1. SOCIALLY DISTANCED SPACES SYSTEM – PART A

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2. VISION STATEMENT

The vision for this project is to provide a modern and advanced answer to the problem of social distancing on public transport in NSW. Every passenger and employee on public transport will feel safe and appropriately distanced while receiving vital and up-to-date information in real time through display systems put in place. We will do our part to ensure we stop the spread on public transport.

Socially Distanced Spaces System on NSW Public Transport

Software Requirement Specifications Document

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DOCUMENT CHANGE HISTORY

Version Number	Date	Contributor	Description
0.0	14/09/20	Calleum Pecqueux	Agreed with customer rep Hong (Ty) Lim

Background/Summary

Introduction

DOCUMENT OVERVIEW

Socially distancing is a neccessity in the current pandemic, and this is hard to manually enforce for employees of Transport NSW as bus drivers have been advised against enforcing it, and train guards could only attempt to enforce it over 8 carriages with upstairs and downstairs seating.
The client wants to ensure social distancing measures are effectively put in place through the automation and remote control of Opal card-readers and real-time displays to limit the number of passengers on each service and direct and inform passengers of available seating.
This document will describe the requirements of this system closely to the IEEE 830-1998 IEEE Recommended Practice for Software Requirements Specifications.

THE CLIENT

The client of the system has named Hong Lim as the person with ultimate responsibility for accepting the system which will be presented to Transport for NSW in a bid for implementation.

SCOPE

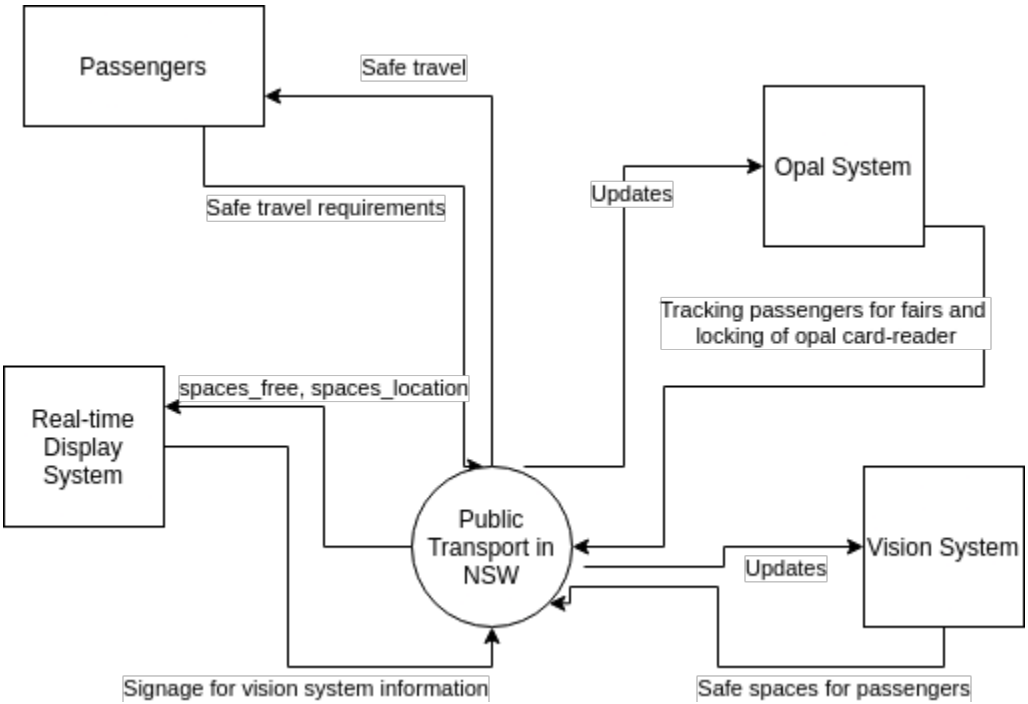


Figure 1: Context Diagram of Socially Distanced Spaces System

RELATED DOCUMENTS

https://www.opal.com.au/en/opal-fares/60_minute_transfer/
https://transportnsw.info/tickets-opal/opal/fares-payments
https://ilearn.mq.edu.au/pluginfile.php/6578930/mod_resource/content/2/caBIG_Software_Requirement_Specifications_Template.pdf *(template used for SRS)*

DEFINITIONS

Passenger – This is a paying user of the Transport for NSW System.
Opal, Opal Card – This is the system used for fares and electronic ticketting in NSW. The card uses a microchip that interacts with a card reader to access the public transport network and charge the necessary fees.
Card Reader - This comes in two types: A single-service access point such as those found on buses and a multi-service access point, such as those found at ferry terminals and train stations. These card-readers accept both Opal cards and credit cards as payment. Single-service access points prompt users to continue past with an affirmative confirmation on the card-reader screen and a positive beep. Multi-service access points provide a prompt with gates in addition to the method single-service access points uses.
Social Distancing – This is distancing each person 1.5m away from the next person, to reduce spread of sars-cov2.
Socially Distanced Spaces – These are predetermined areas found on any form of public transport that allow for social distancing to be maintained.

Overview

OVERALL DESCRIPTION – PRODUCT PERSPECTIVE

The Social distancing system will use technology to effectively and safely socially distance passengers of all Transport for NSW services while minimising human intervention and the chance for conflict. This will allow for transport systems to run smoothly and allow for employees to focus on tasks without the need for enforcing social distancing.
This system will use a machine learning trained vision system to accurately count number of passengers in an area and locate socially distanced spaces for new passengers. This information will be sent to a display system provided by the client to show the number of free spaces in each vehicle for users on the outside, and show the location of thes spaces to these users once they are inside the vehicle.

PRODUCT FUNCTIONS

FU-1 : Integration with Opal ticketting system
FU-2 : Log data about system characteristics to improve system
FU-3 : Manage number of passengers on any single vehicle at one time
FU-4 : Display number of free socially distanced spaces on a vehicle
FU-5 : Display location of free socially distanced spaces on a vehicle
FU-6 : Remotely lock opal access points when maximum number of passengers is reached
FU-7 : Manage display and vision system manually

USER CHARACTERISTICS

Passenger	The passenger is the main user of the system, they must be catered to in convenience, timeliness and safety.
Employee (Also Driver)	The employees and drivers of tfNSW will be the operators of the Social Distancing system where processed cannot be automated or if an error occurs. These employees will monitor and responded to any errors in the system as required.

CONSTRAINTS

CO-1:	System shall extend the Opal ticketing system.
CO-2:	System must store anonymous usage data.
CO-3:	System must use the clients remote locking and display products.
CO-4:	Interfaces must be self explanatory.

ASSUMPTIONS AND DEPENDENCIES

AS-1:	System shall only be implemented during the duration of the pandemic.
AS-2:	System shall interface freely between Opal system, Opal database and client display system.
DE-1:	Opal system
DE-2:	Client remote locking and display system.

Social Distancing System Requirements

FUNCTIONAL REQUIREMENTS

R1: The system shall ensure that the predetermined number of passengers is not exceeded.
Purpose: To ensure public safety and limit spread of coronavirus.
Fit Criteria: The number reported by the vision system must be equal to the sum of passengers registered as active within the opal system, to an accuracy of 90%, accounting for fare evasion.

R2: The system shall allow users to make a trip.
Purpose: To ensure there is public transport for all users.
Fit Criteria: User has the opportunity to travel on a non-full public transport service within the operating hours of that service at all times, without a waiting time of more than twice as long as before the system is implemented.

R3: The system shall display locations socially distanced areas on publlic transport.
Purpose: To give users information to keep safe and reduce the spread of coronavirus.
Fit Criteria: Accurate information is given in 1000 test cases before the product is shipped.

R4: The system shall display the number of available spaces in vehicle on outside of vehicle.
Purpose: To give users information about the availability of spaces left in any one vehicle.
Fit Criteria: The display system displays accurate information in 1000 test cases before the product is shipped.

R5: The employee shall be able to manually overide the information provided by the system.
Purpose: To give the system flexibility in the situation that an untested edge case arises, or an error occurs in the system.
Fit Criteria: The employee can access a system interface which updates the display, and logs the intervention to the vision system in real-time.

NON-FUNCTIONAL REQUIREMENTS

R6: The System shall extend the current Opal ticketing system.
Purpose: To ensure public transport quality is not decreased.
Fit Criteria: Regression testing has 100% coverage and passes.
R7: The System shall access the Opal database to verify vision system data.
Purpose: To ensure calibration is accurate.
Fit Criteria: Opal system data and Social distancing system data are equivalent 95% of the time in randomised real-time testing on the production system.
R8: The System shall only store anonymised usage data and store this with sha256 encryption.
Purpose: Personal data, especially in applied AI systems is of upmost importance and must remain secure.
Fit Criteria: System follows engineering best practices regarding security of personal information.

R9: The System shall use the client display system.
Purpose: To reduce costs and leverage the expertise of the client in the project.
Fit Criteria: Display system is used and regression testing passes with 100% coverage.

R10: The System shall update the display system in real-time across all linked vehicles.
Purpose: A linked system gives the user the most useful information.
Fit Criteria: All display system components must update in real-time.

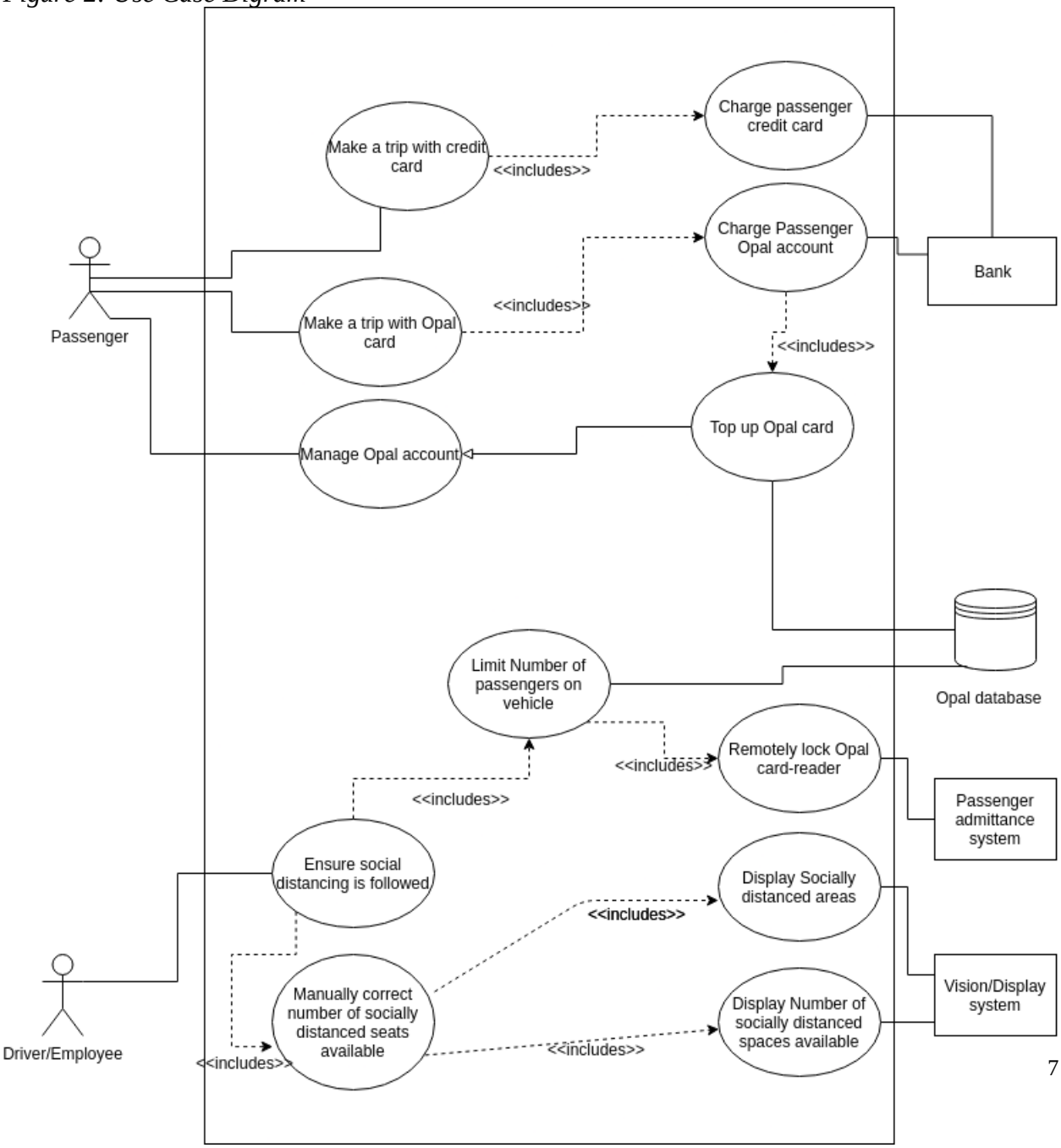
R11: The display system shall display different colours for different states of availability.
Purpose: To increase the ease of use for the passenger.
Fit Criteria: The displays show green for available, red for engaged and blue for (ease of access) disability specific spaces.

R12: The passenger shall not need training to use the system.
Purpose: Training passengers is costly, time consuming and inconvenient.
Fit Criteria: A test group of 30 first-time users, representative of the clientele of tfNSW will understand the product intuitively upon first sight, and follow the directions of the display system with 80% accuracy.

R13: The System shall extend the current Opal ticketing system.
Purpose: To ensure public transport quality is not decreased.
Fit Criteria: Regression testing has 100% coverage and passes.

4. USE CASE DIAGRAM

Figure 2: Use Case Digram



5. USE CASE DESCRIPTIONS

Use Case	Limit Passenger Admittance on bus – specific vehicle	
Goal <a longer statement of the goal in context if needed>	Track and limit automatically the amount of passengers that will be allowed onto public transport using the Opal system.	
Preconditions <what we expect is already the state of the world>	User (passenger) has Opal card or credit card with funds. Opal system is operational.	
Success End Condition <the state of the world upon successful completion>	Number of passengers travelling in one area does not exceed set maximum – Opal tap-on facilities are remotely locked.	
Failed End Condition <the state of the world if goal abandoned>	Number of passengers travelling in one area does exceed set maximum.	
Primary Actors; **Secondary Actors**	**User** **Driver**	
Trigger <the action upon the system that starts use case>	The vehicle begins service for the day – driver turns on vehicle.	
Description / Main Success Scenario <the steps of the scenario from trigger to goal delivery and any clean up after. Indicate substeps using numbering>	**Step**	**Action**
	1	Driver powers on vehicle.
	2	System boots and calibrates with number of passengers set to zero
	3	Driver begins route.
	4	Passenger taps opal card upon entering vehicle.
	5	System registers tap, charges card, intiates passenger travel manifest for trip.
	6	System increments passenger admittance counter.
	7	Opal tap-on facilities are locked once maximum passengers number is reached.
	8	Steps 4 – 6 repeat for each unique passenger.
	9	Passenger taps Opal card ending trip, exits vehicle.
	10	System registers tap and updates passenger travel manifest for trip.
	11	System decrements passenger admittance counter.
	12	Steps 8-10 repeat for each unique passenger.
Alternative Flows <a: condition causing branching>	**Step**	**Branching Action**
	1.1.a	Vehicle does not start.
	1.1.b	System code returned to driver, driver restarts bus.

<a1: action or name of sub use case>	**2.1.a**	System does not calibrate correctly.
	2.1.b	System returns error code.
	5.1.a	System unable to connect to network
	5.1.b	Driver resets system.
	6.1.a	System unable to connect to network.
	6.1.b	Driver will manually count number of passengers in vehicle.

Use Case	Direct passenger to available socially distanced space.	
Goal <a longer statement of the goal in context if needed>	Automatically configured signs on public transport inform passengers of free and suitable socially distanced space to use for their trip.	
Preconditions <what we expect is already the state of the world>	Passenger is entering vehicle. Opal card system is functional and will be successful.	
Success End Condition <the state of the world upon successful completion>	Vison system monitors free spaces and configures signage, which displays number of free spaces on outside of vehicle and directs passengers to said spaces once inside the vehicle.	
Failed End Condition <the state of the world if goal abandoned>	Displays do not show number and/or location of socially distanced spaces available.	
Primary Actors; **Secondary Actors**	**User, vision system/display system** **Driver**	
Trigger <the action upon the system that starts use case>	Vehicle route is initiated by driver. This triggers the vision system.	
Description / Main Success Scenario <the steps of the scenario from trigger to goal delivery and any clean up after. Indicate substeps using numbering>	**Step**	**Action**
	1	System boots and calibrates upon route initiation.
	2	Vision system determines and sends number of empty spaces and location to display system.
	3	Display system receives number and location of empty seats and sends this to inner and outer displays.
	4	Outer display receives and shows total free number of socially distanced spaces.
	5	Inner system receives and displays number and location of socially distanced seating.
	6	Upon being taken by passenger, locating display state is switched from free to engaged and the counter of available spaces is decremented and updated.

	7	System updates numbers of inner and outer available spaces.
	8	Updated numbers are pushed to inner and outer displays.
Alternative Flows <a: condition causing branching> <a1: action or name of sub use case>	**Step**	**Branching Action**
	1.1.a	System does not calibrate correctly.
	1.1.a.1	Problem with camera connection to vision system – check connection.
	1.1.a.2	Problem with connection between vision system and diplays – check this connection.
	1.1.b	Driver will follow a.1 and a.2 then restart the system calibration.
	2.1.a	Vision system on startup can poll opal system manifest to check whether any transactions have occurred, and use this to verify the intial number of available socially distanced spaces.
	3.1.a	Drive notices a display locating a space is labelled as engaged when it is free.
	3.1.b	Driver can access the admin interface of the vehicle and manually adjust the label to free.
	3.1.c	The system will log this driver intervention and use it in improving the system.

Use Case	Charge bus fee from passenger.	
Goal <a longer statement of the goal in context if needed>	The passenger pays the bus fee using an opal card or credit card. The system charges based on number of trips and checks for transferds between services.	
Preconditions <what we expect is already the state of the world>	Opal system is implemented in Buses, Trainstations, Ferries. Opal system is powered and operational.	
Success End Condition <the state of the world upon successful completion>	The passenger is charged the correct fee for the distance travelled, and a list of trips with parameters of time, location, distance travelled and price is collected and used to apply discounts to some trips.	
Failed End Condition <the state of the world if goal abandoned>	Passenger is not charged, data is not collected or passenger is charged an incorrect fee.	
Primary Actors; **Secondary Actors**	**User (Passenger), Opal system.** **Driver**	
Trigger <the action upon the system that starts use case>	The action is triggered by a passenger tapping either a credit card or Opal card against an Opal card-reader.	
	Step	**Action**

Description / Main Success Scenario <the steps of the scenario from trigger to goal delivery and any clean up after. Indicate substeps using numbering>	**1**	Passenger approaches opal card-reader and taps opal card.
	2	System checks database for card type, available funds and previous trips.
	3	System returns available funds on card-reader screen if funds are above the threshold amount after charging the initial fee.
	4	System logs trip start time, location, and price paid.
	5	Passenger is directed to enter past opal reader and begins the trip.
	6	Passenger ends trip by approaching exit card-reader and tapping Opal card.
	7	System updates trip distance, time travelled, queries for any previous trips and finds a price based on these parameters.
	8	System charges opal card, updates data log for the unique card.
	9	Passenger is directed to exit past the opal card reader.
Alternative Flows <a: condition causing branching> <a1: action or name of sub use case>	**Step**	**Branching Action**
	1.1.b	If the passenger uses a credit card and not an opal card, the same process occurs but does not return any available balance.
	2.1.a	System does not connect with database.
	2.1.b	Problem network connection, system provides an error.
	2.1.c	Worker can manually reset card-reader and direct passenger to another working card-readrer.
	3.1.a	System query shows that available funds are below the threshold limit and prompts the passenger to top up opal card.
	3.1.b	Opal top up facilities are located nearby to train and ferry stations, and an app is provided in addition to this and for the case of buses where no physical facilities are available.
	6.1.a	If the available balance on the passengers card is below $5, upon tapping, a low balance alert will be displayed for the passenger, on the card-reader display.
	8.1.a	Passenger is charged based on the data logged against the unique card ID in the Opal system, where trips within an hour of eachother are counted as “Transfer” trips, and other concessions are provided based on the number of trips made in a day, in a week, and the type of card being used – these can be concession, pensioner, student, adult.

6. SEQUENCE DIAGRAM

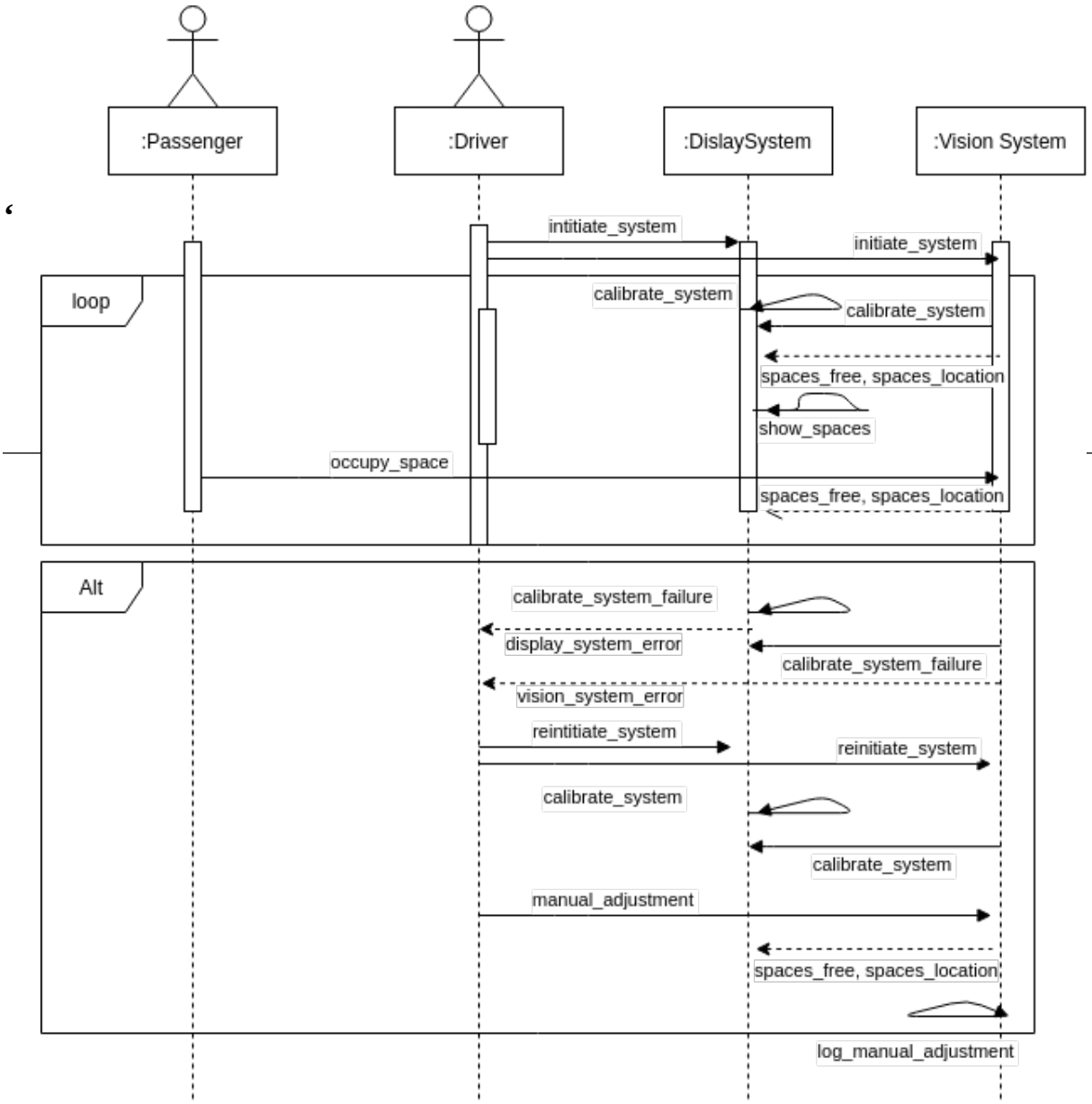


Figure 3: Interaction Diagram, Socially Distanced Space Locator

7.PRIORITISATION

The use cases chosen were some of the obvious examples that stuck out. Charging the opal card is a key part of the integration with the opal system, and using this to verify the result from the vision system and ensure the remote locking is availble meant that it was a prerequisite use case for the overall system. The main uses of the system are to provide safe, socially distanced spaces for passengers and to automate the enforcement of social distancing, and the next two use cases are the basis for that; identify and display these spaces with the vision system, and remotely lock the opal acess points once these spaces are filled.

8. REQUIREMENTS ELICITATION

The process of requirements elicitation in this project was challenging but fulfilling. We all use public transport, and we all have vested interests in maintaining our health during the pandemic we are currently experiencing. Ensuring social distancing is a joint effort in all fronts and so I found that emulating the Joint Application Design elicitation technique along with a pyramid structure of interview questions for the “passenger” interviewees which I conducted with my family to reach a list of requirements that Ty, the client representative, and I were happy with.

During the JAD process, Ty assumed the roles of IS analyst, Executive sposonsor and user, and I assumed the roles of session leader, user and engineer. This expedited the elicitation process through assuming different viewpoints with our limited resources, in order to quickly and concisely produce the most beneficial and conclusive functional and non-functional requirements. The drawbacks of using this method were that with the lack of all physical attendees, some detail could have been missed in acting from a perspective other than our own, but the benefits to my project outweighed the drawbacks, so I chose to continue with using this method.

Interviews were also used to further elicit the requirements of users of the system, and for this I used my family, all regular users of the tfNSW public transport system, and require this to get to work and study commitments. The process of interviewing users of the system was approached with a pyramid method, where I introduced questions beginning with closed-ended questions, gradually becoming more open and conversational as the interview progressed. This helped to structure the interview in a more formal format, while still allowing the flexibility for each individuals’ opinions to be heard and considered.

Once these interviews were conducted, I began to analyse what I had gathered and explore the possible systems, and the integration with the existing systems and requirements set forth in our project brief. I put forth a formulation of requirements that I had extracted from the elicitation process to Ty, and we made some minute changes at that point and agreed that I would workshop these requirements and develop a Software Requirements Specification (SRS).

9. CLIENT REPRESENTATIVE

The client representative sent by the client, Ty Lim, was a great communicator to work with. Ty was positive on the outcomes of the project and was resposive to the different requirements elicitation techniques that we used over the life of the requirements specification phase.

Overall, I found the client representative to be useful in the process of this project. The best things which Ty did was taking on many viewpoints during the Joint Application Design phase, and he helped to speed up the reporting process by checking in at multiple points during the process before the deadline.

The least helpful aspects were to do with organisation of a client representative. The client representative intially assigned to the project was inactive and unresponsive, so quite close to the deadline I connected with Ty and we secured a line of communication to establish the requirements successfully.

10. FURTHER PROJECT DEVELOPMENT

If I was to further develop the project, I would follow the structure of this plan:

1. Expand the elicitation aprocedure to include questionairres with larger groups of users.

    By expanding the elicitation procedure, I increase the need for analysis of the elicited information, and would require a team of engineers and analysts to expedite the process, as the speed of implementation of this system is paramount, given its usefulness in the pandemic. These quesetionairres could be outsourced to market research groups through connections which tfNSW has, to further align the responses with the expected format that is easily describable to the client and tfNSW.

2. Consult with industry leaders in computer vision.

    The use of machine learning and computer vision in this system leverages the high-availability network that is currently being used for the Opal system. I would use this network and employ machine learning engineers to implement and optimise the ideal open source algorithm used for object detection. The consultation with industry leaders ensures that best practices are followed and any requirements that can be accepted into the system will be considered.

3. Expand the scope of the project to include an api which can be used in existing applications to provide users with information from the vision system if implemented by developers.

    The portability of application based information in the public transport sector is of high importance, and expanding the scope to include an api that is available to developers

means that tfNSW supported and independent trip planning apps can use and account for the dynamic system being used in the social distancing system, resulting in the most convenient, reliable and time sensitive experience for the user/passenger.

4. I would rapidly develop using agile methodology and test frequently to further refine the requirements specifications and iteratively improve edge case coverage.

> Developing with the agile methodology allows the project the iteratively solve the additional requirements that are elicited through points 1 and 2 in this plan. The nature of the methodology means that the system will be improved alongside a working production version of the system, providing the most value for the client and users while ensuring the dafe, social distancing measures are always kept in place successfully.

5. Once the project is endorsed by transport for NSW, I would liase with project managers and tech leads to ensure that my project follows the engineering style set out by those teams.

> This opens the project to true integration with the tfNSW systems. Using cues of the architecture in use by tfNSW allows for familiarity within the company. This means that any conflicting updates to the tfNSW code base can more easily be identified within either the social distancing system or opal/tfNSW systems and a fix can be made.

11. MYSELF AS A CLIENT REPRESENTATIVE

I believe that I played a reasonable job in being the client representative, although not the level that I would if it were a job. The job of client representative was most interesting in the requirements elicitation precedure, where having impact on my partners project was a fun and creative informative process. I think that I communicated well, athough my speed of reply is not as high as it should be. This could cause some issues in a real-world situation where many different teams may be competing for a single bid, and if that was the case, I think that I would feel more motivated to respond faster.

The actions of keeping a log were a pitfall for me, as I did not remember a few of these times.

I am proud of reaching out to Ty when I thought it was appropriate to check up as if it was a real engineering situation.

12. INTERACTION LOG

Date, Time	Duration	Topic	Outcome
27/08/20, 4pm	5 minutes	Exchanging contact details	
30/08/20, 10:42pm	10 minutes	Picking project	I am completing Part A.
1/09/20, 12pm	20 minutes	Project Ideas	I will use JAD elicitation next week

2/09/20, 1:10pm	30 minutes	Project B requiremens	Decided on requirements for project B.
7/09/20, 2pm	1 hour	Joint Application Design	Decided on all main requirements for my project.
10/09/20, 4:20pm	30 minutes	Project B details	Scoping and requirements decided for project B.
12/09/20, 6pm	20 minutes	Project A details	Ty helped to refine requirements and check up on my project
14/09/20, 7pm	30 minutes	Project B	Validate requirements and test products for project B.
15/09/20, 8pm	25 minutes	Project A details	Ty checked in to ensure I was on track with my project
16/09/20, various	40 minutes	Check in	During this day we checked in to answer any questions eachother had and agreed on assumptions made in eachothers project.
17/09/20, 9am, 12pm, 3pm, 4:30pm	1 hour total	Various	We are ensuring that each of us has the details that are needed in the report.