Vision document

Revision History

Name	Date	Reason For changes	Version
Arun Woosaree	Oct. 1 '18	Edit Sections 3.1, 4.2, 4.4, 5, 1.3, 4.1	1.0
Liyao	Oct. 3 '18	Edit Sections 1.2, 3.2, 4.1, 4.3.2&3	1.1
Max		Edit Sections 2.2, 2.3	1.2
Arun Woosaree	Oct 3, '18	Edit Sections 1, 2.1	1.3
Arun Woosaree	Oct 15, '18	Add/edit use cases (Section 6)	1.4
Max	Oct 15, '18	Edit use cases	1.5
Liyao	Oct 15, '18	Edt use cases	1.6
Arun Woosaree	Oct 15 '18	Edit Sections 7,8,9	1.7
Max		Edit Sections 7,8,9	1.8
Liyao		Edit Sections 7,8,9	1.8

1   Introduction

1.1   Purpose of the vision document

This document outlines HireMe Software Ltd.'s vision for the implementation of a new traffic control system at a busy intersection, for customer Alberta Traffic Supply Ltd. This document is intended to be used for communication with the project's stakeholders, and the members of the team that will implement and verify the functionality of the system. Unless specified otherwise, all requirements specified here are high priority and committed for release 4.

1.2 Product overview

The software will be used to control the traffic lights system at the intersection. The software controls the sequence of the traffic going through the intersection and provides signals for vehicles and pedestrians to cross the intersection safely. The system implements a sensor to detect the traffic on road 2, and the traffic light for road 2 only shows green when there is traffic waiting. As a result, the main road traffic will have more time to go through the intersection.

1.3 References

Cost of project: https://wsdot.wa.gov/Operations/Traffic/signals.htm

2 Business requirements

2.1 Background, Business opportunity, Customer needs

The intersection is currently quite busy and unsafe for travelers. The system should help with optimizing the flow of traffic through the intersection so that travelers get to their destination safely. Priority should be given to vehicles on Road 1, since that is the road with the most volume of vehicles passing through the intersection. Road 3 is also a main road, and Road 2 should be given the least priority. With the implementation of a traffic light control system, the intersection should become much safer overall, and help decrease congestion in the area.

2.2 Business objectives and success criteria

- BO-1: Implement a fully functional traffic light control system at the target intersection.
- BO-2: Implement a "night mode" which controls the intersection during specified night hours.
- BO-3: Implement an "emergency mode" which controls the intersection in case malfunctions occur in the control system.
- BO-4: A pedestrian light that turns green only when a button is pressed and is safe to do so.
- BO-5: Make sure the control system complies with local traffic laws.

- SC-1: Make sure the traffic flows well following initial release.
- SC-2: Decreased injuries after the system has been implemented.

2.3 Business risks

- RI-1: The implementation of a traffic light control system might increase traffic flow through said intersection, causing unexpected congestion (Prob=0.5, Impact= 4)
- RI-2: The timing of the lights may not be synced with lights from close-by intersections, causing frustration in drivers (Prob=0.8, Impact=6)
- RI-3: Drivers ignoring traffic laws and cross red lights (Prob=0.000371, Impact=9)
- RI-4: Pedestrians ignoring pedestrian lights(Prob=0.1, Impact=9)

2.4 Assumptions and dependencies

- AS-1: People will use the intersection
- AS-2: The roads are properly marked
- AS-3: The necessary road signs are already in place
- AS-4: Most users will obey traffic laws
- AS-5: The hardware is functioning correctly

- DE-1: The system must fit within the constraints of the hardware.

3 Scope and limitations

3.1 Scope of initial and subsequent releases

Feature	Release 1	Release 2	Release 3	Release 4
FE-1	Implement	-Demo with customer -Test with simulation	✓	✓
FE-2		Implement	-Demo with customer -Test with simulation	✓
FE-3		Implement	-Demo with customer -Test with simulation	✓

FE-4		Implement	-Demo with customer -Test with simulation	✓
FE-5			Implement	-Demo with customer -Test with simulation
FE-6			Implement	-Demo with customer -Test with simulation
FE-7				Implement
FE-8				Implement

3.2 Limitations and exclusions

- LI-1: the system will be running on an embedded system with a 550KB hard drive and 50KB RAM

- LI-2: design must comply with the Alberta Traffic Safety Act

4 Business context

4.1 Stakeholder profiles

Stakeholder	Major Value	Attitudes Major	Interests	Constraints
Manager	Time and cost efficient coordination of project	Commitment to project management	On-time product delivery within available budget	None identified
Maintainers	Maintain the system so it	Commitment to keep maintain	Easy access to the system;	Access to the system that the

	runs properly	the system runs as expected and safely	maintainable, well-documented system design	software runs on
Road workers	Fieldwork safety; Controllable traffic	Concern about the confusion the traffic light might give to the road users during a road construction or closure	Their own safety when working near the intersection; Ease of providing guidance to the traffic when road closed.	Road workers might not have the access to close the intersection and the system.
Traffic Enforcer/ Police	Enforce traffic law and rules, expeditious flow of vehicular	Responsible for maintaining the order of the intersection	Safety and order of the traffic	None identified
Software Engineers	Make a smart solution; safe design; maintainable and testable software	Strong commitment to software system development and release.	Reliable hardware interfaces of the devices; available test or simulation environment	the software will be running on an embedded system with a 550KB hard drive and 50KB RAM; design must comply with the Alberta Traffic Safety Act
Drivers	Time savings; intuitive signal; safety when driving through	Happy about the increase of efficiency and safety	Easy and safe to follow the signal; minimum waiting time	Inform about the new signal system is needed
Pedestrians	Time savings; Accessibility of button; safety when walking through	Not happy about the effort needed to wait for the light to change and/or press a button, but recognizes the enhanced safety	Minimum waiting time; enough time to cross; easy to reach buttons	Inform about the new signal system is needed

4.2 Project priorities

Dimension	Driver	Constraint	Degree of Freedom
Schedule		Release 4 scheduled for Jan. 1 2019	At most 2 weeks late.
Features		All features scheduled for release 3 must be fully operational	Features in release 4 won't be needed right away
Quality		The system should work continuously with little to no downtime	
Staff	Projected team size is one half-time project manager, 3 developers, and one full-time tester.		Additional staff if necessary
Security		Members of the public should not have the ability to tamper with the system	
Cost		$428 000 CAD	Budget overrun up to 20% acceptable without sponsor review

4.3 Product overview

The system is designed to direct the traffic lights system at the intersection. The software controls traffic lights in each direction in a predefined priority sequence. The software allows the traffic on main roads to go through the intersection first to reduce congestion of the main roads. The software signals the pedestrians to go across when safe after they pressed the button. The road 2 traffic light only goes green when the sensor detects cars and motorcycles on road 2 which will minimize the green light time of road 2 to give more time to the main road traffic.

4.3.2 Summary of capabilities

- The software is designed to follow the Alberta Traffic Safety Act and control traffic lights system at the intersection.
- During the day, the system will prioritize on the traffic flow in the order of road 1, road 3, road 2.
- The system allows the pedestrians to press a button when they want to go across the intersection and gives them signals when it is safe to go.
- The system shows red light in road 2 unless there is a car or motorcycle waiting on the sensor.
- In case of any hardware malfunction, the system switches to emergency mode.
- The system enters night mode between 8:00 PM and 6:00 AM.

4.3.3 Cost and pricing

Prices in Canadian Dollars (CAD)
- Salary of 3 Software Engineers over 3 months - $120,000
- Maintenance - $8,000
- Materials cost - $100,000
- Construction - $200,000
- Total: $428,000

4.4 Feature attributes

Feature	Attributes
FE-1	The default mode is the main feature of the system. It should operate in the daytime. The system will be operating mostly in this mode. Therefore, it's priority is high, and will require significant effort to implement. Accidents would occur if this were to fail, which makes the risk for this high.
FE-2	The system should switch to emergency mode briefly when starting up, and in case of a hardware malfunction. This functionality is required and comes with high risk because it serves as a backup if hardware fails. Since most of the system is implemented in version 1, this would require medium effort
FE-3	The system must be able to be reset with a button. This should not be difficult to implement and poses little risk.
FE-4	The system should switch to night mode at night. Since this is similar to emergency mode, this should not require much effort to implement, but it carries the same risks
FE-5	The user should be able to press a button to request to cross road 3. This will require medium effort and has high risk since pedestrians are more prone to injury than drivers
FE-6	The sensor on road 2 should be able to detect if a vehicle is waiting for a light change and change the light when appropriate. This requires medium effort to implement, and medium risk
FE-7	Timings for the traffic signals should be modifiable in the future. This functionality is important, but not required right away. This will require medium effort to implement, and low risk
FE-8	A nice-to-have is to have data available for a traffic engineer to analyze. This carries low risk, since it should not affect the functionality of the system but will require some extra effort, given the system's limited resources.

5 Product features

Feature	Status	Propriety	Effort	Risk	Target ver.
FE-1 Default mode	Approved	Critical	High	High	1

FE-2 Emergency mode	Approved	Critical	Medium	High	2
FE-3: Reset mechanism to reset the system from emergency mode to default mode	Approved	Important	Low	Low	3
FE-4: Night mode: System should switch states at night	Approved	Critical	Low	Low	4
FE-5: Pedestrian can press a button to cross road 3	Approved	Critical	Medium	High	5
FE-6 Sensor on road 2 should detect when a vehicle is waiting for the light to change.	Approved	Critical	Medium	Medium	6
FE-7 Timings should be modifiable in the future	Proposed	Important	Low	Low	7
FE-8 Traffic data logging	Proposed	Useful	Medium-High	Low	8

6   Key use cases   💬

Use cases:
- UC-1 Return to Default Mode
- UC-2 Make G1 Green
- UC-3 Make Light 3 Green
- UC-4 Make P3 Green
- UC-5 Make Lights 2 and 3 Green
- UC-6 Activate Emergency Mode
- UC-7 Activate Night Mode

Primary Actor	Use cases
Pedestrian	UC-1, UC-2, UC-4, UC-5
Vehicle	UC-1, UC-2, UC-3, UC-4, UC-5, UC-6, UC-7
Maintenance Worker	UC-6
Malfunction input	UC-6
Timer t1	UC-1, UC-2, UC-4
Timer t2	UC-1, UC-2, UC-3, UC-4, UC-5

Use case ID: UC-1	**Use case name: Return to Default Mode**
Description/Story: **Story:** System signals the traffic on road 1 and pedestrians on P2 to go **Includes:** ○ UC-3 Make Light 3 Green ○ UC-5 Make Lights 2 and 3 Green **Frequency of Use:** Every 60 to 90 seconds. **Special Requirements:** None. **Assumption:** None.	

Notes/Issues: None.	

Pre-condition:
System in Green 3 mode and t2 has ended
System in Green 2&3 mode and t2 has ended
On system startup, after the brief emergency state

Post-condition:
Go to State Green P3 if t1 ends and B3 is pressed before switching state
Go to State Green G1 if t1 ends and no button was pressed

Actor(s): ● Drivers ● Pedestrians	**Package: N/A**
Status: In Progress	**Priority:** High
Created by: Zhijie Shen	**Created Date: Oct 15th**

Normal flow:
1. Green 3 state
2. t2 counts down
3. Return to default mode

Alternative flow:
1. Green 2&3 state
2. t2 counts down
3. Return to default mode

Exceptions:
Hardware malfunctions -> Emergency Mode

Business Requirements:
BO-1

Use case ID: UC-2	**Use case name: Make G1 Green**

Description/Story:
Story:
During day time, system signals traffic waiting at G1 to go by making G1 green.

At the same time, System signals pedestrians waiting at P1 to go by making P1 green. Everything else should turn red. The system stays in mode G1 Green until timer T2 finishes.

Includes:

UC-1 Return to Default Mode

UC-4 Make P3 Green

Frequency of Use:

Every couple minutes

Special Requirements:

None.

Assumption:

- All devices (traffic lights, magnetic sensor and pedestrian button) and malfunction input function correctly in all weather conditions.
- Current time is during the day (6:00-22:00)

Notes/Issues:

None.

Pre-condition:

System in Default Mode, and timer T1 finishes

or System in P3 Green Mode, and timer T2 finishes

Post-condition:

G1 and P1 turns green, everything else turns red

Timer T2 starts.

Actor(s):

- Pedestrian
- Vehicle
- Malfunction input
- Timer T2

Status: In Progress	**Priority:** High
Created by: Liyao Jiang	**Created Date:** Oct 15, 2018

Normal flow:

1. Green P3 state
2. t2 counts down
3. Make G1 Green (Green G1 state)

Alternative flow:

1. Default state
2. Vehicle is detected on S2 and t1 counts down
3. Make G1 Green (Green G1 state)

Exceptions:

Hardware malfunctions -> Emergency Mode

Business Requirements:

Satisfies BO-1, BO-4, BO-5

Use case ID: UC-3	**Use case name: Make Light 3 Green**

Description/Story:

Story:

During daytime, the system signals the drivers waiting on road 3 to go. When this happens, G3 also switches green, while all other lights are red. The system remains in this state until timer t2 finishes.

Includes:

UC-2 Make G1 Green

Frequency of Use:

Very frequent (Every couple of minutes, depends on t1 and t2)

Assumption:

Current time is during the day (6:00-21:59)

Pre-condition:

System was in Green G1 state (i.e. G1 was green) and timer t2 finished

Post-condition:

Lights 3, G3 are green, everything else red
Timer t2 starts

Actor(s):
- Vehicles
- t2

Status: In Progress	**Priority:** High
Created by: Arun Woosaree	**Created Date: Oct 15, 2018**

Normal flow:
1. Green G1 state

2. t2 counts down
3. Make light 3 green (Green 3 state)

Alternative flow:
    N/A

Exceptions:
    Exception 1.0.E.1
    Hardware malfunction -> Activate Emergency Mode

Business Requirements:
    Component of BO-1

Use case ID: UC-4	**Use case name: Make P3 Green**

Description/Story:

    Story:
    When a pedestrian wants to cross road 3, a button B3 must be pressed. The pedestrian is then allowed to cross if pedestrian light P3 is green
    Includes:
    UC-1 Return to default state
    Frequency of Use:
    Frequently, every couple of minutes (depends on timers t1 and t2)
    Assumption:
    Current time is during the day (6:00-21:59)

Pre-condition:
    System in default state, a pedestrian pressed B3, and timer t1 has counted down

Post-condition:
    Lights 1, P2, P3 are green, rest are red
    Timer t2 starts

Actor(s):
- Vehicles
- Pedestrians
- t2

Status: In Progress	**Priority:** High

Created by: Arun Woosaree	Created Date: Oct 15 2018

Normal flow:
1. Default state
2. B3 pushed by pedestrian, and t1 counts down
3. Make P3 Green (Green P3 state)

Alternative flow:
    N/A

Exceptions:
    Exception 1.0.E.1
    Hardware malfunction -> Activate Emergency Mode

Business Requirements:
    BO-1, BO4

Use case ID: UC-5	Use case name: Make Lights 2 and 3 Green

Description/Story:
    Story:
    When a vehicle is present at road 2, the system is expected to detect that and be able to turn light 2 green when it is safe to do so.
    Includes:
    UC-3 Make Light 3 Green
    Frequency of Use:
    Low frequency
    Special Requirements:
    None
    Assumption:
    S2 is functioning correctly
    Notes/Issues:
    None

Pre-condition:
    S2 detected vehicle and in State Green 3

Post-condition:
    Default state

Actor(s): Drivers	**Package:**
Status: In Progress	**Priority:** Medium
Created by: Zhijie Shen	**Created Date: Oct 15**

Normal flow:
1. Green 3 state (with vehicle detected on S2)
2. Vehicle detected on S2 and t2 counts down
3. Make lights 2 and 3 green (Green 2&3 state)

Alternative flow:
    N/A

Exceptions:
    Exception 1.0.E.1
    Hardware malfunction -> Activate Emergency Mode

Business Requirements:
    N/A

Use case ID: UC-6	**Use case name: Activate Emergency Mode**

Description/Story:
    Story:
    Simple description of the use case
    Includes:
    UC-1 Return to Default state
    Frequency of Use:
    Rarely, only in case of emergencies
    Assumption:
    None

Pre-condition:
    Malfunction input received

Post-condition:
    Return to default state if hardware is fixed by maintenance worker

Actor(s):

• Vehicles • Pedestrians • Maintenance Worker	
Status: In Progress	**Priority:** High
Created by: Arun Woosaree	**Created Date: Oct 15, 2018**
Normal flow: 1. Hardware malfunction (Malfunction signal received) 2. Activate Emergency Mode (Maintenance worker will fix later)	
Alternative flow: 1. System starts up after hardware malfunction is fixed 2. Emergency mode is briefly activated before returning to default state	
Exceptions: N/A	
Business Requirements: BO-1, BO-3	

Use case ID: UC-7	**Use case name: Activate Night Mode**
Description/Story: **Story:** The system enters night mode without the external intervention between 8pm am and 6 am every day. **Includes:** None. **Frequency of Use:** Everyday **Special Requirements:** None. **Assumption:** All devices (traffic lights, magnetic sensor and pedestrian button) and malfunction input function correctly in all weather conditions. **Notes/Issues:** Noen.	

Pre-condition:
Time is at 8:pm am

Post-condition:
Time is after 6:00 am

Actor(s):
● Vehicles ● Pedestrians ● Maintenance Worker

Status: In Progress	**Priority:** High/Medium/Low
Created by: Liyao Jiang	**Created Date:** Oct 20, 2018

Normal flow:
1. Clock changes from Day (6:00-21:59) to Night (22:00-5:59) 2. Activate Night Mode

Alternative flow:
N/A

Exceptions:
Exception 1.0.E.1 Hardware malfunction -> Activate Emergency Mode

Business Requirements:
● BO-2

7 Other product requirements

7.1 Applicable standards

- Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED) Circular Signal Supplement, section 4.2 Chromaticity
- Pedestrian Traffic Control Signal Indications - Part 2: Light Emitting Diode (LED) Pedestrian Traffic Signal Modules
- Federal, provincial and local traffic laws

7.2 System requirements

The software will run on an embedded system with 50KB RAM and 550KB hard drive

7.3 Licensing and installation

Follows the end-user license agreement (EULA)
Software should be installed on embedded system only by authorized users

7.4 Performance requirements

The software shall run on an embedded system with 50KB RAM and a 550KB hard drive
Lag is unacceptable as it can result in collisions.

8 Documentation requirements

System state and state machine should outline clearly the state transitions of the system
Documentation for hardware maintainer to repair the system

8.1   User manual

Should have operation guide for starting the system, restarting after hardware malfunction is fixed, and the user manual should include a common system malfunction code message specification and how to resolve each type of malfunctions.

8.2   Installation guides, configuration and read me files

Should have step-by-step software installation guide, and any dependencies required for the program. Should provide a test procedure and expected results for testing after the configuration and before putting into use.

8.3   Labeling and packaging

System requirements and description should be on the packaging.
Software should ideally ship as an easy to install package

9   Glossary

P1 - Pedestrian light on road 1
P2 - Pedestrian light on road 2
P3 - Pedestrian light on road 3
t1 - Timer for road 1
t2 - Secondary timer for everything else
G1 - Left turn signal on road 1
G3 - Left turn signal on road 3
S2 - Magnetic sensor which detects if a car/motorcycle is waiting on road 2
B3 - Button on road 3 which a pedestrian can hit to request to cross the intersection