

PEW

by

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A PEW

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Acronyms and Abbreviations

AES	- Advanced Encryption Standard
eNAP	- Emergency Network Access Point
PEW	- Portable Emergency WISP
PKI	- Public Key Infrastructure
PoE	- Power over Ethernet
PSK	- Pre-Shared Key
WISP	- Wireless Internet Service Provider
XML	- Extensible Markup Language (File Format)



Abstract

Since the year 2000, there have been on average over 400 natural disasters per year affecting rural and metropolitan areas alike. These disasters leave communications networks broken and segmented. The victims are left merely helpless while they wait for assistance and emergency first responders to save their lives. Even after these tragic events, communication services may not be restored for months or even years. This leaves families and individuals vulnerable to further hardship due to lack of supplies. Our solution aims to reconnect disaster victims faster. With our GoKits, families and emergency services will come back online in dramatically less time. A GoKit includes everything you need to connect to our emergency communications network. With this GoKit, users can connect from up to 15km away from our eNAP (Emergency Network Access Point). PEW believes access to communications networks should remain a human right.



Introduction

Problem

According to the National Centers for Environmental Information, since 1980, the US alone has suffered 250 weather and climate disasters where the overall damages exceeds \$1.7 trillion (Smith 2019). These disasters leave communications networks broken and segmented. The victims are left merely helpless while they wait for assistance and emergency first responders to save their lives. Even after these tragic events, communication services may not be restored for months or even years. This leaves families and individuals vulnerable to further hardship due to lack of supplies.

Solution

PEW aims to reconnect disaster victims faster. With a PEW GoKit, families and emergency services will come back online in dramatically less time. A GoKit includes everything you need to connect to PEW's emergency communications network: A high-capacity battery, long-range wireless antenna, durable outdoor access point, premium cables and a portable expanding tripod. With this GoKit, users can connect from up to 15km away from a PEW eNAP (Emergency Network Access Point). The eNAP consists of a pre-configured high-powered long-range station, redundant network infrastructure and a weather resistant housing that can be rapidly deployed by any community.



Project Goals

The goal of PEW will be a robust, lightweight, wireless telecommunications infrastructure solution aimed at helping disaster-struck areas. PEW will offer GoKits for users to connect their wireless or wired devices to. The GoKits will get an Internet connection from the eNAP (emergency wireless access point), which can be setup by anyone, even those with little to no technical knowledge. PEW will be extremely simple to interact with, even from an administrative standpoint as the hardware all comes pre-configured.

Overview

The remainder of this final report outlines in detail how the project was completed. The report includes the following sections: design objective, methodology, budget, timeline, problems encountered, and future recommendations.



Discussion

Project Description

PEW was conceived by Christian Shaheen, Nicholas Thomas, and Conner Paul. Christian initially proposed the idea to the team that involved a long-range wireless solution for people in need. Conner envisioned the idea of a flagship product that could be deployed to a consumer of any demographic. Nicholas created the robust marketing strategy, including but not limited to, names, support structure, and market research. Together, the team set to work developing their life saving solution. Prior to the first day of classes, the team discussed ideas for possible projects and brainstormed solutions to aid in the recovery of natural disasters (such as damages caused by Hurricane Katrina, Hurricane Maria and Hurricane Dorian). Finally, after determining the potential of the project, the group decided on the idea, and Portable Emergency WISP was established.

Project Objectives

The goal of PEW will be a robust, lightweight, wireless telecommunications infrastructure solution aimed at helping disaster-struck areas. PEW will offer GoKits for users to connect their wireless or wired devices to. The GoKits are made of lightweight, inexpensive but strong PVC tubing. The individual components are then mounted to the tubing using standard home improvement hardware. The kit comes with a PVC stand but the pole can be mounted to any surface to improve connection.

The GoKits will get an Internet connection from the eNAP (emergency wireless access point), which can be setup by anyone, even those with little to no technical knowledge. Similar to the GoKits, the eNAP comes with PVC to allow flexible mounting options. The eNAP is able to receive Internet from a variety of uplinks to fit into any post-disaster situation. PEW, overall, will be extremely simple to interact with, even from an administrative standpoint as the hardware all comes pre-configured.



Methodology

The WISPy Bois team decided to take the waterfall development approach to the task at hand. All of the objectives were listed out in detail then approached one at a time to progress to a solution. Once all of the steps were completed, the team reviewed the project for flaws and errors, repaired them, and retested until the solution was completed.

User Profile

Table 1

The User Profile presents the user profile used through the development of the product. It provides the team with details of the target market this product was built for. Throughout development, the team will revisit this user profile to ensure the team has not lost sight of the real reason for this project; the users.



<p>Project Title: PEW</p>
<p>Potential Users:</p> <ul style="list-style-type: none"> · Emergency Personnel · Disaster Victims
<p>Software, Interface, and Related Experience: All PEW users should have experience using the Internet and following instructional booklets. All equipment is preconfigured and as such does not require any in depth technology experience.</p>
<p>Experience with Similar Services:</p> <ul style="list-style-type: none"> · Spectrum · AT&T · Comcast · Cox · Verizon · Local ISPs
<p>Task Experience: In the event of a disaster, new users will receive a GoKit with included instruction booklet. The user will be instructed to first setup the adjustable tripod and select a suitable location (e.g. At the highest point available without obstructions). Once the tripod is setup, the user will be guided through pole mounting the equipment. Finally, the user is shown a simple, color-coded, plug-n-play diagram for networking and power. The user is then able to connect to the network like any other network.</p>
<p>Frequency of Use: PEW's services are intended to be used in the immediate aftermath of a disaster for the duration of the community's recovery period. This can be as long or as short as is required. While PEW is not targeted at permanent installations, its durable design permits it.</p>
<p>Key Interface Design Requirements that the Profile Suggests:</p> <ul style="list-style-type: none"> · Plug n Play · Preconfigured / No Management · Durable · Solar-Powered / Self-sufficient

Table 1: User Profile

Figure 2

Use Case Diagram seeks to visualize in a simple graphic, the different roles a user might possess and how each of those roles interact with the product.

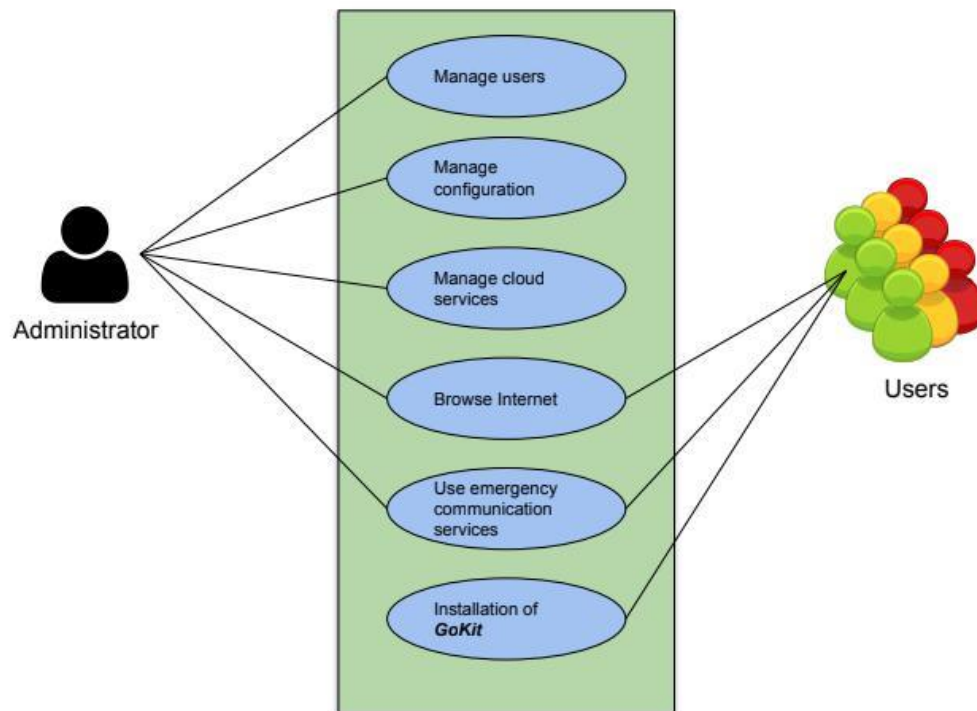


Figure 2: User Case Diagram



Project Management

Objectives and Deliverables

The PEW team wanted to develop an emergency response kit that will allow disaster-struck victims to rapidly deploy network communications infrastructure. A GoKit provides the user with pre-configured networking equipment that can be deployed in any scenario. GoKits are water resistant and buoyant to ensure reliability under any circumstances.

Our eNAP is a weather resistant, mobile, and redundant solution to provide backhaul wireless to the GoKit. The eNAP is deployable by a disaster recovery team, community members, or emergency responders. In many scenarios this can be as easy as a few vehicles and little support staff delivering and distributing the equipment. Ultimately providing rapid network access to a community in need.

Table 3

MAJOR PROJECT MILESTONES				
FALL 2019 MILESTONES				
Initial Meetup	06/17/19		User Profile Drafted	10/21/19
Initiation Phase	08/26/19		Elevator Speech	10/21/19
Team Contract Written	09/23/19		Fall Presentation	11/26/19
Project Abstract Drafted	10/14/19			
SPRING 2019 MILESTONES				
Filming Day	01/25/20		Spring Presentation	03/30/2020
Start Video Editing	02/01/20		Tech Expo	04/14/20

Table 3: Major Project Milestones



Budget

Table 4

The Budget is a line item cost breakdown of a full scale version of the product.

Device	Item	Unit Label	Unit Count	Cost / Unit	Total
GoKit	Solar Panel (100w)	Panels	1	\$ 100.00	\$100
	Stand	Stands	1	\$ 30.00	\$30
	Case	Cases	1	\$ 35.00	\$35
	Foam	Sheets	5	\$ 15.00	\$75
	PoE Switch	Switch	1	\$ 100.00	\$100
	Router	Router	1	\$ 50.00	\$50
	Station Radio	Radios	1	\$ 65.00	\$65
	Client Radio	Radios	1	\$ 110.00	\$110
	Battery	Battery	1	\$ 50.00	\$50
	Cabling	Feet	35	\$ 0.75	\$26
	Man Hours	Hours	2	\$ 75.00	\$150
	eNAP	Shipping Container (20')	Containers	1	\$ 2,500.00
Solar Panel (300w)		Panels	3	\$ 450.00	\$1,350
Battery (12v)		Battery	8	\$ 150.00	\$1,200
Generator (1kw)		Gnerator	1	\$ 2,000.00	\$2,000
Charge Controller (750w)		Controllers	1	\$ 80.00	\$80
Network Rack (22U)		Rack	1	\$ 100.00	\$100
PDU		PDUs	2	\$ 195.00	\$390
Tower (20')		Tower	1	\$ 650.00	\$650
Cabling		Feet	750	\$ 0.75	\$563
Router (ER-6P)		Routers	8	\$ 275.00	\$2,200
Backhaul Radio (AF-5XHD)		Radios	2	\$ 700.00	\$1,400
AP Radio (Rocket Prism)		Radios	6	\$ 450.00	\$2,700
Man Hours		Hours	30	\$ 75.00	\$2,250
Backend	Servers	Servers	2	\$ 750.00	\$1,500
	Windows Server OS	Licenses	2	\$ 6,000.00	\$12,000
	Man Hours	Hours	5	\$ 75.00	\$375
Total					\$32,049

Table 4: Budget



Project Schedule

Figure 5

Fall Semester 2019 Gantt Chart is a visual representation of the Work Breakdown Structure or, in other words, how the team plans to utilize their time to develop the product.

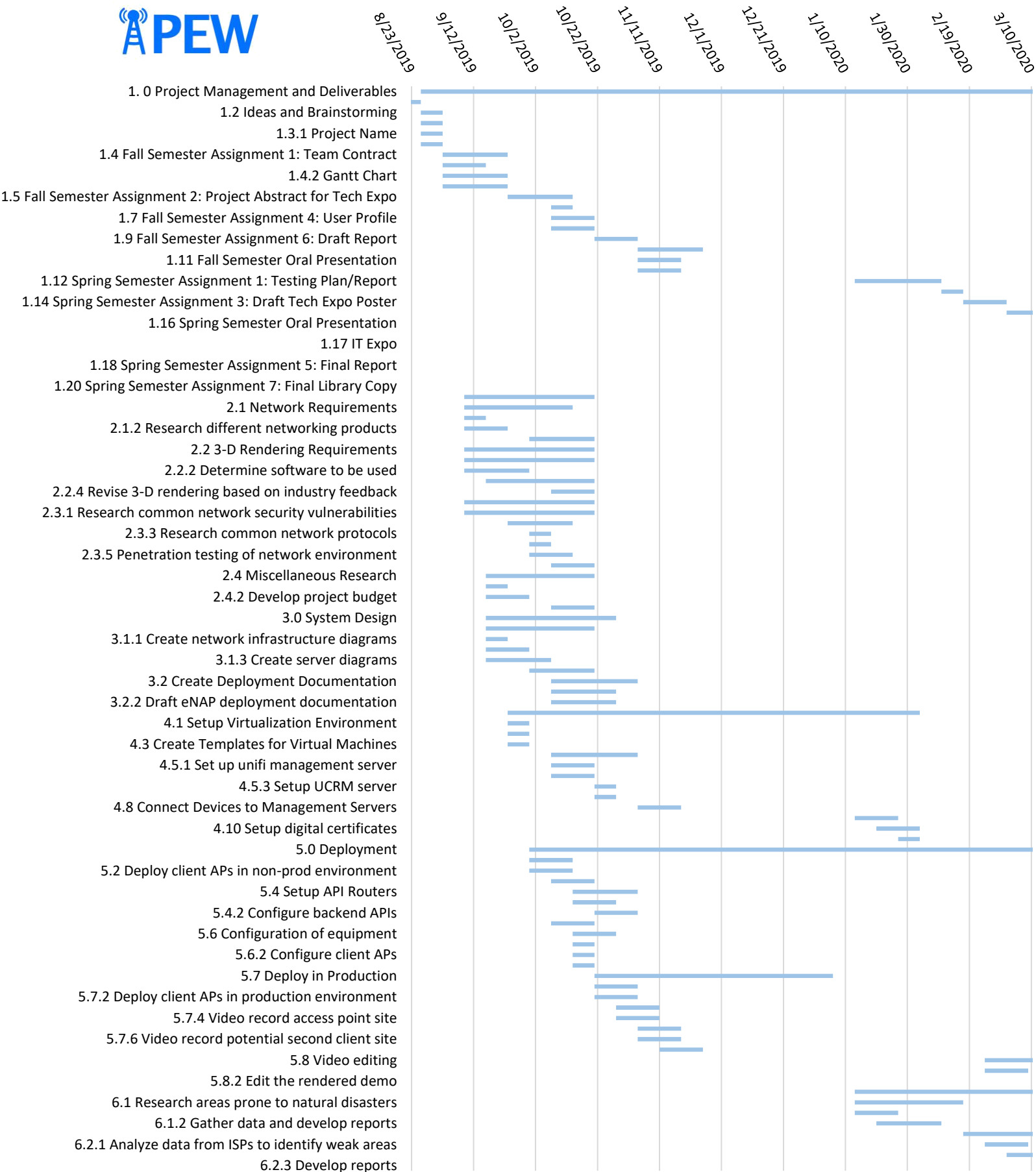


Figure 5: Project Schedule



PEW Work Breakdown Structure

Table 6

Work Breakdown Structure outlines the projected schedule for completion of this project.

Task Name	Duration (Days)	Start Date	End Date
1. 0 Project Management and Deliverables	235	8/26/19	4/17/20
1.1 Team Building	7	8/19/19	8/26/19
1.2 Ideas and Brainstorming	7	8/26/19	9/2/19
1.3 Fall Semester Assignment 0: Team Members & Project Name	7	8/26/19	9/2/19
1.3.1 Project Name	7	8/26/19	9/2/19
1.3.2 Project Logo and Branding	7	8/26/19	9/2/19
1.4 Fall Semester Assignment 1: Team Contract	21	9/2/19	9/23/19
1.4.1 Project Approval	14	9/2/19	9/16/19
1.4.2 Gantt Chart	21	9/2/19	9/23/19
1.4.3 Work Breakdown Structure	21	9/2/19	9/23/19
1.5 Fall Semester Assignment 2: Project Abstract for Tech Expo	21	9/23/19	10/14/19
1.6 Fall Semester Assignment 3: Team Contract Resubmission	7	10/7/19	10/14/19
1.7 Fall Semester Assignment 4: User Profile	14	10/7/19	10/21/19
1.8 Fall Semester Assignment 5: Use Case Diagram	14	10/7/19	10/21/19
1.9 Fall Semester Assignment 6: Draft Report	14	10/21/19	11/4/19
1.10 Fall Semester Assignment 7: Final Fall Semester Report	21	11/4/19	11/25/19
1.11 Fall Semester Oral Presentation	14	11/4/19	11/18/19
1.11.1 Presentation Practice	14	11/4/19	11/18/19

Table 6: Work Breakdown Structure

1.12 Spring Semester Assignment 1: Testing Plan/Report	28	1/13/20	2/10/20
1.13 Spring Semester Assignment 2: Abstract	7	2/10/20	2/17/20
1.14 Spring Semester Assignment 3: Draft Tech Expo Poster	14	2/17/20	3/2/20
1.15 Spring Semester Assignment 4: Final Poster	14	3/2/20	3/16/20
1.16 Spring Semester Oral Presentation	14	3/16/20	3/30/20
1.16.1 Presentation Practice	14	3/16/20	3/30/20
1.17 IT Expo	7	3/30/20	4/6/20
1.17.1 IT Expo Exhibit and Preparation	7	3/30/20	4/6/20
1.18 Spring Semester Assignment 5: Final Report	14	3/30/20	4/13/20
1.19 Spring Semester Assignment 6: Safe Assign Final Report	14	3/30/20	4/13/20
1.20 Spring Semester Assignment 7: Final Library Copy	14	4/13/20	4/27/20
2.0 Research	42	9/9/19	10/21/19
2.1 Network Requirements	35	9/9/19	10/14/19
2.1.1 Research other WISPs	7	9/9/19	9/16/19
2.1.2 Research different networking products	14	9/9/19	9/23/19
2.1.3 Research product plans	21	9/30/19	10/21/19
2.2 3-D Rendering Requirements	42	9/9/19	10/21/19
2.2.1 Self-teaching use of software	42	9/9/19	10/21/19
2.2.2 Determine software to be used	21	9/9/19	9/23/19
2.2.3 Map out eNAP	35	9/16/19	10/21/19
2.2.4 Revise 3-D rendering based on industry feedback	14	10/7/19	10/21/19
2.3 Security Requirements	42	9/9/19	10/21/19
2.3.1 Research common network security vulnerabilities	42	9/9/19	10/21/19

Table 6: Work Breakdown Structure

2.3.2 Determine encryption to be used	21	9/23/19	10/14/19
2.3.3 Research common network protocols	7	9/30/19	10/7/19
2.3.4 Research and test firewall rules	7	9/30/19	10/7/19
2.3.5 Penetration testing of network environment	14	9/30/19	10/14/19
2.3.6 Remediate vulnerabilities found	14	10/7/19	10/21/19
2.4 Miscellaneous Research	35	9/16/19	10/21/19
2.4.1 Focus on industry outreach	7	9/16/19	9/23/19
2.4.2 Develop project budget	14	9/16/19	9/30/19
2.4.3 Budget Analysis	14	10/7/19	10/21/19
3.0 System Design	42	9/16/19	10/28/19
3.1 Create Networking Diagrams	35	9/16/19	10/21/19
3.1.1 Create network infrastructure diagrams	7	9/16/19	9/23/19
3.1.2 Create eNAP drawing	14	9/16/19	9/30/19
3.1.3 Create server diagrams	21	9/16/19	10/7/19
3.1.4 Create cloud diagrams	21	9/30/19	10/21/19
3.2 Create Deployment Documentation	28	10/7/19	11/4/19
3.2.1 Draft GoKit deployment documentation	21	10/7/19	10/28/19
3.2.2 Draft eNAP deployment documentation	21	10/7/19	10/28/19
4.0 Environment Set-Up	133	9/23/19	2/3/20
4.1 Setup Virtualization Environment	7	9/23/19	9/30/19
4.2 Provision Account Access	7	9/23/19	9/30/19
4.3 Create Templates for Virtual Machines	7	9/23/19	9/30/19
4.5 Set up Management Servers	28	10/7/19	11/4/19
4.5.1 Setup unifi management server	14	10/7/19	10/21/19
4.5.2 Setup UNMS management server	14	10/7/19	10/21/19
4.5.3 Setup UCRM server	7	10/21/19	10/28/19

Table 6: Work Breakdown Structure

4.5.4 Add customer information to UCRM	7	10/21/19	10/28/19
4.8 Connect Devices to Management Servers	14	11/4/19	11/18/19
4.9 Setup subdomain	14	1/13/20	1/27/20
4.10 Setup digital certificates	14	1/20/20	2/3/20
4.10.1 Provision digital certificates	7	1/27/20	2/3/20
5.0 Deployment	175	9/30/19	3/23/20
5.1 Deploy radios in non-prod environment	14	9/30/19	10/14/19
5.2 Deploy client APs in non-prod environment	14	9/30/19	10/14/19
5.3 Deploy routers in non-prod environment	14	10/7/19	10/21/19
5.4 Setup API Routers	21	10/14/19	11/4/19
5.4.1 Configure API to UNMS server	14	10/14/19	10/28/19
5.4.2 Configure backend APIs	14	10/21/19	11/4/19
5.5 Design and Deploy Mounting Mechanism	14	10/7/19	10/21/19
5.6 Configuration of equipment	14	10/14/19	10/28/19
5.6.1 Configure radios	7	10/14/19	10/21/19
5.6.2 Configure client APs	7	10/14/19	10/21/19
5.6.3 Configure routers	7	10/14/19	10/28/19
5.7 Deploy in Production	77	10/21/19	2/24/20
5.7.1 Deploy radios in production environment	14	10/21/19	11/4/19
5.7.2 Deploy client APs in production environment	14	10/21/19	11/4/19
5.7.3 Deploy routers in production environment	14	10/28/19	11/11/19
5.7.4 Video record access point site	14	10/28/19	11/11/19
5.7.5 Video record client site	14	11/4/19	11/18/19
5.7.6 Video record potential second client site	14	11/4/19	11/18/19
5.7.7 Video record rendering and explanation of eNAP	14	11/11/19	11/25/19

Table 6: Work Breakdown Structure

5.8 Video editing	28	2/24/20	3/23/20
5.8.1 Edit the live demo	14	2/24/20	3/9/20
5.8.2 Edit the rendered demo	14	3/16/20	3/30/20
6.0 Market Research	77	1/13/20	3/30/20
6.1 Research areas prone to natural disasters	35	1/13/20	2/4/20
6.1.1 Consult online databases	14	1/13/20	2/17/20
6.1.2 Gather data and develop reports	21	1/20/20	2/10/20
6.2 Research areas without good internet access	42	2/17/20	3/30/20
6.2.1 Analyze data from ISPs to identify weak areas	14	2/24/20	3/9/20
6.2.2 Consult ISPs to verify lack of coverage	21	3/2/20	3/23/20
6.2.3 Develop reports	7	3/30/20	4/6/20

Table 6: Work Breakdown Structure

Technical Elements

Technical Mockup

Figure 7

Below is the basic infrastructure of how PEW will function with existing equipment. In future deployments, PEW would have multiple eNAPs and thousands of nanostations connecting into the eNAPs. This design below is based upon a proof of concept, not how it would actually be deployed in a disaster recovery scenario. Below the “client side” on the right, and the “Internet connection” side on the left.

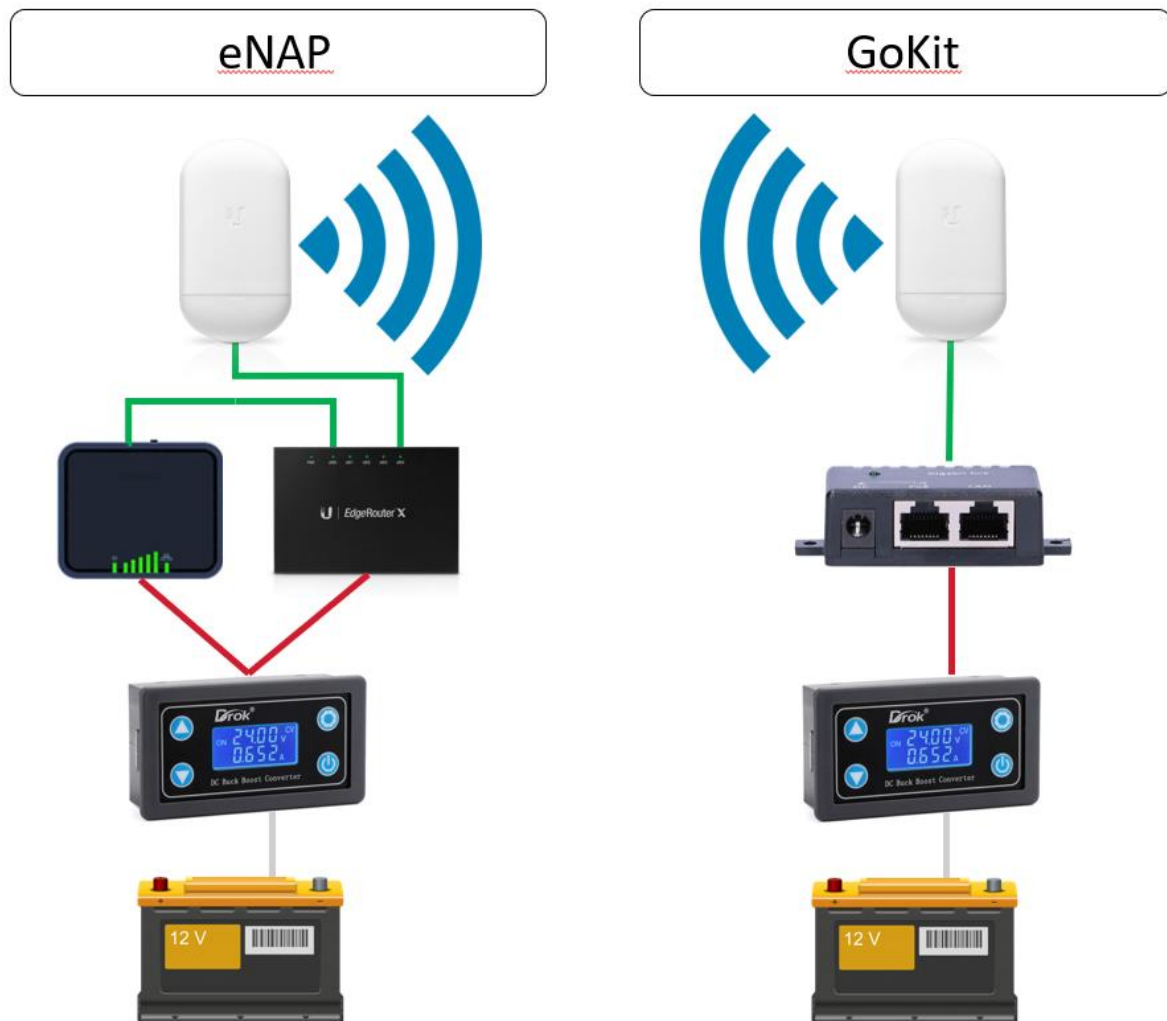


Figure 7: Technical Diagram



Network

PEW's network is actually quite simple in concept and in testing. The eNAP will have two "power sources" providing power to two Ubiquiti nanostations connecting to one another. One of the nanostations will have an edge router attached to a cellular modem providing an "input" Internet connection. Then the two nanostations will connect to each other and then the "client side," that doesn't have a cellular modem, will receive an Internet connection from the other nanostation, essentially connecting them together and creating a simple portable WISP.

If PEW were to be deployed in an actual disaster recovery scenario, all of PEW's equipment capacity would be increased as well as more nanostations being deployed. Instead of two devices connecting together it would be along the lines of hundreds of devices connecting to one eNAP, which provides the Internet connection from a wireless backhaul, available terrestrial connection, cellular, or satellite.

Security

The security of PEW relies almost entirely on web application security, as the only real application/software that is going to be running is the Ubiquiti software. Therefore, PEW will have no additions to their Ubiquiti software for security. However, Ubiquiti does allow us to configure the wireless security of the devices in which will be configured with WPA2-PSK (AES), this includes a pre-shared key that was made secure using a random password generator. The only other settings that can be adjusted in the nanostations for ample security is to add a secure administrator password and to disable the local wireless management network that the device initially broadcasts when it is being setup. In concept PEW could install a full PKI (public key infrastructure), but it is better for the ease of configuration and cost for PEW to simply use Let's Encrypt digital certificates.



Penetration Testing

Since the team didn't have much to configure on PEW, security testing will be focusing more heavily on a penetration test. Penetration tests will be mainly against the Ubiquiti web application, UNMS, that will be running on the eNAP hardware. The web application is installed onto a virtual machine on a local server that one of the members of PEW owns, then the team conducted penetration testing on that application. There could be an argument for a physical security test of the GoKits but since an attacker can easily plug in an ethernet cable into the client switch, this isn't much of a penetration test. There could also be an argument for intercepting the wireless communication and trying to crack that, but all of the communications from the nanostations will be AES encrypted, which is the current standard for encryption, and given any reasonable computing power, will be uncrackable. Therefore, the team will be aiming to follow the standard of web application security testing/vulnerabilities, the OWASP Top 10 of 2017. The OWASP Top 10 Application Security Risks of 2017 are: Injection, Broken Authentication, Sensitive Data Exposure, XML, External Entities, Broken Access Control, Security Misconfiguration, Cross-site Scripting, Insecure Deserialization, Using Components with Known Vulnerabilities, Insufficient Logging & Monitoring. This testing was done during the week of December 15th and resulted in no discovered vulnerabilities.



Testing Plan

Overview

This section outlines the testing methodology for the PEW infrastructure solution. Testing assumes that the GoKit has been deployed and the eNAP has been powered on. The user set for this testing is both client and administrative privilege. The testing completed ensures that the cloud application and infrastructure solution of the project are fully functional. Any anomalies will be recorded and subsequently corrected upon the completion of testing. The infrastructure will be tested now and at each future deployment to ensure consistency and reliability. The following outline will service these future tests.

Scope

The scope of testing encompasses the digital infrastructure of the eNAP and GoKits as well as connectivity to the UNMS cloud monitoring solution running in a Docker container.

Entry and Exit Criteria

The entry and exit criteria outline the basic expectations for the infrastructure and are the primary goals for the data gathered from the testing.

Entry Criteria

- Infrastructure is mounted and deployed
- Client is stationed a maximum of 15 kilometers away from eNAP
- Clear line of sight from any client to an eNAP
- Client and tower are powered

Exit Criteria

- End to end connectivity is established from any client to the Internet
- Any anomalies are documented and addressed



System Requirements

The testing of the infrastructure was designed to ensure that each of the determined requirements was addressed. Requirements were tested as either functional or non-functional as outlined in the sections below.

Functional Requirements

1. The components of the eNAP are mounted together and stood up
2. Some number of clients, GoKits, have been assembled and deployed
3. All GoKits and eNAPs have been powered on
4. Clients are roughly pointed at an eNAP and a connection is established
5. The eNAP's backhaul connection has been established
6. Clients and tower equipment have Internet access
7. All infrastructure devices begin reporting to UNMS

Non-Functional Requirements

1. The eNAP and GoKits are painted
2. Branding has been applied to the GoKits
3. All wires have been properly color-coded

Testing of Requirements

1. The eNAP will be deployed at tower site, powered on
2. Backhaul connection for the eNAP is established
3. The GoKit will be deployed at client site and powered on
4. The GoKit is affixed in a position pointed toward the eNAP
5. Infrastructure devices reporting to UNMS console
6. A speed test is conducted via fast.com to ensure Internet and reliable power

Test Results

The following table represents the execution of the testing plan for the infrastructure solution. The testing was concluded after several runs. However, the reported results are displayed for all of the rounds of testing conducted.

Table 8

Requirement No.	Attempt No.	Action	Expected Outcome	Actual Outcome	Pass/Fail	Reason for Outcome
1	1	Supply power	Devices power on	Null	Fail	Boost converter interface non-responsive
1	2	Supply power	Devices power on	Devices power on	Pass	Voltages adjusted mechanically
2	2	Null	Cellular connection established	Cellular connection established	Pass	Cell modem automatically connects
3	2	Supply power	Client powers on	Client powers on	Pass	Ample power supplied
4	2	Affix client radio	Achieve connectivity	Connectivity achieved	Pass	Range less than 15km
Requirement No.	Attempt No.	Action	Expected Outcome	Actual Outcome	Pass/Fail	Reason for Outcome
5	2	UNMS device registration	Devices reporting	Intermittent connection	Fail	Range too short, too much noise
5	3	UNMS device registration	Devices reporting	Devices reporting properly	Pass	Minimum range: 300ft
6	3	Speed test	Speed test complete	Tower shut down	Fail	Insufficient power
6	4	Speed test	Speed test complete	Speed test complete	Pass	Added additional power

Table 8: Test Plan



Recommendations for Improvement

Given the opportunity to build PEW again, the team would do the majority of the work the same. The eNAP and GoKit products both came out well and performed exceptionally. The stand on the eNAP be anchored better but that's a minor detail. Given more time to redo the project, the team would have loved to learn to 3D render and create a model of the eNAP at full scale. The model could be 3D printed for a more hands-on experience and a better fundraising experience.

The PEW team received one important recommendation over the year which was to start early. The team formed during the previous school year and was coming up with ideas before the members could even register for the class.



Conclusion

Fall Semester 2019

The process of creating the product and making it stand out has been stimulating and impactful for the PEW team thus far. The project is somewhat unique in the fact that the idea of a WISP (wireless internet service provider) is not a new concept, so a lot of the work has been proving that PEW can make a legitimate business out of the idea to modify and specify the application of a WISP. The team landed on the idea because two thirds of the members were already very comfortable with the infrastructure side of things within IT. Because of this, it was a goal of ours to find some infrastructure-related project idea. The thought of a WISP came up and was chosen because of how digestible it is, even for non-tech people. The problem was then realizing how it could be unique. How could this business be a profitable business? The team wanted to choose an application of a WISP that would be impactful to people. PEW's purchaser demographic could be anyone at any time, but the time in which this product will most likely be used is after a natural disaster or some other type of event that would cause the Internet to be out for a large area. The project focused on the intended use of this product to be to offer this business as a humanitarian-style type of business. The team wanted this not only because PEW truly sympathizes with these disaster-struck victims, but also because it adds a layer of identifiability to the business.

The group did not struggle very much in terms of creating the idea for the product or planning to market it. A speed bump experienced has been, as a group, finding appropriate times to meet to work on PEW. All three of us work part-time or full-time, are enrolled in 12+ credit hours of classes, participate in extracurricular university clubs/organizations, and one member lives at least thirty minutes from campus by car. Because of this, the team has been hard-pressed to find time to work on PEW-related things. PEW has been very



committed in its endeavors, compromising on times to meet, using Cisco's WebEx to communicate while working on assignments, and always planning to meet on Monday evenings even when there is no class. The team members of PEW are committed to the vision of the company and its strategy.

The team has already purchased the equipment needed and stood up a proof of concept for the project, completed tests, and knows exactly what PEW needs moving forward. It is believed that PEW has been a front-runner and always ahead of schedule this entire year. Moving forward, the team simply needs to complete a production run-through of the products while being filmed. Once done, there is a lot of editing to do to have a well-polished finished product. Beyond that, the GoKits need packaging for the consumer product. The team members at PEW will remain attending all classes, keeping up to date with assignments, and continuously communicating about the company and how the team can improve moving forward.



Spring Semester 2020

Throughout the spring semester, while the team finished PEW, the team learned a fair bit. Professional branding was a big one. This came in the form of PEW's poster which needed to be completely redo and one point. This also came in the form of writing technical documentation in an organized manner with logos and diagrams throughout. Furthermore, the team learned how to work more efficiently as a team. Between managing three schedules packed with courses, work, and extracurriculars the team worked to find time to meet and progress. In the spring semester, the team worked to migrate to a virtual platform for meetings.

Since the fall, the team has completed a fair bit. At the end of the fall semester, the team had a mostly working prototype. During the spring semester, the bugs were combed out of the prototype. This included a faulty PoE injector that was causing the radios to not report back to command and controller. The team then built stands for the prototype and painted the stands. It was later discovered that the eNAP's stand would require anchoring. With the stands built, the prototype was taken to the test range for its maiden connection and recording. Editing the video from the connection proceeded to consume the remainder of the semester along with the assigned class work.

Lessons Learned at IT Expo

At Expo, there was a lot of great speakers and dialogue. The new IT Expo format provided a new set of challenges. In the past, PEW members had not interacted with corporate sponsors or industry leaders as was done during Expo. While intimidating at first, PEW overcame the new challenges and delivered a superior performance. Overall, it was a great experience seeing all of the class grow and develop their projects.

Appendix A. Industry Contact

The team contacted an industry professional, Andrew Hammer, owner of The Web Factors, for guidance, feedback, and recommendations during the development process.

Appendix B. References

2018's Billion Dollar Disasters in Context: NOAA Climate.gov. (2019, February 7). Retrieved October 7, 2019, from <https://www.climate.gov/news-features/blogs/beyond-data/2018s-billion-dollar-disasters-context/>

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Appendix C. Poster

Figure 9



Figure 9: Poster