
Software Requirements Specification

for

SURTS

System for Uniform Route-based Transportation Simulation

Version 1.0 approved

Prepared by Group A41

CSCI 5801

10.22.2020

Table of Contents

1 Introduction	1
1.1 Purpose	1
1.2 Document Conventions	1
1.3 Intended Audience and Reading Suggestions	1
1.4 Product Scope	1
1.5 References	1
2 Overall Description	2
2.1 Product Perspective	2
2.2 Product Functions	2
2.3 User Classes and Characteristics	2
2.4 Operating Environment	2
2.5 Design and Implementation Constraints	2
2.6 User Documentation	2
2.7 Assumptions and Dependencies	2
3 External Interface Requirements	3
3.1 User Interfaces	3
3.2 Hardware Interfaces	3
3.3 Software Interfaces	3
3.4 Communications Interfaces	3
4 Use Cases	3
4.1 Simulate Buses and Routes	3
4.2 Produce Logs and Generate Reports	4
4.3 Configure Simulation Parameters	4
4.4 Run/End Simulation	5
5 User Requirements	6
5.1 Simulate Buses and Passengers	6
5.2.1 Simulate Buses	6
5.2.2 Simulate Passengers	6
5.2.3 Generate Buses	7
5.2.4 Create and Configure Buses	7
5.2.5 Delete Buses	8
5.2.6 Generate Passengers	9
5.2.7 Create Passengers	9
5.2.8 Passenger Historical Data	9
5.2.9 Create Passenger Pattern	10

5.2.10	Class Schedules	11
5.2.11	Inclement Weather	11
5.2.12	Delete Passenger Pattern	12
5.3	Generate Routes	13
5.3.1	Create and Configure Routes	13
5.3.2	Delete Routes	14
5.4	Generate Logs	14
5.4.1	Create Log	14
5.4.2	Store Log(TBD)	15
5.4.3	Inspect Log(TBD)	16
5.4.4	Delete Log	16
5.5	Generate Reports	17
5.5.1	Generate Report from Log	17
5.5.2	Store Report(TBD)	18
5.5.3	Send Report(TBD)	19
5.5.4	Delete Report	19
5.6	External Systems	20
5.6.1	TBD	20
5.7	Graphical User Interface	20
5.7.1	TBD	20
Other Nonfunctional Requirements		20
Performance Requirements		20
Safety Requirements		20
Security Requirements		20
Software Quality Attributes		21
Business Rules		21
Appendix		21

Revision History

Name	Date	Reason For Changes	Version
Austin Wessel	10.07.20	Original Req Specification	1.0
Wessel, et al	10.22.20	Update and Aggregate Requirements	1.1

1. Introduction

1.1 Purpose

Develop a system that will simulate a uniform route-based transportation system. Because transportation systems handle many diverse populations in motion, developing transit routes that meet the needs of the users while keeping costs low is a challenge. This simulation will be used as a testing environment to determine optimal routes, fleet usage, and profitability.

1.2 Document Conventions

Pay close attention to items that are **bolded** as they are significant. It is also to be noted that priorities for higher-level requirements are assumed to be inherited by detailed requirements.

1.3 Intended Audience and Reading Suggestions

This document is intended for developers, project managers, marketing staff, users, testers, documentation writers, and all other stakeholders in the development of this system. The rest of this document contains all the information required to build the system to the standard agreed upon by all parties. It is best to read through each section sequentially. If there is a specific section that needs to be reviewed, please find it in the table of contents.

1.4 Product Scope

The software specified in this document is to be used by transportation system staff, urban planners, statisticians, economists, and system administrators to develop a more optimal transportation system. By controlling different attributes of the simulation like traffic conditions and bus capacity, the users can test different scenarios and make decisions about the actual transit system based on that information. This system hopes to serve the transportation system in providing better insights to their staff who will then make changes to better serve their customers.

1.5 References

IEEE Recommended Practice for Software Requirements Specifications," in *IEEE Std 830-1998*, vol., no., pp.1-40, 20 Oct. 1998, doi: 10.1109/IEEESTD.1998.88286. (1)
Parking and Transportation Services and Office of Measurement Services at University of Minnesota. (2015). Campus Traveler Mode Share and Origin Destination Study 2014 Report. Retrieved from the University of Minnesota Digital Conservancy, <http://hdl.handle.net/11299/171518>. (2)
[Elicitation Session with Joseph Dahep.](#)

2. Overall Description

2.1 Product Perspective

The product defined in this SRS document is the first system in a family of systems to be developed for transportation companies. This will be a self-contained product, but future iterations will use the successes and failures of this specific system in the retrospect.

2.2 Product Functions

- Simulate buses transporting passengers from an origin to a destination
- Generate buses at a user-defined interval
- Generate passengers needing transportation in a configurable matter
- Configure routes for the buses under simulation
- Produce logs detailing a variable amount of information about the simulation run
- Allow users to inspect logs
- Interface with external systems by providing an externally accessible data service
- Retain logging information for a set period of time
- Provide an interface for the modification of system attributes
- Produce reports summarizing simulation results

2.3 User Classes and Characteristics

<Identify the various user classes that you anticipate will use this product. User classes may be differentiated based on frequency of use, subset of product functions used, technical expertise, security or privilege levels, educational level, or experience. Describe the pertinent characteristics of each user class. Certain requirements may pertain only to certain user classes. Distinguish the most important user classes for this product from those who are less important to satisfy.>

2.4 Operating Environment

TBD

2.5 Design and Implementation Constraints

TBD

2.6 User Documentation

TBD

2.7 Assumptions and Dependencies

TBD

3. External Interface Requirements

3.1 User Interfaces

TBD

3.2 Hardware Interfaces

TBD

3.3 Software Interfaces

TBD

3.4 Communications Interfaces

TBD

4. Use Cases

4.1 Simulate Buses and Routes

Iteration: TBD

Summary: The user configures a route and simulates buses transporting passengers from an origin to a destination.

Basic Course of Events:

1. User selects a pre-configured route.
2. User starts the simulation.
3. Simulation generates buses and passengers in a default matter

Alternative Paths: In step 1, the user may choose to configure a custom route. The system will still generate buses and passengers based on the default setting.

Exception Paths: None

Extension Points: None

Trigger: User wants to begin the simulation.

Assumptions: User is familiar with how to operate the system and wants to simulate buses.

Precondition: None.

Postcondition: The simulation is running, and the user can now continue to observe, configure, and generate reports.

Author: Austin Wessel

Date: 10.22.2020

4.2 Produce Logs and Generate Reports

Iteration: TBD

Summary: A log is created upon termination of each simulation that a user can either inspect or generate a report from.

Basic Course of Events:

1. Upon termination of a simulation, the system produces a log.
2. Users can choose to view the entire log or specific attributes of the log.
3. Log is stored in a memory source TBD.
4. Users can choose to generate a report from a log and obtain the information in a more portable form.

Alternative Paths: None

Exception Paths: None

Extension Points: None

Trigger: User runs a simulation for the purpose of collecting data on that configuration.

Assumptions: User is familiar with how to operate the system. System has enough available storage to store the created log.

Precondition: None.

Postcondition: The log has been produced and can be referenced in the future for additional inspection or reporting.

Author: Austin Wessel

Date: 10.22.2020

4.3 Configure Simulation Parameters

Iteration: TBD

Summary: The user will configure the attributes of the buses, bus routes, bus types, and passengers.

Basic Course of Events: The user will interact with the interface to modify the bus routes data, bus stops, number of buses, amounts of passengers, bus capacity, number of buses over-capacity, which buses are overcapacity, and where they are overcapacity.

Alternative Paths: None

Exception Paths: Show an error message (TBD implementation) if one of the inputs is outside of the constraints for the input (TBD constraint values)

Extension Points: None

Trigger: User will use TBD UI to trigger configuration

Assumptions: User is familiar with how to operate the system.

Precondition: None.

Postcondition: The system parameters have been configured and are ready to use.

Author: Connor Boehm

Date: 10.22.2020

4.4 Run/End Simulation

Iteration: TBD

Summary: Running and ending the simulation successfully: the user will run the simulation and eventually be able to stop it.

Basic Course of Events: The user will use the UI (TBD) to start the simulation. They then let it run for an amount of time, then end the simulation if they want.

Alternative Paths: None

Exception Paths: The Simulation fails

Extension Points: None

Trigger: User hits start on the UI (TBD implementation)

Assumptions: User is familiar with the system and if the system cannot be run if it is already running.

Precondition: The system is configured correctly.

Postcondition: The log and report are generated, the simulation is no longer running, and the UI is reset in a way that the user is able to restart the simulation when ready.

Author: Connor Boehm

Date: 10.22.2020

5. User Requirements

5.1 Simulate Buses and Passengers

5.1.1 Simulate Buses

REQ: 1 **Requirement Title:** Simulate Buses **Use Case: 1**

Date: 10.22.2020

Introduction: Generate buses at a user defined interval and of the type specified by the user.

Rationale: Users need to add buses to a simulation to transport passengers.

Inputs: Type of bus, time interval, route, bus generation point(default to bus depot)

Requirement Description: Select a bus from those previously defined and add it to the selected route in the current simulation. Additionally, may set an interval to automatically add buses.

Outputs: The selected bus is added to the simulation at the generation point and travels the selected route.

Persistent Changes: TBD

User Satisfaction: TBD

User Dissatisfaction: TBD

Related Requirements: 2,3

Conflicts:

Support Material: None

Test Cases: TBD

5.1.2 Simulate Passengers

REQ: 2 **Requirement Title:** Simulate Passengers **Use Case: 1**

Date: 10.22.2020

Introduction: Simulate passengers at a user defined level with attributes specified by the user.

Rationale: Passengers are required for a transportation simulation to have meaning. These passengers must be able to be moved in the system in accordance with buses.

Inputs: Origin, Destination, Time of arrival.

Requirement Description: The simulated Buses must be able to pick up generated passengers from their bus stop origin, and transport them to their destination.

Outputs: Passenger information in the form of a log.

Persistent Changes: TBD

User Satisfaction: TBD

User Dissatisfaction: TBD

Related Requirements: 1, 7

Conflicts:

Support Material: None

Test Cases: TBD

5.2 Generate Buses

5.2.1 Create and Configure Buses

REQ: 3 **Requirement Title:** Create Buses **Use Case: 1**

Date: 10.22.2020

Introduction: Allow the user to create different types of buses. These buses can then be saved to use in future simulation runs.

Rationale: This feature will allow users to add buses matching the specifications of those currently in their fleet. It will also allow them to experiment with different model buses they could purchase in the future.

Inputs: Maximum capacity, Length, Fuel consumption

Requirement Description: Create buses with user defined attributes and save them.

Outputs: The newly created bus added to the simulation's bus repository.

Persistent Changes: TBD

User Satisfaction: TBD

User Dissatisfaction: TBD

Related Requirements: 1, 4

Conflicts: Needs to be validated via error checking (Validate Bus Configuration).

Support Material: None

Test Cases: TBD

5.2.2 Delete Buses

REQ: 4

Requirement Title: Delete Buses

Use Case: 1

Date: 10.22.2020

Introduction: Allow the user to delete buses from the simulation's bus repository.

Rationale: This feature will allow users to remove buses from the simulation's scope. Deleted buses will not be available for use in future simulations.

Inputs: Indication to delete bus through user Input

Requirement Description: Delete buses from the simulation's bus repository.

Outputs: Success or Failure.

Persistent Changes: TBD

User Satisfaction: TBD

User Dissatisfaction: TBD

Related Requirements: 3

Conflicts: None

Support Material: None

Test Cases: TBD

5.3 Generate Passengers

5.3.1 Create Passengers

REQ: 5 **Requirement Title:** Generate Passengers **Use Case: 1**

Date: 10.22.2020

Introduction: For this system to simulate passengers, said passengers must be generated. This is done by the system.

Rationale: Generating passengers is the first step in simulating passengers, which is a prime functionality of this system.

Inputs: Passenger origin bus stop, passenger destination bus stop, time of arrival at initial origin.

Requirement Description: The system creates a passenger based on given inputs and adds it to the system's passenger repository.

Outputs: The created Passenger.

Persistent Changes: TBD

User Satisfaction: TBD

User Dissatisfaction: TBD

Related Requirements: 1

Conflicts:

Support Material: None

Test Cases: TBD

5.3.2 Passenger Historical Data

REQ: 6 **Requirement Title:** Upload Historical Passenger Data **Use Case: 1**

Date: 10.22.2020

Introduction: Allow the user to enter data collected by the transportation system employees in the past. This includes information regarding how many passengers are at each stop, the final destination of most passengers, which hours have the most passengers, etc.

Rationale: The transportation system employees are already knowledgeable in this area. This would allow them to create a basis of a passenger pattern for the simulation to build upon.

Inputs: Passenger count per hour for each day of the week, correlation between temperature and passenger counts, start point popularity, destination popularity

Requirement Description: Utilize data collected by transportation system employees prior to simulation implementation. This data will be used as a basis to build the simulation on.

Outputs: None

Persistent Changes: TBD

User Satisfaction: TBD

User Dissatisfaction: TBD

Related Requirements: 3

Conflicts: None

Support Material: None

Test Cases: TBD

5.3.3 Create Passenger Pattern

REQ: 7 **Requirement Title:** Create and Save Passenger Pattern **Use**
Case: 1

Date: 10.22.2020

Introduction: To have an accurate representation of the frequency of passenger arrival at bus stops, a system to define this frequency must be in place.

Rationale: Passenger arrival frequency will be different at each stop based on outstanding circumstances. For the simulation to represent these differing frequencies, the pattern will be in place.

Inputs: Passenger arrival frequencies per bus stop based on time of day.

Requirement Description: Passenger generation in the system will be tied to a passenger pattern. This pattern defines the rate of passenger generation at each bus stop for any time of day during operating hours. The system must be capable of creating these passenger patterns based on the above input and saving these patterns for later simulation.

Outputs: The created passenger pattern

Persistent Changes: TBD

User Satisfaction: TBD

User Dissatisfaction: TBD

Related Requirements: 3

Conflicts: None

Support Material: None

Test Cases: TBD

5.3.3.1 Class Schedules

REQ: 8 Requirement Title: Import Class Schedules to Passenger Pattern **Use Case:** 1

Date: 10.22.2020

Introduction: Ridership is heavily influenced by the times that classes begin and are let out. This requirement will allow the user to import class schedules, enrollment numbers, and infer how it would affect passenger counts.

Rationale: Class schedules make a great impact on passenger counts at specific times.

Inputs: Class schedule, class enrollment numbers, general bus ridership rates

Requirement Description: This will allow the transportation system to accurately account for spikes and valleys in passenger traffic depending on changes in class schedules.

Outputs: None

Persistent Changes: TBD

User Satisfaction: TBD

User Dissatisfaction: TBD

Related Requirements: 3

Conflicts: None

Support Material: None

Test Cases: TBD

5.3.3.2 Inclement Weather

REQ: 9 **Requirement Title:** Import Weather Data to Passenger Pattern **Use Case: 1**

Date: 10.22.2020

Introduction: Weather conditions can greatly affect ridership rates. This requirement will allow the transportation system employees to effectively adjust and correct for changes in weather conditions.

Rationale: Passenger counts increase dramatically when the weather is poor and decrease during favorable weather conditions. This is one of the most important variables the transportation system needs to account for and simulate.

Inputs: Current weather forecast, historical impact of weather on ridership.

Requirement Description: Controlling and adapting the simulation based on user specified weather conditions.

Outputs: None

Persistent Changes: TBD

User Satisfaction: TBD

User Dissatisfaction: TBD

Related Requirements: 3

Conflicts: None

Support Material: None

Test Cases: TBD

5.3.4 Delete Passenger Pattern

REQ: 10 **Requirement Title:** Delete Passenger Pattern **Use Case: 1**

Date: 10.22.2020

Introduction: Passenger patterns define the frequency of passenger generation. The system must be capable of removing these patterns from the system.

Rationale: Depending on the longevity and implementation of SURTS, the saved passenger patterns may either become absolute or not warrant the space they are occupying. The system then needs to free memory or organization space by deleting these patterns.

Inputs: Passenger pattern to be deleted

Requirement Description: Any given passenger pattern must be capable of being removed from the system.

Outputs: Success or Failure

Persistent Changes: TBD

User Satisfaction: TBD

User Dissatisfaction: TBD

Related Requirements: 3

Conflicts: None

Support Material: None

Test Cases: TBD

5.3 Generate Routes

5.3.1 Create and Configure Routes

REQ: 11

Requirement Title: Create/Configure Route

Use Case: 1

Date: 10.22.2020

Introduction: The user creates or configures a route and to allow the system to simulate buses transporting passengers from an origin to a destination.

Rationale: For the system to accurately simulate a bus traversing the UMN campus, it must have a defined route to take. The system must be able to save these user created/configured bus routes.

Inputs: Bus stops in order of traversal.

Requirement Description: The system must be able to create/configure a bus route based on user input. This route is composed of bus stops that exist within the system. This route is then saved within the system.

Outputs: None

Persistent Changes: TBD

User Satisfaction: TBD

User Dissatisfaction: TBD

Related Requirements: 3

Conflicts: None

Support Material: None

Test Cases: TBD

5.3.2 Delete Routes

REQ: 12

Requirement Title: Delete Route

Use

Case: 1

Date: 10.22.2020

Introduction: Routes are used by buses to accurately simulate a traversal throughout the UMN campus bus stops. These routes must have a method of deletion from the system.

Rationale: In the case where a system implementation has a long lifespan, routes may become obsolete and serve no purpose. To eliminate wasted memory and increase organization, these retired routes must be capable of deletion.

Inputs: Route to be deleted

Requirement Description: Any route in the system must be capable of deletion. This deletion takes an input from the user defining said route to be deleted. The system then removes this route from the system.

Outputs: Success or Failure

Persistent Changes: TBD

User Satisfaction: TBD

User Dissatisfaction: TBD

Related Requirements: 3

Conflicts: None

Support Material: None

Test Cases: TBD

5.4 Generate Logs

5.4.1 Create Log

REQ: 13 **Requirement Title:** Create Log **Use Case:** 4.1, 4.4

Date: 10.22.2020

Introduction: The system should create a file and store data collected during runtime.

Rationale: The log is to be created in order for it to be evaluated later.

Inputs: Bus routes data, bus stops, number of buses, location of buses, locations of passengers, amounts of passengers, bus capacity, number of buses over-capacity, which buses are overcapacity, and where they are overcapacity.

Requirement Description: Create the log using the data collected during the simulation and place it in a file (The output to the file is TBD.)

Outputs: File (TBD type) with collected log data

Persistent Changes: TBD

User Satisfaction: TBD

User Dissatisfaction: TBD

Related Requirements:

Conflicts: None

Support Material: None

Test Cases: TBD

5.4.2 Store Log (TBD)

REQ: 14 **Requirement Title:** Store Log **Use Case:** 4.1

Date: 10.22.2020

Introduction: Create a way for the system to save a log produced by the simulation.

Rationale: The user may want to reference the log after they exit the program, and this would provide them with the means to do that.

Inputs: Previous log, memory storage (TBD)

Requirement Description: Save a log to a memory location (TBD)

Outputs: Stored log in a memory location (TBD)

Persistent Changes: TBD

User Satisfaction: TBD

User Dissatisfaction: TBD

Related Requirements: 13

Conflicts: None

Support Material: None

Test Cases: TBD

5.4.3 Inspect Log(TBD)

REQ: 15

Requirement Title: Inspect Log

Use Case: 4.1

Date: 10.22.2020

Introduction: The program should provide a means to view the log.

Rationale: It will allow the user to be able to look at the log while still in the program, so allows for ease of access.

Inputs: Previously produced log

Requirement Description: The program will allow the user to view the logs (TBD implementation)

Outputs: Viewable log

Persistent Changes: TBD

User Satisfaction: TBD

User Dissatisfaction: TBD

Related Requirements: 13

Conflicts: None

Support Material: None

Test Cases: TBD

5.4.4 Delete Log

REQ: 16

Requirement Title: Delete Log

Use Case: 4.1

Date: 10.22.2020

Introduction: The system should allow for a way to delete a previously saved log.

Rationale: The user should be able to delete logs they no longer want to keep freeing up memory space.

Inputs: Previously saved log

Requirement Description: Allow for a means to delete the log from the memory device. (TBD which users have access to this function)

Outputs: Freed memory space from removing the log

Persistent Changes: TBD

User Satisfaction: TBD

User Dissatisfaction: TBD

Related Requirements: 13, 14

Conflicts: None

Support Material: None

Test Cases: TBD

5.5 Generate Reports

5.5.1 Generate Report from Log

REQ: 17

Requirement Title: Generate Report from Log

Use Case: 1

Date: 10.22.2020

Introduction: After the simulation has ended, generate a summary report using the log data.

Rationale: The user will need to view a larger report of multiple simulations that have been run and be able to see trends or changes in data over different simulations.

Inputs: None.

Requirement Description: The system shall generate a summary report of previous bus simulations from the generated logs.

Outputs: A report will be stored on the system. The type of file and who has access to the file is still TBD.

Persistent Changes: The method of storing the report is currently TBD.

User Satisfaction: TBD

User Dissatisfaction: TBD

Related Requirements: 1

Dependency: A simulation must have run and completed on the system.

Conflicts: None

Support Material: None

Test Cases: TBD

5.5.2 Store Report(TBD)

REQ: 18

Requirement Title: Save Report

Use Case: 1

Date: 10.22.2020

Introduction: Allow a user to save a report upon generation.

Rationale: Users need to be able to store reports for later reference.

Inputs: Selected report, save destination

Requirement Description: Save reports for future inspection.

Outputs: A report of a specific file type (TBD) stored at a user specified location.

Persistent Changes: TBD

User Satisfaction: TBD

User Dissatisfaction: TBD

Related Requirements: 1

Conflicts:

Support Material: None

Test Cases: TBD

5.5.3 Send Report (TBD)

REQ: 19 **Requirement Title:** Share Report **Use Case: 1**

Date: 10.22.2020

Introduction: The reports for the simulation are exportable outside of the system.

Rationale: Users should be able to view and reference the report outside of the system.

Inputs: The reports that have been generated on the system.

Requirement Description: Report will be in an exportable format. The system to export to is TBD.

Outputs: TBD

Persistent Changes: TBD

User Satisfaction: TBD

User Dissatisfaction: TBD

Related Requirements: 1

Conflicts:

Support Material: None

Test Cases: TBD

5.5.4 Delete Report

REQ: 20 **Requirement Title:** Delete Report **Use**
Case: 1

Date: 10.22.2020

Introduction: Allow users to delete reports.

Rationale: Users may choose to delete reports after a period of time.

Inputs: Selected report

Requirement Description: User will be able to delete a previously saved report from memory.

Outputs: Memory recovered from deleted report.

Persistent Changes: TBD

User Satisfaction: TBD

User Dissatisfaction: TBD

Related Requirements: 1

Conflicts:

Support Material: None

Test Cases: TBD

5.6 External Systems

5.6.1 TBD

5.7 Graphical User Interface

5.7.1 TBD

6. Other Nonfunctional Requirements

6.1 Performance Requirements

TBD

6.2 Safety Requirements

TBD

6.3 Security Requirements

TBD. There may be security concerns with the acquisition and storage of data provided by Parking and Transportation Services. Other possible concerns are listed in section 5.5.

6.4 Software Quality Attributes

The transit organization specifies that the product should be realistic and make the simulation as close as possible to the management of transit on campus, when it comes to simulating variables and creating a model of student demand.

However, more precise information has not been asked of the user yet, so more information will need to be collected. TBD.

6.5 Business Rules

Only designers and producers of the system or staff within the transit organization will be allowed access to the data for previous Parking and Transportation Services' ridership. No user external to the transit organization should have the ability to control, see, collect, delete, or otherwise change this data during normal use of the system.

7. Other Requirements

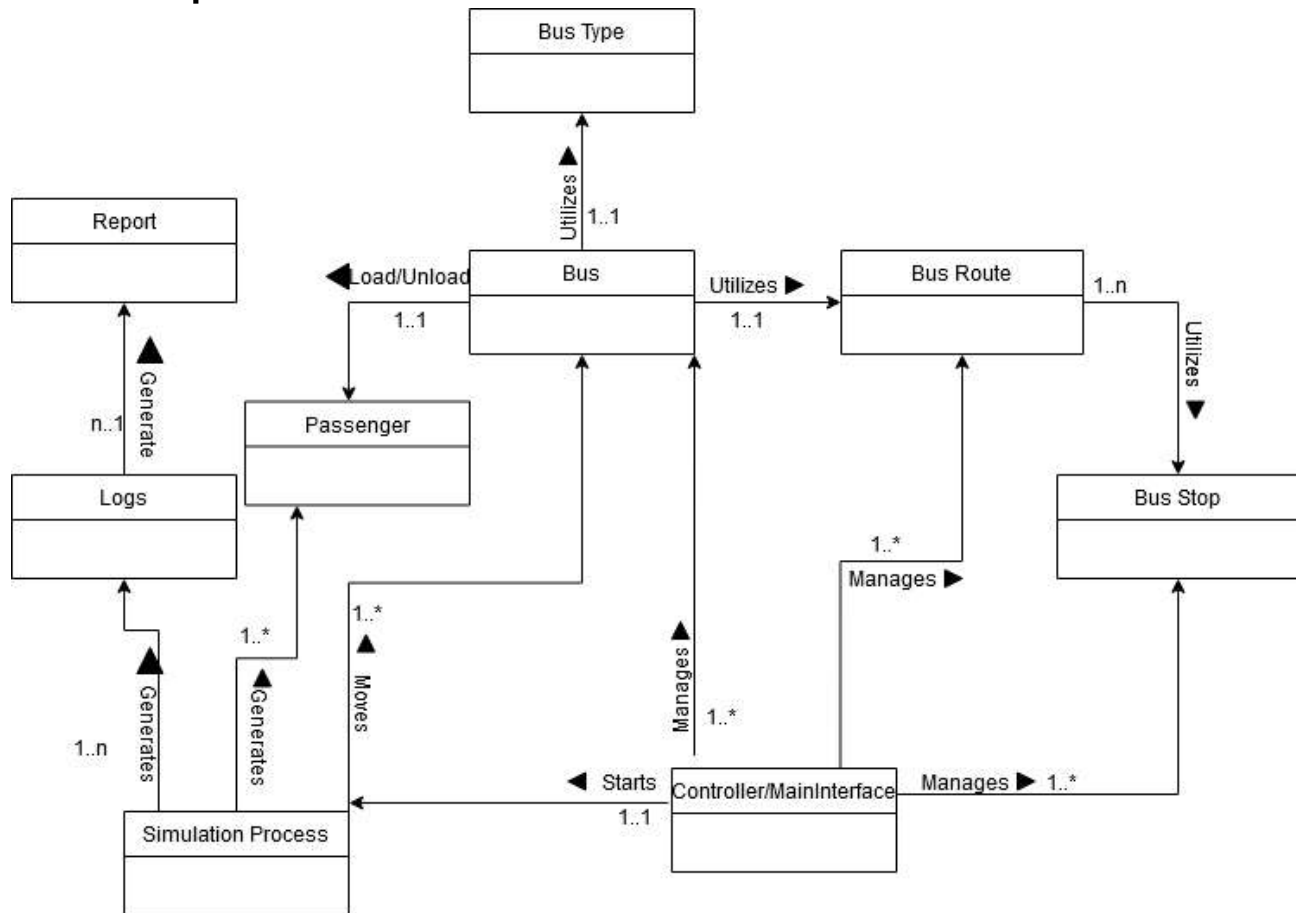
TBD

Appendix A: Glossary

SURTS	System for Uniform Route-Based Transportation Simulation
IEEE	Institute of Electrical and Electronics Engineers
P&TS	Parking and Transportation Services
UMN	University of Minnesota

Appendix B: Analysis Models

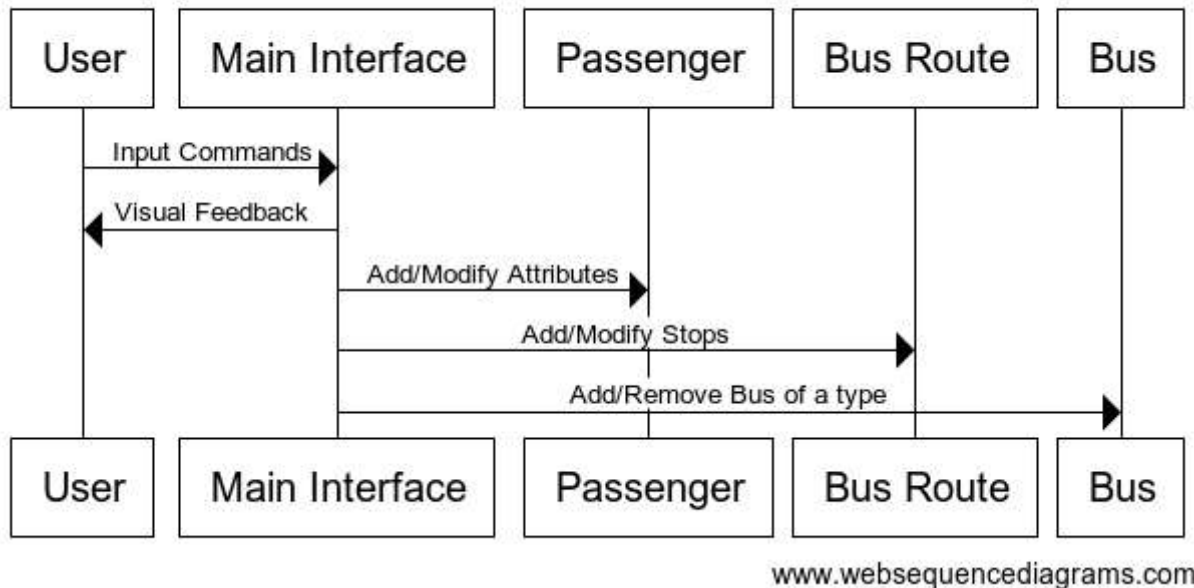
B1. Conceptual Model



B2. Interaction Model

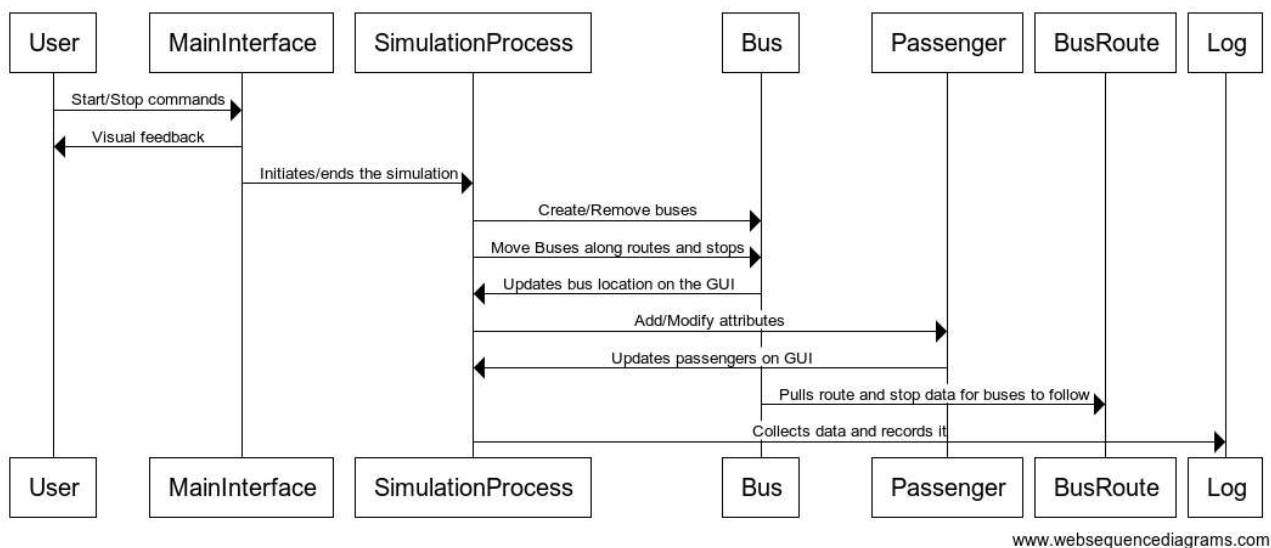
B2.1 Simulation Parameter Configuration

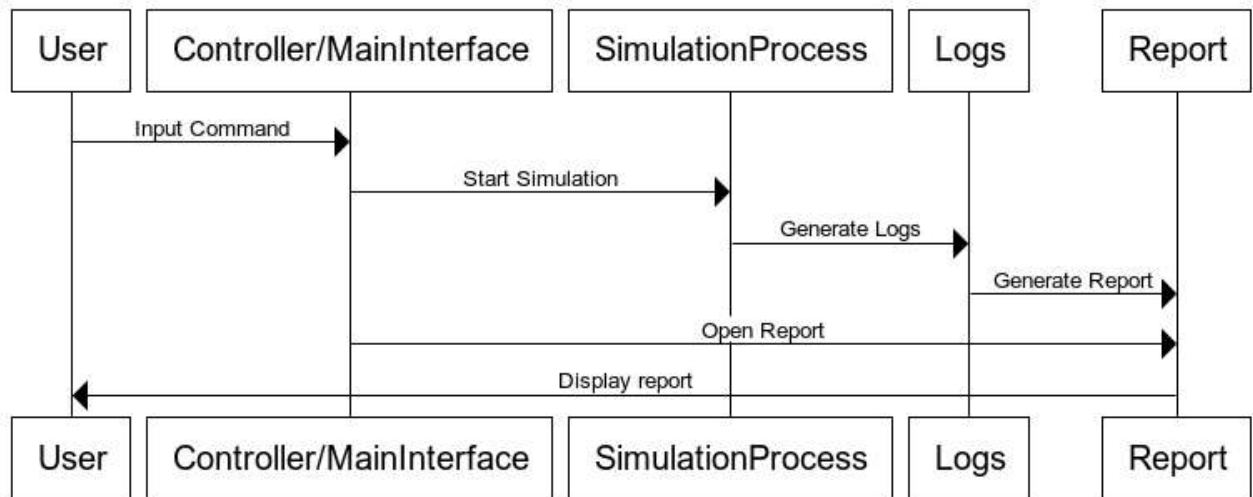
Simulation Parameter Configuration Interaction Diagram

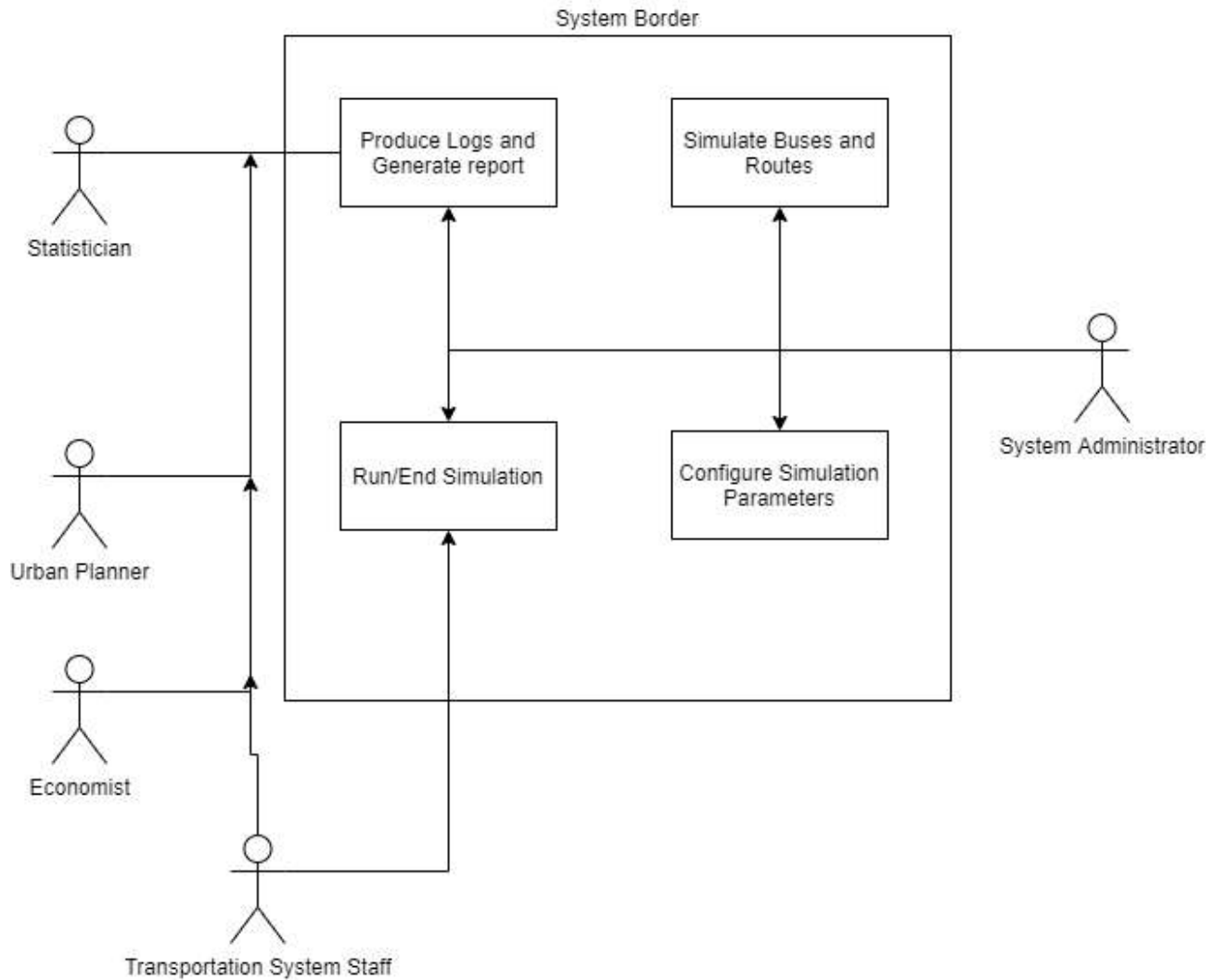


B2.2 Simulation Runtime

Run Simulation Interaction Diagram



B2.3 Generating a Report from a Simulation**Generating a report from a simulation**

B3 Use-Case Diagram**Appendix C: To Be Determined List**

1. Operating Environment - The user has not yet specified required operating environments.
2. Nonfunctional requirements - The user has not yet been questioned thoroughly on nonfunctional requirements.
3. Software Quality - What attributes does the user value in the system?
4. Other Requirements - Added as needed to the Document.