

WAVE

Wireless Automatic Vendor E-Receipt System

User Requirements & Project Plan

Conestoga College

Institute of Technology and Advanced Learning

Bachelor of Engineering – Electronic Systems

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Table of Contents

Introduction	3
User Requirements	4
MuSCoW List	4
SMART Goals	6
Mobile	6
NFC Device	12
Splitter Device	19
POS	25
Project Plan	25
System Breakdown	25
System Integration (TBD)	27
Resource and Knowledge Requirements	27
Tools, Off-the-Shelf Components, and Software	27
Knowledge and Skills	28
Task Assignment & Schedule	29
Risk Analysis & Risk Management Plan	34
Technical, Quality and Performance Risks	35
Project Management Risks	35
Organizational Risks	35
External Risks	36
Risk Management Plan	37

Introduction

This document serves as an outline to the requirements of the project as well as a plan to achieve them. The main goal of WAVE has been sub-divided into individual functional units which are then analyzed for their requirements, allocation, and obstacles. Together with this, there is a proposed plan for how the project will proceed as well as an analysis of the risks involved. This document is intended for the Electronic Systems Engineering Capstone Faculty as they evaluate WAVE and its implications.

WAVE is a system designed to provide a new standard for receipts in the consumer field. Instead of getting bombarded with paper receipts, customers need only *wave* their device across a WAVE terminal and, with our application, receive a digital copy of their receipt directly to their mobile device. WAVE is made possible by augmenting the power of NFC. The short range of NFC is a benefit to WAVE as it restricts who can get their hands on a customer's receipt. Much like how NFC is used to provide contactless payment.

The following will be a short summary of how WAVE aims to achieve this goal. All business owners marketing to the consumer field has a point-of-sale system (POS) in place. The POS is responsible for ringing up a customer's order as well as providing a receipt. WAVE will be a peripheral added onto the POS. To keep compatibility with the majority of POS systems, WAVE will not be making any changes to the POS software. Instead, WAVE will consist of two devices. The first, which is directly connected to the POS via USB, is the splitter device. This device will be set as the destination for all receipts of the POS. When a receipt is received, the splitter will look at the state of a switch, controlled by the cashier, to see if the receipt is going to be printed or provided digitally. If provided digitally, the receipt will be formatted into a digital friendly format and sent to the second device, the NFC terminal. The NFC terminal will format the receipt into an appropriate NFC message and signal an LED to let the recipient know that their receipt is ready. The customer will then open the WAVE mobile application and *wave* their device over the terminal to receive their receipt. From there, the customer will be able to see their receipts and open them accordingly. The customer has successfully received a digital receipt while preserving their privacy and security.

User Requirements

The following section will focus on the scope of the project. This will be shown through the individual requirements we must include within the project, seen in the MuSCoW list. Beyond the MuSCoW list will be multiple milestone objectives, all defined individually, and shown in a SMART goal like format. The SMART goals section is also separated by type; Mobile, NFC device, Splitter device, and POS. See the table of contents for quick links to each section.

MuSCoW List

Requirements	Must	Should	Could	Wouldn't
Mobile				
Mobile receives receipt data via NFC	X			
Store receipts locally on mobile device	X			
Receipts are stored on mobile in a readable file format	X			
Mobile application has android support	X			
Receipt transfer process takes maximum 3 seconds	X			
Receipts can be organized locally via the application (eg: put into specific folders)		X		
Mobile application has a UI		X		
Receipt transfer process takes maximum 2 seconds		X		
Mobile application provides a quick sum of all receipts without needing to open each receipt		X		
Receipts can be seen in an organized manner through the mobile application			X	
Receipt transfer from POS → Mobile is encrypted & decrypted			X	
Option for users to accept receipts automatically (without starting our app)			X	
User is prompted to accept an incoming receipt before transfer begins			X	
Receipt transfer process takes maximum 1 second			X	
Mobile application has iOS support				X
Receipts can be shared from the mobile application (eg: text, snapchat, cloud, etc)				X
Mobile application provides an expense analysis of the receipts (eg: \$spent per receipt, \$spent total, \$spent per location, etc)				X
NFC Device				
Device is able to transmit receipt data with NFC	X			
Device can send & receive data from Splitter device	X			
Device does not exceed 15x15cm (eg: small enough to fit in the hand)	X			

Device has an LED to signal when receipts are ready for transfer	X			
Device able to store receipts until they are transferred	X			
Device clears memory of receipt after transfer has taken place	X			
Powered by 1 of: USB, or 110AC (if possible, powered by the connection to the POS)	X			
Multiple LEDs to better indicate the status of the NFC device		X		
Device has minimum 1MB of memory		X		
Device memory of receipt clears after 10 seconds of being idle		X		
Device has an enclosure case		X		
Device has an LCD screen to indicate the status of the device			X	
Device has an override button to clear receipt data (kinda like a reset)			X	
Device has a touchscreen for interaction and status				X
Splitter Device				
Device can communicate with the POS	X			
Device can communicate with a paper printer	X			
Device can communicate with the NFC device	X			
Device can choose to send data to the paper printer or NFC device	X			
Device dynamically formats receipts into appropriate formats for paper printer or NFC device.	X			
Device does not exceed 15x15cm (eg: small enough to fit in the hand)	X			
Device has an enclosure case		X		
Device uses toggle switch with labels to pick output to NFC device or paper printer		X		
Device has an LED indicator stating what device is currently being output to			X	
Device is able to handle encryption for NFC transfer			X	
Device connects to the POS wirelessly				X
POS				
POS creates & sends receipts to NFC device in an appropriate format	X			
POS Sees Splitter device as a printer	X			

SMART Goals

Mobile

Task / Goal	Mobile Application NFC Component
Specific	<p>What:</p> <p>Ability for the mobile device to use this app and receive NFC data from the WAVE device.</p> <p>Who: Brandon & Dan</p> <p>Requirements:</p> <ul style="list-style-type: none">• Knowledge of NFC protocol• Knowledge of Android development
Measurable	The mobile device is able to receive NFC data from the WAVE device.
Attainable	<p>Obstacles:</p> <ul style="list-style-type: none">• Lack of android development experience
Relevant	Without this feature, WAVE is unable to achieve it's goal of digitizing receipts because we will have no method of giving the digital receipt to the customer.
Time-Bound	<p>Not strictly time bound. Must be completed for prototype stage.</p> <ul style="list-style-type: none">• Required before testing of the NFC transfer between the WAVE device and mobile device can happen.

Task / Goal	Mobile Application Storage Component
Specific	<p>What:</p> <ul style="list-style-type: none"> • Mobile application stores receipts locally. • Mobile application is able to retrieve all receipts and perform basic organization (storing in a specific folder) <p>Who: Brandon</p> <p>Requirements:</p> <ul style="list-style-type: none"> • Knowledge of Android development • The file format of the digital receipts
Measurable	The mobile application will read all receipts on the mobile device & they can be shown organized to a specific folder.
Attainable	<p>Obstacles:</p> <ul style="list-style-type: none"> • Lack of Android experience
Relevant	This feature retrieves receipts for the user and organizes them. Without it, receipts could be scattered on the phone and difficult to access.
Time-Bound	<ul style="list-style-type: none"> • Required before UI can be completely tested because this component handles getting the receipts for the UI. • Required before any 'budget' like features can be included.

Task / Goal	Receipt File Format
Specific	<p>What:</p> <p>The file format being used for the digital receipts.</p> <p>Who: All (design decision)</p> <p>Requirements:</p> <ul style="list-style-type: none"> • Research into if file format must support images/logos. • Research into capabilities of some file formats (.pdf, .csv, etc)
Measurable	The WAVE device is able to convert the receipt generated by the POS into the specified file format.
Attainable	<p>Obstacles:</p> <ul style="list-style-type: none"> • Research into file formats & capabilities
Relevant	This feature determines the file format of a digital receipt. Without it, we have no digital receipt file.
Time-Bound	<ul style="list-style-type: none"> • Priority goal - complete ASAP • Required before any NFC transfer can take place. • Required before storage component of mobile device can be tested.

Task / Goal	Mobile Application Supports Android
Specific	<p>What:</p> <p>The mobile application developed has support for the Android OS</p> <p>Who: Brandon</p> <p>Requirements:</p> <ul style="list-style-type: none"> • Android development
Measurable	The mobile application functions in an android environment
Attainable	<p>We have programming experience & have dived into web development through previous courses. We will develop this application with android support through YouTube videos & self study.</p> <p>Obstacles:</p> <ul style="list-style-type: none"> • Lack of Android development experience
Relevant	<p>With no OS support, the mobile application won't work on any mobile device. Being able to receive a receipt directly to your phone is a core value of WAVE.</p>
Time-Bound	<ul style="list-style-type: none"> • Priority goal • Without Android support, no other mobile development can take place.

Task / Goal	Mobile Application UI Component
Specific	<p>What:</p> <p>The user interface of the mobile application that the user will interact with.</p> <p>Who: Brandon</p> <p>Requirements:</p> <ul style="list-style-type: none"> • Android development • UI development
Measurable	There is a UI that displays the users receipts from which they are able to open them individually.
Attainable	<p>Obstacles:</p> <ul style="list-style-type: none"> • Lack of Android experience
Relevant	Without a UI, it will be more difficult for customers to access there receipts. Using the native file management system is not intuitive.
Time-Bound	<ul style="list-style-type: none"> • Lower priority goal • Required before final testing can begin

Task / Goal	Mobile Application Budget Component
Specific	<p>What:</p> <p>Application will display the total \$ spent beside each receipt.</p> <p>Who: Brandon</p> <p>Requirements:</p> <ul style="list-style-type: none"> • File analysis • Android development
Measurable	The total spent on each receipt is shown to the user.
Attainable	<p>Obstacles</p> <ul style="list-style-type: none"> • Lack of Android experience • Accessing & retrieving data from a file
Relevant	This allows the user to see what they're spending without opening each receipt.
Time-Bound	<ul style="list-style-type: none"> • Low priority • Required for final testing

NFC Device

Task / Goal	Device NFC Component
Specific	<p>What:</p> <p>The NFC device is able to send NFC data to a mobile device.</p> <p>Who: Dan & Brandon</p> <p>Requirements:</p> <ul style="list-style-type: none">• NFC protocol knowledge• Circuit design• Soldering• Circuit analysis
Measurable	Data has been transferred from the device to a mobile phone via NFC protocol.
Attainable	<p>Obstacles:</p> <ul style="list-style-type: none">• Designing & Implementing circuitry for the NFC protocol which we have never used before.
Relevant	Required, otherwise digital receipts will not get to the customer & WAVE fails in its goal of providing digital receipts to customers.
Time-Bound	<ul style="list-style-type: none">• Priority goal• Required before testing if the mobile application can receive NFC data

Task / Goal	NFC Device to Splitter Interface Component
Specific	<p>What:</p> <p>The connection between the Splitter & the NFC device.</p> <p>Who: Dan & Justin</p> <p>Requirements:</p> <ul style="list-style-type: none"> • USB understanding & standards • Transfer protocols (ethernet, USB)
Measurable	Receipts from the Splitter are transferred to the NFC device.
Attainable	<p>Obstacles:</p> <ul style="list-style-type: none"> • Configuring USB ports properly to allow reliable data transfer.
Relevant	Required, otherwise WAVE has no interface to the NFC device and can't get receipts that would be send to customers.
Time-Bound	<ul style="list-style-type: none"> • Priority goal • Required before any testing relating to receipts can be done.

Task / Goal	NFC Device Size
Specific	<p>What:</p> <p>The physical size of the device</p> <p>Who: Dan</p> <p>Requirements: N/A</p>
Measurable	The device is within 15x15cm in size
Attainable	<p>Obstacles:</p> <ul style="list-style-type: none"> • Circuit restraints • Component sizes
Relevant	Required so that the device is not absurdly large. It should not take up significant space on the cash counter.
Time-Bound	<ul style="list-style-type: none"> • This is more of an awareness goal. It won't block anything & is done when everything else is done.

Task / Goal	NFC Device User Indicators Component
Specific	<p>What:</p> <p>LED indicators to show the customer & cashier the status of the NFC device.</p> <p>Who: Dan</p> <p>Requirements:</p> <ul style="list-style-type: none"> • Circuit design • Circuit analysis
Measurable	<p>When an LED is on, the NFC device is ready for transfer. Blinking slow/fast means it is processing data or is idle. Off means lack of power.</p>
Attainable	<p>Obstacles:</p> <ul style="list-style-type: none"> • Circuit design
Relevant	<p>Important so that the customer & cashier know the current state of the NFC device.</p>
Time-Bound	<ul style="list-style-type: none"> • Not connected to any other task & can be tested independently.

Task / Goal	NFC Device Storage Component
Specific	<p>What:</p> <p>NFC device can store the receipts locally, clear receipts when done with them & do any processing on them.</p> <p>Who: Dan</p> <p>Requirements:</p> <ul style="list-style-type: none"> • Micro-controller • Embedded development
Measurable	<p>The NFC device successfully gets receipt data, formats it correctly & stores it until transfer. After transfer the data is deleted.</p>
Attainable	<p>Embedded development would be an obstacle except through our studies we have significant experience with this.</p> <p>Obstacles:</p> <ul style="list-style-type: none"> • Micro-controller design/selection
Relevant	<p>Required in order to convert receipts & send them to the mobile device which is the main feature of WAVE.</p>
Time-Bound	<ul style="list-style-type: none"> • Priority goal • Required to test NFC transfer functionality • Required before POS interface can be tested

Task / Goal	NFC Device Power Component
Specific	<p>What:</p> <p>NFC device is powered successfully. Whether it be through 110AC, USB, or Ethernet</p> <p>Who: Dan</p> <p>Requirements:</p> <ul style="list-style-type: none"> • Circuit design • Circuit analysis • Research into current peripheral power methods in POS systems
Measurable	The NFC device successfully powers up (led indicator can be used to test this).
Attainable	<p>Obstacles:</p> <ul style="list-style-type: none"> • Variable conditions with different POS systems.
Relevant	Without power WAVE can't do anything and no customers will get their receipts.
Time-Bound	<ul style="list-style-type: none"> • Priority goal • Required before any testing of NFC device can be done

Task / Goal	NFC Device Enclosure
Specific	<p>What:</p> <p>The enclosure the NFC device will be put into</p> <p>Who: Dan & Justin</p> <p>Requirements:</p> <ul style="list-style-type: none"> • CAD design • Research into market enclosures
Measurable	The NFC device fits inside its enclosure with all ports accessible.
Attainable	<p>3D printing is an option since we have access to a 3D printer.</p> <p>Obstacles:</p> <ul style="list-style-type: none"> • CAD experience
Relevant	Without an enclosure, the device is exposed. This is dangerous to the device and the people around. It also wouldn't look pretty without an enclosure.
Time-Bound	<ul style="list-style-type: none"> • Requires dimension specifics of the circuit, port locations and component heights before the enclosure can be determined.

Splitter Device

Task / Goal	Support for WAVE & Legacy Paper Receipts
Specific	<p>What:</p> <p>The ability for the cashier to select whether the receipt is printed paper form or given to the customer digitally via WAVE</p> <p>Who: Justin</p> <p>Requirements:</p> <ul style="list-style-type: none">• Knowledge of current POS systems• Knowledge of paper receipt printer systems
Measurable	The user can select between getting a paper receipt or digital WAVE receipt.
Attainable	<p>Obstacles</p> <ul style="list-style-type: none">• Paper receipt printer systems.• The vast number of different POS systems with various different pieces of software.
Relevant	Important because not all customers will want or be able to receive a WAVE receipt (fear, no compatible phone, dead phone, etc)
Time-Bound	<ul style="list-style-type: none">• Not strictly tied to other requirements but should be considered early in case changes need to be made to other components

Task / Goal	Splitter to POS Interface Component
Specific	<p>What:</p> <p>The connection between the Splitter & the POS.</p> <p>Who: Justin</p> <p>Requirements:</p> <ul style="list-style-type: none"> • USB understanding & standards • Transfer protocols (ethernet, usb)
Measurable	Receipts from POS are sent to the Splitter device.
Attainable	<p>Obstacles:</p> <ul style="list-style-type: none"> • Configuring USB ports properly to allow reliable data transfer. • Getting the Splitter to act as a printer
Relevant	Required, otherwise WAVE has no interface to the POS and can't get receipts that would be send to customers.
Time-Bound	<ul style="list-style-type: none"> • Priority goal • Required before any testing relating to receipts can be done.

Task / Goal	Splitter to Paper Printer Interface Component
Specific	<p>What:</p> <p>The connection between the Splitter & the paper printer.</p> <p>Who: Justin</p> <p>Requirements:</p> <ul style="list-style-type: none"> • USB understanding & standards • Transfer protocols (ethernet, usb) • Printer protocol understanding
Measurable	Receipts from the Splitter are transferred to the paper printer & then printed.
Attainable	<p>Obstacles:</p> <ul style="list-style-type: none"> • Configuring USB ports properly to allow reliable data transfer. • Printer protocol understanding
Relevant	Required, otherwise WAVE will not be able to support paper printers and thus be unlikely to be popular.
Time-Bound	<ul style="list-style-type: none"> • Priority goal • Required for complete prototype testing

Task / Goal	Splitter Size Component
Specific	<p>What:</p> <p>The physical size of the device</p> <p>Who: Justin</p> <p>Requirements: N/A</p>
Measurable	The device is within 15x15cm in size
Attainable	<p>Obstacles:</p> <ul style="list-style-type: none"> • Circuit restraints • Component sizes • Market uController sizes
Relevant	Required so that the device is not absurdly large. It should not take up significant space on the cash counter.
Time-Bound	<ul style="list-style-type: none"> • This is more of an awareness goal. It won't block anything & is done when everything else is done.

Task / Goal	Splitter Enclosure Component
Specific	<p>What:</p> <p>The enclosure the Splitter device will be put into</p> <p>Who: Justin</p> <p>Requirements:</p> <ul style="list-style-type: none"> • CAD design • Research into market enclosures
Measurable Attainable	<p>The Splitter device fits inside its enclosure with all ports accessible.</p> <p>3D printing is an option since we have access to a 3D printer but not necessary for this as we will likely use something like a RPi.</p> <p>Obstacles:</p> <ul style="list-style-type: none"> • CAD experience
Relevant	<p>Without an enclosure, the device is exposed. This is dangerous to the device and the people around. It also wouldn't look pretty without an enclosure.</p>
Time-Bound	<ul style="list-style-type: none"> • Requires dimension specifics of the circuit, port locations and component heights before the enclosure can be determined.

Task / Goal	Receipt Processing Component
Specific	<p>What:</p> <p>Receipt files are formatted correctly based on if they will be a digital or paper receipt.</p> <p>Who: Justin</p> <p>Requirements:</p> <ul style="list-style-type: none"> • File processing • Printer protocol requirements
Measurable	The Splitter device can send the receipt to the paper printer which correctly prints that receipt OR it can send the receipt to the NFC device which correctly transfers it to mobile in a readable file format.
Attainable	<p>Obstacles:</p> <ul style="list-style-type: none"> • Printer protocol requirements • NFC transfer limitations
Relevant	Required in order to preserve the option of having a paper receipt.
Time-Bound	<ul style="list-style-type: none"> • Not strictly required for prototype testing but this is an important feature.

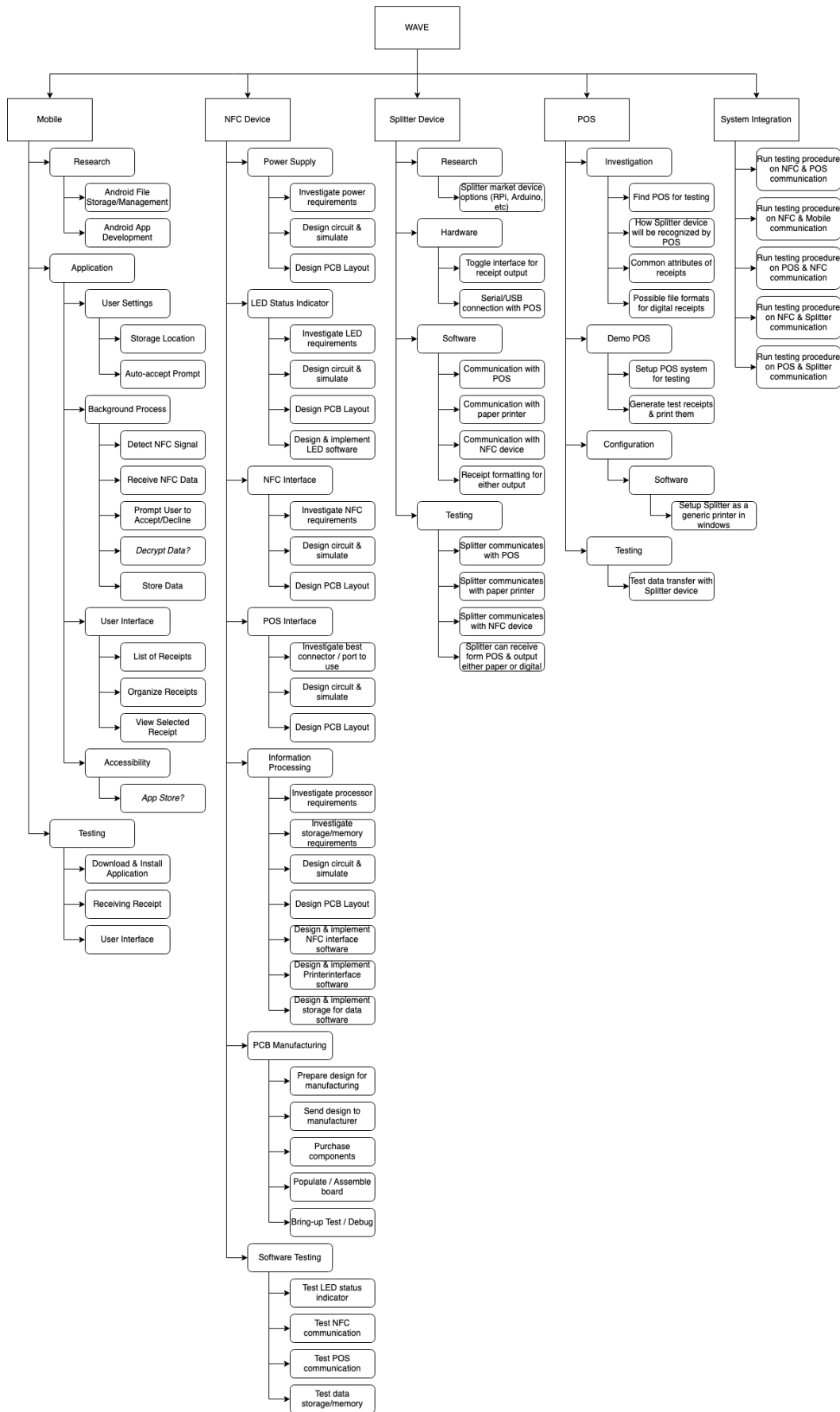
POS

Task / Goal	Splitter device recognized as a printer
Specific	<p>What:</p> <p>The splitter device is seen as a printer device so that POS softwares can set the splitter as there destination for receipts.</p> <p>Who: Justin</p> <p>Requirements:</p> <ul style="list-style-type: none">• POS software knowledge• Some understanding of printer devices in windows
Measurable	The splitter device is selectable as a printing option in a windows environment.
Attainable	<p>Obstacles:</p> <ul style="list-style-type: none">• Poor understanding of printer protocols• Uncharted territory in terms of setting up custom printers
Relevant	Important so that receipts can be sent to the NFC device OR paper printer, preserving the choice for the customer.
Time-Bound	<ul style="list-style-type: none">• Required before proper prototype testing can begin

Project Plan

System Breakdown

The following section demonstrates a breakdown of the MuSCoW list, SMART goals, and general focus of WAVE. The next page contains a flow chart showing all functional units of the project. Primary features are broken down into smaller bite sized components that can be used to stay organized and monitor our progress during this project. The above SMART goals outlined which members will be focusing on what tasks. While the flow chart below does not specify this, generally, Brandon will be handling mobile units, Dan will be handling NFC device units, Justin will be handling splitter and POS units, and there will be collaboration for the system integration units.



System Integration (TBD)

Resource and Knowledge Requirements

The two tables below will focus on the resources and knowledge requirements of this project. The first table displays all the tools, components, and software that will be needed, as well as an estimated cost of each item. Keeping in mind budget restraints, there is a focus on using tools already available as well as open source or free software. Despite this focus, there is an estimated cost of about \$350.

The second table focuses on any knowledge or skills that are missing from the team and how we plan to overcome these obstacles. Many of the skills lacking are obtainable via online tutorials. Considering we have a foundation in embedded design and serial communication, none of the obstacles are brand new concepts. The current knowledge and skills of the team will be applied to assist with overcoming these obstacles.

Tools, Off-the-Shelf Components, and Software

Category	Required Component	Estimated Cost (CAD)
Tools	Digital Multimeter	In possession
	Power Supply (maybe)	\$20
	Oscilloscope (maybe)	Borrow from school
	Soldering iron	In possession
	Solder	In possession
	Solder paste (if self-populating)	\$20
	Hot-air gun (if soldering iron insufficient)	\$50
	Firmware connector (maybe)	\$80
	Android Device with NFC	In possession
	Micro-controller	\$20
Off-the-shelf Components	NFC component	\$50
	USB cable	In possession
	LED	Negligible
	Toggle switch	Negligible
	USB Cables	\$10
	RPi or alternative	In possession
	Thermal Printer	\$40
	Thermal Printer Paper	\$20
	USB Cables	\$10
Software	POS Software (Unicenta oPOS)	Free/Open Source
	Windows	In possession
	Firmware flasher/debugger (possibly Kiel)	Free
	VS Code or alternative	Free/Open Source
	Android Studio	Free for our purposes

Knowledge and Skills

Required Knowledge / Skill	How to attain
NFC Protocol stack	Many different online tutorials on how to setup
NFC Capabilities	Research common NFC component datasheets
NFC requirements	Research common NFC component datasheet
USB communication	Online tutorial
USB as power supply	Online tutorial
Communicating in “printer” language to splitter device	Online tutorial
C/C++ Experience	In class study
Python Experience	Online tutorials
Serial Communication	Online tutorials
ESC/POC Protocol	Online tutorials
Understanding of printer devices in windows	Online tutorials
Understanding of printer protocols	Online tutorials
Android App Development	Online tutorials
Android File Management	Online tutorials
Java	Online tutorials

Task Assignment & Schedule

The following section will show a Gantt chart. This chart will show the many tasks that make up this project, their associated deadlines, as well as their links to other tasks. Our main source for the Gantt chart is Jira, which provides a much more user-friendly interface and is easier to manage. The following is a replica of the original, which is reduced in size for simplicity.

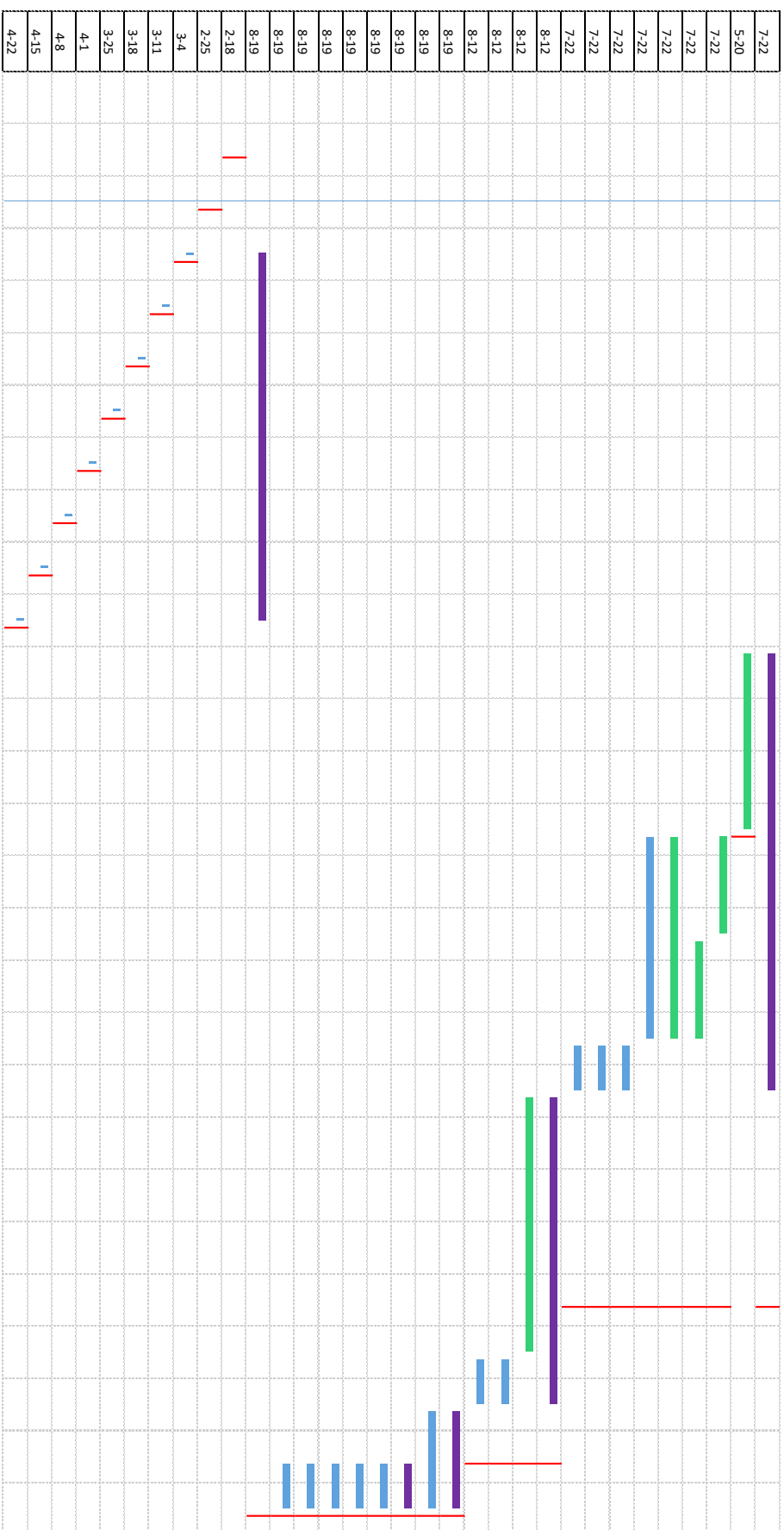
The legend is as follows:

- Purple – Epic (Main Deliverables)
- Green/Blue – Functional units
- Red – Due Dates

#	Project / Version / Ticket	Key	Type	Assignee	Priority	Status	Start	Plan Finish	Days	Due Date
1	Capstone		Project							
1-1	Brainstorm ideas	CAP-1	Epic		Medium	Done				12-12
1-2	Setup work environment	CAP-3	Epic		Medium	Done				12-30
1-3	Preliminary Research	CAP-2	Epic		Medium	Done				12-30
1-4	Project Proposal Document - 20%	CAP-29	Epic		Medium	Done				2-11
1-5	User Requirements & Project Plan - 10%	CAP-30	Epic		Medium	In Progress	2-19	2-25	7 d	2-25
1-6	Investigation & Design - 25%	CAP-34	Epic		Medium	To Do	2-26	4-15	49 d	4-22
1-6-1	Power Supply	CAP-62	Story	Dan Dreise	Medium	To Do	2-26	3-4	7 d	4-22
1-6-2	POS Interface	CAP-65	Story	Dan Dreise	Medium	In Progress	3-5	3-11	7 d	4-22
1-6-3	NFC Interface	CAP-64	Story	Dan Dreise	Medium	To Do	3-12	3-25	14 d	4-22
1-6-4	Information Processing	CAP-66	Story	Dan Dreise	Medium	To Do	3-27	4-9	14 d	4-22
1-6-5	LED Status Indicator	CAP-63	Story	Dan Dreise	Medium	To Do	4-10	4-15	6 d	4-22
1-6-6	Research	CAP-105	Story	Brandon Harkness	Medium	To Do	2-26	3-4	7 d	4-22
1-6-7	User Settings	CAP-104	Story	Brandon Harkness	Medium	To Do	3-5	3-11	7 d	4-22
1-6-8	Background Process	CAP-106	Story	Brandon Harkness	Medium	To Do	3-12	3-25	14 d	4-22
1-6-9	User Interface	CAP-107	Story	Brandon Harkness	Medium	To Do	3-26	4-8	14 d	4-22
1-6-10	Accessibility	CAP-108	Story	Brandon Harkness	Medium	To Do	4-9	4-15	7 d	4-22
1-6-11	Research	CAP-126	Story	Justin Turcotte	Medium	To Do	2-26	3-4	7 d	4-22
1-6-12	Investigation	CAP-141	Story	Justin Turcotte	Medium	To Do	3-5	3-11	7 d	4-22
1-6-13	Hardware	CAP-127	Story	Justin Turcotte	Medium	To Do	3-12	3-18	7 d	4-22
1-6-14	Software	CAP-128	Story	Justin Turcotte	Medium	To Do	3-19	4-1	14 d	4-22
1-6-15	Demo POS	CAP-142	Story	Justin Turcotte	Medium	To Do	4-2	4-8	7 d	4-22
1-6-16	Configuration	CAP-143	Story	Justin Turcotte	Medium	To Do	4-9	4-15	7 d	4-22
1-7	Presentation & Demonstration (Semester 1) - 10%	CAP-33	Epic		Medium	To Do	4-16	4-22	7 d	4-22
1-7-1	Oral presentation of engineering investigation, design, and test plan	CAP-173	Story	Dan Dreise	Medium	To Do	4-16	4-22	7 d	4-22
1-7-2	Powerpoint presentation document	CAP-174	Story	Dan Dreise	Medium	To Do	4-16	4-22	7 d	4-22
1-7-3	Demonstration of experimental and simulated work	CAP-175	Story	Brandon Harkness	Medium	To Do	4-16	4-22	7 d	4-22
1-7-4	Document that describes demonstration setup	CAP-176	Story	Justin Turcotte	Medium	To Do	4-16	4-22	7 d	4-22
1-8	Engineering Design Document & Test Plan - 20%	CAP-31	Epic		Medium	To Do	4-16	4-22	7 d	4-22
1-8-1	Engineering design of all functional units and the integrated system	CAP-169	Story	Justin Turcotte	Medium	To Do	4-16	4-22	7 d	4-22
1-8-2	Test plans for each functional unit AND verification & validation of integrated system	CAP-170	Story	Brandon Harkness	Medium	To Do	4-16	4-22	7 d	4-22



1-9	Prototype Development & Testing - 30%	CAP-159	Epic		Medium	To Do	4-27	6-24	59 d	7-22
1-9-1	PCB Manufacturing	CAP-67	Story	Dan Dreise	Medium	To Do	4-27	5-20	24 d	5-20
1-9-2	Testing	CAP-129	Story	Justin Turcotte	Medium	To Do	5-21	6-3	14 d	7-22
1-9-3	Testing	CAP-144	Story	Justin Turcotte	Medium	To Do	6-4	6-17	14 d	7-22
1-9-4	Testing	CAP-109	Story	Brandon Harkness	Medium	To Do	5-21	6-17	28 d	7-22
1-9-5	Software Testing	CAP-68	Story	Dan Dreise	Medium	To Do	5-21	6-17	28 d	7-22
1-9-6	Documented evidence of all significant verification testing, results, and analysis	CAP-179	Story		Medium	To Do	6-18	6-24	7 d	7-22
1-9-7	Updated user requirement and project plan document	CAP-177	Story		Medium	To Do	6-18	6-24	7 d	7-22
1-9-8	Demonstration of all functional units	CAP-178	Story	Justin Turcotte	Medium	To Do	6-18	6-24	7 d	7-22
1-10	System Integration and Performance Analysis - 15%	CAP-160	Epic		Medium	To Do	6-25	8-5	42 d	8-12
1-10-1	System Integration	CAP-153	Story	Dan Dreise	Medium	To Do	6-25	7-29	35 d	8-12
1-10-2	Documented evidence of all significant verification and validation testing, results, and analysis	CAP-181	Story	Brandon Harkness	Medium	To Do	7-30	8-5	7 d	8-12
1-10-3	Demonstration of fully functional integrated system	CAP-180	Story	Justin Turcotte	Medium	To Do	7-30	8-5	7 d	8-12
1-11	Final Report - 25%	CAP-32	Epic		Medium	To Do	8-6	8-19	14 d	8-19
1-11-1	Refine and consolidate documents for final report	CAP-182	Story		Medium	To Do	8-6	8-19	14 d	8-19
1-12	Presentation & Demonstration (Semester 2) - 15%	CAP-161	Epic		Medium	To Do	8-13	8-19	7 d	8-19
1-12-1	Oral presentation	CAP-183	Story		Medium	To Do	8-13	8-19	7 d	8-19
1-12-2	Powerpoint presentation	CAP-184	Story		Medium	To Do	8-13	8-19	7 d	8-19
1-12-3	Demonstration of completely integrated system	CAP-185	Story		Medium	To Do	8-13	8-19	7 d	8-19
1-12-4	Document that describes the demonstration setup	CAP-186	Story		Medium	To Do	8-13	8-19	7 d	8-19
1-12-5	A video of the project work	CAP-187	Story		Medium	To Do	8-13	8-19	7 d	8-19
1-13	Project Management & Professionalism - 15%	CAP-35	Epic		Medium	To Do	3-4	4-22	50 d	8-19
1-13-1	Status Report (week ending Feb 19)	CAP-55	Task	Dan Dreise	Medium	Done				2-18
1-13-2	Status Report (week 6)	CAP-61	Task	Justin Turcotte	Medium	Done				2-25
1-13-3	Status Report (Week 7)	CAP-188	Task	Brandon Harkness	Medium	To Do	3-4	3-4	1 d	3-4
1-13-4	Status Report (Week 9)	CAP-189	Task	Dan Dreise	Medium	To Do	3-11	3-11	1 d	3-11
1-13-5	Status Report (Week 10)	CAP-190	Task	Justin Turcotte	Medium	To Do	3-18	3-18	1 d	3-18
1-13-6	Status Report (Week 11)	CAP-191	Task	Brandon Harkness	Medium	To Do	3-25	3-25	1 d	3-25
1-13-7	Status Report (Week 12)	CAP-192	Task	Dan Dreise	Medium	To Do	4-1	4-1	1 d	4-1
1-13-8	Status Report (Week 13)	CAP-193	Task	Justin Turcotte	Medium	To Do	4-8	4-8	1 d	4-8
1-13-9	Status Report (Week 14)	CAP-194	Task	Brandon Harkness	Medium	To Do	4-15	4-15	1 d	4-15
1-13-10	Status Report (Week 15)	CAP-195	Task	Dan Dreise	Medium	To Do	4-22	4-22	1 d	4-22



Risk Analysis & Risk Management Plan

The following section focuses on the inherent risks of the project as well as any plans to mitigate these risks. The first table below outlines each risk, its risk level, and the category of the project that it belongs to. There are many minor risks that will be mitigated through research during the design stage as well as open communication amongst team members. Below the table will be a more detailed management plan, detailing any plans to mitigate major risks that could pose a threat to the project.

Category	Risk Description		Risk Level
Technical, Quality and Performance Risks	<i>Unable to obtain POS System (either physical or software)</i>	→	Intermediate
	<i>NFC Certification</i>	→	Minor
	<i>NFC Security</i>	→	Minor
	<i>Lack of knowledge/experience with android app development</i>	→	Minor
	<i>Inability to communicate between splitter (Raspberry Pi) and POS</i>	→	Major
	<i>Inability to configure NFC device as printer</i>	→	Major
	<i>Inability to power NFC device via USB</i>	→	Minor
	<i>Inability to communicate between NFC device and splitter (Raspberry Pi)</i>	→	Major
	<i>Inability to configure the Splitter device as a printer in the Windows environment</i>	→	Major
	<i>Processing or R/W rate of selected Splitter device won't be able to keep up with demand</i>	→	Minor
	<i>Inability to communicate correctly with the paper printer from the Splitter</i>	→	Minor
Project Management Risks	<i>Project design not well defined/incomplete</i>	→	Minor
	<i>Project scope too large for timeline</i>	→	Minor
	<i>Project schedule not clearly defined</i>	→	Minor
	<i>Unplanned work that must be allocated</i>	→	Minor
	<i>Lack of communication</i>	→	Minor
	<i>Exceeding budget</i>	→	Minor

Organizational Risks	<i>Jira/Confluence/GitHub servers/database compromised</i>	→	Intermediate
	<i>Slack server compromised</i>	→	Minor
External Risks	<i>COVID-19 inhibiting the use of the lab</i>	→	Major
	<i>COVID-19 affecting manufacturing process</i>	→	Major

Technical, Quality and Performance Risks

This project has several technical, quality and performance risks throughout the entire project. On the POS side, there's potential risk of being unable to obtain a POS system. However, there are many options for open-source POS software, thus this is an unlikely risk.

There are also potential risks surrounding NFC such as acquiring NFC certification (more research required) as well as potential security risks inherent with the transfer of data. We have identified the potential need for encryption/decryption should more security be required. These risks do not pose critical threats to the objectives of the project, as other methods of file transfer have been considered and are alternate options.

On the mobile end of the project, the lack of knowledge/experience with android development is a potential risk. This again is a minor risk as there are more than adequate resources online to help learn what is necessary to complete this part of the project.

Project Management Risks

There are several risks surrounding the project design and scope though all of the risks have minor consequences. Firstly, if the project design/scope is not well defined it could lead to confusion and uncertainty in the future causing delays in the prototyping phase of the project. The project schedule/workload distribution may be not clearly defined or not equal which could also cause delays and possibly risk not completing the project on time. If the project scope is too large for the timeline this could also have a similar outcome. Going off both these topics, if there is any unplanned work that must be completed this could jeopardize our timeline and completion of the project.

Other risks could involve a lack of communication which may cause a lack of clarity and create confusion, especially if there are dependencies between the different sections of work in the project. A minor risk is if the project ends up exceeding the budget, though this can be resolved fairly easy as we have intended to make the budget well below the maximum comfort level of the project members.

Organizational Risks

The main organizational risks stem from our choice for our documentation and code database. Details of our project are documented and saved using Jira/Confluence and our code database will be stored both locally and using GitHub. Should these servers/databases be comprised or go down, access to our project information/code may be temporarily unavailable and worse case permanent lost on those platforms. For these reasons, we will also backups stored locally. Our communication platform could also have similar issues if the slack servers are comprised, though this is a minor risk as we have various other platforms at our disposal.

External Risks

The greatest external risks are due to COVID-19 including inhibiting the use of the lab for testing/debugging as well as potentially affecting our PCB Manufacturing process and/or supply chain for components. This is likely one of the major risks as it has the most severe consequences to our project. If there are issues with PCB manufacturer availability and components stocks, a physical board may not be within our capability. The fallback if these risks do occur is to focus on creating perfect designs for all aspects of the project and excellent documentation. The software components of the project should still be completable if these risks do occur.

Risk Management Plan

Category	Risk	Probability	Contingency Plan
Technical, Quality and Performance Risks	<i>Inability to configure NFC device as printer</i>	Low	This risk can be mitigated by ensuring adequate research is done and a thorough understanding is achieved during the design phase. Should this risk occur, a simulation of data from POS can be used to test the other components of the project.
	<i>Inability to configure splitter as printer in Windows Environment</i>	Low	This risk can be mitigated by ensuring adequate research is done and a thorough understanding is achieved during the design phase. Should this risk occur, a different OS can be used.
	<i>Inability to communicate between splitter and POS</i>	Low	This risk can be mitigated by ensuring adequate research is done and a thorough understanding is achieved during the design phase. Should this risk occur, a different method of communication other than USB can be used.
	<i>Inability to communicate between NFC device and splitter</i>	Low	This risk can be mitigated by ensuring adequate research is done and a thorough understanding is achieved during the design phase. Should this risk occur, a different method of communication other than USB can be used.
External Risks	<i>Inhibited use of the lab</i>	High	This risk is out of our control. Should it occur, tools can be sourced to enable hardware testing and debugging from home at the cost of increasing the budget (i.e., power supply, oscilloscope, etc.)
	<i>Complications in the manufacturing process</i>	Medium	This risk is out of our control but can be mitigated. Part selection will be done considering available stocks and multiple options for manufacturing outsourcing will be identified.