

Florida International University
Knight Foundation School of Computing and Information Sciences

Software Engineering Focus

Network Outage Call Home

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Abstract

Network availability is critical to everyday life, at both work and home. Life is upended if the network is down and you need to call someone to fix it. Unfortunately if you are out on vacation, or it is the weekend, network outages can go unnoticed for hours or days at a time.

With the network outage call home, we built and connected a small device (Raspberry Pi) into our network that sends alerts via a GSM network to proactively alert its owner when the network is down.

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INTRODUCTION

The Network Outage Call Home project is all about providing you (the end user) with a device that would be able to contact service technicians via a cellular network if your particular network is either down or having health issues. The major use of this is for businesses if the office is closed or if you have many servers you would be able to detect exactly which one is acting up. This also helps technicians who come to identify the problem work faster and more efficiently on site.

Current System

The current method for diagnosing and repairing network issues requires an onsite user to first take notice of the network error and then contact support staff accordingly. This leads to the larger issue of an MSP having to actively deploy technicians for on-site calls, thus reducing the number of available technicians that can address other incoming requests.

Purpose of New System

Through the addition of this new device, the notification/detection process will be entirely automated as well as providing a means for technicians to remotely troubleshoot/fix network issues. With the newly introduced automated detection system, incidence response time can be greatly improved as there is no longer a reliance on a human actor to first take notice of an outage. This new detection device is intended to run uninterrupted at all times of day, because of this, outages that may occur during the absence of end users can now be addressed before any significant repercussions are faced by the customers business.

USER STORIES

This section serves as an overview for the user stories that were developed throughout the semester. While the majority of user stories were completed, the final three stories contain sections that will be carried over to the next semester. However, despite portions of these stories being placed in the backlog, the core functionality of the device is present. Supplementary to the user stories, multiple tiers of acceptance criteria were developed, while we did not completely satisfy all criteria, four of the five tiers were implemented successfully.

Satisfied Acceptance Criteria

T1 - Device should be capable of not only detecting when an internet outage has occurred but should also highlight obvious internet-related instability or capacity problems.

T2 - Device should be capable of 'phoning home' and communicate critical information as required.

T3 - Device should be capable of performing basic to advanced troubleshooting to help diagnose ongoing network issues.

T4 - Device should be capable of proxying an SSH or remote session.

Backlogged Acceptance Criteria

T5 - Device should be capable of forwarding critical (QoS) information collected by VSA agents.

Implemented User Stories

- **User Story #1 Hardware Testing and Requirements (MB, JC, JN):**
As an MSP owner, I need visibility into my environment even when Internet issues occur. Based on this, I would be willing to pay upfront to deploy a cost-efficient 'rescue device' that can help me resolve or avoid issues.

- **User Story #2 Network Outage Detection (MB):**
As a network administrator at an MSP, I need to know as soon as one of my client's campuses goes offline. This enables me to react quickly and minimize my MTTR (Mean Time to Recovery).
- **User Story #3 Network Tests and Troubleshooting - North/South (JN & CP) :**
As a network administrator at an MSP, I expect feedback generated by the point of presence I've deployed at my client's campus. This feedback should be possible due to automated testing and troubleshooting related to the local Internet connection. This will give me data to analyze during the incident, enable me to perform incident retrospectives and receive product-generated insights.
- **User Story #4 Network Tests and Troubleshooting East/West (JC & BC):**
As a network administrator at an MSP, I expect feedback generated by the point of presence I've deployed at my client's campus. This feedback should be possible due to automated testing and troubleshooting related to the local network environment. This will give me data to analyze during the incident, enable me to perform incident retrospectives and receive product-generated insights.
- **User Story #5 Ethernet/Wi-Fi vs Cellular (JC & CP):**
As a network administrator at an MSP, I expect that the hardware agent I've deployed as a point of presence on the network is intelligent enough to utilize all communication technologies available to it.
- **User Story #6 Communication Path (CP & JF):**
As a network administrator at an MSP, I expect that the hardware agent I've deployed as a point of presence on the network is able to 'phone home' during an incident and push important information back to me.
- **User Story #7 Hardware Order and Testing (MB):**
As an MSP owner, I need visibility into my environments even when Internet issues occur. Based on this, I would be willing to pay upfront to deploy a cost-efficient 'rescue device' that can help me resolve or avoid issues.
- **User Story #8 Build Simple Service (JF):**
As a user, I expect that a service must be installed on my hardware for it to perform any sort of dedicated function.

- **User Story #9 N/S Tests (A Portion of the tests have been pushed back) (JN & CP):**

As a network administrator at an MSP, I expect feedback generated by the point of presence I've deployed at my client's campus. This feedback should be possible due to automated testing and troubleshooting related to the local Internet connection. This will give me data to analyze during the incident, enable me to perform incident retrospectives and receive product-generated insights.

- Network Outage Device can no longer communicate with the default gateway.
- Network Outage Device has detected Internet issues.
- Network Outage Device has detected that Internet capacity is close to maximum threshold.
- Network Outage Device has detected that Internet usage has been sustained near maximum threshold.

- **User Story #10 E/W Tests (A portion of the tests have been pushed back) (JC & BC):**

As a network administrator at an MSP, I expect feedback generated by the point of presence I've deployed at my client's campus. This feedback should be possible due to automated testing and troubleshooting related to the local network environment. This will give me data to analyze during the incident, enable me to perform incident retrospectives and receive product-generated insights.

- Network Outage Device is unable to contact %host%.
- Network Outage Device has detected a network outage.
- Network Outage Device has detected that %host% is offline.
- Network Outage Device has detected that %SSIDNAME% is no longer visible.
- Network Outage Device has detected a new SSID:%SSIDName%
- Network Outage Device has detected a Rogue Accesspoint: %OffenderMacAddress% broadcasting known SSID: %SSIDname%

- **User Story #12 Outage Device Tests (A portion of the tests have been pushed back) (MB & JF):**

As a network administrator at an MSP, I expect feedback generated by the point of presence I've deployed at my client's campus. This feedback should be possible due to automated testing and troubleshooting related to the local Internet connection. This will give me data to analyze so that I know if there are problems with the outage device itself.

- Network Outage Device has been compromised.
- Network Outage Device is experiencing hardware failure or unplanned system restart.
- Network Outage Device has detected or is experiencing ethernet NIC failure.

- Network Outage Device has detected or is experiencing wireless radio failure.
- Network Outage Device has detected or is experiencing cellular radio failure.
- Network Outage Device is no longer able to communicate using cellular service.

Pushed Back/Planned for later:

- **User Story #9 N/S Tests (A Portion of the tests have been pushed back) (JN & CP):**
As a network administrator at an MSP, I expect feedback generated by the point of presence I've deployed at my client's campus. This feedback should be possible due to automated testing and troubleshooting related to the local Internet connection. This will give me data to analyze during the incident, enable me to perform incident retrospectives and receive product-generated insights.
 - Network Outage Device is unable to use the provided DNS to resolve successfully.
 - Network Outage Device has failed to successfully communicate with configuration host.
- **User Story #10 E/W Tests (A Portion of the tests have been pushed back) (JC & BC):**
As a network administrator at an MSP, I expect feedback generated by the point of presence I've deployed at my client's campus. This feedback should be possible due to automated testing and troubleshooting related to the local network environment. This will give me data to analyze during the incident, enable me to perform incident retrospectives and receive product-generated insights.
 - Network Outage Device has detected network congestion or instability.
 - Network Outage Device has detected an issue with the associated ethernet port.
 - Network Outage Device has detected a network configuration change.
 - Network Outage Device has detected a broadcast storm.
 - Network Outage Device has detected a significant change in network performance between itself and %host%
 - Network Outage Device has detected an SSID that is not adhering to security best practices.
- **User Story #11 Configuration API Architecture and Syntax:**
As a device deployed to raise alerts when issues occur and to act as a communication backdoor into my environment. I need to phone home on a regular basis and collect any updates to my

configurations. These may be commands that I follow to update my software version or reflect changes in my configured behavior.

- **User Story #12 Outage Device Tests (These tests have been pushed back) (MB & JF):**
As a network administrator at an MSP, I expect feedback generated by the point of presence I've deployed at my client's campus. This feedback should be possible due to automated testing and troubleshooting related to the local Internet connection. This will give me data to analyze so that I know if there are problems with the outage device itself.
 - Network Outage Device/has experienced power failure.

PROJECT PLAN

This section describes the planning that went into the realization of this project. This project incorporated agile development techniques and as such required the sprints to be planned. These sprint plannings are detailed in the section. This section also describes the components, both software and hardware, chosen for this project.

Hardware and Software Resources

The following is a list of all hardware and software resources that were used in this project:

- **Arduino UNO R3** - Initial device before switching to Raspberry Pi
- **Raspberry-Pi**
- **Raspberry Pi Cellular IoT Kit (LTE-M)**
- **Sim Card**
- **Test Toolkit (For improving and creating backlogged tests)**
 - Ping
 - Traceroute
 - Speed Test
 - Serial Monitor
 - SSID Scanner
 - DNS Settings
- **Python 3**
- **Visual Studio Code**

Sprints Plan

Sprint 1

Attendees: Jennsy Cespedes, Jose Fernandez, Jamsher Nigmatulloev, Michael Beall, Brandon Castano, Christopher Puglisi

Product Owner: Mike East, MBA, B. CmpE, mike.east@kaseya.com

Velocity: 100 hours

Network Outage Call Home

Product Owner Meeting

The initial meeting with the product owner was at 6:00pm to 6:40pm on Thursday, January 20th. This meeting was for my team and Mike East, the product owner, to become familiarized with the Network Outage Call Home project. Another formal planning meeting will be held on Monday, depending on the availability of the rest of the group members. They will be given the introduction and overview of the project, as well as time to become familiar with the project, the class, and ask any questions they may have.

Minutes 0 – 5: Introductions

- Introducing ourselves

Minutes 6 – 15: Overview of the Project

- Background of Network Outage Call Home
- Idea behind Network Outage Call Home
- Reason for creation of Network Outage Call Home
- Progress that has been made

Minutes 16 – 30: Explanation of Capstone Class

- Scrum system Daily/Nightly meetings for discussing progress, challenges, plans, etc.
- Capstone Hierarchy
- Project Owner
- Capstone II Team Leader
- Capstone I Members
- Senior Project Member
- Weekly/Biweekly Planning Meetings with Project Owner
- Sprint System: Two-week work/development periods

Minutes 31 – 40: Wrap-Up

- Plans for Capstone I
- Bringing them up to speed with the project
- Familiarizing them with class structure
- Planning another meeting with the entire group

Sprint 2

Attendees: Jennsy Cespedes, Jose Fernandez, Jamsher Nigmatulloev, Michael Beall, Brandon Castano, Christopher Puglisi

Product Manager: Ryan Hutcheson, ryan.hutcheson@kaseya.com

Velocity: 100 hours

Network Outage Call Home**Product Owner Meeting**

The meeting with the product owner was from 6:00pm to 7:00pm on Monday, January 31st. This meeting was for my team and Ryan Hutcheson, the product owner, to learn more elaborately about the Network Outage Call Home project. Another formal planning meeting will be held next Monday. We were given the introduction and overview of the project vision, as well as time to become familiar with each aspect of the project (1 week), Trello, and ask any questions we may have.

Minutes 0 – 10: Progress Update

- Catching product owner up on current progress (connecting arduino to network and detecting basic outage)

Minutes 10 – 20: Overview of the Last Sprint

- Background of the product owner
- The progress since the last sprint
- The resources found and the research made since the last sprint meeting
- Going over Arduino connection and its basics

Minutes 20 – 40: Explanation of Expectations Going Forward

- Scrum system Daily/Nightly meetings for discussing progress, challenges, plans, etc.

- Ticket Assignment
- Project Owner Vision on the Project
- Introduction to Acceptance Criteria

Minutes 40 – 60: Wrap-Up

- Plans for the next week
- Instructions to familiarize with specific spikes of the project on Trello
- Planning another meeting with the entire group

Sprint 3

Attendees: Jennsy Cespedes, Jose Fernandez, Jamsher Nigmatulloev, Michael Beall, Brandon Castano, Christopher Puglisi

Product Manager: Ryan Hutcheson, ryan.hutcheson@kaseya.com

Velocity: 100 hours

Network Outage Call Home**Product Owner Meeting**

The meeting with the product owner was from 6:00pm to 7:00pm on Monday, February 14th. This meeting was for my team and Ryan Hutcheson, the product owner, to go over the current progress involving tickets assigned during sprint 2. Another formal planning meeting will be held next Monday. We each gave a rundown of our current progress on our tickets and brought up any questions we may have had regarding each assignment.

Minutes 0 -10: Progress Update

- Catching product owner up on current progress (connecting Arduino to network and detecting basic outage)

Minutes 10 - 20: Overview of the Last Sprint

- Ticket Progress Upcoming Tickets
- The resources found and the research made since the last sprint meeting Going over new hardware requirements

Minutes 20 - 40: Explanation of Expectations Going Forward

- Explanation of new tickets.
- Project Owner Vision on the Project Breaking down acceptance criteria

Minutes 40 - 60: Wrap-Up

- Plans for the next week
- Instructions to familiarize with specific spikes of the project on Trello
- Planning another meeting with the entire group

Sprint 4

Attendees: Jennsy Cespedes, Jose Fernandez, Jamsher Nigmatulloev, Michael Beall, Brandon Castano, Christopher Puglisi

Product Manager: Ryan Hutcheson, ryan.hutcheson@kaseya.com

Velocity: 100 hours

Network Outage Call Home**Product Owner Meeting**

The meeting with the product owner was from 6:00pm to 7:00pm on Monday, March 7th. This meeting was for my team and Ryan Hutcheson, the product owner, to go over the current progress involving tickets assigned during sprint 3. Another formal planning meeting will be held next Monday. We each gave a run down of our current progress on our tickets and brought up any questions we may have had regarding each assignment. New tickets were created and assigned, story points were estimated for the new tickets. We also discussed who would be best to work together for the newer tickets due to growing complexities in requirements.

Minutes 0 – 10: Progress Update

- Catching product owner up on current progress

Minutes 10 – 20: Overview of the Last Sprint

- Ticket Progress (Updated the status of tickets from in progress to completed)
- Upcoming Tickets
- The resources found and the research made since the last sprint meeting

- Going over new hardware requirements

Minutes 20 – 40: Explanation of Expectations Going Forward

- Explanation of new tickets.
- Assigned new tickets
- Story Point estimations completed for new tickets
- Breaking down acceptance criteria

Minutes 40 – 60: Wrap-Up

- Plans for the next week
- Instructions to familiarize with specific spikes of the project on Trello
- Planning another meeting with the entire group

Sprint 5

Attendees: Jennsy Cespedes, Jose Fernandez, Jamsher Nigmatulloev, Michael Beall, Brandon Castano, Christopher Puglisi

Product Manager: Ryan Hutcheson, ryan.hutcheson@kaseya.com (absent this meeting)

Velocity: 100 hours

Network Outage Call Home**Product Owner Meeting**

The meeting with the product owner was from 5:00pm to 6:00pm on Monday, March 21st. This meeting was originally intended for our team to provide a basic demonstration of our device in its current state. Unfortunately, our product owner had to reschedule, and we held the meeting without them. In our meeting we discussed current ticket progress as well as possible optimizations for our product. New tickets are expected to be created on Wednesday March 23rd as the meeting with our product owner has been rescheduled too.

Minutes 0 – 10: Progress Update

- Going over current progress as a group

Minutes 10 – 20: Overview of the Last Sprint

- Ticket Progress (Moved majority of tickets into the testing phase, awaiting Ryan's approval)
- Current technical barriers.
- What can be improved on the tickets that have carried over into this sprint

Minutes 20 – 40: Potential Optimizations

- How the scheduling system can be improved.
- Planning for N/S and E/W Tickets
- Breaking down acceptance criteria

Minutes 40 – 60: Wrap-Up

- Plans for Wednesday's meeting with the product owner.
- Last minute updates to tickets on the Trello board
- Last minute adjustments before Wednesday's meeting

Sprint 6

Attendees: Jennsy Cespedes, Jose Fernandez, Jamsher Nigmatulloev, Michael Beall, Brandon Castano, Christopher Puglisi

Product Manager: Ryan Hutcheson, ryan.hutcheson@kaseya.com

Velocity: 100 hours

Network Outage Call Home**Product Owner Meeting**

The meeting with the product owner was from 6:00pm to 7:00pm on Monday, April 4th. The purpose of this meeting was to discuss the current progress with the device tests cases that are currently in development. These are now the only remaining tickets that are expected to be completed by the end of the sprint.

Minutes 0 – 10: Progress Update

- Going over current progress as a group

Minutes 10 – 20: Overview of the Last Sprint

- Went over current progress with reverse SSH and troubleshooting going forward.

- Current technical barriers.
- Tests that have been completed and how to automate them for gathering data.

Minutes 40 – 60: Wrap-Up

- Goals for final 2 weeks of development sprint.
- Potential midweek meeting with product owner to continue troubleshooting SSH issues.

Sprint 7

Attendees: Jennsy Cespedes, Jose Fernandez, Jamsher Nigmatulloev, Michael Beall, Brandon Castano, Christopher Puglisi

Product Manager: Ryan Hutcheson, ryan.hutcheson@kaseya.com (absent)

Velocity: 100 hours

Network Outage Call Home**Product Owner Meeting**

The meeting with the product owner was from 6:00pm to 7:00pm on Monday, April 18th. The purpose of this meeting was to finalize preparations for the showcase on Friday, April 22nd. Unfortunately our product owner could not make it to today's meeting, because of this, we chose to spend this time working on our final deliverables (documentation, videos, presentation slides).

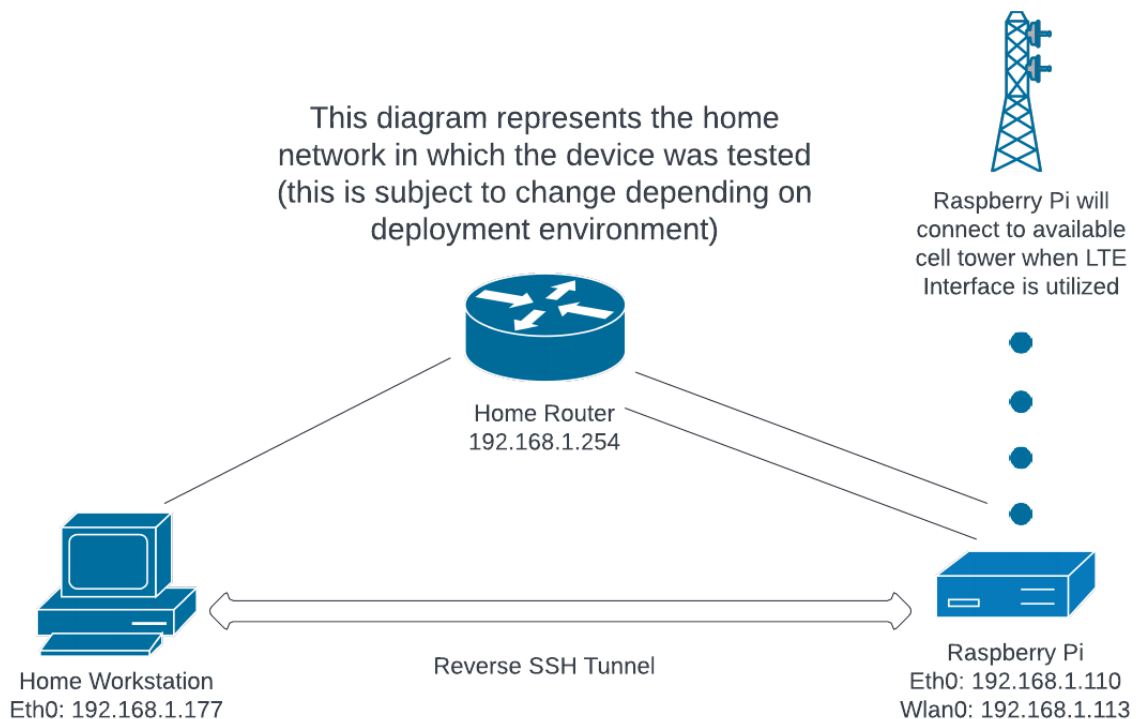
Minutes 0 – 60: Wrap Up

- Continued preparations for the Senior Design Showcase
 - Worked on Final Documentation.
 - Worked on PowerPoint Slides
 - Worded on Demonstration Videos

SYSTEM DESIGN

This section contains information on the design decisions that went into this project. The architecture patterns are outlined and explained. The entire system is shown in a package diagram and the subsystems are explained. Finally, the design patterns used in the project are discussed.

Architectural Patterns



SYSTEM VALIDATION*Device Tests*

Test Cases	Expected Results	Observed Results
Power failure	To know UPS has switched to battery/kicked in or know that the device restarted after having power cut	Device correctly shows if it powered off suddenly and displays if device was shut off correctly or incorrectly on startup
Compromised	To know where the majority of traffic from the outage device is headed OR CPU/Memory utilization average has jumped up and stays high	Correctly shows new SSIDS that show up on the device and shows if a previous SSID name was changed
Hardware failing	To know whether the device is experiencing multiple unplanned restarts in a small period of time, To know whether it is overheating or experiencing high CPU/memory utilization	Device shows CPU/memory usage and temperature with the script we created to determine if the device is failing due to overheating or CPU/memory utilization
Ethernet NIC issues or failed	To know whether there are issues pinging loopback, if there are transmit failures or packet drops on a regular basis or is unable to pass traffic via ethernet NIC	Device pings from the correct interface
Wireless NIC issues or failed	To know what other SSID are in the given area and detect intervals or a permanent state	Device pings from the correct interface

	where they 'all' disappear at the same time	
Cellular NIC issues or failed	To know whether the cellular radio is failing to transmit or detecting intervals or a permanent state where the radio can no longer be used to send or receive	Device pings from the correct interface
Cellular service issues	To know whether data being sent over the cellular radio is transmitted and returned successfully	Device sends a heartbeat out and if nothing is received technicians required to fix this issue

North/South Tests

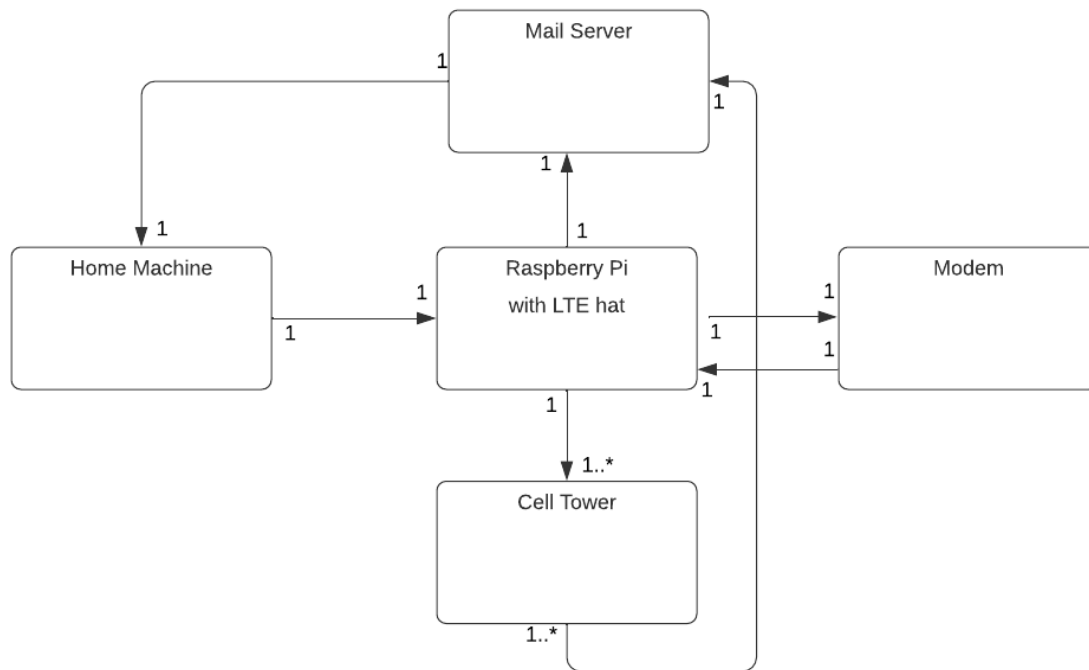
Test Cases	Expected Results	Observed Results
Inability to contact gateway	To know whether pings sent to default gateway are working, if not, confirm network stack is working and confirm if other devices on the subnet are working	Device pings default gateway after running module that pings 8.8.8.8
Inability to contact internet	To know whether pings sent to online IP are working, if not trigger local and gateway checks to confirm device is working as intended and that it IS the internet that is out	Device pings 8.8.8.8 and awaits to see if the online IP pings back in order to confirm if the device is connected to the internet.
Internet Capacity concern	To know how much capacity is available via speed testing (fast.com?) and trigger when less than 20% capacity is detected	Device runs a module that performs a speed test
Decreased Internet capacity	To know if internet capacity has dropped for a sustained period (hour+) of time by using the Internet Capacity test	Runs a module that runs a internet capacity test

East/ West Tests

Test Cases	Expected Results	Observed Results
Inability to contact subnet peers	To know whether a specific host in collision domain is no longer pingable	Device pings the specific host and makes note of the ping status of the host
Network configuration change outage	To know whether a group of devices (subnet) is no longer pingable	Device pings the whole subnet and makes note of the pingable devices
Known device is offline	To know whether a specific host in broadcast domain is no longer pingable	Device pings the whole subnet and makes note of the pingable devices
SSID offline	To know whether a previously visible SSID is no longer available	Device makes a list of the detected networks
New SSID detected	To know whether a new, never before seen SSID is available	Device makes a list of the detected networks
Rogue access point	To know whether a known SSID is being served from a 'new' device (mac address)	Device makes a list of the detected MAC addresses and network names

GLOSSARY

- **SSID:** Service Set Identifier, is the network's name
- **Broadcast Domain:** Computer network where all nodes can reach each other
- **Collision Domain:** Network segment connected by a shared medium where simultaneous data transmissions collide with one another
- **Access Point:** Networking hardware device that allows other Wi-Fi devices to connect to a wired network.
- **Default Gateway:** Node in computer network that serves as forwarding host to other networks
- **Reverse SSH:** A secure shell that allows you to access systems that are behind a firewall from the outside world.
- **MAC Address:** Media Access Control Address, unique identifier assigned to electronic devices on a network.
- **Subnet:** A part of a larger network such as the internet.
- **UPS:** Uninterruptible Power Supply, large backup battery used to provide connected devices temporary uninterruptible power.

APPENDIX**Appendix A - UML Diagrams**

Appendix B - Sprint Review Reports

Sprint 1

Sprint Review Meeting Minutes

Attendees: Jennsy Cespedes, Michael Beall, Christopher Puglisi, Jamsher Nigmatulloev, Jose Fernandez

Start time: 7:00pm

End time: 7:30pm

Minutes 0 - 5: Scheduling of future meetings

- Meetings will be on Monday & Tuesday nights, rotating every other week.
- Most of the work for the week will already be done by this point
- Allows students have the weekend free
- Can help to prepare for any extra work to be done over the weekend

Minutes 6 – 10: Review of Progress

- Go over the code behind the prototype device.
- Future advancements

Minutes 11 – 20: Organization & Planning

- More specific tasks
- Helps to assign proper amounts of work to each team member
- Goals for entire semester
 - o Further optimize the product.
 - o Add further functionality to the product so that it may interact with a network over wifi in addition to ethernet.
- Using Trello to assign work
 - o Making a large list of notes
 - Not started
 - In progress
 - Finished
 - o Help to distribute work
 - o Give team members a choice of what they want to work on

Minutes 20 – 30: Wrap-up

- For Sprint 2

- o Set up Trello
- o Define specific tasks that need to get done for better organization
- o Generalized goals → specific tasks

Sprint 2

Sprint Review Meeting Minutes

Attendees: Jennsy Cespedes, Michael Beall, Christopher Puglisi, Jamsher Nigmatulloev, Jose Fernandez

Start time: 7:00pm

End time: 7:30pm

Minutes 0 - 5: Research Review

- Went over what each member researched for their ticket
- Most of the work for the week will already be done by this point
- Allows students have the weekend free
- Can help to prepare for any extra work to be done over the weekend

Minutes 6 – 10: Ticket Progress

- See how far each member has progressed on their ticket
- Future advancements

Minutes 11 – 20: Organization & Planning

- More specific tasks
- Helps to assign proper amounts of work to each team member
- Goals for entire semester
 - o Further optimize the product.
 - o Add further functionality to the product so that it may interact with a network over wifi in addition to ethernet.
- Using Trello to continue working
 - o Finish tickets
 - o Help to distribute work

Minutes 20 – 30: Wrap-up

- For Sprint 3
 - o Went over each person's progress on Trello tickets
 - o Define specific tasks that need to get done for better organization

- o Generalized goals → specific tasks
- o Once done with tickets help others progress on theirs

Sprint 3

Sprint Review Meeting Minutes

Attendees: Jennsy Cespedes, Michael Beall, Christopher Puglisi, Jamsher Nigmatulloev, Jose Fernandez

Start time: 7:00pm

End time: 7:30pm

Minutes 0 - 5: Research Review

- Went over what each member researched for their ticket
- Most of the work for the week will already be done by this point
- Allows students have the weekend free
- Can help to prepare for any extra work to be done over the weekend
- Discuss shortage in chips that are used in required hardware.

Minutes 6 – 10: Ticket Progress

- See how far each member has progressed on their ticket
- Future advancements.
- Discussed changing hardware requirements as well as potential obstacles.

Minutes 11 – 20: Organization & Planning

- Goals for entire semester
 - o Further optimize the product.
 - o Adjust to newer hardware.
 - o Add further functionality to the product so that it may interact with a network over wifi in addition to ethernet.
- Using Trello to continue working
 - o Finish tickets
 - o Add research comments and questions in the tickets
- Research about application of APIs, specifically REST API
- Look up example runs of REST APIs
- Practice running REST API in a preferred programming language

Minutes 20 – 30: Wrap-up

- For Sprint 4
 - o Went over each person's progress on Trello tickets
 - o Define specific tasks that need to get done for better organization
 - o Discussed what could be done while waiting on hardware shortages.
 - o Generalized goals → specific tasks
 - o Once done with tickets help others progress on theirs

Sprint 4

Sprint Review Meeting Minutes

Attendees: Jennsy Cespedes, Michael Beall, Christopher Puglisi, Jamsher Nigmatulloev, Jose Fernandez

Start time: 7:00pm

End time: 7:30pm

Minutes 0 - 5: Research Review

- Went over what each member researched for their ticket
- Most of the work for the week will already be done by this point
- Allows students have the weekend free
- Can help to prepare for any extra work to be done over the weekend
- Discuss shortage in chips that are used in required hardware.

Minutes 6 – 10: Ticket Progress

- See how far each member has progressed on their ticket
- Went over new functionalities of the device.
- Discussed the current hurdles
 - o Primarily revolving around distinguishing connection types as well as a means to remotely connect to the device while exclusively on a cellular connection

Minutes 11 – 20: Organization & Planning

- Goals for entire semester
 - o Further optimize the product.
 - o Provide a proof of concept for the device
- Plans for upcoming sprints
 - o Move on to tier 2 functionality requirements
 - o Discuss potential workarounds for current issues during the next sprint meeting with the product owner.

- Reprioritize Tickets
 - o Moved RestAPI requirements to the ticket backlog as it is not the highest priority

Minutes 20 – 30: Wrap-up

- For Sprint 5
 - o Quick review over current tickets
 - o Allotted more time for extended daily meetings
 - o Discussed any questions we might have regarding assigned tickets.
 - o Made notes on each ticket as reminders for the next week.

Sprint 5**Sprint Review Meeting Minutes**

Attendees: Jennsy Cespedes, Michael Beall, Christopher Puglisi, Jamsher Nigmatulloev, Jose Fernandez

Start time: 7:00pm

End time: 7:30pm

Minutes 0 - 5: Current Test Results

- Went over the current status of each device test.
- Determine if any tests could be grouped together.

Minutes 0 - 15: Demonstrations

- Demonstration of current capabilities.
- Explanation of method behind current tests.

Minutes 15 - 25: Going forward.

- Which tests can be accomplished before the midpoint of the next sprint.
- Questions for the Product Owner.
- Concerns with E/W Test Tickets.

Minutes 25 – 30: Wrap-Up

- Goals for entire semester
 - o Further optimize the product.
 - o Provide a proof of concept for the device
- For Sprint 6
 - o Extended daily meetings.

- o What tests are expected to be finished by mid-point of the sprint.

Sprint 6

Sprint Review Meeting Minutes: 30 minutes

Attendees: Jennsy Cespedes, Michael Beall, Christopher Puglisi, Jamsher Nigmatulloev, Brandon Castano, Jose Fernandez

Minutes 0 - 15: Demonstrations

- Final Demonstration of the device before development ends.
- Explanation behind the current scripts.
- Demonstrated that the device can be accessed over cellular using reverse SSH

Minutes 15 - 30: Discussion Regarding the Showcase.

- Discussed features to be focused on during the Showcase.
- Final development discussion (What will be pushed back for the next group)
 - Small portion of tests under each section will be pushed back
- Product owner gave tips for presenting.
 - Be sure to discuss Reverse SSH
 - Rehearse prior to showcase and make sure we are familiarized with the initial product vision.
 - Think of some likely questions that the audience may have.
- For Sprint 7
 - Make sure Posters accurately represent what was accomplished.
 - Develop clear and concise instructions for the next group.
 - Finish and review final documentation

Sprint 7

Sprint Review Meeting Minutes: 30 minutes

Attendees: Jennsy Cespedes, Michael Beall, Christopher Puglisi, Jamsher Nigmatulloev, Brandon Castano, Jose Fernandez

Minutes 0 - 15: Final Doc Touch Ups

- Added finishing touches to the final documentation.
- Each of us proofread the final doc in order to check for errors.

Minutes 15 - 30: Final Video Scripts

- Created scripts for the final two videos required for the deliverable.
- The wishlist/shortcomings video was created.
- The guide/how-to video has been created for the next group.

Appendix C - User Manuals, Installation/Maintenance Document, Shortcomings/Wishlist Document and other documents

Simple Service:

- Once you have the file you want to run on startup save the file path because it will be needed for the simple service, in our case the path for our file was /home/pi/run.py
- Next you will need to navigate to where the services are on the raspberry pi, the command for that is `cd /lib/systemd/system`
- To create a service you will need to run the command `sudo touch phonehome.service`
- Once it is created to edit it you will need to do the following command `sudo nano phonehome.service`
- Finally once you are in the file for the service you can copy the following command and will need to change the second file path in ExecStart to reflect where your file is located

[Unit]

Description=Will run run.py on boot

After=multi-user.target

[Service]

ExecStart=/usr/bin/python3 /home/pi/run.py

User=pi

[Install]

WantedBy=multi-user.target

Reverse SSH:

- Before running the commands required for reverse SSH the user must first port forward a port of their choice on the device that will be accessing the raspberry pi (in our case we used port 2288).
- Once the port has been opened the user will need to run the command listed below (from the raspberry pi terminal)
 - `ssh -f -N -T -R 2250:localhost:22 <username_of_device>@<public_ip> -p 2288`
 - Ex. `ssh -f -N -T -R 2250:localhost:22 Desktop@192.168.1.75 -p 2288`
- Running the above command should establish a persistent connection from the raspberry pi to the device that will be used to access the pi.
- Once the above step is completed you will need to run the following command on the device accessing the raspberry pi
 - `ssh pi@localhost -p 2250` (this will establish the ssh connection from your home device to the raspberry pi.)

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