PROJECT A – SOCIAL DISTANCING THROUGH OPAL

COMP2050

Macquarie University
Rajiv Mehta - 45433062

Table of Contents

1 Roles 3

2 Vision Statement 3

3 Introduction 4

3.1 Purpose 4

3.2 Scope 4

3.3 Definitions 4

4 Overview 5

4.1 Overall Description 5

4.2 Product Perspective 6

Product Functions 6

4.3 User Characteristics 7

4.4 Constraints 7

4.5 Assumptions & Dependencies 7

5 Specific Requirements 8

5.1 Functional Requirements 8

5.2 Usability Requirements 10

5.3 Security Requirements 10

5.4 Operational Requirements 11

5.5 Maintainability Requirements 11

5.6 Performance Requirements 11

6 Use-Case Diagrams 13

7 Use-Case Descriptions 14

7.1 Train Counter System 14

7.2 Gate-Locking System 15

7.3 Bus Counter System 17

8 Interaction Diagram for Gate-Locking System 20

8.1 Prioritisation Explanation 21

9 Techniques to Create Requirements 21

10 Client Report 22

11 Continuing the Project 23

12 Myself as a Client 24

13 Log of Interactions 24

13.1 Interaction 1 24

13.2 Interaction 2........24
13.3 Interaction 3........24
13.4 Interaction 4........25
13.5 Interaction 5........25
13.6 Interaction 6........25

1 Roles

Table 1. Project Roles

Project	Software Engineer	Client
A	Rajiv Mehta - 45433062	Thomas Cowan - 45321760
B	Thomas Cowan - 45321760	Rajiv Mehta - 45433062

2 Vision Statement

The introduction of COVID-19 into the general populous of NSW has seen a dramatic shift in the lifestyle of society. Several laws including social distancing have been put into place in order to combat this disease and in turn, has resulted in changes having to be placed on business, social gatherings and one of the most important aspects of society, public transportation. In order to combat the changes needed for public transportation the client has given several ideas to implement a new system for Opal that will help stop the spread of COVID-19. Our plan is to implement strategies such as using sensors and a counting system in order to lock carriages and opal gates to make sure that all customers have enough space to social distance. Another feature that we hope to implement is the use of electronic signage to indicate number of people on the transport and appropriate places to sit/stand while on these transports.

Systems Requirement Specification

3 Introduction

3.1 Purpose

The Systems Requirement Specification (SRS) section for the Social Distancing System (SDS) project contains details on the project for clients and other stakeholders who require to gain information in order to implement or replicate this system in the future. The document is split into three main sections. The first section is the introduction which contains information on the purpose, scope and other important features that will make the SRS clear and easy to understand. The next section is the overview of the project/product. This sections includes details on the product by first giving an overall description then by giving precise details on functions, characteristics, constraints and assumptions. The last section will highlight both functional and performance requirements for the project and the tests that should be run to see if the project meets the standards placed on by the client.

3.2 Scope

Primarily, the scope of this project includes the three main features of the Social Distancing System (SDS) and how it is implemented throughout each different mode of transportation. The SRS focuses on how the SDS will implement itself on these transport system and how effective they will be at enforcing social distancing through the hardware appliances provided by the client i.e. sensors, LCD signage and locking mechanisms.

In particular the SRS is specified on the requirements for the software of the SDS and how it will use the hardware to enforce social distancing through it's three main features being: Gate locking, counting mechanisms and LCD signage.

3.3 Definitions

Table 2. List of Abbreviations

Abbreviation	***Term***
SRS	System Requirement Specification
SDS	Social Distancing System
LCD	Liquid Crystallised Display
Transport Systems	Busses, Trains and Ferries
FR	Functional Requirement
UR	User Requirement
SR	Security Requirement
OR	Operating Requirement
MR	Maintenance Requirement
PR	Performance Requirements

4 Overview

4.1 Overall Description

The SDS being developed will be a general system that can be employed into any of the three main types of transportation systems that requires OPAL usage mainly being ‘Ferries’, ‘Busses’ and ‘Trains’. Each mode of transportation requires different variations of the systems employed but in terms of complexity if the focus of the design for the SDS is on the Train system then features from the trains can be directly implemented into the Busses and Ferries.

Therefore, as the main focus of the SDS will be focusing on implementation for Trains, the SDS will include three main features. The first feature is the passenger counting system that are implemented through the sensors. The sensors are deployed to count how many passengers are currently on and are stepping onto the transportation device in order to make sure that total number of passengers does not exceed max capacity. The next feature is the LCD signage that will operate directly with the sensors as it will display which transports are safe to jump on and also help staff check number of occupants against max occupancy.

The features mentioned above can then be directly used within Busses and Ferries. Though, in terms of staff having to manage and enforce the social distancing the SDS needs it’s third feature being a ‘Gate Blocking System.’ When max occupancy has been reached on a bus or ferry then the SDS should block the OPAL scanner and in turn gates/doors into the transport system. These features can be seen in figure 1. Indicating how they would work on a conceptual level.

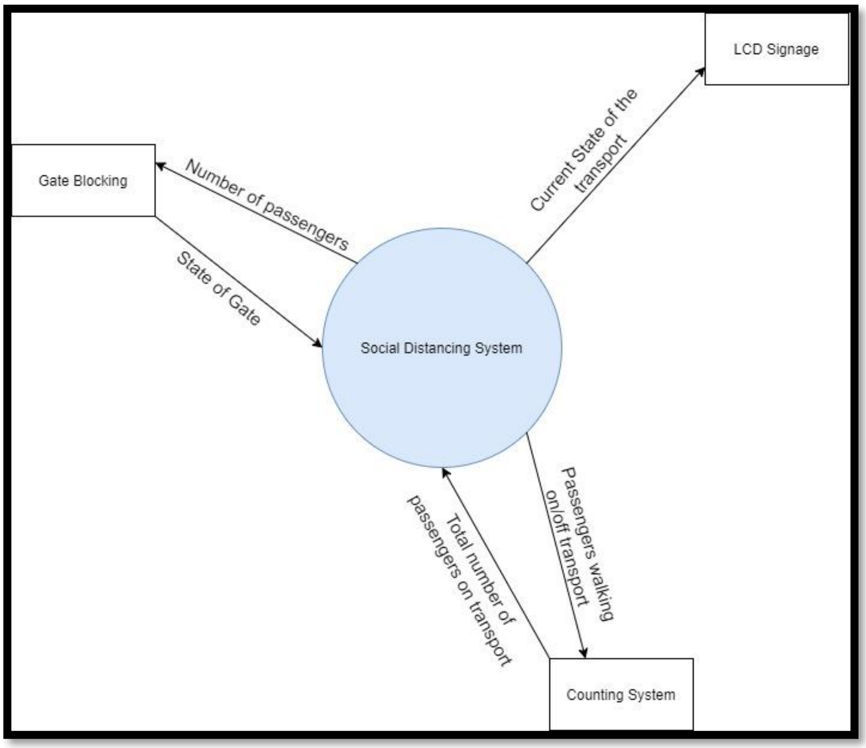

Figure 1. Social Distancing System’s main features

4.2 Product Perspective

The SDS is not a standalone system as it requires the OPAL tap on/off system to count the number of passengers entering/leaving the transport only in terms of the busses and ferries. The SDS when implemented onto the train system does not require any external software systems and is seen as standalone due to the use of sensors for counting passengers entering and leaving the train carriage. The products that is used in conjunction such as the sensors, LCDs and gate-locking mechanisms handled by the client are outside of the scope for this document and in turn, will not be discussed. The SDS subsystems will be required to be interfaced with each other as the all the subsystems are interconnected with each other. For example, the counting subsystem will directly interface with the gate-locking mechanism and the LCD signage as it provides the current state/passenger count of the transport.

Product Functions

The SDS has three main functions that it performs in order to achieve the needs of the client being to enforce social distancing on all modes of public transport. The main functions include:

- Counter system: This function counts all the passengers that are on transport and keeps track of both the max number of occupants on that transport and whether that number has been exceeded. If the number has been exceeded then a signal to close is sent to the gate control if on a ferry or to the driver on a bus or train. Continuous signals are also sent to the LCD screens to update them on the current number of passengers on the transport so the states of the LCD can be updated.
- Opal Gate System: This system is only implemented into one of the three transportation systems used by Opal being ferries. This is because of the main function of the gate system. The function is that the system is used for locking people out of entering the transportation but as train stations are the place where passengers tap on/off, not the actual train itself, it would be undesirable to have passengers not be able to enter the station and is outside of the scope of this document. So this first function is mainly used on ferries as the opal gates are used just before passengers enter the ferry area and is in the most desirable location. This function is not used on busses though as bus doors need to be manually closed by the driver, which passengers enter the bus before they tap on/off. Therefore, the only implementation of this feature is ferries.
- LCD Screens: The next function is the usage of LCD screens in order to update both passengers and staff on the number of passengers currently on the transport systems. On trains and busses this is especially useful as the doors on trains and busses are manually operated so when the driver sees that the max occupancy has been reached they can close the doors to ensure that there is enough space within the transport systems to safely social distance. This way drivers can easily enforce distancing as they do not have to keep track of passengers themselves. On trains, the driver can have multiple screens for each carriage while there can be screens on each platform showcasing the number of passengers on each carriage and if that carriage door is about to close.
- Bluetooth Modules: The last subsystems are the Bluetooth modules used to communicate between the subsystems mentioned above. The use of Bluetooth modules to send information between subsystems is ideal as short range Bluetooth will make it easier for the subsystems to disconnect with other stations and destinations when the

transport is stopped due to it's short range. This way, the use of Bluetooth, in particular at train stations, the LCD's would only be connected to the train at the platform rather then another train on a different platform in the same station. Also if two busses were to pass each other while driving, then due to the limited range, the Bluetooth modules won't connect to the other busses modules.

4.3 User Characteristics

The users of the SDS will consist:

- Commuters:
  - Everyday commuters
  - Children
  - Tourists
  - First time users
  - People with disabilities
- Staff
  - Bus drivers
  - Train drivers
  - Train platform staff
  - Ferry staff

4.4 Constraints

The client has given the following constraints on the SDS:

1. The SDS has to be fully designed and operational within the next three months.
2. Within the carriage of each type of transportation, the system has too provide enough space to allow for social distancing of passengers, i.e. number of passengers should be capped dependent on size of carriage.
3. Implementation costs should be kept within reason and should not exceed $1 million.
4. SDS operating time should be as efficient as possible to avoid delays in updating the number of people in the transport system.
5. The SDS has to be robust and not break if rules are not followed.
6. The SDS must help passengers move towards safe areas on public transport.
7. The LCD screens cannot cause harm to passengers or staff i.e. flashing lights can cause epilepsy.
8. Must take into account peak hours and unexpected periods of high volume of passengers.
9. All information transfer to other subsystems must be done via Bluetooth, with the exception of information transfer between train stations.

4.5 Assumptions & Dependencies

1. The SDS will integrate with the Opal software system with no problems.
2. The equipment that requires the SDS to function is not faulty and is available to the client.
3. People follow the guidelines set out for social distancing while on the transport.
4. Passengers follow the LCD signage as indicated by the SDS to perform social distancing while using transportation.
5. The number of passengers allowed on each type of transport is same within their each respective type i.e. double-decker busses and single-level busses can only carry 30 people regardless of size.
6. System does not have to function on the Metro.

5 Specific Requirements

5.1 Functional Requirements

- FR_1: The Counting system when implemented on busses and ferries shall count the number of passengers on the transport system via the number of tap on/off's via the Opal system.
    - Purpose: To keep an accurate track of the number of passengers.
    - Fit Criteria: 100% of the time, the counter will keep a correct count of the number of people who are on the transport based on the Opal system.
- FR_2: The Counting system when implemented on trains shall count the number of passengers on each carriage via the motion sensors.
    - Purpose: To keep an accurate track of the number of passengers on each carriage.
    - Fit Criteria: 90% of the time, the counter will keep a correct count of the number of people who are on the transport based on the Opal system.
- FR_3: The Counting systems in each transportation system shall transmit the correct signals to the LCD screens.
    - Purpose: LCD show's correct information for passengers/staff.
    - Fit Criteria: 100% of the time, the display is updated to match the current state of the transport.
- FR_4: The LCD should be able to receive a signal from the Counter system.
    - Purpose: LCD gets accurate information on number of passengers on transport.
    - Fit Criteria: 100% of the time, the LCD should be able to receive information from the Counter System.
- FR_5: The Counting system should be able to receive signals from both Opal's systems and motion sensors:
    - Purpose: To give the Counter system correct information to analyse.
    - Fit Criteria: 100% of the time, the counter system should be able to receive information.
- FR_6: The Counting system should be able to transmit signals to the Gate-Locking system.
    - Purpose: Gate-Locking system gets the correct information so that it can decide when to open/close its gates.
    - Fit Criteria: 100% of the time, the Counting system should be able to transmit information to the Gate-Locking system.
- FR_7: All LCD's should be programmed to show the correct state of the transportation system when a signal is received from the counter subsystem.
    - Purpose: LCD's should display correct information for passengers/staff.
    - Fit criteria: 100% of the time, the LCD should display the correct state of the transports.
- FR_8: The LCD's inside the transports, while the transport is moving should display the next stop and to remind all passengers to social distance.
    - Purpose: To remind passengers to social distance.
    - Fit Criteria: 100% of the time, the LCD's should display information.
- FR_9: The LCD's on the train platforms should be able to receive signals via radio-waves from other train stations on the number of passengers on each individual train.

- Purpose: To be able to display information on upcoming trains.
    - Fit Criteria: 100% of the time, the LCD system should be able to receive information from other train stations.
- FR_10: All LCD's screens should display the number of passengers against the maximum number of passengers allowed on transport/carriage.
    - Purpose: To provide information on the transportation system for passengers/staff.
    - Fit Criteria: 100% of the time, the system should display correct information.
- FR_11: All LCD screens should display if the gates/carriages are open/closed based on the Gate-Locking system.
    - Purpose: To provide information on the transportation system for passengers/staff.
    - Fit Criteria: 100% of the time, the system should display correct information.
- FR_12: The LCD screens on the train platforms should display which sections of the carriages on trains are safe to enter based on information from the sensors:
    - Purpose: To indicate to passengers which carriages can be boarded.
    - Fit Criteria: 100% of the time, the system should display correct information.
- FR_13: The LCD screens on the train platforms should provide information on the number of passengers on the next arriving train if there is no current train at the station.
    - Purpose: To provide information on the transportation system for passengers/staff.
    - Fit Criteria: 100% of the time, the system should display correct information.
- FR_14: The Gate-Locking subsystem should only activate if the number of passengers reaches the maximum number of people allowed on the transport.
    - Purpose: To stop passengers from entering the Ferry transport.
    - Fit Criteria: 100% of the time, the subsystem should lock it's gates if the maximum number of passengers is reached.
- FR_15: The Gate-Locking system should lock two or more people out if the number of passengers would exceed the maximum if they tap on at the same time.
    - Purpose: To stop passengers from entering the Ferry transport system to cause the passenger number to exceed the maximum.
    - Fit Criteria: 100% of the time, the Gate-Locking system should block passengers if they would exceed the maximum number allowed on the transport.
- FR_16: The Gate Locking system should allow passengers to come onto the transport if the number of passengers does not exceed the maximum amount:
    - Purpose: To allow passengers to get on the transport.
    - Fit Criteria: 85% of the time, the Gate-Locking system should allow passengers on to the transport.
- FR_17: The Gate-Locking system should unlock itself if passengers exit the transportation system and more space is available on the transport.
    - Purpose: To make sure that each transport will take the maximum amount of passengers in order to improve efficiency and reduce congestion on the waiting areas.
    - Fit Criteria: 80% of the time, the Gate-Locking system should reopen if there is space on the transport.

- FR_18: The Gate-Locking system should send a signal to LCD screens to update passengers on the state of the gate i.e. open or closed.
    - Purpose: To inform staff/users to the state of the gate.
    - Fit Criteria: 100% of the time, the Gate-Locking system should send the correct signals to the LCD.
- FR_19: The Gate-Locking system should be able to receive a signal from the counting system and change the state of the gate from open/close to open/close.
    - Purpose: To change the state of the gate.
    - Fit Criteria: 100% of the time, the Gate-Locking system should be able to receive and change the state of the gate.
- FR_20: The Bluetooth modules on trains should be able to pair/disconnect from each destination to update information on SDS.
    - Purpose: To have the current station's LCD be able to display the correct information about that particular train.
    - Fit Criteria: 100% of the time, the train's Bluetooth modules should connect to the LCD's on the train platforms.
- FR_21: The Bluetooth modules should always be connected within the SDS subsystems on the busses and ferries.
    - Purpose: Subsystems are always connected to avoid data loss.
    - Fit Criteria: 95% of the time, the Bluetooth modules within each subsystem should be connected.

5.2 Usability Requirements

- UR_1: The traveller shall be able to use the SDS without any training.
    - Purpose: Training passengers to use the SDS would be pointless as the LCD's would be easy to understand.
    - Fit Criteria: 95% can follow the instructions displayed by the SDS.
- UR_2: Passengers with a disability shall be able to use the SDS with assistance.
    - Purpose: To make sure that people with a disability shall be able to understand the LCD screens.
    - Fit Criteria: 99% of staff shall be trained to assist passengers with a disability.
- UR_3: Engineers and Opal can easily change the SDS and its components.
    - Purpose: To make changes/updates to the SDS efficient.
    - Fit Criteria: To not make the SDS overly complicated and flexible to change.
- UR_4: Travellers must be able to understand what the LCD's are instructing.
    - Purpose: To make the words simple enough so that a non-English speaker would understand what to do.
    - Fit Criteria: 95% of initial users can follow the instructions of the SDS.
- UR_5: The LCD's must have a simple layout and be easy to read.
    - Purpose: To make sure users are not confused about the state of transportation.
    - Fit Criteria: 100% of the display must be laid out with large characters for easy readability against a solid background.

5.3 Security Requirements

- SR_1: The Bluetooth modules must not be able to be accessed by anyone except the modules in the respective transports.

- Purpose: So nobody with clearance can hack the system and display things on the LCD.
- Fit Criteria: 100% of external users cannot pair with the modules unless with proper security clearance.

- SR_2: The SDS shall protect itself from malicious damage.
  - Purpose: So the SDS does not break.
  - Fit Criteria: The SDS does not stop functioning at an efficient amount.
- SR_3: The SDS will send constant signals to its each subsystems.
  - Purpose: To help keep the system running if data loss occurs.
  - Fit Criteria: 100% of the time, the subsystems of the SDS will transmit data.

5.4 Operational Requirements

- OR_1: The SDS shall be deployed on all transportation types that use Opal, i.e. Busses, Trains and Ferries.
  - Purpose: To implement social distancing on all transports and to check if the SDS can operate on all modes of transport.
  - Fit Criteria: The SDS operates during both morning and afternoon peak times across all types of transportation without losing any efficiency and making any errors.
- OR_2: The SDS must be able to handle large volumes of foot traffic.
  - Purpose: To make sure the system doesn't break under pressure.
  - Fit Criteria: 100% of the time, the SDS must be operational.

5.5 Maintainability Requirements

- MR_1: New destinations can be added to the SDS at any time in the product life-cycle.
  - Purpose: To reduce the sizes of updates and the time needed for implementation.
  - Fit Criteria: Any destination added, the SDS will not be needed to be taken offline for more than 15min.
- MR_2: Updating the SDS with new features can be done at any point during the product life-cycle:
  - Purpose: To reduce the size of updates and the time needed.
  - Fit Criteria: New updates can implemented and tested within a small time-frame.

5.6 Performance Requirements

- PR_1: The SDS shall be operational 24 hours a day, 7 days a week.
  - Purpose: So that the number of passengers on each transport is always recorded.
  - Fit Criteria: 1 year of testing to make sure the SDS never stops operating.
- PR_2: The LCD's must have a refresh rate between 60Hz and 75Hz.
  - Purpose: To make sure that the LCD's showcase the current state.
  - Fit Criteria: 100% of the time, the LCD's must show the current state of the transport.
- PR_3: The signals sent between each subsystem must be within 100-500 milliseconds.
  - Purpose: To make sure that each subsystem is updated quick enough to operate efficiently.
  - Fit Criteria: 100% of the time, signals are sent between 100-500 milliseconds.

- PR_4: The Gate-Locking system should switch states within 300 milliseconds of receiving a max passenger limit signal from the Counter system.
    - Purpose: To block passengers from entering the transport.
    - Fit Criteria: 100% of the time, passengers are blocked when passenger limit is reached.
- PR_5: Counter system should not lose track of the number of passengers entering and leaving the transport.
    - Purpose: No inconsistent numbering of passengers.
    - Fit Criteria: 99% of the time, the number of passengers on the transport is correct.
- PR_6: SDS on Busses, Trains and Ferries shall reset when the transports are no longer operating each day.
    - Purpose: In order to remove any mistakes made by the SDS.
    - Fit Criteria: 100% of the time, the SDS shall turn off during times the transport is not in use.
- PR_7: There must have a constant flow of information between subsystems.
    - Purpose: To help prevent data loss
    - Fit Criteria: 100% of the time, if Bluetooth modules are connected there should be information transmitting between the modules.

6 Use-Case Diagrams

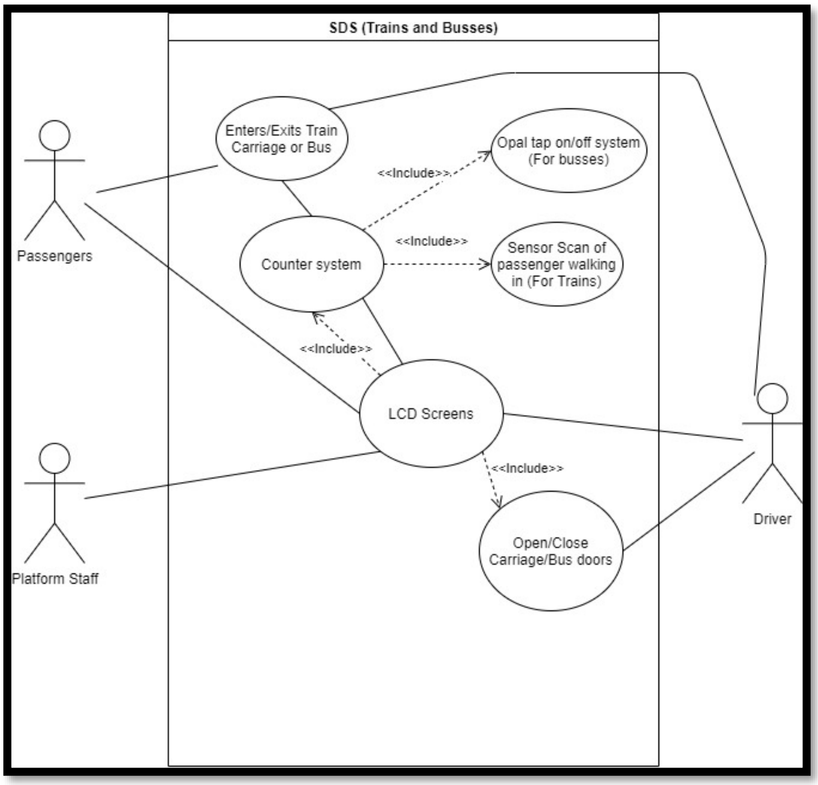

Figure 2. Use-Case diagram for Trains and Busses SDS

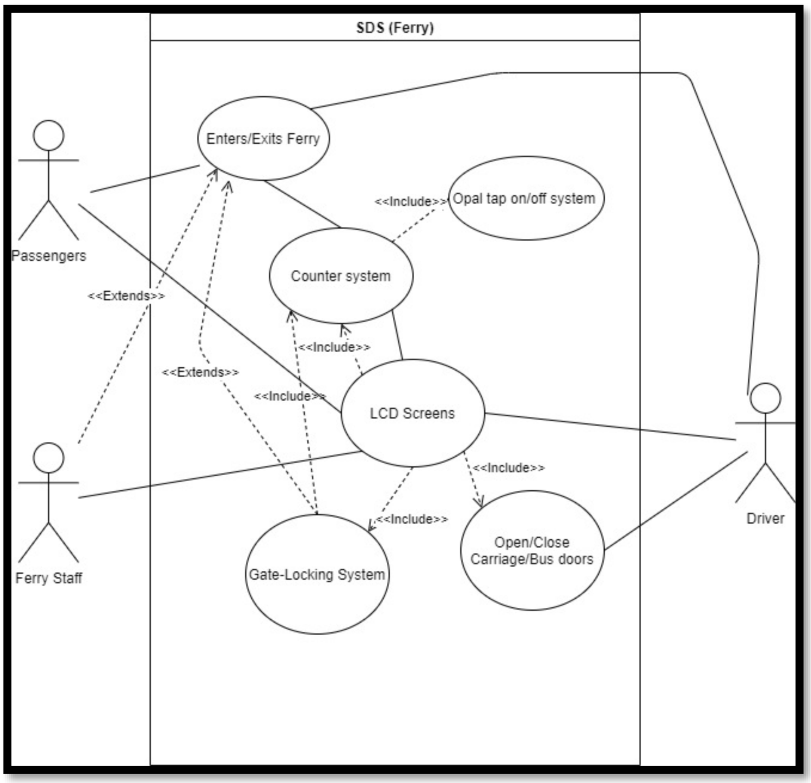

Figure 3. Use-Case diagram for Ferry SDS

7 Use-Case Descriptions

7.1 Train Counter System

Table 3. Use-Case for Train Counter System

<table>
<tr><td>Use Case</td><td colspan="2">Train Counting System</td></tr>
<tr><td>Goal</td><td colspan="2">To count the number of people entering one train carriage.</td></tr>
<tr><td>Preconditions</td><td colspan="2">- The motion sensors to be fully operational
- Passengers to enter the train
- The SDS to be fully operational
- A regular volume of passengers
- Train staff are already onboard
- Passengers does not want to change their mind on getting on the carriage.</td></tr>
<tr><td>Success End Condition</td><td colspan="2">- The number of passengers on the train carriage is accurate.
- Train doors closed by time or if the maximum number of passengers on carriage is reached.
- LCD screen displays that carriage is full.</td></tr>
<tr><td>Failed End Condition</td><td colspan="2">- Number of passengers counted is inaccurate.
- Train doors close with too many people inside carriage.
- LCD screen displays the incorrect state of the carriage.</td></tr>
<tr><td>Primary Actors;

Secondary Actors</td><td colspan="2">- Passengers
- Train Staff/Driver

- Motion Sensors
- LCD screens
- Train Doors</td></tr>
<tr><td>Trigger</td><td colspan="2">Passenger walks onto train platform</td></tr>
<tr><td rowspan="3">Description / Main Success Scenario</td><td>Step</td><td>Action</td></tr>
<tr><td>1</td><td>Passenger checks LCD screen on platform to see which carriages are open and chooses an open carriage.</td></tr>
<tr><td>2</td><td>Passenger moves towards chosen carriage and walks into carriage.</td></tr>
</table>

	3	Carriages motion sensors scans that passenger has entered the carriage and sends a signal to Counter system.
	4	Counter System passenger integer increments by one.
	5	Counter System sends a signal that another passenger has entered the carriage to the LCD screens on the train and platform
	6	LCDs updates to show that the number of passengers on the train carriage has increased.
	7	Repeat steps 1-6 until maximum number of passengers has been reached or 30 seconds have passed since last passenger boarded.
	8	Driver closes doors
Alternative Flows	**Step**	**Branching Action**
	1.1	Passenger chooses to go to a closed carriage
	3.1	Motion sensor does not register that passenger has entered the carriage.
	3.2	Motion sensor reads a passenger enter as a passenger exit.
	3.3	2 passengers enter at the same time and sensor only registers that one has entered.
	4	Counter system passenger Integer increases by the incorrect amount.
	5.1	Signal to LCD is lost so LCD does not change
	6.1	LCD does not update correctly
	7.1	Passenger count exceeds maximum number
	8.1	Driver leaves door open
	8.2	Driver closes door when passenger count exceeded maximum number allowed on carriage.

7.2 Gate-Locking System

Table 4. Use-Case for Gate-Locking System

Use Case	Gate-Locking System

<table>
<tr><td>Goal</td><td colspan="2">To lock the Opal gates if number of passengers has reached maximum capacity of the Ferry</td></tr>
<tr><td>Preconditions</td><td colspan="2">- The SDS to be fully operational
- A regular volume of passengers
- Opal gates are fully operational
- Ferry staff are already onboard
- Passenger does not change their mind about getting on the ferry</td></tr>
<tr><td>Success End Condition</td><td colspan="2">- The number of passengers on the ferry does not exceed the maximum allowed on.
- Opal gates lock to not let any more passengers through
- LCD screen displays the correct state of the ferry.</td></tr>
<tr><td>Failed End Condition</td><td colspan="2">- Number of passengers counted is inaccurate.
- Ferry doors close with too many people on board.
- LCD screen displays the incorrect state of the carriage.
- Opal gates do not lock.</td></tr>
<tr><td>Primary Actors;

Secondary Actors</td><td colspan="2">- Passengers
- Ferry Staff/Captain
- Opal gates

- LCD screens
- Ferry Doors
- Counter System</td></tr>
<tr><td>Trigger</td><td colspan="2">Passenger walks onto Wharf</td></tr>
<tr><td rowspan="9">Description / Main Success Scenario</td><td>Step</td><td>Action</td></tr>
<tr><td>1</td><td>Passenger checks LCD screen on platform to see if the ferry is available to be boarded.</td></tr>
<tr><td>2</td><td>Passenger moves towards Opal gate</td></tr>
<tr><td>3</td><td>Passenger taps on and walks through the gate onto the Ferry</td></tr>
<tr><td>4</td><td>Signal is sent to the Counter System</td></tr>
<tr><td>5</td><td>Counter System increments its passenger value.</td></tr>
<tr><td>6</td><td>Counter System sends signal to LCDs</td></tr>
<tr><td>7</td><td>LCD updates to show new passenger count</td></tr>
<tr><td>8</td><td>Repeat steps 1-7 until max passenger count is achieved or departure time is reached.</td></tr>
</table>

	9	Counter system sends signal to Gate-Locking system
	10	Gate-Locking system locks Opal gate so other passengers cannot enter
	11	Ferry departs
Alternative Flows	**Step**	**Branching Action**
	1.1	Passenger cannot comprehend LCD
	3.1	Opal gates are already locked
	3.2	Two passengers try to tap on at the same time which would breach COVID-19 rules meaning that both would get blocked
	4.1	Signal is lost
	7.1	LCD does not update correctly
	8.1	Exit condition never starts
	9.1	Signal lost
	10.1	Gates do not lock

7.3 Bus Counter System

Table 5. Use-Case for Bus Counter System

Use Case	Bus Counter System
Goal	To count the number of passengers entering and exiting the bus
Preconditions	- Passengers already on the bus - SDS is fully operational - More passengers would like to get on the bus - Bus is not already at max capacity
Success End Condition	- Bus leaves without exceeding the maximum capacity of passengers.

Failed End Condition	- Bus leaves with too many passengers on board.	
Primary Actors; **Secondary Actors**	- Bus driver - Passengers - Opal tap on/off device - LCD's - Bus doors	
Trigger	Bus stops at bus stop	
Description / Main Success Scenario	**Step**	**Branching Action**
	1	Bus driver opens doors
	2	Passenger that would like to get off the bus taps off
	3	Opal system sends signal to Counter system
	4	Counter system decreases passenger count by one
	5	Counter system sends signal to LCD
	6	LCD updates display to indicate number of passengers left on board
	7	Repeat steps 2-6 until all the passengers that want to get off leave.
	8	New passengers walk onto bus and tap on
	9	Opal system sends signal to Counter system
	10	Counter system increments passenger count by one
	11	Counter system sends signal to LCD
	12	LCD updates to show new passenger count
	13	Repeat steps 8-12 until all new passengers are on or the passenger count is equal to the max number of passengers
	14	If any more passengers, bus driver instructs passengers who haven't tapped on to exit the bus and wait for the next one
	15	Bus driver closes doors
	16	Bus leaves
Alternative Flows	**Step**	**Branching Action**

	2.1	Not all passengers tap off
	3.1	Signal lost
	5.1	Signal lost
	6.1	LCD does not update correctly
	8.1	No new passengers
	8.2	Passengers do not tap on
	9	Signal lost
	11	Signal lost
	12.1	LCD does not update correctly
	14.1	Passengers do not exit the bus

8 Interaction Diagram for Gate-Locking System

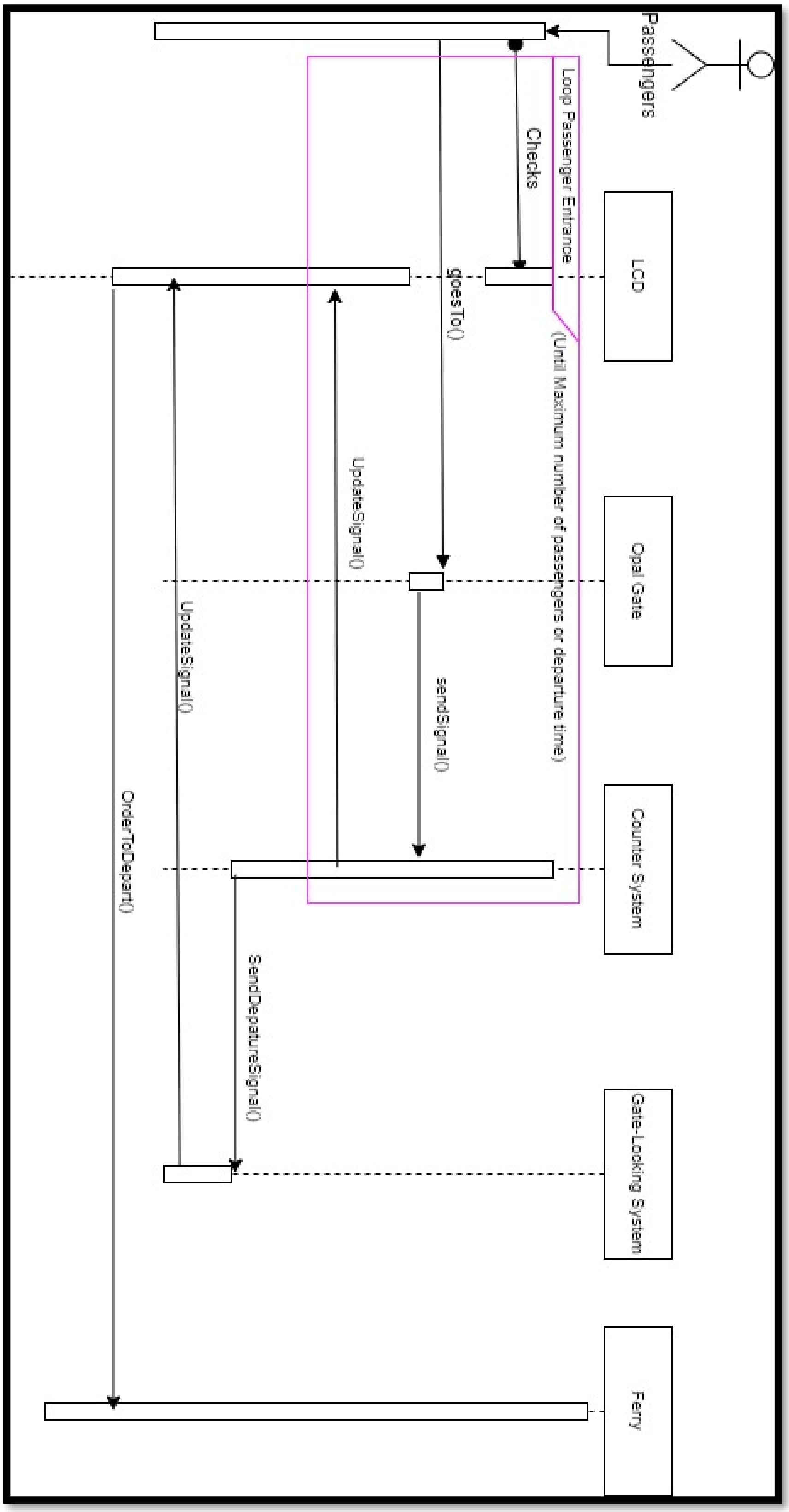

Figure 4. Interaction Diagram for Gate-Locking System

8.1 Prioritisation Explanation

In order to decide which use-cases were the most important, it was paramount to test how the subsystems would function on a regular day to day basis then in random unpredictable situations. This is because the system runs close to 24 hours a day, where it resets when the train network stops for the night. Therefore, the counting systems for all three transportation types became one of the most important user-cases. Fortunately the counter system for the ferries and busses work in the same way so they basically have a combined user-case. The next really important user-case that had to be prioritized was the Gate-Locking system. This was chosen because unlike the counting system that could technically be done by sight, the gate locking is fully automatic and then requires extensive testing to make sure that it would be able to handle the predicted volume of passengers each day. Therefore, the three use-cases that were prioritized were chosen based on the fact that the system will be used daily for extensive periods of time.

9 Techniques to Create Requirements

In terms of creating requirements for SDS, the requirements were split into six different categories of requirements. Each of these requirements used a different type of thinking in order to create the requirements. A list of how these were created can be seen below:

- Functional Requirements: In order to come up with the functional requirements for the SDS I decided to first come up with a rough sequence on how the subsystems would operate together when applied into the real world. I first started with the Counter system as it acted as the central part of the subsystem. I thought about how it would operate with the other subsystems on a conceptual level. Then by simply looking at each subsystem I checked what they would require from the other subsystems in order for them to function. Then I looked at what the client was asking for in terms of constraints and what he was asking for and then created the functional requirements based on how the subsystems were connected and what the client was asking for. An example of this would be that the 'The Counting system when implemented on busses and ferries shall count the number of passengers on the transport system via the number of tap on/off's via the Opal system.'
- Useability Requirements: The next requirements list that I came up with were the useability requirements. These requirements refer to how the users of the transport system would interact with the SDS. So in order to create these I imagined myself as a normal passenger and asked came up with questions such as 'How do I want the design of the LCD's to be like?' and 'What information would I like to see?' Using this method of creating these requirements put things into perspective on how a passenger would feel and in turn, the list of requirements became clear. I also asked the client on his thoughts and what he would like to see when he was using the SDS.
- Security Requirements: The security requirements was a tough list to come up with as in a sense the security on the SDS needs to be high, but due to it's simple nature the security in terms of software does not need to be that sophisticated. This is because the SDS has a heavy reliance on the hardware. Therefore, in terms of security the biggest security risk was data theft/loss. Therefore, in order to combat this, I came up with a simple solution which was to make the subsystems to continuously send data to each

other so even if a packet of data goes missing, another packet would be following right behind it.

- Operational Requirements: The operational requirements refer to how the SDS is going to be deployed and how it should handle situations when implemented. Therefore, only two things needed to be listed, ‘where it was being deployed’ and the ‘situations it should be able to handle.’
- Maintainability Requirements: The maintainability requirements referred to how the SDS will updated and fixed throughout the product life-cycle. In order to come up with these requirements I thought about what I would want if I was editing an already existing program. So things such as a simple layout of the code with nothing too complex would make the updating easy and efficient. This reduces the cost of updates as efficiency increases. So the list for these requirements came from this mindset.
- Performance Requirements: The performance requirements was the last list that I wrote and it lists how the SDS should perform when implemented into the real world. In order to come up with this list I thought about the subsystems from a more technical perspective rather than at a conceptual level. Things like the speed of signals being set and the refresh rate of the LCD’s were important as this system requires things to be updating at a relatively fast pace as the movement of passengers especially during peak times can be quite rapid and unpredictable.

Therefore, the requirements that were listed all required different thought processes on how to achieve and write them. In particular coming up with the useability requirements was the most difficult requirement to list as it required thinking outside of the software engineer mindset and rather what an average user would want from the system.

10 Client Report

Thomas Cowan (Tom), the client that I was partnered with for this assignment was an amazing client representative that helped me understand many different parts of this project. He helped me understand the clients perspective on what would be required from a project like this if given to me in the real world. To give an idea on how the client helped me through the project, below is a list of some of the details talked about during interactions and how they helped me design and understand the project:

During the first meeting that we had, Tom helped me understand the different paths of design that I could take within the project so that I could meet the original demands of the client. Also he helped me understand how the document should be laid out with the correct headings and what needed to be included and excluded.

In the second meeting, Tom really helped me with understanding the scope of project as he told me that the focus should be on the software, so hardware components can be seen as outside of the scope of the project. This was helpful as the time spent on having to figure out types of hardware used in real life projects was reduced to 0.

In the third and fourth meeting, Tom helped me a lot with the constraints of the project and in turn, the functional requirements. He clearly gave me a set of constraints such as the data transfer between subsystems has to be done via Bluetooth. This helped a lot when doing the final design of the SDS and in turn, the functional requirements that followed suit.

In the fifth meeting, Tom helped me identify which of the User-Cases I had were the most important in terms of prioritization as the client he explained that system should be able to consistently run for long periods of time with no error, meaning that the focus should be on day to day implementation rather then having use-cases for extreme events.

In conclusion, Tom was a great client and an amazing partner to work with, whether it would be from him acting as a client or from other small things as figuring out times for weekly meetings, he was great and I look forward to working with him again in the future.

11 Continuing the Project

In terms of continuing the project, ideally the SDS would not have to be in operation for a very long time due to a cure/vaccine for COVID-19 being in development around the world. Though in a worst case scenario and if the vaccine wouldn't be developed for another two years, then improvements to the current SDS would need to be carried out moving forward.

The first step to these upgrades would be to first see how the current SDS is performing in the real world by doing hypothesis tests to check if there is a difference in mean of different aspects in order to measure performance of what the client desires and the current performance i.e. ANOVA of LCD update times across different samples.

Then by taking these results, I would be able to identify the problems within the current SDS. This would help me come up with a full new list of functional and non-functional requirements which would then help me improve the system as a whole, as I would need to figure out how to upgrade the current system.

I would come up with concepts on how these systems could be improved. For instance if the Bluetooth modules do not work as well as intended, then I could look into other methods of transmitting data wirelesses such as through frequency modulated waves or amplitude modulated waves. By coming up with several methods of improvements I could select the options that I think would fulfill the needs of the client again and push them into a detailed design and prototyping phase to see how they would perform. If the prototypes did not give the desired results, I would go back to the client and inform him that we need to go back to the conceptual stage. Rinse and repeat this process till we get the results we want.

Then after getting the prototypes to give the desired results I would then implement the system into the real world at only a few segregated transport systems such as one individual ferry, a few train stations and a few busses. Then by gathering more data and doing more statistical analysis we can calculate if there is an improvement in the changes made to the SDS.

Features that could be added include:

- Sensors to detect what seats are free like in a carpark
- Carriage scanning to see if someone is coughing or sneezing
- Automatic carriage cleaners
- System to be implemented into the Metro
- Changing the type of transmission method between subsystems.
- Upgrading hardware components.
- Adding a memory component to the subsystems.

12 Myself as a Client

As the client for Thomas and his project on the social distancing systems that he designed for his elevator system I believe that I did a good job as the representative. During this experience I learnt many things about the details of client needs from a different point of view, rather then from the point of view of a Software Engineer.

One of the key things I learnt was that from a client's perspective when giving constraints to the project is that the constraints are very general and is probably like this in the real world as well. This is because as a client I had no real idea on how the system worked, so all the constraints I gave were generalised. This idea furthered into all the other communications that were discussed throughout the project.

Through the form of communication where the feedback and information given was vague to how the systems work but make sense in a real world situation, I do believe that I was a good client as the experience of working with vague instructions would help Tom out a lot in the future.

13 Log of Interactions

13.1 Interaction 1

Date: 18/8/2020, Time: 20:30, Duration: 2.5 hours

Topics Discussed:

- Read over Project A and Project B
- Document design choices
- Document creation
- Vision statements
- Key points:
    - I will be the Software Engineer for Project B
    - I will be the Client for Project A

13.2 Interaction 2

Date: 25/8/2020, Time: 20:30, Duration: 2.5 hours

Topics Discussed:

- The scope of Project A as a whole
- Spoke about purpose and scope of each project
- Requirements in the SRS are to be about the additional features, not the general use
- Key points:
    - Told Software Engineer for Project A that he must design a general case to be implemented on all transport methods, but with a detailed analysis of trains.

13.3 Interaction 3

Date: 1/9/2020, Time: 20:30, Duration: 2 hours

Topics Discussed:

- Discussed sections to be completed in the overview of the SRS document

- Key points:
    - Both projects must account for a wide variety of people, up to the engineer to split them into groups
    - Client's on both ends have specified constraints for the other software engineer to adhere to

13.4 Interaction 4

Date: 8/9/2020, Time: 20:30, Duration: 1 hour

Topics Discussed:

- Requirement sections on the SRS document
- How to split up the requirements we would do for our projects
- Key points:
    - Split requirements up in a way shown in class or in a lecture, whichever one the software engineer feels would best represent the project's requirements.

13.5 Interaction 5

Date: 11/9/2020, Time: 19:00, Duration: 1.5 hours

Topics Discussed:

- Covered potential use cases that each project would likely encounter
- Spoke about Sequence diagram and discussion on best way to do it
- Key points:
    - Decided on the most important use cases each software engineer would write about

13.6 Interaction 6

Date: 16/9/2020, Time: 18:30, Duration: 1 hour

Topics Discussed:

- Client representation and Client review
- Spoke about how we felt we performed in each role
- Key points:
    - We were both very helpful to each other as we had scheduled a weekly meeting to talk about this assignment