

Argus

Final Design Report

Table of Contents

Abstract	3
Project Description	4
User Stories	5
Design Diagrams	5
High-Level	6
Mid-Level	6
Low-Level	6
Design Components	7
Project Tasks	8
Task List	8
Effort Matrix	10
ABET Constraints Essay	11
Slideshow	13
Self Assessment Essays	15
Professional Biographies	21
Budget	25
Appendix	25

Abstract

Obtaining physical locations of devices is becoming essential with the massive quantity of internet connected machines. GPS is frequently used for obtaining device location, but it's battery expensive and not accurate indoors. Argus allows a network administrator to monitor the locations of devices connected to, or nearby, a mesh network. Using a combination of signal strength and Time of Flight information obtained from intercepting packets sent over a wireless mesh network, the goal of Argus is to display relative locations of devices with a resolution of up to 2 meters.

Project Description

Team Members

- Matt Ihlenfeld: ihlenfmt@mail.uc.edu
- Anthony Jantzen: jantzean@mail.uc.edu
- Pat Millott: millotpg@mail.uc.edu
- Kyle Trout: troutkt@mail.uc.edu

Faculty Adviser

- Dr. Dharma Agrawal: agrawadp@ucmail.uc.edu

Background Description

A tool that allows a central node to measure distance between multiple WiFi emitters. This tool will use a hybrid of RSSI and time of flight based distance measurements to estimate target locations.

Problem Statement

This application will allow for indoor location tracking where GPS is not reliable. This application also provides a cross-platform user interface.

Inadequacy of Current Solutions

Current solutions use signal strength information (RSSI) which requires pre-known information on wireless access points in order to triangulate location. RSSI based distance measurements are also not as accurate as time of flight based distance calculations which is hybridized in this project.

Background Skills/Interests

Our team overall has a general interest in networking and security, with three out of the four members possessing a background in security already. In addition, most if not all team members have some experience in web development and UI design, peaking the interests of those more inclined to application development and design. Above all else, this project looks to be a challenging task that will no doubt result in a very useful final product.

Goals

- A listing of devices on a network including MAC address, hostname, manufacturer, and status
- Approximate location for each device listed with visual representation
- Live, cross-platform interface with location mapping and notifications
- Location accuracy within 2 m

Expectations

Ideally, our team aims to fulfill the goals above and any additional requirements added along the way. A hands on demo targeting the visual rendering of a device's location and information will be essential to our development and planning.

User Stories

The following are stories presenting potential use cases of the solution for three different user roles:

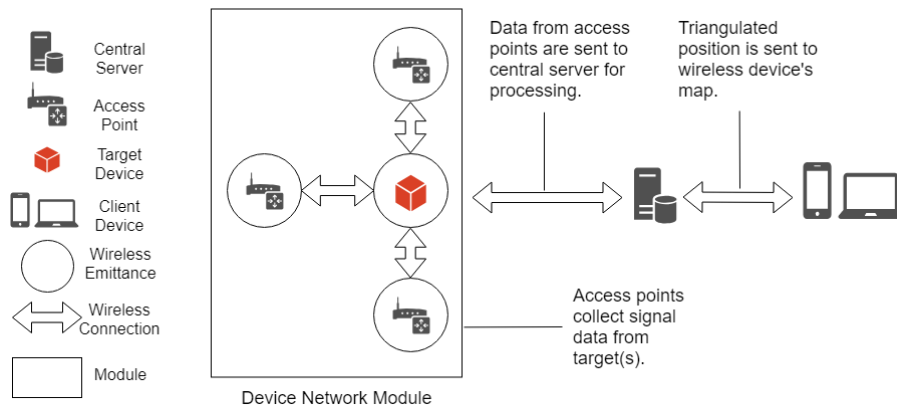
- As an IT Specialist, I want to view the devices on my network so I can obtain full transparency over it.
- As a warehouse manager, I want to track the location of IoT devices in my warehouse to monitor their actions.
- As a conference planner, I want to view movement patterns of conference attendees to determine hot spots in the building(s).

Design Diagrams

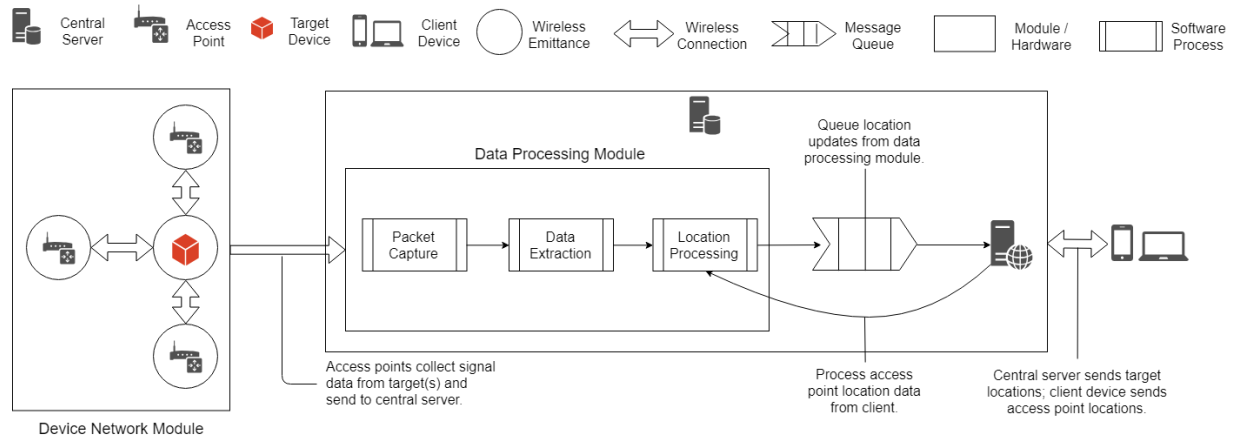
Below are three design diagrams representing the solution at varying complexity. They are detailed as follows:

- High-Level: Basic overview of inputs and outputs to the system.
- Mid-Level: Intermediate overview of modules and submodules to the system.
- Low-Level: Advanced overview with granular descriptions of modules/submodules in the system.

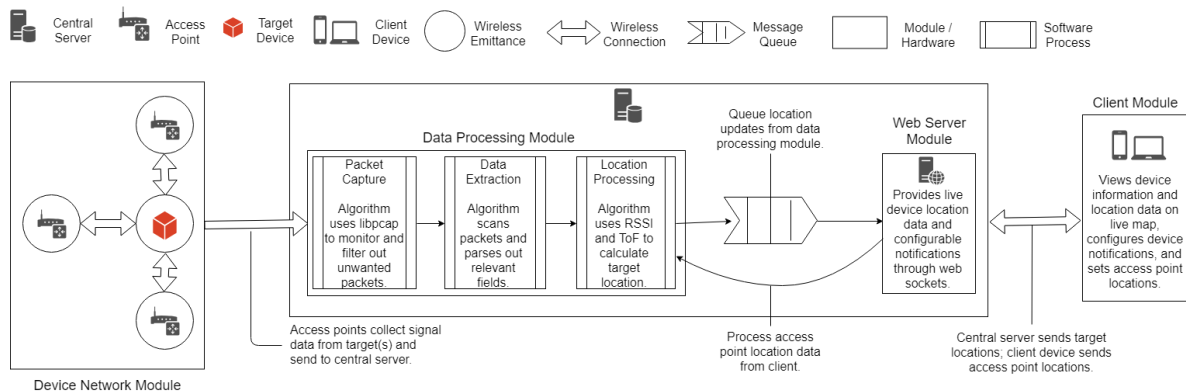
High-Level



Mid-Level



Low-Level



Design Components

The following is a brief description of each component featured in the design diagrams:

- Central Server
 - A central server to process the data received from access points for device locations and house the web server for communications with the client device.
- Access Point
 - A device that creates a wireless local area network (WLAN).
- Target Device
 - Device(s) for which the user is attempting to track the location of.
- Client Device
 - Device(s) that the user administrates with and uses to view and locate target devices.
- Wireless Emittance
 - An area where a wireless internet connection is detected/emitted from a device or access point.
- Wireless Connection
 - A wireless internet connection between two computing systems.
- Message Queue
 - A submodule to queue and efficiently send updated location data to the web server.
- Web Server
 - A web server to house a web application which provides device information and locations.

Project Tasks

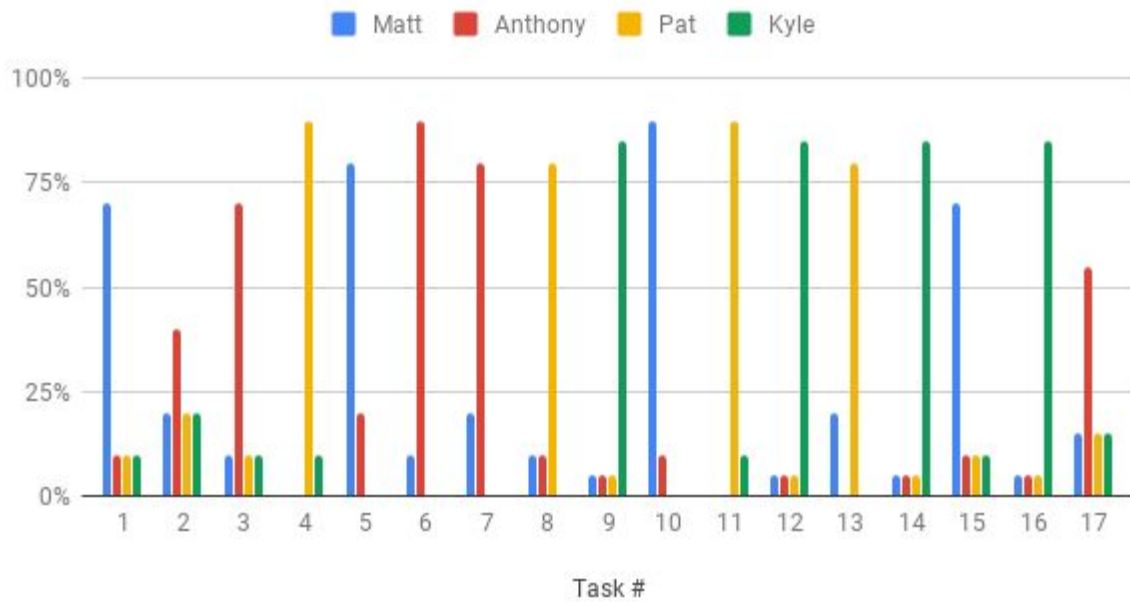
Task List

Task #	Description	Start Date	End Date	Prerequisite
1	Research triangulation/trilateration methods and prior work relevant to project.	2018-10-01	2019-01-16	-
2	Obtain required hardware components for project, such as access points, central server, and client/target devices.	2018-12-12	2019-01-16	-
3	Manage documentation, requirements deadlines, and code testing for project.	2019-01-16	2019-04-03	-
4	Set up web server within central server.	2019-01-16	2019-01-30	2
5	Set up container for central server to be used in CI infrastructure.	2019-01-16	2019-01-30	2
6	Write module to capture and filter packets on central server.	2019-01-16	2019-01-30	2
7	Write module to process packets and retrieve relevant data on central server.	2019-01-30	2019-02-13	2,6
8	Set up lightweight/in-memory data management system to store device information and locations.	2019-01-30	2019-02-13	2,4
9	Develop list view of nearby devices for client device to show general device information.	2019-01-30	2019-02-13	-

10	Write algorithm to locate devices from processed packet data.	2019-02-13	2019-02-27	1,2,7
11	Generate communications module between central server and client device.	2019-02-13	2019-02-27	2
12	Develop display for client device to show nearby devices with map and distances.	2019-02-27	2019-03-13	-
13	Generate message queue from location processing module to the web server to efficiently provide updates to the client.	2019-02-27	2019-03-13	2,4,8,10,11
14	Create configurable push notification system for client device.	2019-03-13	2019-03-27	9
15	Set up continuous integration (CI) infrastructure for seamless deployment and integration of modules.	2019-03-13	2019-03-27	2-13
16	Generate mobile friendly view for client device.	2019-03-13	2019-03-27	9,12
17	Write and perform unit and integration tests for design modules.	2019-03-27	2019-04-03	2-16

Effort Matrix

Effort Per Task



ABET Constraints Essay

Economic

Based on the current standing of our project, there are some financial limitations to our solution. We do not have a formal budget outlined, but we have hardware requirements that must be met. These include the access points, central server, and client devices used for testing which are detailed in our design diagrams. Funds for the hardware are being supplied personally by team members at the moment. However, our solution is very similar to a proposal outlined by Northrop Grumman Corporation, so we may reach out to the contact listed to see if we can secure funds. Because of this cost, we've designed our solution to use only custom built or open source software to keep the software development costs low. We plan on setting up a network in our own homes to test the solution, but we may seek permission to utilize UC networks to test on a larger scale.

Legal

Legally, our project could possibly run into issues. Looking at our user stories, we do not foresee any issues arising from the IT specialist or warehouse manager scenarios. This is because they deal with private or enterprise use cases and the users would have a right to know the information we (they) will be gathering on devices. The conference planner scenario on the other hand could be diving into some gray area because it deals more with public networks. In the U.S., this form of location tracking might not be strictly illegal but we could foresee individuals taking issue with it all the same. Outside of the U.S., European privacy laws (GDPR) are extremely strict, so any form of personally identifiable information gathered could violate these policies.

Security

From a security standpoint, there are certainly concerns that our solution faces. Any form of computer or computing infrastructure is subject to cyber attacks today. Only the role identified in the user stories should have access to the information identified in our solution. However, when dealing with a public network scenario, there is the threat of a random target device sending malicious packets that could be picked up by our access points. Our solution will need to take this into consideration and ensure these packets are filtered out. Additionally, the privacy concerns revolving around the information that is being gathered presents a possible security vulnerability as discussed in the legal section.

Social

Socially, our solution has several benefits. The user stories we have identified only deal with corporations or organizations. However, the enhancements seen by these groups we believe will trickle down to a broader area in society. For example, the conference planner could use our solution to analyze movement patterns of conference attendees or the popularity of certain exhibits or workshops. Consequently, the planner could adjust exhibit locations or other conference items to reduce wait times or relieve congestion in the facility, thereby enhancing the attendee experience. Additionally, our solution could improve the efficiency of the IT specialist, allowing them to address other pressing issues for company employees. As a result, this reduces response times and improves employee sentiment for the company.

Slideshow

Argus

Senior Design I
Fall 2018

General Information

Team Members

- Matt Ihlenfeld: ihlenfmat@mail.uc.edu
- Anthony Jantzen: jantzean@mail.uc.edu
- Pat Millott: millotpg@mail.uc.edu
- Kyle Trout: troutkt@mail.uc.edu

Project Adviser

- Dr. Dharma Agrawal

Abstract

- More and more devices are emitting wireless traffic
 - Having access to these devices' locations can be extremely useful
- GPS is inefficient and unreliable
- Argus collects location information using devices' WiFi connection
 - Uses signal strength and time of flight to obtain an accurate reading

Project Background

Purpose

An application that will allow for indoor location tracking where GPS is not reliable, providing a cross-platform user interface.

Goals

- A listing of devices on a network including MAC address, hostname, and manufacturer
- For each device, it's approximate location listed, as well as a visual rendering
- Live cross-platform interface with location mapping and notifications
- Location accuracy within 3 m

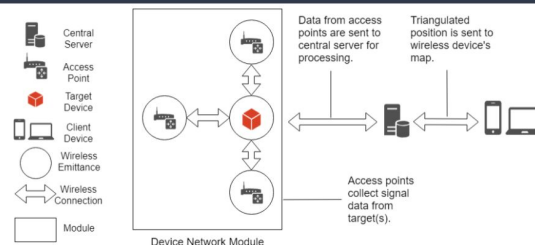
User Stories

As an IT specialist, I want to view the devices on my network to obtain full transparency over it.

As a warehouse manager, I want to track the location of IoT devices in my warehouse to monitor their actions.

As a conference planner, I want to view movement patterns of conference attendees to determine hot spots in the building(s).

High Level Design



Mid Level Design

Central Server, Access Point, Target Device, Client Device, Wireless Emittance, Wireless Connection, Message Queue, Module / Hardware, Software Process

Device Network Module

Data Processing Module

Packet Capture, Data Extraction, Location Processing

Queue location updates from data processing module

Access points collect signal data from target(s) and send to central server

Process access point location data from client

Central server sends target locations, client device sends access point locations

Low Level Design

Central Server, Access Point, Target Device, Client Device, Wireless Emittance, Wireless Connection, Message Queue, Module / Hardware, Software Process

Device Network Module

Data Processing Module

Packet Capture, Data Extraction, Location Processing

Queue location updates from data processing module

Access points collect signal data from target(s) and send to central server

Process access point location data from client

Central server sends target locations, client device sends access point locations

Web Server Module

Client Module

Project Progress

Current State

- Project has been divided into individual modules
- Next steps will be:
 - Determining hardware requirements
 - Developing individual modules
 - Stitching dataflow together for a working prototype

Accomplishments

- Conceptual design and implementation plan
- Inefficient and unrealistic alternative solutions exhausted
- Researched wireless networking protocols
- Project title

Division of Work

Matt: Infrastructure, triangulation and location processing

Anthony: Data collection and processing, testing and documentation, team management

Patrick: Communications module, web application back-end, data management

Kyle: Web application front-end, notification management

Self Assessment Essays

Matt Ihlenfeld

Argus is a project which aims to solve the problem of inaccurate indoor position tracking. We plan to take the latest in wireless technology and position tracking research and combine it with a friendly user interface to create a product that will supply users with easy to use and accurate position readings. Argus has a variety of use cases, such as tracking product positions in a warehouse, identifying popular or crowded hotspots at a conference, locating rogue wireless devices in restricted areas, and many more. More importantly, Argus is an opportunity for our team to apply the knowledge we've accrued while at UC on a challenging and interesting problem.

While at UC each team member has taken classes and participated in learning experiences which have helped to prepare us for this task. In my experience three classes have been particularly useful: Introduction to Operating Systems, Introduction to Networks and Cloud Computing, and Software Engineering. Operating Systems introduced me to the low level concepts and algorithms that allow operating systems to function. Most relevant to this project was the class's section on networking, in which I learned the basics of network communication via sockets. In Introduction to Networking and Cloud Computing I had the opportunity to take an even deeper dive into network communication; we learned about the different layers of the common networking stack, how they operate, and how they are able to pass information to each other. While these classes showed me how complex systems worked, Software Engineering show me how to go about building complex systems in an organized and efficient way. It also allowed me to put what I'd learned into practice via a fairly complex project that lasted the duration of the class.

I was also able to put what I learned into practice while working in a few different co-op positions. My first position, as a Web Developer at Matco Tools, served as an introduction to real world software development. I learned the basics of web development, how to use version control systems, how to work on a software project on a small team, and I became acquainted with the joys of locating bugs in massive code bases. I then carried what I learned at Matco over into a new position as an Applications Developer at UPS Airlines. At UPS I took part in a much larger and more formal software development process. I continued to develop technical skills while working on projects in web development, large scale message passing systems, and automated testing. After working two semesters at UPS I moved on to my current position as a Software Engineer at ICR, where I develop code for specialized embedded systems. My experiences at ICR are likely the most relevant to the technical aspects of developing

Argus, as I've also been able to work on projects that deal with low level network protocols while at ICR.

Just about all of the skills I've developed while at UC will help during the implementation of Argus. While we're still working out design plans for Argus, we plan to implement it as follows. We will be locating nearby target devices by listening for the wifi packets that the devices send out and using the information from the packets to triangulate the devices. To estimate the distance of the target device from our listening device we plan to use a hybrid of two methods: one which uses signal strength to estimate distance and one which use the time that the packet took to travel from the device to our listening device. We plan to use the the time based method as much as possible as it provides the most accuracy, but we may need to fall back to the signal strength method when devices haven't provided enough data to estimate. Both methods require that we have three listening devices that receive the same data from a target. That way each of the three listening devices can calculate their distance from the target device and we can use the three distances to triangulate the target device location.

We plan to then take that device location data, as well as any other useful data we've gathered, and display it using an interactive map on a webpage that shows the target device locations in a room or just relative to other known locations. The map will show the user where the target devices are, what kind of devices the targets are, where they are moving, and more. We hope to be able to provide the user with device locations that are accurate to within three meters of the actual target device location.

Anthony Jantzen

My team's project for senior design is a network management and device location system. We will be building a desktop and mobile application designed to help individuals manage and locate the devices on their network. The core functionality of the tool will allow individuals to view devices connected to their network and pinpoint the location of these devices within their facility. They will be able to configure settings to geotag their facility, the central processing server on the network, and notifications for when devices disconnect from the network. Network transparency is key to this project's success. Therefore, all of this will be done through a simple and sleek user interface. To see this project through, I will be utilizing skills obtained through my academic and work experiences.

At the University of Cincinnati, there are several courses I've taken that will be particularly useful. Network and Cloud Computing (CS 4065) and Information Security and Assurance (IT 2030C) taught me about computer networking and the applicable methods to secure a network. Software development will be at the core of this project. I learned the basic concepts of this in various courses including Data Structures (CS

2028C), Programming Languages (CS 4003), Design and Analysis of Algorithms (CS 4071), and Database Design and Development (CS 4092) and expect to apply it to the application development. Software Engineering (EECE 3093C) exposed me to a major software development project, including software development lifecycles and various methods to attack software development. I think this will be helpful in managing the group and project over the course of the year. In addition, I am currently in User Interface I (CS 5167) which will help me in making decisions regarding the UI/UX of our applications. These courses would not mean much, however, without my co-op rotations.

All my work experience has been with Siemens out in Milford, Ohio. There, I worked five rotations (including some part-time) as a software developer on the Development and Operations team in their Cyber Defense Center. My time there allowed me to hone the technical skills I learned during class including Python, SQL, JavaScript, Linux, and more. The real benefit of co-op was the non-technical skills I picked up or improved. Collaboration and communication will better enable me to work with my team members. Flexibility and time management will be key in juggling this project with the rest of my coursework and other priorities. Organization and the more technical agile development methodology will help me keep my and my teammate's progress on track. Collectively, the fusion of my past experiences (in addition to my teammate's) led us to selecting this project.

Our motivation behind this tool stems from the cost and complexities associated with similar tools on the market currently. The overall goal is to reach individuals who may not be savvy with technology or networking and provide them with a tool that makes it easy to enhance the security of their network. This goal is what motivates me, specifically, to complete the project. If I'm able to take the final product home with me and see my parents using it, I know we will have succeeded. My previously mentioned experience in security and application development will make this project fun. In addition, I believe the project will give me a good experience in networking and software engineering lifecycles.

Our preliminary approach to this project is already underway with the project description we have created. I believe that clearly identifying the problem and stating our goals will provide us with solid direction moving through the year. The next step is to take those goals and generate specific requirements to fulfill every one of them. As I've stated before, we expect to create a tool simple enough for non-tech savvy individuals (such as my parents) to use and enable them to watch over their networks. We will measure our accomplishments and overall success by how well we solve the problem and the difficulties experienced by users in tests we perform. If we design and implement the core functionalities we have brainstormed, I have no doubt that this project will be successful. At the end of the day, senior design is still an academic course. If we exit the course without completing the project, I will be disappointed. But if all team

members learn something new to help them in their professional careers, then the project will be successful.

Pat Millott

With every modern home having WiFi, network security is no longer a subject that concerns industrial and business networks. The average home, however, is not equipped with the software or skillset to properly defend a network. The goal of our project is to make network security more accessible for home networks by building a layer of software on top of open source router firmware. Utilizing a mobile interface, users will be able to analyse the current state of their network, accept or reject new connections, and perform other tasks crucial to network administration. Skills I have obtained throughout my college degree both through my education and my co-ops will aid the completion of this project.

This project will require three main skillsets to complete: knowledge of network security, knowledge of user interface design, and knowledge of the software development process. Throughout my coursework at the University of Cincinnati I have learned these topics and obtained these skillsets. Network and Cloud Computing (EECE 4029) and Cyber Defence Overview (CS 5155) taught the necessary networking topics to deal with network security. User interface design was taught in User Interface (CS 5167). Finally, software development was instructed in Software Engineering (EECE 3093), Data Structures (CS 2028) and Database Design (CS 4092). Attempting this project would be much more difficult had I not taken these classes.

While these classes are useful for providing the knowledge required for this project, it would be difficult to complete without experience. Having participated in UC's Co-Op program for four semesters, I have gained experience that will aid development for this senior design project. During my first two Co-Op semesters, I worked at Balluff Inc. doing a lot of work with industrial networking and web development. This experience will aid the User Interface and Network Security portions of this project. My next Co-Op at Diebold Nixdorf required me to create a Windows .NET application in addition helping test production software. Here, my abilities developing a User Interface and developing software were further improved. Finally, my time at ICR has pushed me further into the direction of Security. With the practical knowledge obtained from my Co-Ops in combination with the theoretical knowledge from classes will properly equip me to tackle this project.

My motivation for this project comes from two main sources. Firstly, my parents, who are not very technically inclined, nor do they desire to be, represent the perfect use case. Their lack of technical awareness in combination with their assets that they have acquired over many years make them the perfect target for an attack. This presents a

challenge to create an application that is user friendly enough for the less technical to use while simultaneously being effective enough to protect a network from potential attackers. Further motivating me is my desire to delve deeper into the subject of network security. This subject is an area of interest to me as it will play a prominent role in my career post-graduation.

Upon completion of this project, success will be measured not only with its functionality but in how effective users with a less technical background are at protecting a network from potential attackers. Through the applications functionality, users should be able to receive mobile notifications on new potential device connections, revoke access to foreign and suspicious devices, and view potential suspicious network activity. By having a mobile and web application, the application functionality should be accessible to virtually any device. The overall end-goal for this tool will be to abstract away the detailed technicalities while providing a more universal audience a powerful tool that provides network security.

Kyle Trout

The plan for our project is to build a network manager for those who are less technologically savvy. It will allow a user to deny access to devices they do not recognize, while permitting friendly devices. They will also be able to view all devices connected to the network and other indicators regarding the state of the network in general. The project will be deployed as a mobile application as well as a desktop or web application. This will allow users to view the state of their network on whichever device they currently have on hand. The courses and experiences over the course of my college career have developed the skills needed to succeed in this project.

There are a few classes that I have taken that have prepared me for this project. The first of which is (EECE 3093C) Software Engineering. This was a project-based course that required documenting and developing an application from the ground up. I learned a lot about the documentation side of development in this course, as well as working collaboratively with others. The second course is (CS 4092) Database Design and Development. In this course, I learned about how to properly structure and store information in databases, which will be integral to our network manager. The final course is one I am taking right now, (CS 5167) User Interface I. I hope to learn how to make an application intuitive and accessible throughout my time in this class. While these courses have been helpful, the opportunities I had while on co-op have been especially important.

Having co-oped at four different companies, I was able to narrow down where exactly I fit in the field of Computer Science. The first two companies I worked at, Assurex Health and Siemens PLM Software, gave me a look into web development and software

development, respectively. Being more interested in web development, I pursued a position at Balluff Inc. as a Technical Displays Co-op. I independently built several different small-scale web applications during my time at this company. This process gave me immense experience with debugging and problem-solving on my own, as there were no technical employees I could rely on for assistance. My position at Balluff also solidified my understanding of how all parts of a web application are connected. The other co-op that has prepared me for this project was at Outlier Technologies, where I worked as a JavaScript Application Developer. At Outlier, I worked with one other developer who was my manager. It was here that I gained experience working on a small team with a iterative development workflow. We had to constantly push out new features to clients and diagnose bugs they ran into. The combination of both of these co-ops will help me to efficiently work with others and pinpoint possible bugs in our application.

The approach for our solution came from a lack of similar applications currently available. While some tools exist, they do not have all the features that our project will provide. They are also confusing to use for those who may not have an interest in this area. Our solution will bridge the gap between inexperienced users and network security. This is where my motivation comes from, as I am interested in learning more about network security while building an application that allows other users to protect themselves more easily. If I have done a good job, our application will be intuitive and accessible to any potential user.

I am also interested in the technologies our project will be built with. Whether it be using a cross-platform framework like Electron or a service worker to create a Progressive Web App, our application will utilize modern technologies used in real-world solutions. This has yet to be decided, but either choice will be an accomplishment for me. Learning about building native applications will be a new experience, as I have only built web applications in the past. Though the Progressive Web App route will allow me to gain more in depth experience with service workers and progressive enhancement. I have limited knowledge of these currently, so working with them on a project in a more formal environment will be very beneficial.

Professional Biographies

Matt Ihlenfield

Work Experience

Matco Tools - Web Developer - Fall 2014

- Technical skills
 - Java/javascript web development
 - Software development process (version control, testing, etc...)
- Non-technical skills
 - Networking
- Other relevant work experience
 - Worked on a team which developed Matco's online store and financial services payment/management system.
 - Developed tools to improve customer service workflow.

UPS Airlines - Applications Developer - Summer 2015 to Spring 2016

- Technical skills
 - Java applications development
 - Message brokering systems
- Non-technical skills
 - Large scale project development
- Other relevant work experience
 - Worked on one of UPS Airlines message brokering systems which was used to pass information on flights, pilots, loads, etc.. to other applications which needed the info.

ICR - Software Engineer - Fall 2017 to Present

- Technical skills
 - C programming
 - Embedded software development
 - Reverse engineering

Project Sought

I'd like to work on a project which pertains to cybersecurity, although I do not currently have anything specific in mind.

Anthony Jantzen

Work Experience

Siemens - DevOps Engineer - 08/15 to 08/18 (5 rotations + part-time)

DevOps related duties in the Cyber Defense Center Americas for Siemens. These included creating web application tools, generating rules and detections, and monitoring system and rule functionality to aid analysts in their investigations of various threats or attacks.

- Technical Skills
 - Python
 - HTML/CSS
 - JavaScript
 - Shell Scripting
 - SQL
 - Puppet
 - Postgres
 - Elasticsearch
 - Logstash
 - Kibana
 - APIs
 - Windows/Linux
- Non-technical Skills
 - Teamwork/Collaboration
 - Communication
 - Flexibility
 - Time Management
 - Problem Solving
 - Organization
 - Detail-oriented

Project Sought

Nothing specific immediately jumps out at me. I think something to do with healthcare or security sounds interesting. I don't claim to be a full stack developer, but I have a decent amount of experience in most stages of full stack development. Ideally, I would love a project that encompasses all of them. In addition, containerization and continuous integration sound really awesome and useful to me, so I would be very interested in projects that incorporate one or both of these ideas.

Pat Millott

Work Experience

Balluff Inc.

- Wrote logic that was applied to PLC's in the industrial automation setting
- Developed User interfaces that were applied to Human Machine Interface's that allowed users to interact with industrial automation equipment
- Developed web application that displayed live sensor input through AJAX queries
- Managed SQL database that kept historian data on conveyor belt efficiency
- Languages/Technologies used:
 - SQL
 - Ladder Logic
 - Javascript/CSS/HTML/Node.js
 - Express.js

Diebold Nixdorf Inc.

- Wrote tests that were applied to ATM modules
- Developed multithreaded windows application
- Wrote a DLL that communicated with an ATM device
- Languages/Technologies used
 - C#
 - C++
 - .NET Framework
 - Team Foundation Server

ICR Inc.

- Developed applications for internal use
- Languages/Technologies used
 - Python
 - Git

Project Sought

I love projects that operate on a local networks specifically on raspberry pi's. On my free time, I also enjoy working on pet projects that mine data.

Kyle Trout

Work Experience

Outlier Technologies - Developer Co-op - 05/18 to Present

- Built and iteratively developed upon a custom application for a client that utilized SansWrite APIs.
- Replaced SansWrite's web storage interface, utilizing localForage, with IndexedDB.

Balluff Inc. - Technical Displays Co-op - 01/17 to 12/17

- Developed and maintained several web applications interfacing with production sensors.
- Acted as a full-stack developer for these applications and responded to design critiques.

Siemens PLM Software - Co-op - 05/16 to 08-16

- Created C++ autotests to ensure new fixes did not propagate regressions.
- Performed functional testing of NX to discover bugs in the platform.

Assurex Health - Product Development Co-op - 08/15 to 12-15

- Automated test cases in Quality Assurance using C# and Selenium WebDriver.
- Pinpointed and resolved bugs in the production website while in Product Development.

Project Sought

I am hoping to find a project that includes a web aspect. I am interested in Progressive Web Apps, so incorporating one into the senior design project would be of great interest to me.

Budget

Expenses to Date

There have been no expenses to date. Winter break will be utilized to determine hardware requirements, expenses, and possible sources of donation.

Appendix

Github Repository

<https://github.com/anthony-jantzen/senior-design>