ECE435: Embedded Systems – Final Project

Due: Friday, 5 May 2023 (Last day of Finals)

Overview:

- Design a project that in some way involves a network.

Guidelines:

- You may work either alone or in groups of two or three. If you work in a group your end project will have higher expectations.
- You may use any hardware you like, as long as it is network related.
- You may use any programming language you like.

Part 1: Topic Selection (due 28 March 2023) (5pts)

Each group should send a brief e-mail describing your project topic and listing group members.

Part 2: Progress Report (due 13 April 2023) (10pts)

A brief status update detailing progress your group has made. This is primarily to make sure your project is on track to be finished in time; if things are not going well the topic can be adjusted.

Send this report by e-mail. Only one submission is needed per group.

1. State in one sentence a summary of your project.
2. Describe the hardware/software that you will be using
3. Have you done any preliminary testing yet? Are you on track for being finished on time?
4. Will you be willing to volunteer to present Tuesday (25 April) rather than Thursday (27 April)?
5. Submit the status update by e-mail.

Part 3: In-Class Presentation 25 & 27 April 2023 (40pts)

- You will have 10 minutes to present. Be sure to budget time for questions and demo (8 minutes of presenting, 2 minutes of demo/questions?) Points may be taken off for going over.
- You may present slides using the projector if you want, but that's not strictly necessary.
- Your presentation should have at least the following information. Feel free to include more.
  - Brief overview of your project.
  - A summary of the hardware/software being used
  - What network layers are involved
  - Any security issues with the project
  - Challenges: list any challenges you had getting things working.
  - Future work: things you might add if you had more time.
  - Leave time to do a brief demo if possible

Part 4: Project Writeup, Due 5 May 2023 (45pts)

This will be a short paper (at least 6 pages, but you can include pictures, diagrams, etc.) that must contain all of the following:

1. Introduction: The purpose of your project and a high level overview.
2. Related Work
   (a) Has anyone done a project like this before?
   (b) How does your project compare to existing similar projects?
3. Experimental Setup:
   (a) Describe the devices and software you used.
   (b) Include enough info so someone can replicate your results.
   (c) Are there any security implications?
   (d) What network layers are involved?
4. Results: What results did you find? Tables and Graphs are nice.
5. Conclusion
   (a) If you worked in a group: List who worked on what part.
   (b) Challenges: List any challenges you had, and if things didn't work, explain why.
   (c) Future Work: List any improvements you might make if you had more time and resources to work on the project.

6. Appendix

   (a) Any source code (this can be submitted as a separate file, does not have to be included in the report).

   (b) I plan to put a summary of the projects on the course website, possibly including project reports. If you do not want your project posted, please indicate this in the final writeup.

E-mail your final report to me. pdf or word document is fine, the code should be attached too.

Project Ideas:

- Physical Layer
  - GNU radio, software-defined radio
    Use SDR to capture network packets
    Use SDR to monitor airplane flights
    Use SDR to download images from satellites
  - Compare fiber vs wired vs wireless
- Link Layer
  - Explore limits of Bluetooth
  - Connect two pis over bluetooth?
  - Use pi3 to do bluetooth stuff (wii controller? headset?)
  - Xbee/Zigbee
  - HAM radio networking
  - Use bluetooth near 802.11 and see if packet rates go down due to interference?
  - How does 802.11 bandwidth/latency go down with distance?
  - Triangulate position based on nearby wireless routers and signal strength
- Network Layer
  - Set up routing in a Network Simulator
  - Set up a IPv6 network between some raspberry pis
    Compare to IPv4 setup
- Internet Layer
  - Write simple IP stack for small embedded board (Apple II, arduino, etc)
  - Packet intercepting. Project where wireless router acts as proxy, flips all images upside down
  - Benchmark. What's the fastest bandwidth you can get out of your machine? our of a Pi/Pi2/Pi3?
  - fastest bandwidth you can get of a gigabit Ethernet on windows/linux/osx?
  - Multicasting. Multicast something?
- Application Layer

  - Write a web browser (this is very hard!)
  - Set up a webserver on a Raspberry Pi and do something interesting with it
  - Write a networked video game, chat room, etc
  - Set up network attached storage
  - Benchmark various web-servers.
  - Write some code using web-sockets.
- Security
  - Explore (on a private network) various DoS methods and how to block them
  - Set up a firewall with advanced features
  - Set up pi-hole ad blocking software

Project Ideas from Previous Years:

- Webserver benchmarking
- Pi webcam
- SDR monitoring airline flights
- Online checkers game
- UDP audio streaming
- Pi webserver guestbook
- ARP spoofing
- Bluetooth light sensor
- Weather station with SQL/Web interface
- Network-connected robot
- Networked video game
- Networked parking sensor
- DNS server setup
- Ping pong score server
- VPN setup
- Text-based web browser
- Custom ethernet driver in FPGA
- Encrypted network tunnel

- Raspberry Pi network chat
- Unity to python client/server interface
- Raspberry Pi DDoS mitigation
- Networked Battleship game
- Raspberry Pi network attached storage