IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Utilizing PAWR Programs to Develop Advanced Hands-On Labs for Networking and Cybersecurity Courses

492 - Final Report

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Team Members & Associated Roles

Brendon Droege	Informational Manager #1
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Bryan Pope	Technical Lead
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Executive Summary

Development Standards & Practices Used

- Our group and project will not require us to be hands-on with the Hardware of each PAWR Platform, but we do need to be mindful and respectful of the resources and limitations set forth by the development team. Regarding Software, we will comply with secure coding practices and adhere to the platform specifications and requirements of allotted permissions and possibilities. These include IEEE 802.11ad (5G network access), 802.11a/b (Wireless Ad Hox Networks) and 1733-2011 (Transport Layer).

Summary of Requirements

- Develop an IEEE Standard Research Paper that discusses the educational opportunities of various PAWR Platforms: ARA, AERPAW, COSMOS, and POWDER.
- Develop and publish various introductory networking and cybersecurity course labs and supplemental documentation to aid in the success of the student's knowledge.

Applicable Course From Iowa State Curriculum

- **English 314**
  - This course pioneered our research abilities and writing skills
- **ComS / SE 309**
  - This course introduced project management and project coordination
- **CybE 230 / 231**
  - This course introduced various cyber security content and is a great introductory resource
- **CybE 430/530**
  - This course looked at various protocols and packet implementation on networks
- **CprE 489**
  - This course focused on computer networking and general internet communications

New Skills/Knowledge Acquired That Was Not Taught In Courses

- The art and practice of Researching data and papers
- Learning how each platform works and operates
- Writing a curriculum for labs

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1. Project Introduction

1.1 Team Members

Brendon Droege	Informational Manager #1
Susanna Noble	Informational Manager #2
Leha Dutta	Project Manager
Bryan Pope	Technical Lead
Camron Corcoran	Client Liasion
Corey Lieu	Project Secretary

1.2 Problem Statement

- Our project mission is to remediate the loss of the GENI infrastructure and find a replacement PAWR (Platforms for Advanced Wireless Research) platform to sustain Iowa State University Wireless Network and Security courses. After extensive research and gathering information on the various platforms and comparing their hardware, infrastructure, software, and capabilities, we decided to dedicate our time and resources to incorporating ARA, a wireless living lab set to target farming and rural communities.

1.3 Intended Uses & Users

- Our project focuses on providing education and material to educators, students, and researchers looking to implement wireless networking and cybersecurity related hands-on labs into their curriculum. Our small score intended audience focuses on educators of Iowa State University, specifically those geared towards CprE 431 and CprE 489. We've since broadened our influence to other universities and professors who teach wireless networking and cybersecurity.
- Our project aims to replace and be a supplemental resource for students to get hands-on and practical lab experience within the field.

1.4 Project Management Style Adopted By The Team

- Our group has elected a *Waterfall+Agile* combination to complete the project. This style is most effective for us as our sequential approach allows us to divide into distinct phases and blocks. We are taking the agile aspect of flexibility and adaptability as our project grows and expands with the research we conduct. We are modeling the waterfall model by breaking down and categorizing our goals into phases: Requirements, Research, Comparison, Report, Implementation, Testing and Analyzing, Documentation, and then Deployment.

1.5 Initial Project Management Roles

- **Informational Manager** (Brendon Droege & Susanna Noble)
    - This role will be responsible for uploading, presenting, and managing all information and data collected throughout the project. This role will have the responsibility of designing and building the lightning talks, the documentation of the assignments, the project plan, and ensuring the website and all relevant information are up-to-date and accurate.
- **Project Manager** (Leha Dutta)
    - This role will be responsible for ensuring that tasks are completed on time and at the quality expected of us. They will perform quality control and hold members accountable and honest about the work completed.
- **Technical Lead** (Bryan Pope)
    - This role will be responsible for ensuring all technical aspects meet the quality and expectations of the project. As we move towards the lab creation and simulation side of the project, this role will be vital in ensuring our labs comply with PAWR Platform standards and requirements.
- **Client Liaison** (Camron Corcoran)
    - This role will be responsible for being the mediator between the project team and the client and advisor. They will be the main form of communication and contact between all parties involved. This role will also be responsible for relaying this information back and forth and being consistently involved and active.
- **Project Secretary** (Corey Lieu)
    - This role will be responsible for keeping track of the meeting minutes and any other notes or important information discussed during class, during TA meetings, client meetings, and project meetings. They will be responsible for organizing and uploading this information and ensuring all members are in compliance with what was discussed.

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Project Plan

2.1 Risks And Risk Management/Mitigation

- There are two places where risk might become a concern in this project. The first is during the information collection phase. The risk involved here is finding the information we are using for comparison and whether we can get a timely response from platforms when we cannot locate that information ourselves. There is not much that can be done to mitigate this risk except to try and exhaust all other forms of information before having to reach out to the developers of the platforms. This first risk should not exceed .5 as the teams running the platform are supposed to respond to questions in a timely manner. The second area is during our implementation phase. During this phase, the risk of not being able to fully implement our experiments is of concern. This risk can be mitigated by contacting the teams in charge of the platforms and working together to come up with solutions.

2.2 Engineering Standards

- At the current stage of our project, the only "Engineering Standards" we see are the high-quality IEEE research standards and proper citing and referencing. Based on our research, each program may require its own Engineering Standard that will be documented and respected once we begin implementing various labs on their platform; this will be revealed to us later. Our advisor also recommends holding ourselves to the Iowa State Lab documentation standards when organizing interactive deliverables with accompanied research.

- For all platforms, however, we will be in compliance with IEEE's 802.11ad with the topic of 5G, 802.11a/b with the topic of Wireless Ad Hoc Networks, and 1733-2011 regarding how we interact with the Transport Layer on each platform.

2.3 Other Resource Requirements

- For our project we do not have any major resources required to complete our project. Our project is heavy on research and collecting data and information. Your standard resources include the internet, computer, and time. Platform resources and costs.

3 Design

3.1 Design Content

- The first semester will hold a rough draft of an IEEE Research Paper. This will involve compiling all individual research, data, and information into a comprehensive and cohesive research paper describing the alternatives to GENI.

- We strive to create and simulate Network and Security-related introductory labs in the second semester. We'll have a design flow of creating Lab Documentation, the Lab Simulation, and then supplemental documentation on the justification and reasoning behind the lab. The content of our design is the hardware specification and user statistics of each specific platform and the comparisons between them.

3.2 Requirements & Constraints

- Building and designing labs dedicated to network and security on various platforms like Geni (a now deprecated open infrastructure distributed research system) that will hold their longevity. **(Functional)**
- Develop relevant lab documents to accompany various activities and programs **(Functional)**
- Create Interactive Learning Materials with supported research and documentation **(Functional)**
- Research various platforms and programs to simulate real-world network activities and security threats **(Non-Functional)(Quantitative)**
- The project needs to be completed before May 2024 **(Quantitative)(Resource Constraint)**
- Project members are expected to do 8-10 hours of research and involvement within each week **(Quantitative)(Resource Constraint)**
- Access to the internet and a computer

- Throughout the project, the biggest constraint and limitation has been how newly developed ARA is. With frequent updates, maintenance outages, and unexpected errors, it proved difficult to rely and trust the sustainability of ARA. These unstable conditions held back progress and made it difficult to progress.

3.3 Modern Engineering Tools

- Computer
  - LaTeX (Overleaf)
  - Research Databases (IEEE, etc.)
  - IEEE Research Document

- Platform (Storage, IDE, VCS, Analysis Tools)
  - After continuous research and development, we have decided to move with the ARA Infrastructure and Network. Their wireless living lab will give us the resources and capabilities to expand further and test on living network infrastructure.

3.4 Design Context & Broader Context

Areas	**Description**
Public Health, Safety, and Welfare	Our solution poses no risk to the general public or wellbeing of people. Claiming anything of the sort is beyond far-fetched. Our solution is meant to help willing educational systems in providing resourceful research and useful lab designs.
Global, Cultural, and Social	Our solution is meant to be an educational jump in providing thorough research and evidence to suggest a preferred platform for introductory Network and Security Labs. Our solution will help mitigate the fall of GENI and encourage Iowa State University, and others, to make a better, smarter change in their lab approach.
Environmental	Our solution poses no risk to the environment. Most of the platform infrastructure is already built, and future plans are not at the expense or benefit of our goal. This Senior Design project cannot be held accountable or liable for any future environmental impacts.
Economic	Our solution poses no risk to the economy. While our solution could cost Universities who choose to participate and enact our research and labs, it is their prerogative and decision to spend their money. Other than that, our research and solution have no impact on the economy - none directly and none in an abstract stance.

Table 2: Design Context and Areas of Concern

3.5 Prior Work/Solutions

- Previously, GENI was the main platform for the education and research components we seek. As Geni is no longer available, we are looking for a new solution to transfer many of the experiments over so they can still be used for educational purposes. Depending on the platforms we wish to incorporate in our paper, and the information we wish to share regarding each of them, there could be some issues regarding the space available for the said educational and research purposes. We plan to cite other research papers to create a document that can provide good information and properly educate the readers so they understand why each platform is good and what to use it for to fully utilize the resources available.

3.6 Design Decisions

- Criteria/Categories: *How we separate and divide the platforms*
    - Important for how we proceed with the research paper and the labs we create for universities.

- Suitable Platforms: *If we allow them into the research paper and why*
    - Important to ensure we get the most relevant and useful information in our research paper

- Research Methodology / Research Paper Format: *How we choose to go forward with research and writing*
    - Important for meeting industry standards and expectations

3.7 Design Changes

- From the first semester of this project, our group shifted and focused our attention on the ARA Platform and developing advanced hands-on labs for wireless networking and cybersecurity courses. We utilized our research and knowledge gained from the first semester and began implementing engineering lab curriculums for this new architecture.

- We adapted existing lab experiments and created new and unique lab walkthroughs to ensure all areas and relevant areas of the course matter are met. We created lab documents, flows, and deliverables for classrooms to experiment and try out our new lab documents and designs.

4 Testing

- Our project testing consists of measuring and quantifying our efforts with the success of the students and educators. We'll provide all the documentation, resources, and assistance while the students and volunteers run through the lab experiments. At the end of each lab completion, students will be asked to fill out a feedback form that quantifies their opinions and thoughts and allows them to expand on certain topics and areas.

4.1 Testing Questions

- In an effort to get the most out of the survey and responses while keeping it short and not entirely time-consuming, we elected to keep most of the questions quantitative and short.

Visually Appealing
- Quantitative data to help gauge an audience's reaction and experience.

Benefit of pictures and photos
- Quantitative data to help and either limit or expand on the amount of image versus text ratio.

Clarity of Lab Instructions
- Quantitative data to ensure our intended audience can understand and follow the instructions.

Relativity to Course Curriculum
- Quantitative data to meet the expectations and demands of Networking and Cybersecurity courses.

Engagement & Interactiveness
- Quantitative data to satisfy the needs of our client to ensure the labs were interactive and engaging.

4.2 System Testing

- In general, our creation of the introductory labs is limited to the complexity we make them, but our duty first is the lab document and justification. We are bound by the PAWR Platform system and sandbox. While we create our Unit Tests (our introductory labs), we'll be testing the strength and system statistics of the platform. In addition, we will be seeing which platforms fit best for the different labs.

4.3 Regression Testing

- These platforms are in active development and may make unannonunced and unexpected changes. Labs should be tested prior to assigning them to students to ensure functionality. The team will monitor these changes and update labs accordingly.

4.4 Results & Process

- When surveying people, it's important to ensure we get a range and variety of people. For this, we, the lab developers tested all of the labs and can be considered the alpha testers. For looking at beta testers, we samples from other Iowa State University engineering students as well as Iowa State University non-engineering students. Input will be crucial from a design, understanding, and relevant point of view. We also sampled from other students from other universities; this allowed for an unbiased and complete third-party sample to help better the labs.

- After surveying a small classroom-size population, we were able to compile a report of quantitative data that provided crucial information on how to further progress and improve on the design and implementation of these lab experiments. With an open field for comments and responses, we gained necessary qualitative data on where we fall short and where we excel.

- It's also important to note that during this, we are the alpha test, and our surveyors are the beta testers.

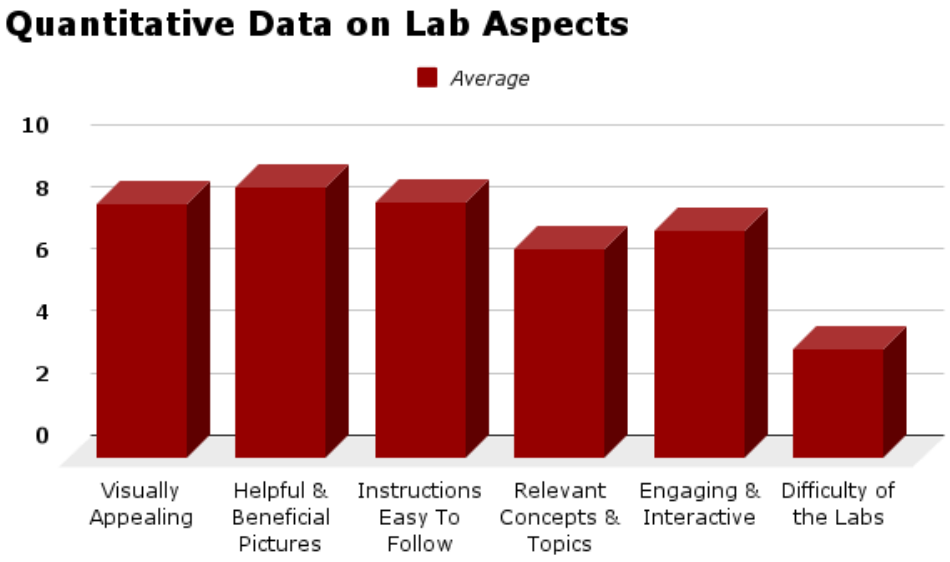


Figure 2 - Survey and Testing data and information

5 Implementation

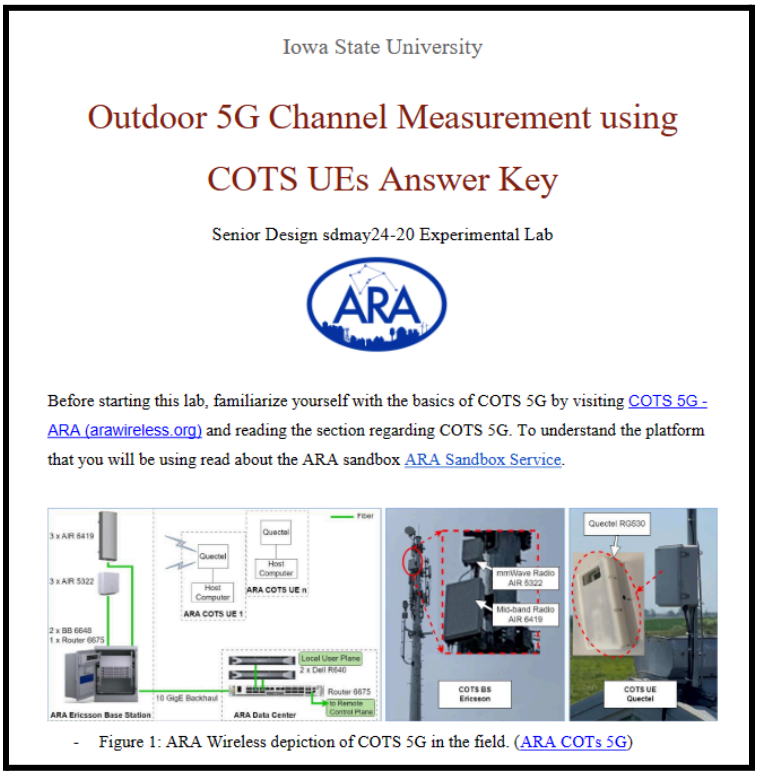
- With the successful adaptation and creation of six (6) advanced hands-on labs for networking and cybersecurity courses, we were finally ready and able to push them into a testing environment.

5.1 Lab Materials

- Each adapted and created lab in itself is a walkthrough that is given to students to guide them in completing the expected outcome. These lab documents contain pictures, explanations, questions, and expected results. The lab documents are meant to be self-guided and self-paced material pieces that allow students to be independent in their studies.

- Each lab document is accompanied by a Lab Report Template that has questions and spaces to allow students to submit their responses. We wanted to give educators the power of choice on how to administer their labs and wanted to ensure a clear and uniform approach.

- Each lab document was built with an Answer Key that instructors and others would have access to. We wanted the transition to be seamless and painless for educators. Creating the answer key allows educators to focus on the material and content. The answer key gives our individualized approach and expectations for the lab and the expected learning objectives.



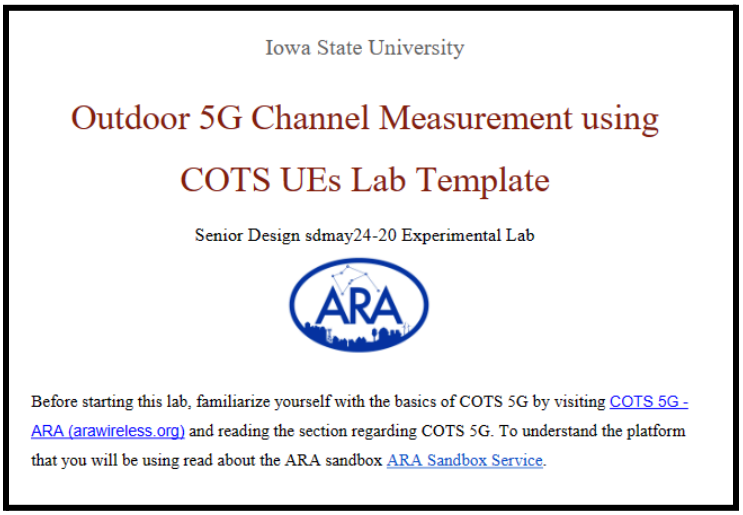
Iowa State University

Outdoor 5G Channel Measurement using COTS UEs Answer Key

Senior Design sdmay24-20 Experimental Lab

Before starting this lab, familiarize yourself with the basics of COTS 5G by visiting COTS 5G - ARA (arawireless.org) and reading the section regarding COTS 5G. To understand the platform that you will be using read about the ARA sandbox ARA Sandbox Service.

- Figure 1: ARA Wireless depiction of COTS 5G in the field. (ARA COTs 5G)

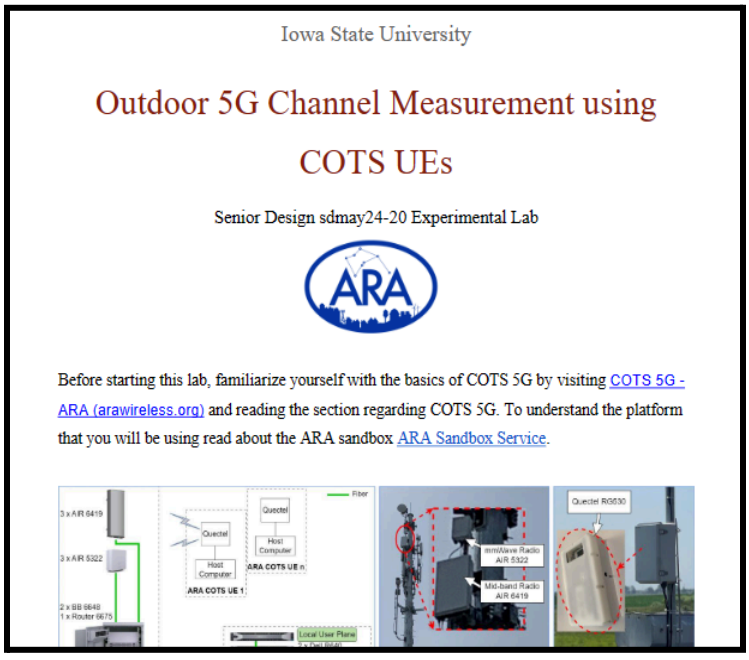


Iowa State University

Outdoor 5G Channel Measurement using COTS UEs Lab Template

Senior Design sdmay24-20 Experimental Lab

Before starting this lab, familiarize yourself with the basics of COTS 5G by visiting COTS 5G - ARA (arawireless.org) and reading the section regarding COTS 5G. To understand the platform that you will be using read about the ARA sandbox ARA Sandbox Service.



Iowa State University

Outdoor 5G Channel Measurement using COTS UEs

Senior Design sdmay24-20 Experimental Lab

Before starting this lab, familiarize yourself with the basics of COTS 5G by visiting COTS 5G - ARA (arawireless.org) and reading the section regarding COTS 5G. To understand the platform that you will be using read about the ARA sandbox ARA Sandbox Service.

Figure 3:
Lab 04 - Outdoor 5G Channel COTS UE Pictures

The pictures above illustrate one whole lab package that would be rolled out to faculty and educators. Each folder contains the Lab Walkthrough, the Lab Report Template, and the Lab Report Answer Key.

5.2 Functionality

- These lab documents and folders are best suited for any and all universities that have a Wireless Networking and Cybersecurity course curriculum. Our mission and deliverable was to complete the work to allow educators to release the documents and information to their classroom simply.
- Instructors will be able to hand out the Lab Walkthroughs. Students will be self-paced and self-guided with our labs. Students will complete the lab and answer the associated questions. Instructors will be able to use the Answer key to compare and review the responses.

6 Professionalism

6.1 Areas of Responsibility

AREA OF RESPONSIBILITY	DEFINITION	NSPE CANON	IEEE CODE OF ETHICS
Work Competence	Perform work of high quality, integrity, timeliness, and professional competence.	Perform services only in areas of their competence; Avoid deceptive acts.	Accept responsibility in making decisions consistent with the safety, health, and welfare of the public; Disclose promptly factors that might endanger the public or the environment.
Financial Responsibility	Deliver products and services of realizable value and at reasonable costs.	Act for each employer or client as faithful agents or trustees.	Avoid real or perceived conflicts of interest; Disclose conflicts when they exist.
Communication Honesty	Reports work truthfully, without deception, and are understandable to stakeholders.	Issue public statements only in an objective and truthful manner; Avoid deceptive acts.	Be honest and realistic in stating claims or estimates based on available data.
Health, Safety, Well-being	Minimize risks to the safety, health, and well-being of stakeholders.	Hold paramount the safety, health, and welfare of the public.	Minimize risks to the safety, health, and well-being of stakeholders.
Property Ownership	Respect the property, ideas, and information of clients and others.	Act for each employer or client as faithful agents or trustees.	Respect the property, ideas, and information of clients and others.
Sustainability	Protect the environment and natural resources locally and globally.	-	Protect the environment and natural resources locally and globally.
Social Responsibility	Produce products and services that benefit society and communities.	Conduct themselves honorably, responsibly, ethically, and lawfully to enhance the profession's honor, reputation, and usefulness.	Produce products and services that benefit society and communities; Conduct themselves honorably, responsibly, and ethically to enhance the profession's honor, reputation, and usefulness.

Table 2: Areas of Responsibility

1. **Work Competence:** The IEEE Code of Ethics emphasizes that judgments must be accepted to promote the public's welfare, safety, and health. This implies that professionals should be aware of the possible effects on the general population and the environment while making sure their job satisfies high standards and integrity.

   Comparison with NSPE: The IEEE's language is more thorough, specifically embracing a dedication to public safety and timely disclosure, even if both codes place an emphasis on competence and avoiding misleading practices.

2. **Financial Responsibility:** The IEEE Code strongly emphasizes averting actual or potential conflicts of interest and declaring them when they do arise. This is consistent with serving as obedient agents or trustees and providing goods and services of realizable value at fair prices.

   Comparison with NSPE: While both codes emphasize financial responsibility and avoiding conflicts of interest, the IEEE Code provides more specific guidelines for professionals by addressing the need to declare conflicts.

3. **Communication Honesty:** The IEEE Code emphasizes the significance of honestly reporting work, refraining from deceptive practices, in line with the NSF Canon, and being fair and reasonable when expressing statements or estimates based on available facts.

   Comparison with NSPE: Both codes emphasize honesty and truthfulness in communication. However, the IEEE Code provides a specific focus on claims or estimates based on available data, offering more detailed guidance in this context.

4. **Health, Safety, Well-Being:** In line with the NSF Canon's emphasis on prioritizing public safety, health, and welfare, the IEEE Code emphasizes the obligation to reduce threats to stakeholders' safety, health, and well-being.

5. **Comparison with NSPE:** Regarding the significance of putting safety, health, and well-being first, both standards agree quite a bit in this regard. While maintaining the fundamental ideas, the IEEE Code's language is more concise.

6. **Property Ownership:** The IEEE Code, which is in line with the NSF Canon's instruction to serve as obedient agents or trustees, emphasizes the value of protecting the assets, concepts, and information of clients and others.

   Comparison with NSPE: Both codes stress the importance of respecting property and information. The

IEEE Code maintains a similar principle but provides a more concise expression of the expectation.

7. **Sustainability:** In keeping with the larger idea of sustainability, the IEEE Code strongly emphasizes the obligation to safeguard the environment and natural resources both locally and worldwide.

   Comparison with NSPE: The NSF Canon does not specifically address sustainability. To further emphasize the environmental issue, the IEEE Code adds an explicit commitment to safeguarding the environment and natural resources.

8. **Social Responsibility:** In addition to emphasizing the necessity to conduct oneself honestly, responsibly, and ethically in order to increase the honor, reputation, and usefulness of the profession, the IEEE Code places a strong emphasis on the provision of goods and services that benefit society and communities.

9. **Comparison with NSPE:** The emphasis of both codes is on moral behavior and societal responsibility. Increasing the societal impact of professional labor, the IEEE Code includes an explicit commitment to creating goods and services that benefit society.

6.2 Project Specific Professional Responsibility Areas

1. **Work Competence**
   a. **Applicability :** Yes, this area applies to the project. Ensuring high-quality work, integrity, and professional competence is crucial for the success of the project, especially given its focus on realistic and real-world labs for networking and cybersecurity courses.
   b. **Team Performance**: High. The group constantly produces excellent work, adheres to schedules, and exhibits professional competency while planning and carrying out lab projects on a variety of platforms.

2. **Financial Responsibility**
   a. **Applicability:** N/A
   b. **Team Performance:** N/A

3. **Communication Honesty**
   a. **Applicability**: Honest and transparent communication is vital, especially when conveying findings to educators and institutions.
   b. **Team Performance:** High. The team ensures that the client's expectations are fulfilled by providing honest and transparent communication regarding the project's status, difficulties, and results.

4. **Health, Safety, Well-Being**
    a. **Applicability:** Partial. While data security and privacy are relevant to our project, traditional health, and physical safety concerns may not be directly applicable.
    b. **Team Performance:** N/A

5. **Property Ownership**
    a. **Applicability:** It is essential to respect clients' and colleagues' intellectual property, particularly when working with lab assignments and instructional materials.
    b. **Team Performance:** High. The team is diligent in respecting the intellectual property of others and adhering to legal and ethical standards related to content ownership.

6. **Sustainability**
    a. **Applicability:** Yes, even if it might not be our project's main focus, preserving the environment and natural resources might be indirectly applicable (e.g., optimizing server resource utilization).
    b. **Team Performance:** N/A. There might not be much of a direct environmental impact because the project's main goal is educational infrastructure. When possible, the team

       might think about optimizing resource utilization.

7. **Social Responsibility**
    a. **Applicability:** It is in line with societal responsibility to create instructional materials that aid Iowa State University and other universities.
    b. **Team Performance:** High, The team is dedicated to creating educational resources that benefit Iowa State University and other universities and upholds ethical standards in professional conduct.

6.3 Most Applicable Professional Responsibility Area

WORK COMPETENCE

- **High-quality Work:** Considering that the project's objective is to close the gap between conceptual knowledge and practical application, generating high-quality work is essential to the endeavor's success.
- **Integrity and Professional Competence:** it requires an elevated standard of professional competence to provide realistic and real-world laboratories for networking and cybersecurity courses. Representing the strengths and weaknesses of the platforms under examination truthfully requires integrity.

- **Timeliness:** Completing duties and the project on time is essential, particularly when it comes to giving educators and institutions.

Having competent team members is essential to our project's success. It has an immediate effect on the caliber of the instructional materials produced, the reliability of the study, and the value of the information offered to teachers.

While other aspects of professional responsibility, such as social responsibility and honest communication, are certainly important, the larger commitment to work competence frequently intersects with and includes them. By placing a high value on work competence, our team can lay the groundwork for fulfilling other ethical responsibilities and producing worthwhile and reliable results.

7 Closing Material

7.1 Discussion

- For the semester of work done, we have completed a rough draft of our IEEE Standard Research Paper with a focus on “Exploring Educational Opportunities with PAWR Platforms: ARA, AERPAW, COSMOS, POWDER.” We have also created two student-friendly lab assignments that

  are awaiting implementation on the PAWR Platforms. We are on schedule with our proposed Gantt Chart and plan on having a proposed published research paper by the spring of 2024, and having 4-8 supplemental introductory lab assignments focusing on networking and security running on PAWR Platforms.

7.2 Conclusion

- Our work so far is exactly on schedule. We have a first rough draft of our IEEE Standard Research Paper as well as two introductory lab assignments ready for deployment. These lab assignments have assigned questions and answers as well as justifications for the labs. While progress was initially slow, this can be a result of the general confusion and fluidity of our project, but now that we have a foundation and initial research done, our current plan is promising for us to meet our advisor's needs. The constraints we have faced so far are the initial confusion of the project, and now our progress halts at the permissions needed from PAWR Platforms.

7.3 Future of the Project

- With our initial work and take off on the labs and ARA, our impact has been able to be the first educational application of the infrastructure and platform. Our project has set the path for ARA and enabled educators and researchers to understand further and utilize the platform.

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7.4.1 Team Contract

1) Susanna Noble
2) Brendon Droege
3)Leha Dutta
4) Bryan Pope
5) Corey Lieu
6) Camron Corcoran

7.4.2 Team Procedures

- Every Wednesday at 4:00 pm, we meet with our TA to discuss the week's progress and upcoming workload.

- Every Thursday at 4:15 pm, we meet with our Advisor/Client to discuss the progress made and the trajectory of the project.

- Spontaneous meetings are expected and hopefully to be delivered in person, but completely virtual is just as acceptable and acknowledged.

7.4.2.1 Preferred method of communication/scheduling

- We will use Microsoft Teams as our main communication method. We will utilize applications like “WhenToMeet” to schedule any impromptu meetings.

7.4.2.2 Decision-making policy (e.g., consensus, majority vote):

- When a decision is needed in a group setting, it will be brought up via Teams or at a meeting where members can discuss and converse. We will run with a simple majority and refer to our TA or advisor if a tie-breaker is needed.

7.4.2.3 Procedures for record keeping (i.e., who will keep meeting minutes, how will minutes be shared/archived):

- Our Project Secretary, Corey Lieu, will be responsible for keeping the Meeting Minutes and being responsible for jotting down notes and information presented at a meeting. These meetings will be immediately published and uploaded to a OneDrive which all team members have access to.

7.4.3 Participation Expectations

7.4.3.1 Expected individual attendance, punctuality, and participation at all team meetings:

- Members should prioritize attending all meetings with exceptions of health reasons and/or other academic responsibilities. If a team member will be late or absent, they should inform the group at least 24 hours in advance if possible.

7.4.3.2 Expected level of responsibility for fulfilling team assignments, timelines, and deadlines:

- Individuals are expected to complete tasks within their deadlines to adhere to the timelines and keep the project moving forward. If a team member believes that a task will not be completed as expected, they are expected to communicate that information as soon as possible.

7.4.3.3 Expected level of communication with other team members:

- Team members should respond to team discussions or direct messages within 12 hours on weekdays and within 24 hours on weekends. If an individual's input is needed or missing, a good-faith effort must be made to notify that individual directly.

7.4.3.4 Expected level of commitment to team decisions and tasks:

- Suppose the team has come to a consensus and majority vote on a topic. In that case, all members will be committed to the choice unless a new discussion is had with different arguments from the original and a new consensus or majority vote is reached.

7.4.4 Leadership

7.4.4.1 Leadership roles for each team member:

Brendon Droege	Informational Manager #1
Susanna Noble	Informational Manager #2
Leha Dutta	Project Manager
Bryan Pope	Technical Lead
Camron Corcoran	Client Liasion
Corey Lieu	Project Secretary

7.4.4.2 Strategies for supporting and guiding the work of all team members:

- If a team member is struggling with contributing or progressing with their tasks, a strong effort will be made by the rest of the team to help guide them through whatever they are stuck on. The goal of this project for every team member is to learn and to accomplish this, every team member will be ready and willing to assist each other.

7.4.4.3 Strategies for recognizing the contributions of all team members:

- All work will have author contributions from the team members who have worked on that task. We will respect and appreciate the work and contributions made by each team member to keep the morale high.

7.4.5 Collaboration and Inclusion

7.4.5.1 Describe the skills, expertise, and unique perspectives each team member brings to the team.

Bryan Pope - C, C++, Python, and Java. Internship experience in embedded systems, Linux operating systems, and agile development processes.

Brendon Droege - I have the background of being the only Software Engineering major here. This comes with experience in different workflows and a variety of languages, ranging from Python, Java, C, Javascript, HTML, and CSS.

Leha Dutta - Python, Java, Linux, Bash Scripting, AWS. Internship experience in IT Security and Risk Management.

Corey Lieu - Java, C, C#, Linux, experience with the agile development process.

Susanna Noble - C, C++, Java. Internship with project requirement organization and Optimization

7.4.5.2 Strategies for encouraging and supporting contributions and ideas from all team members:

- Contributions from everyone will be encouraged and highlighted during team meetings. We will establish a safe and inclusive environment that is filled with effective and constant communication. With our regular team meetings, we'll be able to recognize and reward contributions and efforts while empowering all team members.

7.4.5.3 Procedures for identifying and resolving collaboration or inclusion issues:

- The member encountering issues with inclusion will start a group discussion in teams or request a separate meeting from normal group meetings to discuss the issue and possible solutions. The member bringing this motion should have possible solutions ready for discussion before meetings or as a part of their group message.

7.4.6 Goal-Setting, Planning, and Execution

7.4.6.1 Team goals for this semester:

- Our team goal for this semester is to come closer together as teammates and strongly encourage each other to grow, learn, and branch out to new areas of this Senior Design Project. We strive to meet the expectations of our clients and advisors while being fluid and flexible with what is realistic and plausible. We hope to publish an IEEE Standard Research Paper while supplying supplemental labs on PAWR Platforms.

7.4.6.2 Strategies for planning and assigning individuals and teamwork:

- Most of this will be assigned during team meetings after deadlines have passed, and tasks for the next step of the development process need to be given. In extenuating circumstances, if tasks are sufficiently large, assignments will be given well in advance to the best of the team's ability.

7.4.6.3 Strategies for keeping on task:

- To best stay on task, it's expected to set clear goals and expectations that are specific, achievable, and important to the project. We will utilize a living document with a "to-do" list of tasks. During our meetings, we will regularly review progress checkups to reflect and adjust. We will hold ourselves accountable and honest with our workload.

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7.4.7 Consequences for Not Adhering to Team Contract

7.4.7.1 How will you handle infractions of any of the obligations of this team contract?

- Infractions will be held on a case-to-case basis. If the team believes a member is not meeting their obligations, they must inform the individual, and they will be given a grace period that is a minimum of one week to resolve the infraction

7.4.7.2 What will your team do if the infractions continue?

- If continued infractions happen, either among a single individual or scattered throughout the group, the issues will be brought to the attention of the faculty advisor and discussed as a team. This is in the case of continued infractions, even after multiple attempts to resolve them among ourselves as a team

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a) I participated in formulating the standards, roles, and procedures as stated in this contract.
b) I understand that I am obligated to abide by these terms and conditions.
c) I understand that if I do not abide by these terms and conditions, I will suffer the consequences as stated in this contract.

1) **Brendon Droege**	DATE **09/10/2023**
2) **Susanna Noble**	DATE **09/10/2023**
3) **Bryan Pope**	DATE **09/10/2023**
4) **Camron Corcoran**	DATE **09/10/2023**
5) **Corey Lieu**	DATE **09/10/2023**
6) **Leha Dutta**	DATE **09/10/2023**

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