

GridSAFE: Cyber Simulation of Grid Attacks with AI Anomaly Detection

DESIGN DOCUMENT

sdmay26-o8

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Executive Summary

Provide a brief (300-500 word) summary of your project. This summary should give the reader enough information to understand the purpose, design strategies, and project progress thus far. It should address at least the following questions/items:

- What is the problem and why is it important?
- What are your key design requirements?
- Summarize your design, include approaches and technologies used.
- How much progress have you made thus far?
- How well does your design meet requirements and address user needs? How do you know?
- What are potential next steps to be taken?

Learning Summary

Development Standards & Practices Used

List all standard circuit, hardware, software practices used in this project. List all the Engineering standards that apply to this project that were considered.

Summary of Requirements

List all requirements as bullet points in brief.

Applicable Courses from Iowa State University Curriculum

List all Iowa State University courses whose contents were applicable to your project.

New Skills/Knowledge acquired that was not taught in courses

List all new skills/knowledge that your team acquired which was not part of your Iowa State curriculum in order to complete this project.

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List of figures/tables/symbols/definitions (This should be the similar to the project plan)

Intrusion Detection System (IDS) - A security tool that monitors network or system activity for malicious behavior or policy violations, alerting administrators when potential threats or unauthorized access are detected.

1. Introduction

1.1. PROBLEM STATEMENT

The broader context of this project operates within the educational domain and critical infrastructure protection. There is a growing need for awareness and knowledge about how cyber intrusions on power systems have real-world consequences. Our project can raise awareness and promote research into this topic by providing an interactive platform. Stakeholders interested in this research include cybersecurity educators and students, utility operators and infrastructure security professionals, policy makers, and stakeholders in national security critical infrastructure, public, and community stakeholders. Cyberattacks on infrastructure are at the forefront of national security, and many nations across the globe seek low-cost solutions to simulate and train for grid-related cyber incidents. Large-scale attacks on critical infrastructure have cascading effects on the population and the economy. By developing an intuitive and user-friendly simulation, we can illustrate how both regular and malicious activity impact critical infrastructure in a way that is easy for anyone to understand.

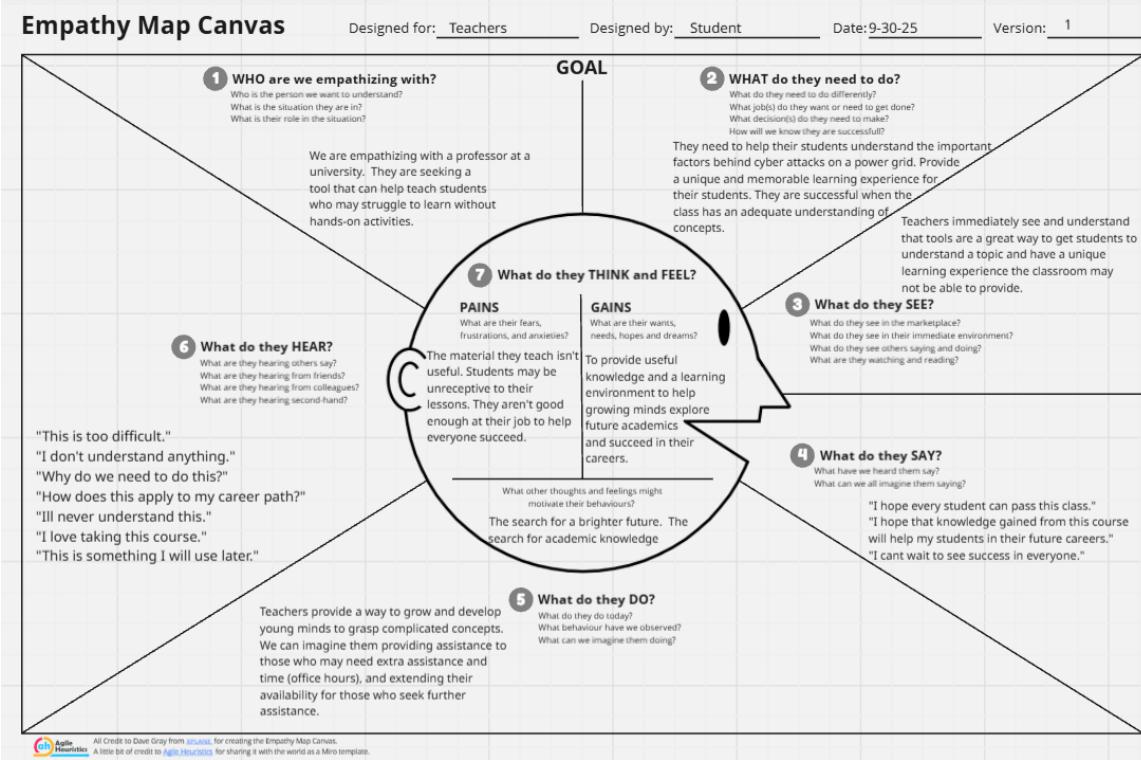
1.2. INTENDED USERS

The intended users are students, professors, and industry professionals who need a tool to visualize and understand attacks on critical infrastructure. This tool is a teaching aid for those groups to represent real-time attacks on critical infrastructure visually.

Professors are educators and experts on specific subject matter, and create, implement, and deliver assignments and lessons to guide students' learning. Professors need to engage students with interactive resources and illustrate complex concepts in a way students can understand. Professors can use this tool to visually represent cyberattacks that support lessons and projects on protecting critical infrastructure.

Students seek to understand new ideas, complex problems, and engage in school activities. One way is through visualization and hands-on experience, which bridges the gap between theory and practical applications. Students value interactive and intuitive tools to aid their learning process. This tool provides them with an interactive and intuitive way to aid their learning process.

Industry Professionals practice and apply specialized knowledge in a practical setting. They value practical and efficient tools to streamline processes or provide clear insights into their problems. Industry Professionals can use this tool to simulate cyberattacks on critical infrastructure to analyze potential impacts, essential vulnerabilities of their own system, and gain insight into their own infrastructure.



2. Requirements, Constraints, And Standards

2.1. REQUIREMENTS & CONSTRAINTS

Functional Requirements

- The microcontroller will receive real-time data from the IDS.,
- The microcontroller will parse input data from the IDS and control the corresponding LEDs based on the data.,
- The LEDs will respond dynamically to updates from the IDS within a reasonable time (1–2 seconds).,
- The microcontroller will support a fail-safe mode that defaults all LEDs to green upon system reboot or loss of communication with the IDS.,
- The microcontroller will allow for a manual reset or override for demonstration and testing purposes.

Physical Requirements

- The city model shall be compact (approx. 3 ft x 3 ft).,
- All wiring and microcontrollers shall be securely enclosed or mounted to prevent short circuits or physical damage.,
- The physical model shall use non-conductive materials such as PLA (3D printed), acrylic, wood, or foam for safety.

Resource Requirements

- Hardware shall utilize components available through the ISU ECpE labs or purchased within the standard senior design hardware budget (~\$100-\$500).

Aesthetic & User Experience Requirements

- The city model will be visually appealing and intuitive for viewers to understand the relationship between LEDs and IDS.,
- The 3D city model will visually represent a city and simulate what attacks on an electrical grid may look like.

Software Requirements

- The IDS software shall collect, parse, and analyze system logs from all grid components to detect anomalies or attacks.
- Detection shall combine rule-based logic with machine learning for improved accuracy over time.
- The software shall communicate LED status updates to the microcontroller through a defined interface protocol.
- A web-based dashboard shall visualize alerts, system health, and current LED states.
- All configurations (thresholds, model parameters, and file paths) shall be editable without modifying source code.
- The system shall maintain structured logs for system activity, detections, and communication events.
- The software shall include a safe-state condition that triggers if communication or detection fails.
- Source code shall be modular and documented for maintainability and future expansion.

2.2. ENGINEERING STANDARDS

The importance of engineering standards is that they help to ensure consistency, safety, and maintain a common approach towards design. They work like generalized rules towards specific problems and concerns that may occur in development. They provide a shared technical foundation that allows engineers to design systems that communicate and function reliably together. They protect public safety and ensure products meet ethical and environmental expectations. Overall, they are set rulesets made in place for development and frameworks to help work towards success in a project in a way that accounts for potential concerns that could arise without the structuring of these standards.

IEEE 1012-2016 — System and Software Verification and Validation

This standard defines a structured approach for verifying and validating software systems to ensure they meet their intended purpose and user requirements. It outlines procedures for testing, documentation, and traceability throughout the development cycle. For GridSAFE, it helps ensure our IDS software functions reliably, accurately detects anomalies, and meets project specifications.

ISO 9001:2015 — Quality Management Systems

This standard focuses on consistent quality across all development and production processes. It promotes clear documentation, defined workflows, and feedback-driven improvement. Applying it to GridSAFE ensures repeatable testing procedures, organized version control, and reliable system performance during demonstrations.

ISO 14001:2015 — Environmental Management Systems

This standard provides guidelines for minimizing environmental impact during design and development. It emphasizes sustainability, material efficiency, and waste reduction. For GridSAFE, it encourages the use of non-conductive, recyclable materials (like PLA and wood) and promotes efficient use of resources during model construction.

ISO 50001:2018 — Energy Management Systems

This standard establishes best practices for monitoring and improving energy efficiency. It supports designing systems that optimize power usage and reduce energy waste. In GridSAFE, it aligns with simulating realistic grid operations while maintaining efficient power consumption for LEDs and microcontrollers.

ISO/IEC 27001:2022 — Information Security Management Systems (ISMS)

This standard outlines how to protect data confidentiality, integrity, and availability. It includes policies for access control, risk management, and secure data handling. Applying it to GridSAFE ensures that simulated grid logs, IDS configurations, and communication between systems remain secure and protected from unauthorized modification or access.

IEEE 1012-2016 is directly relevant because our project includes a complex software pipeline for intrusion detection. Following this standard helps ensure the IDS software is verified and validated against requirements, minimizing false alerts and logic errors.

ISO/IEC 27001 applies to how we handle simulated grid data and potential attack scenarios. Even though the data is not real-world critical infrastructure data, adopting its principles (like secure storage and access control) reinforces cybersecurity best practices.

ISO 9001 supports documentation, testing, and consistency across hardware and software components, ensuring the system remains reliable during demonstrations.

ISO 14001 and **ISO 50001** have limited but conceptual relevance; our physical model consumes little energy, but the project represents an energy infrastructure system, so these standards encourage awareness of efficiency and sustainability in design choices.

We reviewed our selected standards as a team and noticed some differences in focus. While a few of us concentrated more on the physical components and applications of the project, others focused on the software and digital aspects. Several of the standards we discussed were already familiar to the CybE engineers from previous upper-level coursework. Additionally, we realized that considerations like the choice of PLA and other printing materials weren't something everyone initially thought about until we identified the relevant standards.

Q5) What modifications do you intend to make to your project design to incorporate these standards?

To align with these standards, our team will:

- Implement a **structured verification and validation plan** following IEEE 1012 to document test cases, outcomes, and revisions.
- Apply **secure configuration management** consistent with ISO/IEC 27001 by limiting file access, using hashed credentials, and validating data integrity.
- Maintain **versioned documentation and configuration files** to reflect ISO 9001 practices of continuous improvement.
- Consider **energy-efficient operation** of LEDs and microcontrollers to reflect ISO 50001 awareness.
- Incorporate sustainability considerations into material selection for the city model, loosely aligning with ISO 14001.

3 Project Plan

3.1 PROJECT MANAGEMENT/TRACKING PROCEDURES

PROJECT MANAGEMENT STYLE: AGILE METHODOLOGY

OUR TEAM HAS CHOSEN TO ADOPT THE AGILE PROJECT MANAGEMENT STYLE. AGILE IS WELL-SUITED TO GRIDSAFE'S RESEARCH DRIVEN AND EXPERIMENTAL NATURE, WHERE GOALS SUCH AS TRAINING AI MODELS FOR ANOMALY DETECTION, INTEGRATING HARDWARE AND SOFTWARE COMPONENTS, AND ADDING CYBERSECURITY FEATURES REQUIRE FREQUENT ITERATION AND ADAPTATION. AGILE PROVIDES FLEXIBILITY TO CONTINUOUSLY REFINE REQUIREMENTS, PROTOTYPES, AND PERFORMANCE METRICS AS WE MOVE TOWARD OUR FINAL PRODUCT. THIS APPROACH IS ESSENTIAL FOR GRIDSAFE, WHERE BOTH SOFTWARE AND HARDWARE ARE CONSTANTLY EVOLVING TO COALESCE INTO A UNIFIED, FUNCTIONAL SYSTEM. EACH AGILE SPRINT WILL FOCUS ON SMALL, DEMONSTRABLE DELIVERABLES THAT ENABLE MEASURABLE PROGRESS WHILE MANAGING TECHNICAL UNCERTAINTY.

PROGRESS TRACKING AND COMMUNICATION

TO TRACK PROGRESS AND ENSURE TEAM ALIGNMENT THROUGHOUT BOTH SEMESTERS, WE WILL USE THE FOLLOWING INTEGRATED TOOLSET:

TRELLO WITH DISCORD INTEGRATION

AUTOMATED UPDATES FROM TRELLO WILL BE POSTED TO OUR DISCORD SERVER VIA THE TRELLO PLUGIN. THIS INTEGRATION ALLOWS THE TEAM TO EASILY MANAGE TO DO, IN PROGRESS, TESTING, AND COMPLETED TASK LISTS IN REAL TIME.

SPRINT MEETINGS AND CHECK-INS

WEEKLY MEETINGS WILL SERVE AS SPRINT REVIEWS AND PLANNING SESSIONS TO EVALUATE PROGRESS, IDENTIFY BLOCKERS, AND PLAN UPCOMING TASKS.

VERSION CONTROL AND CODE REVIEW

USING GIT WE WILL TRACK CHANGES, MAINTAIN VERSION HISTORY, AND REVIEW EACH MEMBER'S CONTRIBUTIONS IN REAL TIME.

MILESTONE AND DELIVERABLE TRACKING

KEY MILESTONES WILL REPRESENT MAJOR INTEGRATION POINTS OR TESTING PHASES, ENSURING THAT ALL SUBSYSTEMS PROGRESS COHESIVELY TOWARD THE FINAL PRODUCT.

3.2 Task Decomposition

Software

- Train an AI model on logs/signals sent to it
- Use and test said AI model for accuracy of detection
- Create Simulated Network Logs
 - Normal
 - Anomalous
 - Malicious
 - MITRE ATT&CK
- Create Simulated Host Logs
 - Normal
 - Anomalous
 - Malicious
- Network Map/Topology
 - IT
 - OT
- Build Network
 - Set up/image VMs
- Integrate Network with AI
- Integrate AI with Hardware

Hardware

- Develop a 3D city to model an environment for our simulation.
 - Build City baseboard
 - Research materials (plywood, scrap, etc.)
 - Build/Plan/Implement circuit design
 - Design 3D Models in Autodesk Fusion
 - Design 3D Model types (Skyscrapers, houses, apartments, etc.)
 - Develop lights and connections to a Raspberry Pi/Arduino for communication
 - Buy lighting
 - Test lighting
 - Attach communication between devices to a signal/test output
 - Test signal latency, and accuracy/efficiency
 - Set up Raspberry Pi mini or 3
 - Code python to take in IDS data
 - Set up code to control RGB

3.3 PROJECT PROPOSED MILESTONES, METRICS, AND EVALUATION CRITERIA

Hardware Milestones

Milestone 1 – First 3D Prototype

- **Task:** Print the first building on mini baseboard.
 - **Metric:** Dimensions within ± 15 mm (0.006 in) tolerance.

- **Progress Measure:** Compare printed dimensions to CAD design; the measurements will be within the tolerance.
- **Task:** Achieve aesthetic quality of prototype.
 - **Metric:** Prototype passes visual inspection checklist (edges smooth, surfaces clean, proper alignment).
 - **Progress Measure:** Checklist completion rate; 80% of criteria met.

Milestone 2 – LED and Raspberry Pi Integration

- **Task:** Integrate LEDs with prototype and map out circuit plan.
 - **Metric:** LEDs are integrated with the first prototype.
 - **Progress Measure:** LEDs are completed and are 100% functional (They can turn on and off).
- **Task:** Program Raspberry Pi to control LEDs.
 - **Metric:** LEDs change RGB color on command.
 - **Progress Measure:** Test sequence of 3 color changes; ≥95% success rate.

Milestone 3 – Build 3D City Layout

- **Task:** Build and Design 3D City Layout
 - **Metric:** Complete 3D city layout with at least 10 distinct buildings.
 - **Progress Measure:** Successfully print and assemble all buildings.
- **Task:** Integrate LEDs and Raspberry Pi with 3D City
 - **Metric:** LEDs change RGB color on command in the entire city.
 - **Progress Measure:** Test sequence of 3 color changes; ≥95% success rate.

Software Milestones

Milestone 1 – Prototype AI

- **Task:** Define and complete 100% of example log criteria.
 - **Metric:** All log criteria documented and completed.
 - **Progress Measure:** Checklist of example log sections; completion of at least one example per subsection.
- **Task:** Train Base AI on Example Logs
 - **Metric:** Accurate Detection 90% of the time.
 - **Progress Measure:** Demo of 5 log groups for each log classification.
- **Task:** Connect AI output to RaspberryPi
 - **Metric:** 100% Data transferred from AI to RPI
 - **Progress Measure:** Demo of 5 log groups for each log classification.

Milestone 2 – IT Network Integration

- **Task:** Create detailed IT network map.
 - **Metric:** Complete network diagram with all nodes, connections, and protocols.

- **Progress Measure:** Diagram reviewed and approved by team; accuracy rate $\geq 95\%$.
- **Task:** Develop full IT network configuration for project.
 - **Metric:** 100% of network components identified and configured.
 - **Progress Measure:** Verification through simulation or test deployment; all devices communicate successfully.
- **Task:** Feed logs from the network to the AI
 - **Metric:** 100% of expected network activity/logs received by the AI model.
 - **Progress Measure:** Verification through simulation

Milestone 3 – OT Network Integration

- **Task:** Add OT to network map
 - **Metric:** Complete finalized (IT & OT) network diagram with all nodes, connections, and protocols.
 - **Progress Measure:** Diagram reviewed and approved by team; accuracy rate $\geq 95\%$.
- **Task:** Add full OT network configuration for project
 - **Metric:** 100% of IT & OT network components identified and configured.
 - **Progress Measure:** Verification through simulation or test deployment; all devices communicate successfully.

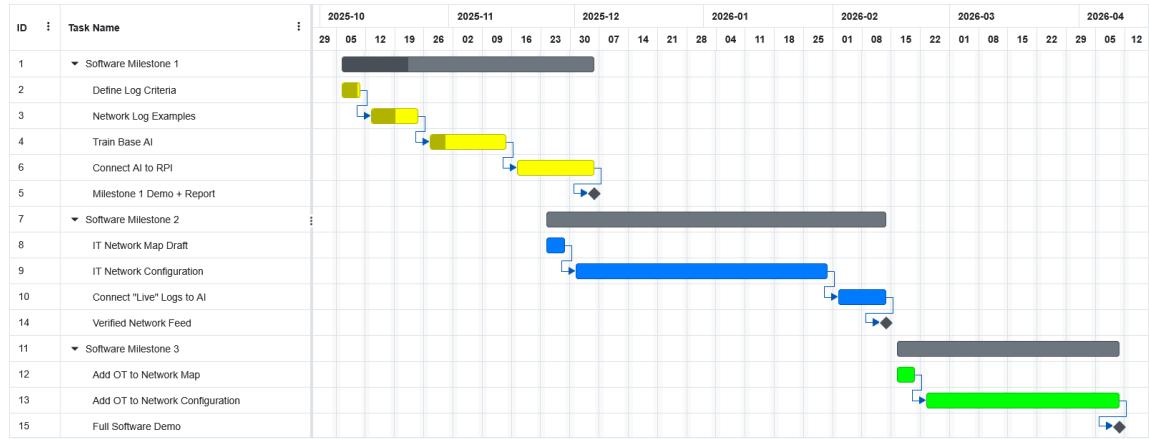
Final Integration

Final Milestone – Hardware and Software Integration

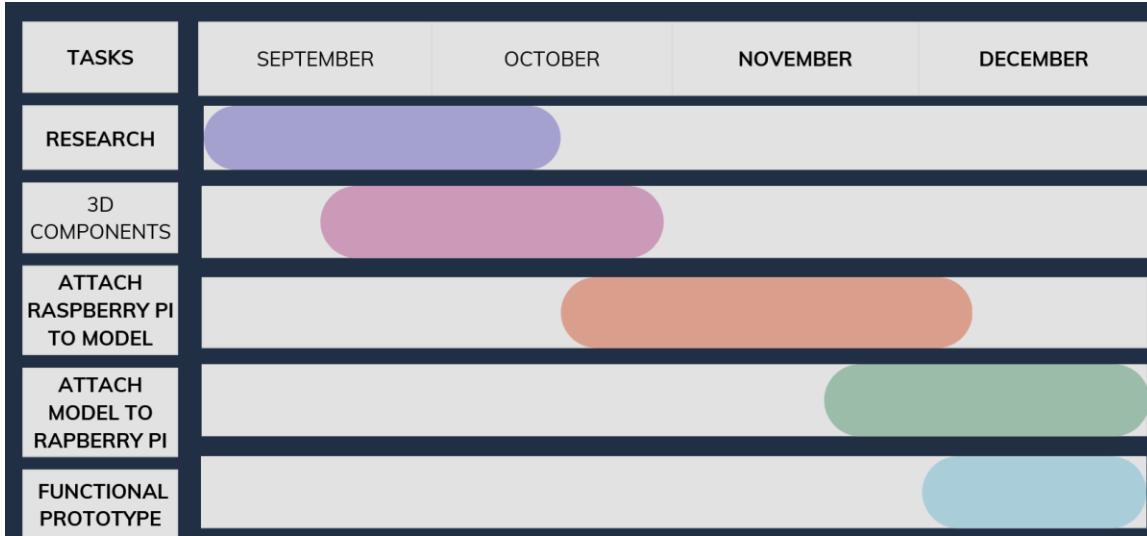
- **Task:** Integrate 3D city with IDS
 - **Metric:** All sensors, LEDs, and Raspberry Pi devices are successful.
 - **Progress Measure:** Verification through simulation and test logs, that all devices communicate successfully.

3.4 PROJECT TIMELINE/SCHEDULE

Software:



Hardware:



3.5 RISKS AND RISK MANAGEMENT/MITIGATION

Software

1. Train an AI model on logs/signals sent to it
 - **Risk factor:** 0.6
 - **Potential risks:**
 - **Risk mitigation plan:** Try out different types of models and evaluate what has the most success. Use and improve training methods until we have acceptable accuracy.

2. USE AND TEST SAID AI MODEL FOR ACCURACY OF DETECTION

- **Risk factor:** 0.0
- **Potential risks:**
- **Risk mitigation plan:**

3. CREATE NETWORK LOGS

- **Risk factor:** 0.2
- **Potential risks:** Once baseline / preset logs are completed, investigate making our own network for the collection of Realtime logs.
- **Risk mitigation plan:**

Hardware

1. Develop a 3D city to model an environment for our simulation
 - **Risk factor:** 0.4
 - **Potential risks:** Models may not fit together correctly; scale or alignment issues; print time could be longer than expected, external environment issues (movement near printers).
 - **Risk mitigation plan:** Start with small test building and incrementally print and test iterations of prototypes.

2. Build city baseboard

- **Risk factor:** 0.3
- **Potential risks:** Baseboard material may warp; measurements may be inaccurate.
- **Risk mitigation plan:** Use commercially available pre-cut boards and verify dimensions with multiple measuring tools before purchasing or assembly.

3. Design 3D Models in Autodesk Fusion

- **Risk factor:** 0.1
- **Potential risks:** Minor modeling errors; complexity may increase print time.
- **Risk mitigation plan:** Use standard libraries and templates to reduce custom modeling errors.

4. Develop lights and connections to a Raspberry Pi/Arduino for communication

- **Risk factor:** 0.6
- **Potential risks:** Wiring may fail; Raspberry Pi/Arduino may not handle timing/voltage requirements; LEDs may not respond correctly.
- **Risk mitigation plan:**
 - Prototype on breadboard first before soldering.
 - Consider using off-the-shelf LED controller boards compatible with Raspberry Pi.
 - Test small sections incrementally.
 - Keep spare LEDs and wiring materials available.

3.6 PERSONNEL EFFORT REQUIREMENTS

Include a detailed estimate in the form of a table accompanied by a textual reference and explanation. This estimate shall be done on a task-by-task basis and should be the projected effort in total number of person-hours required to perform the task.

Task Description	Human Effort	Hours Required
Design and build a baseboard for 3D city	Research potential materials to be used for the 3D city baseboard. Build the baseboard for the city model with planned wiring of the LEDs of the city in mind.	6
Design and build a 3D prototype	Use CAD software to design and print the first (and tallest) building on a mini baseboard that is of acceptable quality and aesthetically pleasing	4
LED and Raspberry Pi integration	Integrate miniature LEDs into the prototype building and ensure they are fully functional, being able to be turned on and off. Program the Raspberry Pi to control the switching of the LEDs as well as the RGB functionality.	3

Design and build the 3D city layout	Design and build the 3D city layout with at least 10 unique building designs that make up 3 distinct zones (e.g. a center business district, a surrounding urban district, and an outlying suburban district) Integrate LEDs into every building and program them to the Raspberry Pi to control their switching and RGB functionality so they can change into three different colors on command.	72
Define and complete 100% of example log criteria.	Create our very own logs for both network and host. These logs will have three categories – normal, anomalous, and malicious.	6
Train Base AI on Example Logs	Aggregating and feeding the simulated logs into the AI as its data and training this model such that it can detect and understand in the scope of our project what normal, anomalous, and malicious logs look like.	30
Connect AI output to RaspberryP	Connecting the AI output such that it feeds into the Raspberry Pi.	8
Create detailed IT network map.	Creating and labeling the network map for our project such that every machine and interactions between machines is clear.	4
Develop full IT network configuration for project.	Allocating, imaging VMs, and setting up the machines such that the machines interact as a IT style network needed for our project.	50
Feed logs from the network to the AI	Using python scripts to aggregate and sent the logs from every machine on the network to the AI	10
Add OT to network map	Adding into the IT network, map the OT machines and their new connections.	4
Add full OT network configuration for project	Allocating, imaging VMs, and setting up the machines such that the machines interact as a full IT and OT network needed for our project.	60

3.7 OTHER RESOURCE REQUIREMENTS

Software

- Python
- Java
- Wireshark
- XGBoost
 - Computer with at least 16g RAM
- Proxmox

Hardware

- Raspberry Pi / microcontrollers
- RGB LED strips
- MOSFETs for LED control
- Breadboards / jumper wires / connectors
- Power supply (5V/12V depending on LED strips)

Materials / Physical Construction

- Plywood / foam / plexiglass / acrylic sheets for buildings
- Glue, screws, or fasteners for assembly
- Paint, markers, or vinyl for city aesthetics
- Mounting brackets or frames for stability

4 Design

4.1 DESIGN CONTEXT

4.1.1 Broader Context

Describe the broader context in which your design problem is situated. What communities are you designing for? What communities are affected by your design? What societal needs does your project address?

List relevant considerations related to your project in each of the following areas:

Area	Description	Examples
Public health, safety, and welfare	How does your project affect the general well-being of various stakeholder groups? These groups may be direct users or may be indirectly affected (e.g., solution is implemented in their communities)	Increasing/reducing exposure to pollutants and other harmful substances, increasing/reducing safety risks, increasing/reducing job opportunities
Global, cultural, and social	How well does your project reflect the values, practices, and aims of the cultural groups it affects? Groups may include but are not limited to specific communities, nations, professions, workplaces, and ethnic cultures.	Development or operation of the solution would violate a profession's code of ethics, implementation of the solution would require an undesired change in community practices

Environmental	What environmental impact might your project have? This can include indirect effects, such as deforestation or unsustainable practices related to materials manufacture or procurement.	Increasing/decreasing energy usage from nonrenewable sources, increasing/decreasing usage/production of non-recyclable materials
Economic	What economic impact might your project have? This can include the financial viability of your product within your team or company, cost to consumers, or broader economic effects on communities, markets, nations, and other groups.	Product needs to remain affordable for target users, product creates or diminishes opportunities for economic advancement, high development cost creates risk for organization

4.1.2 Prior Work/Solutions

Include relevant background/literature review for the project (cite at least 3 references for literature review in IEEE Format. See link: <https://ieeexplore.ieee.org/sites/default/files/analysis/27/IEEE%20Citation%20Guidelines.pdf>)

- If similar products exist in the market, describe what has already been done
- If you are following previous work (e.g., a previous senior design project), cite that and discuss the **advantages/shortcomings**
- Note that while you are not expected to “compete” with other existing products / research groups, you should be able to differentiate your project from what is available. Thus, provide a list of pros and cons of your target solution compared to all other related products/systems.

Detail any similar products or research done on this topic previously. Please cite your sources and include them in your references. All figures must be captioned and referenced in your text.

4.1.3 Technical Complexity

Provide evidence that your project is of sufficient technical complexity. Use the following metric or argue for one of your own. Justify your statements (e.g., list the components/subsystems and describe the applicable scientific, mathematical, or engineering principles)

1. The design consists of multiple components/subsystems that each utilize distinct scientific, mathematical, or engineering principles –AND–
2. The problem scope contains multiple challenging requirements that match or exceed current solutions or industry standards.

4.2 DESIGN EXPLORATION

4.2.1 Design Decisions

List key design decisions (at least three) that you have made or will make. These can include, but are not limited to, materials, subsystems, physical components, sensors/chips/devices, physical layout, features, etc. Describe how you made/will make these decisions and how they have affected or are likely to affect project success.

4.2.2 Ideation

For at least one design decision, describe how you ideated or identified potential options (e.g., lotus blossom technique). Describe at least five options that you considered.

4.2.3 Decision-Making and Trade-Off

Demonstrate the process you used to identify the pros and cons or trade-offs between each of your ideated options. You may wish you include a weighted decision matrix or other relevant tool. Describe the option you chose and why you chose it.

4.3 PROPOSED DESIGN

4.3.1 Overview

Provide a high-level description of your current design. This description should be understandable to non-engineers (i.e., the general public). Describe key components or sub-systems and how they contribute to the overall design. You may wish to include a basic block diagram, infographic, or other visual to help communicate the overall design.

4.3.2 Detailed Design and Visual(s)

Provide a detailed, technical description of your design, aided by visualizations. This description should be understandable to peer engineers. In other words, it should be clearly written and sufficiently detail such that another senior design team can look through it and implement it.

The description should include a high-level overview written for peer engineers. This should list all sub-systems or components, their role in the whole system, and how they will be integrated or interconnected. A visual should accompany this description. Typically, a detailed block diagram will suffice, but other visual forms can be acceptable.

The description should also include more specific descriptions of sub-systems and components (e.g., their internal operations). Once again, a good rule of thumb is: could another engineer with similar expertise build the component/sub-system based on your description? Use visualizations to support your descriptions. Different visual types may be relevant to different types of projects, components, or subsystems. You may include, but are not limited to: block diagrams, circuit diagrams, sketches/pictures of physical components and their operation, wireframes, etc.

4.3.3 Functionality

Describe how your design is intended to operate in its user and/or real-world context. What would a user do? How would the device/system/etc. respond? This description can be supplemented by a visual, such as a timeline, storyboard, or sketch.

4.3.4 Areas of Concern and Development

How well does/will the current design satisfy requirements and meet user needs?

Based on your current design, what are your primary concerns for delivering a product/system that addresses requirements and meets user and client needs?

What are your immediate plans for developing the solution to address those concerns? What questions do you have for clients, TAs, and faculty advisers?

4.4 TECHNOLOGY CONSIDERATIONS

Describe the distinct technologies you are using in your design. Highlight the strengths, weakness, and trade-offs made in technology available. Discuss possible solutions and design alternatives.

4.5 DESIGN ANALYSIS

Discuss what you have done so far, i.e., what have you built, implemented, or tested? Did your proposed design from 4.3 work? Why or why not? Based on what has worked or not worked (e.g., what you have or haven't been able to build, what functioned as expected or not), what plans do you have for future design and implementation work? For example, are there implications for the overall feasibility of your design or have you just experienced build issues?

5 Testing

Testing is an **extremely** important component of most projects, whether it involves a circuit, a process, power system, or software.

The testing plan should connect the requirements and the design to the adopted test strategy and instruments. In this overarching introduction, give an overview of the testing strategy and your team's overall testing philosophy. Emphasize any unique challenges to testing for your system/design.

In the sections below, describe specific methods for testing. You may include additional types of testing, if applicable to your design. If a particular type of testing is not applicable to your project, you must justify why you are not including it.

When writing your testing planning consider a few guidelines:

- Is our testing plan unique to our project? (It should be)
- Are you testing related to all requirements? For requirements you're not testing (e.g., cost related requirements) can you justify their exclusion?
- Is your testing plan comprehensive?
- When should you be testing? (In most cases, it's early and often, not at the end of the project)

5.1 UNIT TESTING

What units are being tested? How? Tools?

5.2 INTERFACE TESTING

What are the interfaces in your design? Discuss how the composition of two or more units (interfaces) are being tested. Tools?

5.3 INTEGRATION TESTING

What are the critical integration paths in your design? Justification for criticality may come from your requirements. How will they be tested? Tools?

5.4 SYSTEM TESTING

Describe system level testing strategy. What set of unit tests, interface tests, and integration tests suffice for system level testing? This should be closely tied to the requirements. Tools?

5.5 REGRESSION TESTING

How are you ensuring that any new additions do not break the old functionality? What implemented critical features do you need to ensure do not break? Is it driven by requirements? Tools?

5.6 ACCEPTANCE TESTING

How will you demonstrate that the design requirements, both functional and non-functional are being met? How would you involve your client in the acceptance testing?

5.7 SECURITY TESTING (IF APPLICABLE)

5.8 User Testing

Describe how the team will include real users to interact with the solution/product. Your user testing plan should evaluate your solution/product's usability and overall user experience by gathering user feedback through observations, surveys, etc. User feedback allows the team to identify areas for improvement and ensure the product meets user needs.

5.9 RESULTS

What are the results of your testing thus far? Include any numerical, graphical, or qualitative testing results here? How do they demonstrate compliance with the requirements or addressing user needs? Use a summary narrative to discuss what you've learned and what next steps need to be taken.

6 Implementation

Describe any (preliminary) implementations of your design thus far. Support any general, descriptive text with relevant images. If your project has inseparable activities between design and implementation, you can list them either in the Design section or this section.

7 Ethics and Professional Responsibility

Use this section to describe your considerations of engineering ethics and professional responsibility. Most importantly how are you defining engineering ethics and professional responsibility in the context of your project and what steps are you taken to ensure ethical and responsible conduct. Each section references one type of ethical/professional responsibility considerations. You may also use this introductory section to note any overarching ethical philosophy among your team.

7.1 AREAS OF PROFESSIONAL RESPONSIBILITY/CODES OF ETHICS

This discussion is with respect to the paper by J. McCormack and colleagues titled “Contextualizing Professionalism in Capstone Projects Using the IDEALS Professional Responsibility Assessment”, *International Journal of Engineering Education* Vol. 28, No. 2, pp. 416–424, 2012

Pick one of IEEE, ACM, or SE code of ethics (all linked in class slides). Create a table, like Table 1 in the McCormack et al. (2012, pg. 418) paper, with the following columns representing: Area of Responsibility (from the paper), Definition (in your own words), Relevant Item from Code of Ethics (from the Code of Ethics you selected, and description of how your team has interacted with that area of professional responsibility or adhered to that code during your project thus far.

In text below the table, describe one area in which your team is performing well. Describe what your team is doing and how that signifies strong performance. Also describe one area in which your team needs to improve. Describe what your team is currently doing and what it should do in the future to improve.

7.2 FOUR PRINCIPLES

Create a table with rows for each broader context area (see Section 4.1.1) and columns for each of the four principles (beneficence, nonmalificence, respect for autonomy, and justice; see Beauchamp, 2007). Within the table, identify at least one way each of the four principles applies to each of the broader context areas. Some principle-broader context connections might be more prominent than others, but you should be able to identify something for each table cell. Note: Your design may end up negative or neutral in some cell. For example, your product might perform poorly in environment-nonmaleficence because it utilizes natural resources without a positive/mitigating effect.

Below the table, note one broader context-principle pair that is important to your project. Briefly describe the benefit in that area you are working towards and how you will ensure it. Also note one broader context-principle pair in which your project/end design is or will be lacking. Describe either (a) how this negative is overcome by other positives in other areas of the project/design or (b) what your team must do to improve in this area.

7.3 VIRTUES

List and define at least three virtues that are important to your team. Describe what you will do or have done as a team to support these virtues among all team members.

Each team member should also answer the following:

- Identify one virtue you have demonstrated in your senior design work thus far? (Individual)
 - Why is it important to you?
 - How have you demonstrated it?
- Identify one virtue that is important to you that you have not demonstrated in your senior design work thus far? (Individual)
 - Why is it important to you?
 - What might you do to demonstrate that virtue?

8 Closing Material

8.1 CONCLUSION

Summarize the work you have done so far. Briefly re-iterate your goals. Then, re-iterate the best plan of action (or solution) to achieving your goals. What constrained you from achieving these goals (if something did)? What could be done differently in a future design/implementation iteration to achieve these goals?

8.2 REFERENCES

List technical references and related work / market survey references. Do professional citation style (ex. IEEE). See link: <https://ieeexplore.ieee.org/sites/default/files/analysis/27/IEEE%20Citation%20Guidelines.pdf>

8.3 APPENDICES

Any additional information that would be helpful to the evaluation of your design document.

If you have any large graphs, tables, or similar data that does not directly pertain to the problem but helps support it, include it here. This would also be a good area to include hardware/software manuals used. May include CAD files, circuit schematics, layout etc., PCB testing issues etc., Software bugs etc.

9 Team

Complete each section as completely and concisely as possible. We strongly recommend using tables or bulleted lists when applicable.

9.1 TEAM MEMBERS

9.2 REQUIRED SKILL SETS FOR YOUR PROJECT

(if feasible – tie them to the requirements)

9.3 SKILL SETS COVERED BY THE TEAM

(for each skill, state which team member(s) cover it)

9.4 PROJECT MANAGEMENT STYLE ADOPTED BY THE TEAM

Typically, Waterfall or Agile for project management.

9.5 INITIAL PROJECT MANAGEMENT ROLES

(Enumerate which team member plays what role)

9.6 Team Contract

Team Members:

- 1) Anthony Nehring _____ 2) Jason Di Giovanni _____
3) Brant Gicante _____ 4) Kyle Maloney _____
5) Nellie Leaverton _____ 6) Evan Booze _____
7) _____ 8) _____

Team Procedures

1. Day, time, and location (face-to-face or virtual) for regular team meetings:

Regular team meetings will be held on Thursdays from 2:30 – 3:30 PM (with the possibility of adjusting to a later time if needed). Attendance is required for all members, but remote participation will be available if a member cannot attend in person.

Acceptable reasons for absence include illness, family emergencies, or conflicts with academic obligations such as exams. Unacceptable reasons include lack of motivation or simply “not feeling like it.” Members are expected to notify the group in advance if they will be absent or attending remotely.

Meetings with the project advisor, Dr. Julie Rursch, will be scheduled every few weeks (date and time TBD). While attendance is not mandatory for all members, it is highly recommended that at least one of the co-proposers be present.

2. Preferred method of communication updates, reminders, issues, and scheduling (e.g., e-mail, phone, app, face-to-face):

The team's primary method of communication will be Discord, which will be used for updates, reminders, quick messaging, online meetings, and general coordination.

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

The team will make decisions based on consensus. If a consensus cannot be reached after thorough discussion, guidance may be sought from the project advisor, Dr. Julie Rursch.

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

A shared **Google Drive** folder will be maintained as the central repository for all meeting notes and project documentation.

- For **full group meetings**, Nellie will serve as the primary recorder, documenting meetings. If Nellie is unable to attend, the responsibility will be passed along to another group member.
- For **smaller group meetings**, one member from each subgroup will be designated to record notes and upload them to the shared folder.

Participation Expectations

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

All team members are expected to attend scheduled meetings and arrive on time to show respect for the group's time and maintain steady progress on the project. Active participation during meetings is required, which includes contributing ideas, providing updates on assigned tasks, and engaging in group discussions.

If a member is unable to attend a meeting due to illness, family obligations, or academic conflicts, they are responsible for catching up on all information discussed. This may involve reviewing the meeting minutes, following up with teammates, or, if necessary, scheduling a brief follow-up meeting to ensure they remain aligned with the group.

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

All team members are expected to take ownership of their assigned tasks and complete them in a timely manner. To support accountability and progress, the team will establish **weekly milestones** to check in on individual contributions and ensure deadlines are being met.

A **Trello board** will be used to organize tasks, assign responsibilities, track progress, and visualize timelines for the project.

3. Expected level of communication with other team members:

Team members are expected to maintain **consistent and proactive communication** with the group. This includes:

- Notifying the team in advance if you need to miss a meeting or will be unable to complete an assigned task on time.
- Regularly checking **Discord** to stay updated on messages, announcements, deadlines, and project discussions.
- Promptly responding to questions, requests for input, or clarifications from teammates if prompted.

4. Expected level of commitment to team decisions and tasks:

All team members are expected to demonstrate a strong commitment to the team's decisions, goals, and assigned tasks. This includes:

- Staying motivated to work collaboratively toward the **common project goal**.
- Following through on agreed-upon responsibilities and contributing consistently to the team's progress.
- Supporting team decisions even if personal preferences differ, while still providing constructive input during discussions.
- Demonstrating reliability and accountability, ensuring that all tasks are completed with quality and on time.

Leadership

1. Leadership roles for each team member (e.g., team organization, client interaction, individual component design, testing, etc.):

Client Interaction: Nellie

Team Organization: Nellie

Component Design: Nellie (Physical) Jason (Software)

Testing: Kyle

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

The team will use **weekly meetings and milestone check-ins** to guide progress and ensure that all members stay on track with their assigned tasks. **Discord** will serve as the primary tool for ongoing communication, allowing team members to ask questions, share updates, and coordinate with each other and with Dr. Julie Rursch as needed.

3. Strategies for recognizing the contributions of all team members:

The team will dedicate time during **weekly meetings** to review work completed by each member and share the progress made.

Collaboration and Inclusion

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

Brant brings decent knowledge on 3d printing and filament knowledge such as TPU vs PLU, as well as cad and fusion 360 experience. I also have a great perspective on some cyber knowledge going into my final few semesters within the CybE major, and have enough coding, and AWS bucket experience to assist in the software development adequately.

Jason brings prior experience with log generation and analysis, as well as base level experience with AWS and locally hosted AI. I'm also confident in my general cyber knowledge as a CybE major.

Nellie brings decent knowlege of electrical systems, including knowledge of power plants as well as an understanding of how the City of Light should function. She can contribute practical hands-on skills such as 3D CAD design and soldering.

Anthony: CYBE senior, Cyber intelligence analyst, junior level experience with both network and host analyst positions. I am very interested in red team / cyber threat emulation work. Worked frontend for 309, comfortable with python, java, C, with beginner level capabilities in assembly (CPRE381 and CYBE536 – currently taking). Competent with using Linux and working on the same level with windows.

Kyle is a software engineer with strong experience in cybersecurity. He has worked with Python for years building tools and applications and has practice training AI models. He also has experience using AWS for development and data management.

Evan understands the basics of circuit design, power plants, and the electrical grid. Evan has moderate experience with circuit design software such as LTspice, and power simulation tools such as PSCAD. Evan also has limited experience using MATLAB.

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

Brant's strategy to motivate other team members to support contribution to the work is to remind them how cool applicable the assignment will be for themselves. Everyone needs a project to say they did something, and this is a great opportunity for them to excel and show they have great teamwork in a professional setting.

Jason's strategy to motivate other team members is to always be available if team members are struggling to get work done, so we can resolve issues quickly. I'll also encourage everyone to pause before moving on in our meetings so if anyone has something to say they have a chance to add it instead of getting skipped.

Evan's strategy to encourage work and contributions to the project is to take an active role in working on the project, working closely with other team members and supporting their work on the project to the best of his ability. Evan will actively contribute to the best of his ability during regularly scheduled team meetings and will seek guidance and support from other team members should he face any setbacks or complications with his work on the project. Evan will also try to be as accommodating of other team members as possible to facilitate their work on the project.

Nellie's strategy to encourage contributions is to create an environment where every team member feels heard and valued. She actively invites input during discussions and makes sure to recognize the unique strengths each person brings to the project. By asking thoughtful questions and showing genuine interest in others' perspectives, Nellie helps spark new ideas and ensures collaboration stays inclusive. She also emphasizes clear communication and accountability, so team members feel confident that their efforts directly contribute to the success of the project.

Anthony's strategy to encourage work and contribution to the project is by always keeping an upbeat attitude and making sure everyone is getting the help they need and maintaining a good pace for completion. Anthony will be open to communicating and be there for other group members when they are stressed. He will also be making sure to keep the group updated and making sure everyone is updating the group on if they are making deadlines / if they need extra help.

Kyle's strategy is to try and encourage those with ideas to build on them if there seems to be any potential. Taking an idea that someone has and trying to incorporate into our design in a meaningful way would be a great way to get everyone in this project to want to be more involved and give more suggestions. This also would mean being openly critical of everyone's ideas so we can have a discussion and really figuring out if an idea will truly work for the design we have in mind or if it's worth changing something.

3. Procedures for identifying and resolving collaboration or inclusion issues (e.g., how will a team member inform the team that the team environment is obstructing their opportunity or ability to contribute?)

For **minor issues**, members are encouraged to bring them up directly in **Discord** or during a team meeting, allowing the group to address the concern promptly and collaboratively.

For **more significant issues**, team members should reach out to **Jason or Nellie**, who will help mediate the situation and work with the team to find a resolution.

If the issue **cannot be addressed within the team**, members may escalate the concern to **Dr. Fila or Dr. Rover** to ensure it is properly handled.

Goal-Setting, Planning, and Execution

1. Team goals for this semester:

The primary goal for the semester is to develop a small-scale prototype board that can simulate attacks on a power grid.

2. Strategies for planning and assigning individual and team work:

The team will break the project into **manageable milestones**. As well as work will be assigned to individual team members based on their skills, expertise, and current workload to ensure that responsibilities are balanced and no one is overloaded.

3. Strategies for keeping on task:

The team will maintain focus and progress through a combination of **regular updates, meetings, and resource management**.

- **Regular check-ins with Dr. Julie Rursch** will provide guidance, feedback, and accountability.
- **Nellie will communicate with ISEAGE** to clarify what resources and support are available, including funding or materials.
- Weekly milestones and Trello task tracking will also help the team monitor progress and stay organized.

Consequences for Not Adhering to Team Contract

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

If a team member fails to meet the obligations outlined in this contract, the team will address the issue promptly and constructively.

- For **first-time or minor infractions**, the team will discuss the concern directly with the member to clarify expectations and provide an opportunity to correct the behavior.
- If **infractions occur more than once**, a designated team member (Nellie or Jason) will reach out to the individual to address the issue more formally and work toward a resolution.

2. What will your team do if the infractions continue?

Persistent or unresolved issues may be escalated to the Senior Design Advisor's, Dr. Rover and Dr. Fila, to ensure the team can maintain a productive and collaborative environment.

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) Evan Booze _____ DATE 9/15/2025 _____

2) Anthony Nehring _____ DATE 9/15/2025 _____

3) Jason Di Giovanni _____ DATE 9/15/2025 _____

4) Brant Gicante _____ DATE 9/15/2025 _____

5) Nellie Leaverton _____ DATE 9/15/2025 _____

6) Kyle Maloney _____ DATE 9/15/2025 _____

7) _____ DATE _____

8) _____ DATE _____