

**Version History**

VERSION	AUTHOR(S)	CHANGE DESCRIPTION	DATE	NOTES
1.0	Dhaval Sharma Himal Patel		28/01/2020	
1.1	Dhaval Sharma Himal Patel	Added new functionalities and updated UI specification	02/02/2020	Functional requirements updated

## **Table of Content**

Software Requirements Specification (SRS) .....	1
1 Introduction .....	4
1.1 System Overview .....	4
1.2 Operating Environment .....	4
1.3 Conceptual Model .....	5
2 Functional Requirements .....	6
2.1 Product Services .....	6
2.2 User Interface Specifications .....	11
2.3 External Interfaces and Database Requirements .....	12
2.4 Error Handling .....	12
2.5 Foreseeable Functional Changes and Enhancements .....	12
3 Non-Functional Requirements .....	13
3.1 Performance Requirements .....	13
3.2 User Documentation .....	14
3.3 Development Requirements .....	14
3.4 Foreseeable Non-Functional Changes .....	14
4 Remarks and Guidelines for Later Lifecycle Phases .....	15
5 Glossary and Index .....	16

# 1 Introduction

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## 1.1 System Overview

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The system will be a simulation software for the electrification of STM Route 211 in which we can configure the requirements that are necessary to implement the technology to see and make changes on the route. This system will give the suggested results according to inputs given for the configuration of the buses and route with charging schedules.

## 1.2 Operating Environment

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### Software Requirements

Client Side:

Window 7 and any Compatible OS

Internet Explorer or any Compatible Browser

### Hardware Requirements

Client Side:

Processor: 1.7GHz

RAM: 2GB

Hard Disk: 2.5GB free space

### 1.3 Conceptual Model

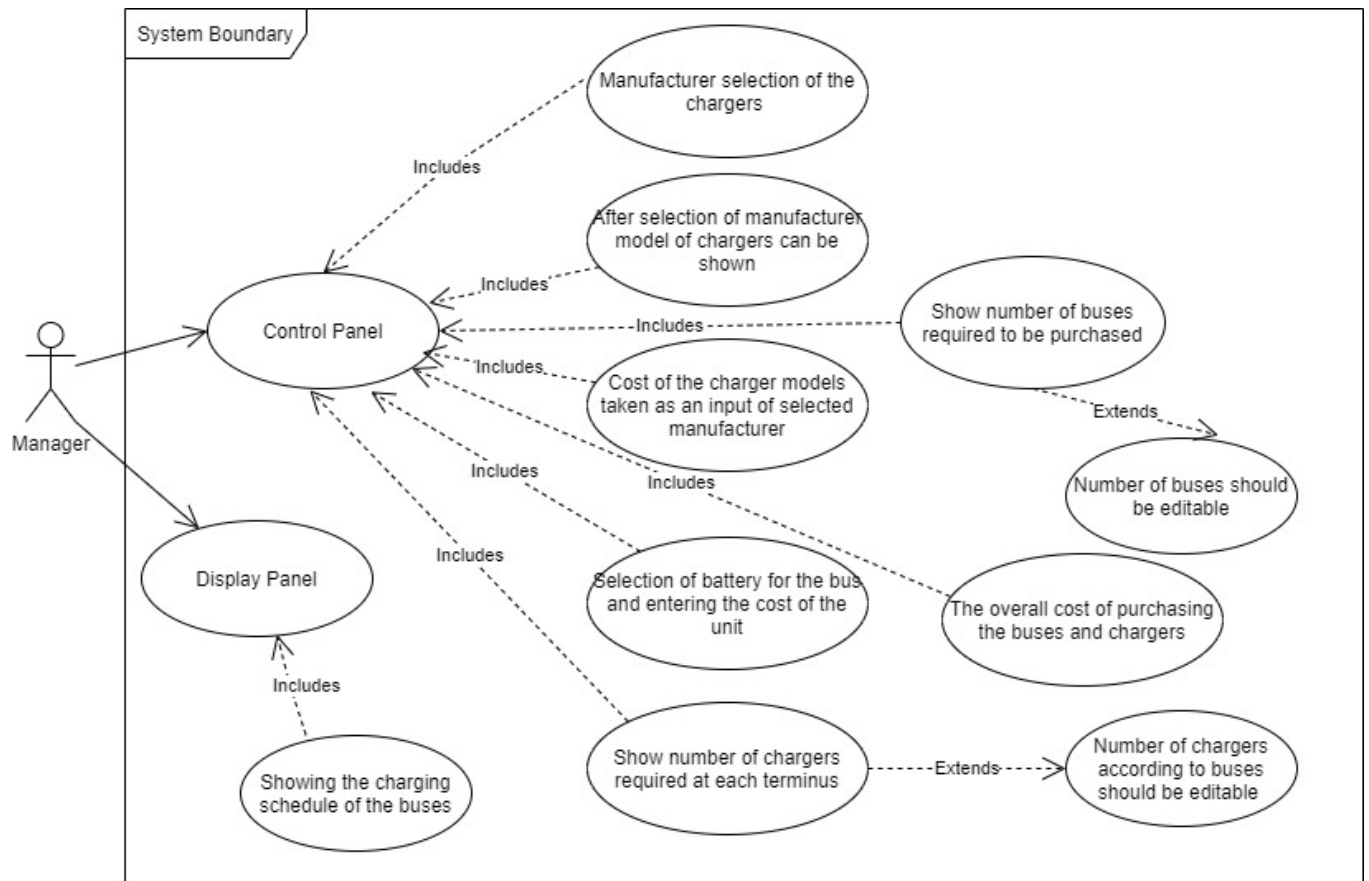


Figure 1 Use - Case of Transit Electrification system

## 2 Functional Requirements

This system provides the information on buses, location of chargers at each terminus, optimal battery size according to charger specification, and prices through selecting the optimal charging models from the manufacturing company. In addition, this system also shows the charging schedule of the buses and can be seen on the webpage.

The functional requirements are as follows:

FR 1. Input Module

FR 1.1. Selection of manufacturers.

FR 1.2. Selection of charging models according to manufacturers.

FR 1.3. Cost input by the user for charger models.

FR 1.4. Selection of battery for the bus.

FR 1.5. User input the unit cost of the bus with selected battery option.

FR 2. Output Module

FR 2.1. View / update the number of chargers required on each terminus.

FR 2.2. View / update the number of buses to be purchased.

FR 2.3. View / update overall expenditure.

FR 3. Display Module

FR 3.1. View the charging schedule of the buses.

### 2.1 Product Services

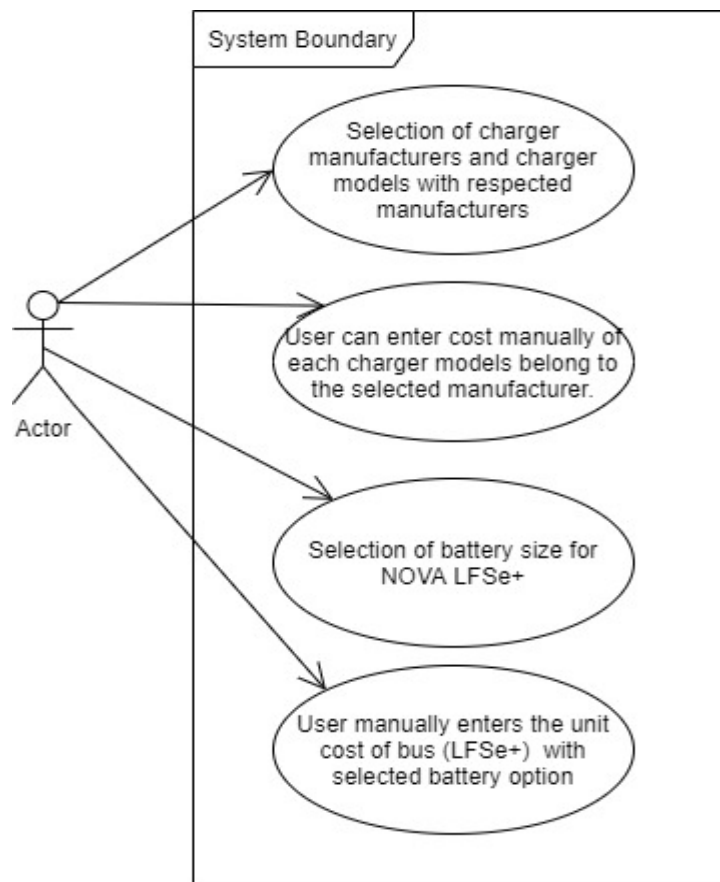


Figure 2 Input Module Use - Case Diagram

- Manufacturer selection: - The option will be enabled by dropdown list to select the manufacturer of charging models.
- Selection of charging model and bus model: - It will be selected by the user according to charger specifications provided by manufacturing company and the bus models.
- Price estimation: - The overall cost to implement the chargers and buses should be entered by the user.
- Battery selection: - Selection of the battery for the bus and entering the cost per unit required.

Identifier/Name	U-1 Manufacturer Selection
Actor	Manager
Goal	The manager selects the manufacturer
Preconditions	The user must run the application
Description	The option will be enabled by dropdown list to select the manufacturer of charging models.
Normal Flow	<ol style="list-style-type: none"> <li>1. Click on radio button</li> <li>2. Enter the cost of each charger</li> <li>3. Select battery configuration with cost</li> <li>4. Submit</li> </ol>
Post – Condition	The system runs the algorithm and gives pre-configured plan.

**Table 1 Use Case 1 Manufacturer Selection**

Identifier/Name	U-2 Selection of charging model
Actor	Manager
Goal	The manager enters each charger cost
Preconditions	The user must select the manufacturer
Description	It will be selected by the user according to charger specifications provided by manufacturing company and the bus models.
Normal Flow	<ol style="list-style-type: none"> <li>1. Click on text field</li> <li>2. Enter the cost of each charger</li> <li>3. Select battery configuration with cost</li> <li>4. Submit</li> </ol>
Post – Condition	The system runs the algorithm and gives pre-configured plan.

**Table 2 Use Case 2 Selection of Charging Model**

Identifier/Name	U-3 Battery selection
Actor	Manager
Goal	The manager selects the bus and battery configuration
Preconditions	The user must run the application
Description	Selection of the battery for the bus and entering the cost per unit required.
Normal Flow	<ol style="list-style-type: none"> <li>1. Click on drop – down menu</li> <li>2. Enter the cost of each charger and bus</li> <li>3. Submit</li> </ol>
Post – Condition	The system runs the algorithm and gives pre-configured plan.

**Table 3 Use Case 3 Battery Selection**

Identifier/Name	U-4 Unit cost of buses
Actor	Manager
Goal	The manager enters the cost of bus with selected battery configuration
Preconditions	The user must run the application
Description	The cost to implement the and buses should be entered by the user.
Normal Flow	<ol style="list-style-type: none"> <li>1. Click on text field</li> <li>2. Enter the cost of the bus</li> <li>3. Submit</li> </ol>
Post – Condition	The system runs the algorithm and gives pre-configured plan.

**Table 4 Use Case 4 Unit Cost of Buses**

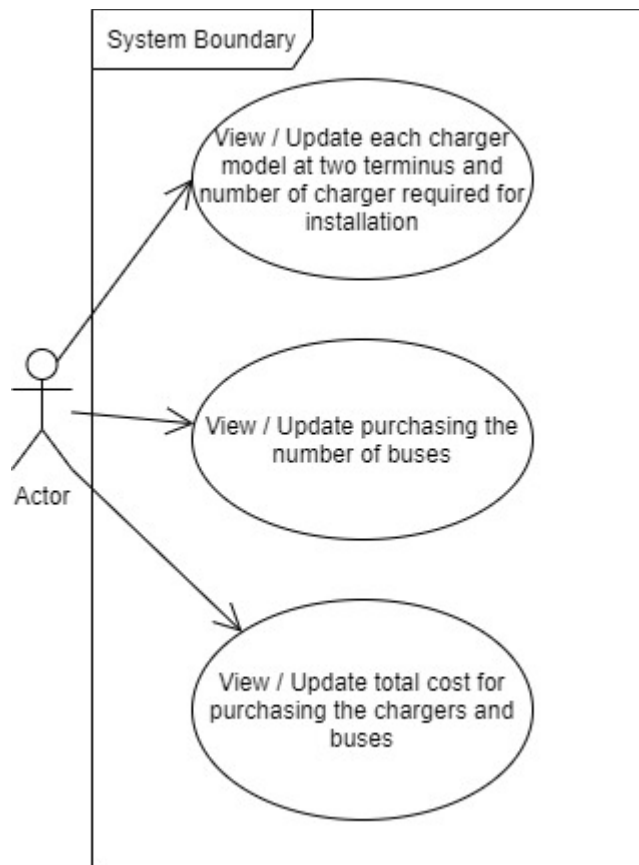


Figure 3 Output Module Use - Case Diagram

Identifier/Name	U-5 Update number of chargers
Actor	Manager
Goal	The manager manually updates the number of chargers at each terminus
Preconditions	The user must submit the inputs
Description	This will allow the user to edit the number of chargers required at each terminus according to number of buses
Normal Flow	<ol style="list-style-type: none"> <li>1. Click on update fields button</li> <li>2. Enter the value of charger</li> <li>3. Click show schedule</li> </ol>
Post – Condition	The system runs the update algorithm and gives revised pre-configured plan and schedule

Table 5 Use Case 5 Update Number of Chargers



Identifier/Name	U-6 Update number of buses
Actor	Manager
Goal	The manager manually enters the number of bus with selected battery configuration
Preconditions	The user must submit the inputs
Description	Number of buses that is required show be able to edit in pre – configured plan
Normal Flow	<ol style="list-style-type: none"> <li>1. Click on update fields button</li> <li>2. Enter the cost of the bus</li> <li>3. Click show Schedule</li> </ol>
Post – Condition	The system runs the update algorithm and gives revised pre-configured plan and schedule

**Table 6 Use Case 6 Update Number of Buses**

Identifier/Name	U-7 Updated overall expenditure
Actor	Manager
Goal	The manager views updated overall cost of buses and charger with selected battery configuration
Preconditions	The user must submit the inputs
Description	Overall expenditure will be re-calculated according to updated inputs.
Normal Flow	<ol style="list-style-type: none"> <li>1. Click on update fields</li> <li>2. View the updated overall cost</li> <li>3. Click show schedule</li> </ol>
Post – Condition	The system runs the update algorithm and gives revised pre-configured plan and schedule

**Table 7 Use Case 7 Updated Overall Expenditure**

- Charger requirement: - The field will show the number of chargers required at each terminus.
- Number of buses: - This field will show the number of buses required to be purchased according to the requirements.
- Editable field of buses: - Number of buses that is required show be able to edit in pre – configured plan.
- Required number of chargers: - This will allow the user to edit the number of chargers required at each terminus according to number of buses.
- Suggested Results: - Computed results will be shown and it can be edited by using the button which placed alongside the respective fields like number of buses, number of chargers including the locations, and battery size required in the buses.

- Display charging schedule: - The system will be showing the charging schedule according to the suggested results.

## 2.2 User Interface Specifications

The system consists of two GUI panels in which the various information will be displayed. In the control panel the user can be able to input the values and according to the inputs the suggested pre- configured plan will be displayed.

### 1. Control Panel

In the control panel the user can be able to enter the values and according to the inputs the suggested pre- configured plan will be displayed. In addition, the pre – configured plan can be updated by clicking update respective field button.

#### Transit Electrification Simulation Software

Fields marked with an \* are required

Select Manufacturer \*

HELIOX

Cost of OC 450kW \*

500

Cost of FAST DC 50kW \*

500

Battery Options for Buses \*

294kWh

Unit Cost of LFSe+ \*

1000

Show Pre - Configured Plan

Figure 4 User Input

#### Suggested Configuration Plan

Number of Chargers Required for Lionel - Groulx

10

Number of Chargers Required for MacDonald

5

Number of Buses To Be Purchased

10

The Overall Expenditure

10000

Update Fields

Show Charging Schedule

Figure 5 Pre - configured Plan

## 2. Display Panel

This panel will show the charging schedule of the bus on the route 211 which includes information on charging time and usage of the battery during the trip between two terminus on Tuesday.

CHARGING SCHEDULE										
Bus		Before Trip Charging						Trip Assigned		
Bus ID	Battery Size	Trip Completed	AT-SOC(KM)	Charger ID	Start Time	End Time	BT-SOC(KM)	Trip ID	Start Time	End Time
BE - 01	250kWh	XY	AB	CD	EF	GH	IJ	LM	NO	PQ

**Figure 6 Display Schedule**

## 2.3 External Interfaces and Database Requirements

It is designed to run in any well-known Operating System, including Windows, Linux and Mac OS with respected internet browser. Database will be used as a storage of inputs given by the user.

## 2.4 Error Handling

The system handles the errors and exceptions like null values, wrong input or datatype input, and empty field. The dialog box will indicate the errors where the users gave the wrong input given by the user. Error handling is crucial part of any software system and producing incorrect results is unacceptable.

## 2.5 Foreseeable Functional Changes and Enhancements

In this system we can implement an animation of different buses according to the charging schedule which will be a useful feature in the future. So, in the future we accommodate more users and more STM bus routes in the system for dedicated environment. In addition, we can provide this as a web service that user can access from anywhere.

### 3 Non-Functional Requirements

Other than functional requirements the software quality attributes should be taken into consideration like performance, design, and adaption of the software system. This category describes the usability and other features of the system which can be fulfilled to satisfy the customer.

The non – functional requirements are as follows: -

#### NFR 1. Performance Requirements

NFR 1.1. Efficiency

NFR 1.2. Integrity

NFR 1.3. Reliability

NFR 1.4. Usability

#### NFR 2. Design Requirements

NFR 2.1. Correctness

NFR 2.2. Maintainability

NFR 2.3. Verifiability

#### NFR 3. Adaption Requirements

NFR 3.1. Expandability

NFR 3.2. Flexibility

NFR 3.3. Interoperability

NFR 3.4. Portability

NFR 3.5. Reusability

#### 3.1 Performance Requirements

- Efficiency: The website should load faster while using the minimum resources.
- Reliability: The system should be reliable and produce the correct results according to the given inputs.
- Robustness: It can work under stressful computations and gives optimal results without the errors. So, if one occurs the system should be able to handle the error.
- Portability: The program should run under different operating system environment without changing much of the code. It can be accessible from anywhere.
- Serviceability: System should be serviceable including adding new feature updates and solving the errors from previous version.
- Usability: User should be able to navigate easily on the system and extract the information needed without any complexity.
- Integrity: The system ensures generated data is real and prevent information from unauthorized alteration.

### **3.2 User Documentation**

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- How to use features of the system
- Example of inputs and outputs
- Minimum requirements of hardware and software to run the software
- If errors occur, then description of that exception and how to resolve the problem will be given
- Support information for the software

### **3.3 Development Requirements**

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The system should show the pre-configured plan on control panel after taking the inputs which are model of buses and chargers. Using virtual server, the creation of the website on the localhost with dynamic inputs and outputs. The front – end of the website will be interactive that user can view and navigate the results easily.

### **3.4 Foreseeable Non-Functional Changes**

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In this system we can implement a more interactive GUI panels which is easy to use and user - friendly. The new look of system will completely change the perspective of the user to interact with the system and extract useful information.

## 4 Remarks and Guidelines for Later Lifecycle Phases

There will be some errors or bugs which can be found in the initial version of the simulation software during testing. These errors should be solved in the nearest future before delivering the final product to the customer and giving feature upgrades. The customer can make the changes in the requirement during any phase of the software development life cycle (SDLC). So, the system should be adaptable to accommodate that requirements in the future. The planning phase should take care of the overall cost of the project and required to be completed in time.

## 5 Glossary and Index

STM - Société de transport de Montréal. The city transport of Montreal which consists of metros and buses.

Route 211 – The buses runs between Terminus Lionel-Groulx station and Terminus MacDonald is on Route 211.

GUI – Graphical User interface (GUI) is an interface through which the user interacts visually.