do you expect to accomplish by the first and second milestones?

a. **First Milestone:** By the first milestone, we aim to have implemented basic router functionality, including packet forwarding based on static routing tables. Additionally, we plan to establish communication between the router and simulated devices using the ARP protocol.

b. **Second Milestone:** By the second milestone, we intend to enhance the router-to-router simulation by implementing link-state protocols (need to google specific ones like OSPF). We also aim to conduct extensive testing using simulated network traffic to validate the efficiency of our simulation.

2. What do you expect to accomplish by the end of the project?

a. By the end of the project, we expect to have a fully functional router simulation capable of dynamically routing packets between simulated devices based on real-world routing protocols. Additionally, we plan to document our findings and experience in a project report.

Artifacts to Deliver

- **Written Report:** a comprehensive report detailing the design, implementation, testing, and evaluation of the router simulation.

- **Source Code:** The Python codebase of the router simulation is hosted on GitHub.

- **Documentation:** User manuals and technical documentation are used to facilitate understanding and usage of the router simulation.

EXTRA (if time allows us):

- We may have a feature to show the simulation. This would create a UI aspect that shows what's happening with the routers. With this, it would ask the user how many nodes in the network, how many clients are for each node, and a button for clients to "send a packet" over the network. The main plan is to have everything printed out in Terminal, but a UI would be more useful as an educational tool.

Survey of Related Prior Artifacts

- Pyrouter, a Python-based router simulation project available on GitHub (useful reference)

  https://github.com/desultory-zz/pyrouter

- The Internet Topology Zoo dataset, which contains network topologies that can be used for testing and evaluating http://www.topology-zoo.org/dataset.html

- Found this 2023 paper about routing:

  https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=10143010

- This article gives us an in-depth overview of some of the routing protocols we plan to use in our project, which can help us with our implementation:

  https://link.springer.com/chapter/10.1007/978-0-387-35600-6_2