
Acorn Software

**Bus Tracking System
Software Requirements Specification**

Version 3.0

<i>Bus Tracking System</i>	Version: 3.0
Software Requirements Specification	Date: April 7, 2006
BTS SRS 3.0	

Revision History

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			Shen, Craig Stuart
April 5, 2006	2.99	Added traceability matrices	Paul McMahon

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Software Requirements Specification

1. Introduction

1.1 Purpose

This document describes the software requirements of a bus tracking system. It is intended for the designer, developer, and maintainer of the bus tracking system. These requirements were created in response to a request for proposals from MetroLink for a bus tracking system.

1.2 Scope

The bus tracking system is intended to assist passengers with route planning, inform passengers of delayed busses, improve inter-bus transfers by informing bus drivers of connecting busses that are running behind schedule, help transit management produce accurate schedules, and help transit management allocate resources more efficiently.

1.3 Definitions, Acronyms and Abbreviations

1.3.1 GPS (Global Positioning System): A system of satellites, computers, and receivers for determining the position of a receiver on Earth.

1.3.2 csv: Comma Separated Variable. A file format used to exchange information between disparate applications

1.3.3 Total Trip Time: The time it will take the traveler to go from the start position to their destination, including all time spent walking to bus stops, waiting for buses and riding on buses.

1.3.4 Start position: The geographic location where the traveler begins their trip. In the system it is described as a street address or intersection of two streets.

1.3.5 Destination: The geographic location where the traveler completes their trip. In the system it is described as a street address or intersection of two streets.

1.3.6 Automated Voice: An automatic recorded voice message service provides instructions to guide users of the bus system with route information.

1.3.7 Kiosk: A secure, independent stand with a computer and display screen that users can interact with through a touch screen. They are located in high traffic areas.

1.3.8 Overlay: A semi-transparent graphic displayed in the same position as another graphic, usually used to provide additional information to the user.

1.3.9 Invalid Location: A location that does not correspond to an existing address or cross street in the city.

1.4 Overview

The remainder of the document is organized as follows: section two provides a general description of the bus tracking system and section three provides detailed functionality, reliability, usability, and performance requirements for the public kiosks, trip planning system, management oriented reporting system, and the driver oriented information consoles.

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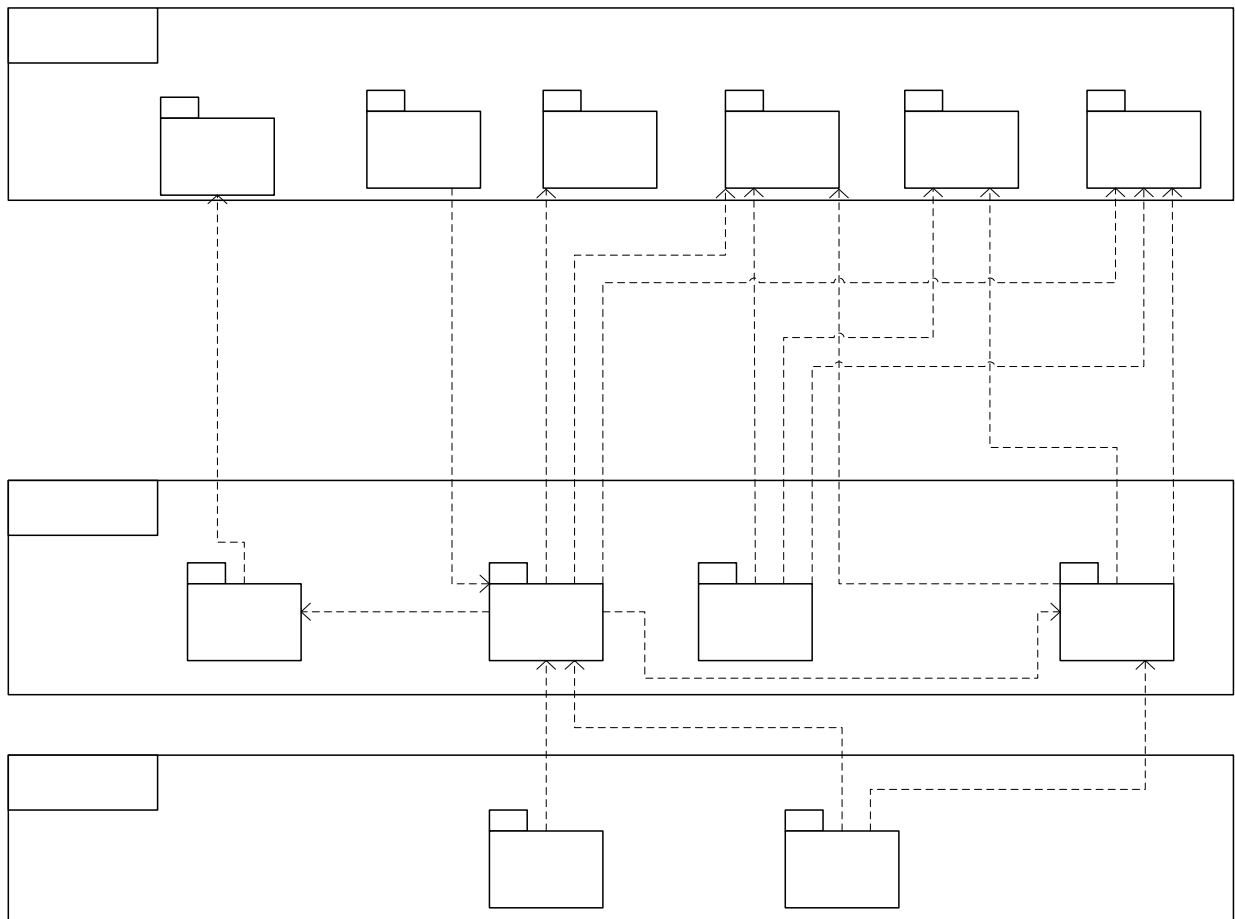
2. Overall Description

2.1 Product perspective

A server that hosts bus route information, current bus locations, and historical bus location data for statistical analysis;

- A GPS-enabled system located on each bus that will send bus location information to the bus information server;
- A collection of statistics that allow transit management to investigate bus delays and bus usage patterns;
- A console on board each bus that receives data from the bus information server and displays notices to drivers;
- A telephone schedule system;
- A web based information system for riders;
- A set of kiosks at bus stops that provide information to potential passengers.

2.1.1 System Architecture



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Components

UI

<i>View Schedule</i>	Displays the expected arrival time for a bus at one or more bus stops
<i>Update Route</i>	Make a temporary change to a bus route
<i>View Statistics</i>	Displays statistics collected by the system, such as how many passengers get on at a given stop
<i>Plan Trip</i>	Aids the user in planning a bus route from one location to another
<i>View Bus Position</i>	Shows the position of a bus on a map of the city
<i>View Next Bus Arrival Time</i>	Displays when the next bus will arrive at a specific bus stop

Software System

<i>Bus Schedule</i>	A list of scheduled arrival times at every bus stop of a bus route calculated from data stored in the database
<i>Database</i>	A repository for information used by this software system
<i>City Map</i>	Renders a map of the city
<i>Bus Position</i>	Estimates when a bus will arrive at a given bus stop
<i>Estimator</i>	

Sensors

<i>Passenger Counter</i>	Counts every passenger that boards the bus
<i>Bus Position</i>	Uses GPS to determine the bus' coordinates

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2.3.2 Bus drivers

Bus drivers need to know the bus schedule and the estimated time of arrival of connecting busses. As the drivers will be driving when using the system, it is important to minimize interaction with the system. Bus drivers also require the system display the current time as well as a notification of any route changes.

2.3.3 Head Office

Personnel at head office need to be able to see the last reported position of each bus. Personnel also need to gather statistical information to assist in decisions about designing routes. Personnel must be able to quickly modify routes in the event of blocked roads and other uncontrollable circumstances.

3. Specific Requirements

3.1 Functionality

3.1.1 Requirements for Kiosk

Kiosks will be located at major bus stops around the city. They will consist of a secure, independent stand built around a computer and touch screen. Users will interact with the kiosk through the touch screen and will be able to see the numbers and names of all busses passing the stop, the arrival time of the next bus at the current location, and the daily schedule for a given route. They will also have the ability to see a real time map that shows the last reported position of each bus. Users will also have the ability to utilize the route planning function of the kiosk to help them to plan a trip from one location to another. The interface will be graphical, and use simple language to maximize usability for non-English speakers.

3.1.1.1 Returning to Main Screen

Requirement [RQ1]:	An option will be displayed on each screen allowing the user to return to the main screen.
Rationale [RA1]:	Users may wish to use a different function from the one they are currently using, the main menu can access all kiosk features.
Test Scenario [T1]:	Navigate to each screen in the kiosk and click the “return to main screen button” the kiosk should reload the main screen.
Importance:	High

3.1.1.2 Handling inactivity

Requirement [RQ2]:	After 30 seconds of inactivity, the kiosk will display a warning that if no activity occurs within the next 15 seconds, the display will reset.
Rationale [RA2]:	Warning should be displayed after thirty seconds so that users can opt to lengthen their session.
Test Scenario [T2]:	Navigate to each screen in the kiosk and wait for 15 seconds.
Importance:	Low
Requirement [RQ3]:	Once 15 seconds have passed since the time of the warning, the kiosk screen will return to the main screen.
Rationale [RA3]:	When a new user approaches the kiosk they should see a main menu screen so they won't be confused.

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Test Scenario [T3]: Wait 30 seconds for warning message to appear. After another 15 seconds, the user should be returned back to the main screen of kiosk.

Importance: Low

3.1.1.3 Bus listings on main screen

The main screen will list the names, numbers, and ETA of all buses stopping at the kiosk will be listed.

Rationale [RA4]: The main screen should enable users to quickly determine which busses pass by the stop, and when the busses will next pass by the stop
Test Scenario [T4]:
The names, numbers, and ETA of all buses stopping at the kiosk should appear in a scrolling list.

Importance: High

Requirement [RQ26]: This information will be presented so that if the list cannot be displayed in one screen, it will scroll such that a user can see the information of any bus within 10 seconds.

Rationale [RA4] The main screen should enable users to quickly determine which busses pass by the stop, and when the busses will next pass by the stop
Test Scenario [T26]:
The maximum amount of time it should take for the system to scroll through the entire list of buses stopping at the kiosk should be no more than 10 seconds.

Importance: Low

3.1.1.4 Visibility and Accessibility of advanced features

Requirement [RQ5]: The main kiosk screen will display buttons for route planning, bus schedules, and the real time map.

Rationale [RA5]: Putting buttons for route planning, bus schedules and real time mapping on the main screen will simplify the process of using these functions.

Test Scenario [T5]: Options for route planning, route schedules, and the real time map should be displayed.

Importance: High

3.1.1.5 Display current day and time on all screens

Requirement [RQ27]: All kiosk screens will display the current day and time.

Rationale [RA16]: The current day and time can be very valuable when analyzing bus arrival times, bus schedules, and trip plans.

Test [T27]: Navigate to each screen in the kiosk and verify that current day and time is displayed.

Importance: Moderate

3.1.1.6 Kiosk Identification

Requirement [RQ28]: Each kiosk has a unique identification code.

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Rationale [RA17]: The identification code allows administrators to determine which kiosks are used most and allows the server to know which bus stop to send information for.

Test [T29]: Upon installation query each kiosk and request its ID. Make sure that no two IDs are the same.

Importance: High

3.1.1.7 Schedule Information

See Section 3.1.7

3.1.1.8 Map Display

See Section 3.1.8

3.1.1.9 Trip Planning

See section 3.1.6

3.1.2 Requirements for Internet Website

Through the website, users will be able to easily plan trips and view route schedules. The trips planned through the system should be efficient (as determined by user selectable metrics). Route schedules for both current and future schedules will be available. Current schedules will reflect the bus's actual position.

Mobile devices such as PDA's and cellphones will be able to access a lightweight version of this site. This lightweight version will have the same functionality as the full version, but it will be optimized for wireless transfer. Fewer images will be included, and the average page size will not exceed 5 KB.

3.1.2.1 Trip Planning

- See section 3.1.6

3.1.2.2 Schedule Information

Description: A bus schedule, listing expected arrival times for any bus route at any bus stop for any day of the week should be accessible by users through the kiosk and web systems.

Input: The user elects to input either a specific bus route, or a specific stop. They can also enter a location such as an address or intersection and choose from a list of nearby stops. The user also specifies a day of the week.

Processing: If the user supplied a specific bus route, then the arrival times at all the major stops are listed for the selected day of the week. If the user supplied a specific stop, then all the arrival times for every bus route that stops at that bus stop for the selected day of the week are displayed.

Output: The matched arrival times for bus routes and stop locations are displayed in a table.

3.1.3 Requirements for On-board Bus System

The on-board bus system will consist of four major components: a cellular uplink, a GPS unit, and a bus card reader/money counting unit that will accept payments for passenger fares. The touch screen will provide an interface to the bus system for the bus driver. The multi-line display on the screen will show the current time and will display the driver's scheduled arrival time at the next 3 stops. GPS will advance the schedule display. Drivers will be able to toggle this display between their own schedule and that of any of connecting buses.

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3.1.3.1 GPS System

Description: In order to implement the feature that allows for central tracking of bus positions, GPS positional data for each bus should be sent to the central server.

Input: Positional data is calculated using the GPS receiver located on each bus.

Processing: The positional data is transferred over the network to the central server.

Output: The central server receives the data and is able to keep track of the position of each bus.

3.1.3.2 Passenger Volume Data

Description: In order for usage statistics to be created, passenger volume data needs to be collected from busses and sent to the central server.

Input: The number of passengers who board the bus at each stop will be automatically recorded and saved.

Processing: Data regarding the number of passengers boarding and exiting the bus at each stop along the route will be sent over the network along with the positional data (every 30 seconds) to the head office. After the data is sent to the head office, it will be purged from the bus's computer.

Output: The head office receives the volume data for analysis. The data will be in csv format, and will include date, bus route, bus stop, and boarding passenger.

3.1.3.3 Current Schedule Information

Description: The drivers display will show the current route schedule

Input: Bus driver selects the schedule information display mode

Processing: The schedule information will be contained on the bus' onboard computer

Output: The next three bus stops and their scheduled arrival times will be displayed.

3.1.3.4 Connecting Bus Information

Description: To aid in making sure passengers can still make connections if buses are running slightly late, the driver's on-board bus display should have the ability to show the ETA of the next bus that should connect with this bus' route.

Input: Bus driver selects the connecting bus information display mode

Processing: Based on the location of this bus that is sent to head office, the central server determines the next connecting bus and sends the ETA information to the on-board bus display.

Output: The ETA of the next connecting bus as well as the stop the connection will take place at is displayed to the driver.

3.1.4 Requirements for Head Office

Head office is where the central server is located. Data from active buses is all routed to the central server and collected for later use. Operators at head office can access live bus location data, communicate with drivers and provide support.

3.1.4.1 Traffic Disruptions

Description: In order to keep bus drivers informed about traffic disruptions such as accidents or construction delays, head office should be able to send information to bus drivers.

Input: Head office will send information about a disruption over the network, along with an alternate route for the driver to take.

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Output: The information about the disruption and the route change will be sent to the desired bus. An audio alert will be broadcast to the bus.

3.1.4.2 GPS Data

Description: In order to detect violations of transit policy, head office should be able to receive and process the last reported position of each bus.

Input: GPS data from busses will be sent every 30 seconds. The information will include the bus' coordinates sampled at every second for the previous 30 seconds.

3.1.4.3 Creating and Updating Landmarks

Description: As per client requests during the negotiation meeting on February 7, 2006, administrators must be able to create and update information about city landmarks.

Input: The system will display a list of categories and landmarks within these categories. The administrator will enter the name of the landmark, along with its street address or GPS coordinates. The administrator may optionally enter a description of the landmark in the notes field or associate the landmark with one or more categories such as (coffee shops, gardens, parks, or bars). If the landmark being entered already exists in the database, the system will inform the administrator. Otherwise, the system will confirm that the landmark has been added.

3.1.4.4 Creating landmark categories

Description: As per client requests during the negotiation meeting on February 7, 2006, administrators must be able to create and update landmark categories.

Input: The system will display a list of all categories and landmarks within these categories. The administrator will enter the name of the new category. If the category already exists, the system will inform the administrator. Otherwise, the system will confirm that the category has been added.

3.1.4.5 Adding landmarks to categories

Description: As per client requests during the negotiation meeting on February 7, 2006, administrators must be able to add landmarks to categories.

Input: The system will display a list of all categories and landmarks within these categories. The administrator will enter the name of the category to which the landmarks are to be added and the names of the landmarks to be added to the category. If the category specified does not exist in the database, the system will inform the administrator. Otherwise, the system will confirm that the landmark has been added to the specified category.

3.1.4.6 Removing landmarks from categories

Description: As per client requests during the negotiation meeting on February 7, 2006, administrators must be able to remove landmarks from categories.

Input: The system will display a list of all categories and landmarks within these categories. The user will enter the name of the category from which the landmarks are to be removed and the names of the landmarks to be removed from the category. If the specified category or landmark does not exist in the database, the system will inform the administrator. Otherwise, the system will confirm that the landmark has been removed from the category.

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3.1.4.7 Accessing Live Bus Locations

Description: In order to facilitate access to the current location of all busses for administrators head office, the last reported position of each bus should be accessible through computer access at head office.

Input: The administrator inputs the bus identification number they wish to lookup.

Processing: The central server retrieves the last reported location of that bus from its GPS system.

Output: The location is displayed on a map.

3.1.4.8 Adding a New Bus Route

Description: Administrators should be able to plan and add new bus routes to the system.

Input: The administrator will place bus stops on a route planning map and will trace a route between the bus stops. The system will display a schedule creation screen and the administrator will enter an ETA for each stop, as well as the start date for the schedule. The administrator will then be prompted to confirm the new schedule.

Processing: The system will save the schedule information to the central server, and when the scheduled start date arrives, the route information will be accessible from the system.

3.1.5 Requirements for Phone System

The Phone system will be an automated voice system which provides users the schedule for any bus route. With automated voice, users can access the schedule of buses easily and quickly by any phone device. In order to use the service, users call the system and follow the automated voice instructions to access the bus schedule of their choice. A touch tone phone is necessary for using this service. If a user does not have a touch tone phone, or requires additional assistance, the user may speak to a live operator.

3.1.5.1 Phone System

Description: In order to provide schedules for requested routes and stops, Users should be able to request the schedule for any bus route.

Input: User selects route number or name, direction of travel, and desired stop.

Processing: The system looks up the bus route.

Output: Automated voice tells user departure times based on input information.

3.1.6 Requirements for Trip Planning

3.1.6.1 Information Prompts for Trip Planning

Requirement [RQ10]: The Initial Trip Planning prompts users to specify their start location, destination, and either their desired departure time, or their desired arrival time

Rationale [RA9]: Trip planning allows users to find information on how to go anywhere in the city utilizing the transit system.

Test Scenario [T10]:
 Select the Trip Planning option from the main screen.
 Enter a starting location or destination by typing in an address.
 Enter a departure time or arrival time.
 Select the landmark button, a list of landmark categories should be displayed. Select a category and choose a landmark from that category.
 Ensure that the destination now reflects the landmark selected.

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Select the map button, a map should be displayed.
Select a location on the map.
Ensure that the destination now reflects the map location selected.

Importance: High

Requirement [RQ29]: The departure time should be set to the current time by default.

Rationale [RA 18]: Users will most often use the trip planning feature around when they wish to leave.

Test Scenario [T30:] Select the Trip Planning option from the main screen. The departure time should be set to the current time.

Importance: Low

Requirement [RQ31]: Kiosk starting location should default to the current kiosk.

Rationale [RA19]: Most users plan trips leaving from the kiosk.

Test Scenario [T31]: For the kiosk only, the starting location should default to the kiosk's location.

Importance: Moderate

3.1.6.2 Handling Missing Data for Trip Planning

Requirement [RQ32]: If the user fails to enter a location into one or both of the location fields, the same page is redisplayed with an message next to the empty field(s) informing the user that they must provide a location.

Rationale [RA9]: Trip planning allows users to find information on how to go anywhere in the city utilizing the transit system.

Test Scenario [T32]: At trip plan screen, submit form with only one of either the destination or starting point fields filled in.
Verify that message is shown requesting user to enter a location next to empty field.

Importance: Moderate

3.1.6.3 Handling Invalid Data for Trip Planning

Requirement [RQ11]: If the user enters an invalid location into one or both of the location fields, the same page is redisplayed with a message next the invalid location(s) explaining that the system can't find the location. Invalid and presents the suggestions.

Rationale [RA9]: Trip planning allows users to find information on how to go anywhere in the city utilizing the transit system.

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Test Scenario [T11]: At trip plan screen, submit form with one of either the destination or starting point fields filled in with invalid address
Verify that message is shown informing user that system cannot find address, and shows list of possible correct addresses

Importance: Moderate

3.1.6.4 Trip Planning Route Summary

The user's web browser or the kiosk display screen will list up to three unique trip possibilities and allow the user to sort them based on "shortest trip time", "shortest walking distance" or "fewest transfers". Each trip possibility will contain a list of steps (rows in a table) the user is required to take to reach their destination. Each step will be one of two types: a walking instruction or a bus trip. Each row will contain, if it is walking instruction, departure time, start position, destination, arrival time, and direction and distance to walk to arrive at final destination, and if it is a bus trip, bus departure time, bus departure location, bus number, bus route title, start position, destination, arrival time, and trip time.

Rationale [RA9]: Trip planning allows users to find information on how to go anywhere in the city utilizing the transit system.

Test Scenario [T20]: At trip plan screen, submit completed form with all data filled in correctly. Verify that each of the shortest route, shortest walking distance and fewest transfers tabs provide correct information as well as all information needed to make a correct decision.

Importance: High

3.1.7 Schedule Information

3.1.7.1 Main screen

Requirement [RQ33]: The main screen of the bus selection function displays a list of all of the busses that pass by the current stop, provides the user the option to view the busses that pass by a different stop, and provides the user the option of listing all busses in the system. The user can then select a bus allowing him or her to view a list showing all the times it will pass a point on its route.

Rationale [RA7]: Users should know when busses are coming at anytime so they can plan future trips on the bus.

Test Scenario [T33]: Select schedule information from the main menu
Select a bus number from the list which passes current location
For busses that have already left, verify that expected time to arrival is varies dynamically with bus location.
For busses that have not already left, verify that the expected time of bus arrival at stop shown is consistent with Metrolink bus schedule.

Importance: High

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3.1.7.2 Default Bus Schedule Listing

Requirement [RQ34]:	Upon selecting any bus shown, the user will be given a list of all the times that the selected bus will pass the current stop.
Rationale [RA7]:	Users should know when busses are coming at anytime so they can plan future trips on the bus.
Test Scenario [T34]:	Enter the trip planning screen. Verify that the list of routes supplied corresponds to the routes that actually pass by the selected stop. Select a bus route from the list of routes that pass by the stop. The system should display all the times that the selected bus route has busses running past the selected stop for that day.
Importance:	Low

3.1.7.3 Generalized Bus Schedule Listing

Requirement [RQ35]:	The bus schedule listing will provide a scrollable list of the times that a particular bus will pass by six major intersections within the city. The user will also be able to select which day he or she would like to view the schedule for.
Rationale [RA7]:	Users should know when busses are coming at anytime so they can plan future trips on the bus.
Test Scenario [T35]:	From the main schedule screen, select the "all routes" button The system should display a sortable list of all the routes in the city. Select a route and a day of the week. The system should display a list of times each bus on the route should pass by 6 major stops on its route for the selected day of the week.
Importance:	High

3.1.8 Map Display

Requirement [RQ8]:	The map display function shows a zoomable, scrollable map of the surrounding area, defaulted to the current location being situated in the centre.
Rationale [RA8]:	The map display will allow users to easily find destinations and visualize routes.
Test Scenario [T8]:	Go to map function Verify that the system displays a map of the surrounding area. Verify that the current location is located in the center of the map. Verify that you can scroll up, down, left and right on the map display and to zoom in/out on the map.
Importance:	Low

3.1.8.1 Default routes shown

Requirement [RQ36]:	By default, the map will only display the busses that pass by the current location.
Rationale [RA20]:	The number of busses shown is limited in order to maximize map readability.
Test Scenario [T36]:	Go to map function. Verify that all of the routes passing by the kiosk are shown. Verify that no other routes are shown.
Importance:	Low

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3.1.8.2 Route Labeling

Requirement [RQ37]:	If seven or less bus routes are shown, each bus route displayed on the map will have a unique colour code.
Rationale [RA21]:	Each bus receives its own color code in order to simplify route identification. This feature is limited to seven routes as there are only seven easily distinguishable colours.
Test Scenario [T37]:	Go to map function Display at least two bus routes on the map Verify that they each have a different colour.
Importance:	Low

3.1.8.3 Display of bus locations

Requirement [RQ38]:	The map will show the position and direction of busses on each route displayed within the current view.
Rationale [RA22]:	Bus position and direction are displayed to help users make educated travel decisions.
Test Scenario [T38]:	Go to map function. Display at least two bus routes on the map. Verify that each bus displayed on the map has an arrow indicating its direction of travel and that this arrow corresponds to the direction the bus is actually traveling.
Importance:	Low

3.1.8.4 Updates frequency

Requirement [RQ39]:	Bus locations are updated every thirty seconds
Rationale [RA23]:	Bus locations are updated frequently to maximize the usefulness of the system. Update frequency is limited to once every 30seconds in order to minimize communication costs.
Test Scenario [T39]:	Go to map function. Watch the map for at least 60 seconds. Verify that the display updates correctly every 30 seconds.
Importance:	Low

3.1.8.5 Show/Hide routes

Requirement [RQ41]:	Users have the ability to add or remove routes from the map by clicking the "Show / Hide routes" button.
Rationale [RA24]:	The "Show / Hide routes" function helps users plan trips on bus routes that don't pass by the current location.

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Test Scenario [T40]: Go to map function.
Select the Show/Hide Routes button.
The route filtering screen should be displayed.
This screen should display a list of all routes in the system. These routes should be storable by both bus number and bus name.
Each bus route should have a checkbox beside it. Placing a checkmark in a checkbox will cause the route to be displayed on the real time map display upon pushing the Return to Map button. Clicking on a checkbox with a checkmark in it should remove the checkmark. If a checkbox is empty, the corresponding route should not be displayed on the real time map.
Upon pressing the Return to Map button, the real time map should be displayed once again. All routes that have been selected in the route filtering screen should be displayed. All routes that were left unselected in the route filtering screen should be hidden.

Importance: Low

3.2 Usability

3.2.1 Kiosks

3.2.1.1 Time to Learn System

When using a kiosk, it should take fewer than 3 minutes to become familiar with the system.

Kiosks should be convenient so that users will use them.

Test Scenario [T13]: A user survey should be conducted, where novice users are presented with the kiosk. It should take each user less than 3 minutes to become familiar with the system.

Importance: High

3.2.1.2 Time to use System

Requirement [RQ14]: Finding the time of a next bus to arrive to the present stop on a specific route from the kiosk should take fewer than 15 seconds.

Kiosks should be convenient so that users will use them.

Test Scenario [T14]: A user survey should be conducted, where familiar users are presented with the kiosk. It should take each user less than 15 seconds to find a bus passing this kiosk.

Importance: Moderate

Requirement [RQ15]: Viewing any other scheduling information, including the route planner via the kiosk should take less than one minute.

Kiosks should be convenient so that users will use them.

A user survey should be conducted, where familiar users are presented with the kiosk. It should take each user less than one to find any one piece of information.

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Importance: Moderate

3.2.2 On-Board Bus System

Bus drivers would require approximately 10 minutes of training to become adept at using their on board display systems.

3.2.3 Website and Telephone System

A new user should take less then 3 minutes to view or hear scheduling information.

3.3 Reliability

3.3.1 Uptime

Requirement [RQ16]: The kiosks will be operational every day from 5:00am to 3:00am with an active network connection during that time.

Rationale [RA14]: Users will become frustrated with the system if it's not available when they need it.

Test Scenario [RQ16]: The kiosk is left running for as long as possible and monitored to ensure it is running between 5:00am to 3:00am.

Importance: High

Requirement [RQ17]: There will be no more than 15 minutes of downtime in a single day (excluding the normal offline time from 3am to 5am).

Rationale [RA14]: Users will become frustrated with the system if it's not available when they need it.

Test Scenario [T41]: The kiosk is left running for as long as possible and monitored to ensure there is no more then 15 minutes of downtime in a single day.

Importance: High

3.3.2 Response time

Requirement [RQ42]: The bus tracking system must respond to 99% of user requests within 3 seconds of the request. The user will be able to retry any requests that take longer the 3 seconds.

Rationale [RA 25]: Users will become frustrated with the system if it doesn't respond to them within a reasonable period of time.

Test Scenario [T42]: The system is issued as many requests as feasible. Response time to those requests should be less then 3 seconds 99% of the time.

Importance: Moderate

3.3.3 Maximum data age

Requirement [RQ43]: The system's location information for each bus must be less than 5 minutes old 99.9% of the time and the bus tracking system's location information for major busses must be less than 2 minutes old 80% of the time for major bus routes.

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Rationale [RA26]:	Users will become frustrated with the system if the data is inaccurate.
Test Scenario [T43]:	A GPS tracker will be placed aboard a bus. This tracker will be manually monitored, and the system's information should be 99.9% of the time less than 5 minutes old. Additionally, the information must be less than 2 minutes old 80% of the time.
Importance:	Moderate

3.3.4 System warnings

Requirement [RQ45]:	If any reliability conditions are violated, a warning notice will be sent to head office.
Rationale [RA27]:	A warning notice should be issued so that appropriate actions can be taken.
Test Scenario [T44]:	Intentionally violate a reliability condition. Check that a warning notice is issued.
Importance:	High

3.4 Performance

3.4.1 Position Reporting Times

Each bus will report its position to head office every 30 seconds.

3.4.2 Passenger Reporting Times

Each bus will report passenger statistics to head office every hour.

3.4.3 Bus Connection Data

When a bus is within an estimated 5 minutes of a connecting bus, it will receive the connecting busses' estimated time of arrival every 30 seconds.

3.4.4 Maximum Bus Limit

The system will support at most 1000 active busses.

3.4.5 Database Size

The database will grow at a rate of 256 kb per operational hour per bus

3.5 Supportability

- Updates and long term support has yet to be negotiated

3.6 Design Constraints

3.6.1 Platform support

The website must be accessible using the following operating systems:

- Windows
- Mac OS 9.2.-Max OS X
- Linux

And the following web browsers:

- Internet Explorer (version 5.5 and above)

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- Netscape (version 4.0 and above)
- Mozilla Firefox (version 1.0 and above)
- Opera (version 8.5 and above)
- Safari (all versions)

3.7 Online User Documentation and Help System Requirements

The kiosk, web site and phone system should be designed in such a way that additional help documentation is not required.

3.8 Purchased Components

To be determined.

3.9 Interfaces

3.9.1 User Interfaces

3.9.1.1 Physical Design of Kiosk

The kiosk will be 4 feet high with a head that can rotate on the horizontal axis to be accessible to people of all heights.

3.9.2 Hardware Interfaces

Each bus will contain the following hardware interfaces:

- a bus card reader and money counting unit
- a cellular uplink to facilitate data communication with head office
- a GPS unit to provide location data
- a three line alphanumeric display with minimal button interface (see section 3.1.3)
- Each kiosk will contain the following hardware interfaces:
 - a networked computer
 - a touch screen

3.9.3 Software Interfaces

Statistics collected will be provided in csv format to allow for easy integration with existing analysis tools.

3.9.4 Communications Interfaces

All communication between busses, head office, and kiosks will be performed over the internet.

3.10 Licensing Requirements

None.

3.11 Legal, Copyright and Other Notices

This document is a fictional requirements specification. All ideas and text are property of the members of Acorn Software.

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3.12 Supporting Information

None.

4. Appendix 1: Use Cases

4.1 User Accesses Trip Planning Feature

Actors: User

Purpose: A passenger at stop wishes to determine the best combination of buses to reach a destination given a specific starting location.

Overview: User selects trip planning feature from website or kiosk. Trip planning feature loads on screen. User selects starting location and destination. After submitting request, bus system displays graphical and textual trip plan options.

Main Scenario:

1. User selects trip planning option from default screen.
2. System displays trip planning screen, starting point defaults to current location (kiosk only)

User does not wish to start from current location or is using web-based interface (see alternate scenario 2.a).

3. User enters address, intersection, or landmark to be starting location

User wishes to select starting landmark from a known list (see alternate scenario 3.a.i).
User wishes to select starting point in city using an on-screen map (see alternate scenario 3.a.ii)
System receives invalid address, intersection, or landmark (see alternate scenario step 3.a.iii)
4. User enters time of departure or arrival.
5. User submits information to system.
6. System computes all permutations of buses that will lead to destination.
7. System compares routes to determine shortest total time, fewest transfers, or shortest walking distance based on user selection.
8. System displays choice of order route by shortest time, order route by least walking distance, order route by fewest transfers, defaulting to shortest time.
9. User selects preference.
10. System displays trip drawn onto map of city based on route selected by system.
11. System displays information about trip including route number(s), transfer locations, and total time to destination.

Alternate Scenario 2.a (User does not wish to start from current location or is using web-based interface):

1. User Enters address, intersection, or landmark to be starting location

User wishes to select starting landmark from a known list (see alternate scenario 2.a.i).
User wishes to select starting point in city using an on-screen map (see alternate scenario 2.a.ii)
System receives invalid address or intersection (see alternate scenario step 2.a.iii)
2. Return to main scenario step 3.

Alternate Scenario 2.a.i (User wishes to select starting landmark from a known list):

1. User selects landmarks button.
2. User selects type of landmark.
3. User selects name of landmark.
4. Return to alternate scenario 2.a step 2.

Alternate Scenario 2.a.ii (User wishes to select starting point in city using an on-screen map):

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1. User selects city map button
2. User selects location in city
3. Return to alternate scenario 2.a step 2.

Alternate Scenario 2.a.iii (System receives invalid address or intersection):

1. System displays notification that invalid address has been entered, displays suggested similar locations and gives option to re-enter location.
2. User selects suggestion or re-enters location.
3. Return to alternate scenario step 2.

Alternate Scenario 3.a.i (User wishes to select starting landmark from a known list):

1. User selects landmarks button.
2. User selects type of landmark.
3. User selects name of landmark.
4. Return to main scenario step 4.

Alternate Scenario 3.a.ii (User wishes to select starting point in city using an on-screen map):

1. User selects city map button.
2. User selects location in city.
3. Return to main scenario step 4.

Alternate Scenario 3.a.iii (System receives invalid address, intersection, or landmark):

1. System displays notification that invalid address has been entered, displays suggested similar locations and gives option to re-enter location.
2. User selects suggestion or re-enters location.
3. Return to main scenario step 4.

4.2 User Accesses Full Schedule

Actors: User

Purpose: Presenting bus schedule information to user.

Overview: The user is currently at a major stop that is equipped with a kiosk. The user selects the schedule option. The user selects the desired bus route and day of the week. The system displays the selected route schedule with expected arrival times at the current location on the chosen day of the week.

Main Scenario:

1. User selects the bus schedule option from the kiosk menu.

The user selects the option to see bus routes at a different stop. (See 1.a.)

The user selects the option to search for a bus route. (See 1.b.)

2. The system lists all the available buses at the current stop by route number and name.
3. User selects the desired bus.

4. User selects the direction of travel (if necessary).

5. User selects the day of the week listing on screen for accessing the bus schedule.

No bus is running on the chosen day. (See 5.a.)

6. System displays the expected time of arrival for each major stop along the chosen route that the bus is heading to, and highlights the arrival time at the current bus stop (if one has been selected).

Alternate Scenario 1.a:

1. User enters an address or region.

Invalid data is entered. (See 1.a.i.)

2. A list of stops are presented near the address or in the region.
3. The user selects a stop.

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- Return to main scenario step 2.

Alternate Scenario 1.a.i:

- The system notifies the user the data location is unrecognizable and suggests similar locations.
- Return to alternate scenario 1.a, step 1.

Alternate Scenario 1.b:

- User enters a bus route number or bus route name.

Invalid data is entered. (See 1.b.i.)

- Return to main scenario, step 5.

Alternate Scenario 1.b.i:

- System notifies the user the bus route they have entered is invalid and suggest similar bus routes.
- Return to alternate scenario 1.b, step 1.

Alternate Scenario 2.a:

- System notifies user if an invalid route number/name or address is entered.
- Return to main scenario step 2.

Alternate Scenario 5.a:

- System notifies user if there is no bus running on the chosen day.
- Return to main scenario step 5.

4.3 Administrator Accesses Bus Position Information

Actors: Administrator

Purpose: Accessing bus position information in order to make scheduling decisions.

Overview: The administrator enters the identification number of the bus he/she wishes to view positional data for. The system displays the position of the bus.

Main Scenario:

- Administrator enters a bus identification number

Invalid bus identification number (see 1a.)

Administrator wants to view position of multiple busses (see 2a.)

- System displays bus position information

Alternate Scenario 1.a (Invalid bus identification number):

- System notifies user that they have entered an invalid bus identification number and presents the form again
- Return to main scenario step 1

Alternate Scenario 2.a (Administrator wants to view position of multiple busses):

- Administrator enters a list of identification numbers
- Return to main scenario step 1

4.4 On-Board Bus Display (Schedule information and Connecting Bus Information)

Actors: Bus, Bus Driver

Purpose: The bus driver will use schedule information to decide whether or not to wait for passengers who are transferring from a connecting bus.

Overview: The on-board bus display has two modes: schedule information mode and connection information mode. The driver can alternate between the two modes through the use of a toggle button.

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Main Scenario:

1. Every 30 seconds, the on-board bus display system requests updated bus display data from the server using: the bus's identification number, route number, direction and GPS coordinates.
2. The server sends the on-board bus display the desired arrival time for the next three stops, the name of the next connection point, a list of busses that are expect to arrive at the connection point behind schedule and the expected arrival times for the late busses. Note: the list of late busses never includes the bus that made the request even if the bus that made the request will be arriving late.
3. When the display is in route information mode, it displays the current time and the expected arrival time at the next three bus stops.

Less than three remaining stops on the route (see 3.a)
--

4. When the display is in connection information mode, it displays: the name of the next connection point, the list of busses that will be arriving

All connecting busses are expected to arrive at the next connection point on time. (see 4.a)
--

No remaining connection points are on the route (see 4.b)

5. The driver can press the toggle button at anytime to alternate between route information mode and connection information mode.

Alternate Scenario 3.a (Less than three remaining stops)

1. If there are exactly two remaining stops the on the route the on-board bus display system displays the desired arrival time for the next two bus stops and leaves the third arrival time field blank.
2. If there is exactly one remaining stop the on the route the on-board bus display system displays the desired arrival time for the next bus stops and leaves the second and third arrival time fields blank.
3. If there are no remaining stops on the route the on-board bus display system, displays the message "No remaining bus stops on this route"

Note this scenario only applies when the display is in route information mode

Alternate Scenario 4.a (All connecting busses are expected to arrive at the next connection point on time):

1. The on-board bus system no longer displays connection info (if connecting bus information is selected by the driver, the system displays the message "No remaining connection points on this route").

Note: this scenario only applies when the display is in connection information mode

Alternate Scenario 4.b (No more connection points on the route):

1. The on-board bus system no longer displays connection info (if connecting bus information is selected by the driver, the system displays the message "No remaining connection points on this route").

Note this scenario only applies when the display is in connection information mode

4.5 Administrator Sends Out Route Update Notice

Actors: Administrator

Purpose: Sending out route update notices due to accidents or uncontrollable circumstances

Overview: An administrator enters a route number. The system displays map of the route. The administrator changes the route. The system sends out update notices.

Main Scenario:

1. Administrator enters route number
2. System displays map with traced bus route.
3. Administrator adjusts traced route, and change duration.

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Administrator does not know change duration (see 3a)

4. System displays updated route, and asks administrator to confirm changes.
5. Administrator confirms updated route.

Administrator does not confirm updated route (see 5a)

6. System schedules route update message for broadcast to busses, and displays notice at affected kiosks.

Alternate Scenario 3.a (Administrator does not change duration):

1. Administrator indicates indefinite duration
2. Return to step 3

Alternate Scenario 5.a (Administrator does not confirm updated route):

1. Return to step 2

4.6 Administrator Adds New Route

Actors: Administrator

Purpose: Allowing an administrator to add a new route to the system

Overview: An administrator traces a bus route on the route planning map. System displays schedule creation screen. Administrator enters ETA at each bus stop and start date of schedule.

Main Scenario:

1. Administrator places bus stops on route planning map.

Administrator places bus stop at invalid location (see 1a)

2. Administrator traces route between bus stops.

Administrator traces route that does not follow road (see 2a)

3. System displays schedule creation screen.
4. Administrator enters ETA at each bus stop.
5. Administrator enters start date for this schedule.
6. System displays confirmation screen.
7. Administrator confirms new schedule.

Administrator does not confirm new schedule (see 7a)

Alternate Scenario 1.a (Administrator places bus stop at invalid location):

1. System displays warning message, and does not place bus stop
2. Return to step 1

Alternate Scenario 2.a (Administrator traces route that does not follow road):

1. System displays warning message, and does not place bus stop
2. Return to step 2

Alternate Scenario 7.a (Administrator does not confirm new schedule):

1. Return to step 7

5. Appendix 2: Kiosk Prototype

The prototype presented in the following pages is one of a kiosk. This kiosk is meant to be located at major transit stops throughout a city, allowing riders an increased access to accurate information regarding the transit system. The kiosk features a touch screen and all interaction with the user is handled through it, using an on screen keyboard when character input is required. A sleek, easy to use interface that can be quickly mastered is the primary goal of this prototype.

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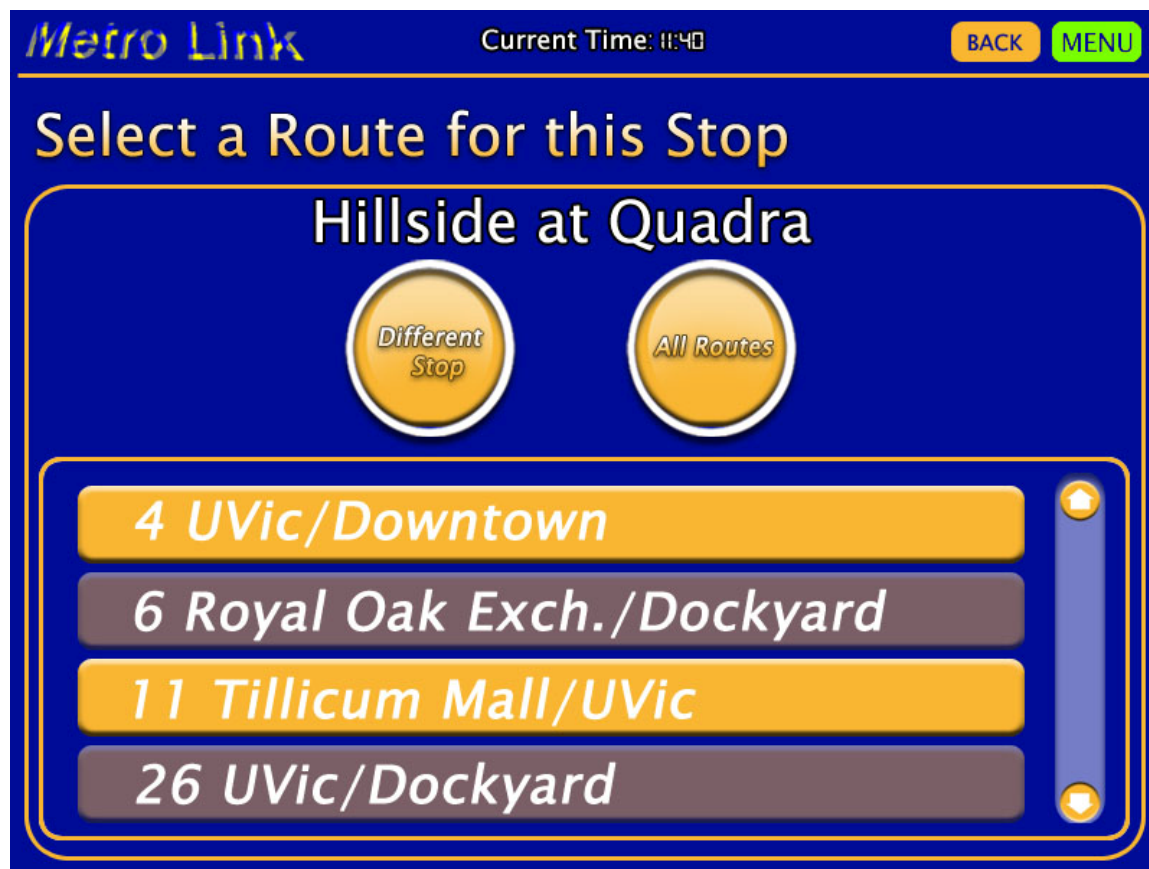


Figure 1 - Main Splash Screen

5.1 Main Splash Screen

Figure 1 shows the main screen that a rider approaching the kiosk should see. Each following screen shown in the kiosk will provide a link back to this screen, and after a period of inactivity, the kiosk will automatically return to this screen.

5.1.1 Bottom of Screen

At the bottom of the screen, the time until the next bus will arrive is shown. All busses that arrive at this stop will be visible as the buttons will shrink to accommodate up to six busses. If more than six busses arrive at a stop, then the list will be cycled through so that a transit user can see when all the busses are to arrive.

5.1.2 Top of Screen

At the top of the screen there are three buttons, each of which allows a user to use one of the kiosk features. From left to right the buttons access a trip planning feature where a user can find out how to go from one point to another, a bus schedule feature, so that users can view a full and complete bus schedule of the transit system, and a real-time map that allows users to view the current location of all busses within a 2km radius of the kiosk's position.

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Figure 2 - Trip Planner

5.2 Trip Planner

Figure 2 shows the input screen for the trip planning feature. At the bottom of the screen a keyboard is shown where a user can manually press the screen to input information into the trip planner. By pressing on one of the input fields on the screen, the user can select what input they wish to provide.

5.2.1 Starting Point and Destination

The starting point and destination can be entered in a number of ways (see section Appendix 1, Section 2.3). While the starting point is defaulted to be the current location, the user can type in any address, intersection or landmark as a starting point or destination and it will be used by the system. If the user types in an invalid location, the system will prompt them to re-enter the data and present suggestions of similar locations.

5.2.2 Leaving and Arrival Times

For the leaving or arriving times, only one or the other can be chosen to facilitate the systems ability to find a reasonable schedule.

5.2.3 Alternate ways of entering locations

There are two green buttons in the middle of the screen titled Landmarks and City Map.

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5.2.4 Landmarks

When a user presses the landmarks button, he or she will be shown a number of categories including restaurants, museums, parks, nightlife, and shopping centers. Selecting a category presents a list of locations. The user can then select the location from this list.

5.2.5 City Map

The city map option displays a zoomable, scrollable map of the city. The user can scroll or zoom the map until they see the location they wish to specify. Simply touching the map screen at that location will input the location data into the trip planner.

5.2.6 Submit Button

The submit button on the right allows a user to go to the next screen.

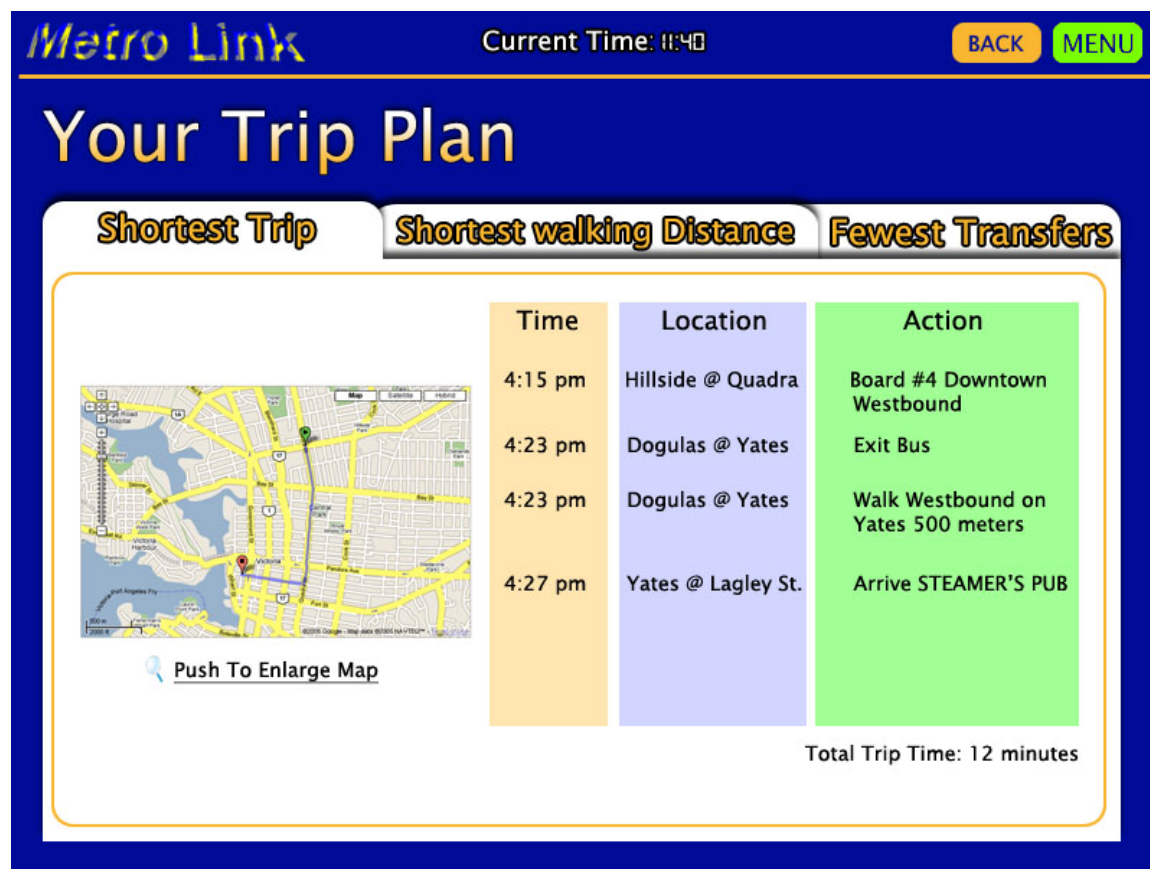


Figure 3 - Trip Planner Output

5.2.7 Trip Planner Output

The goal of the trip planning output screen is to convey to the user exactly how to get from their starting point to their destination. All walking distances required are fully described so that a rider can get to any connecting bus, as well as any location that may not be serviced completely by the transit system. At the bottom of the screen are two additional features. On the left is an overview map of the route traveled by the passenger, and on the right a total time of travel is displayed to the user.

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5.2.8 Options for Output

There are three ways that the kiosk can display a route depending on a user's preference. These are "Shortest Trip Time," "Shortest Walking Distance," or "Fewest Transfers." If all three of these choices can only be satisfied by one route, then the same route will be displayed when touching any of the three tabs. In many cases though, these trip plans will be different and optimized for the tab selected.

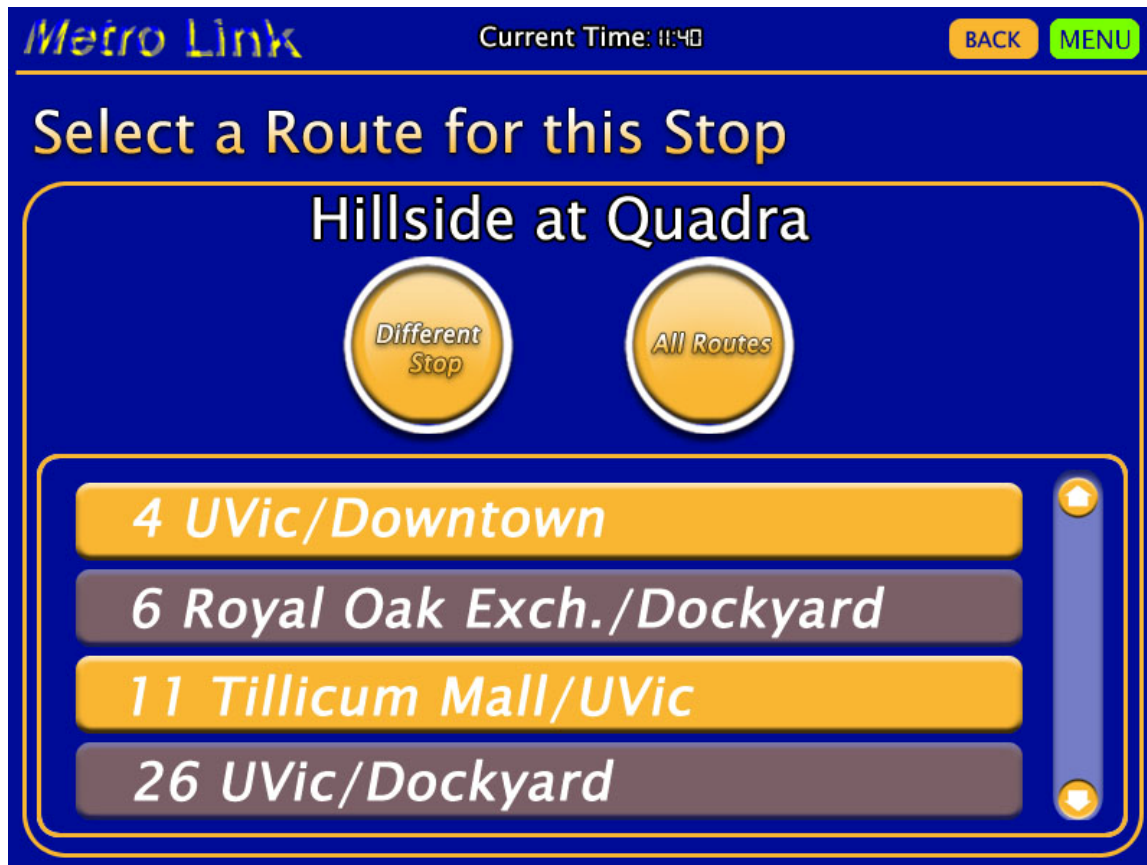


Figure 4 – Schedule View

5.3 Bus Schedule View

By selecting the schedule option from the main menu, the user enters the schedule mode. They are prompted to select a bus route that passes by the kiosk's stop and then will be shown the times that buses for that route pass by the stop for that kiosk.

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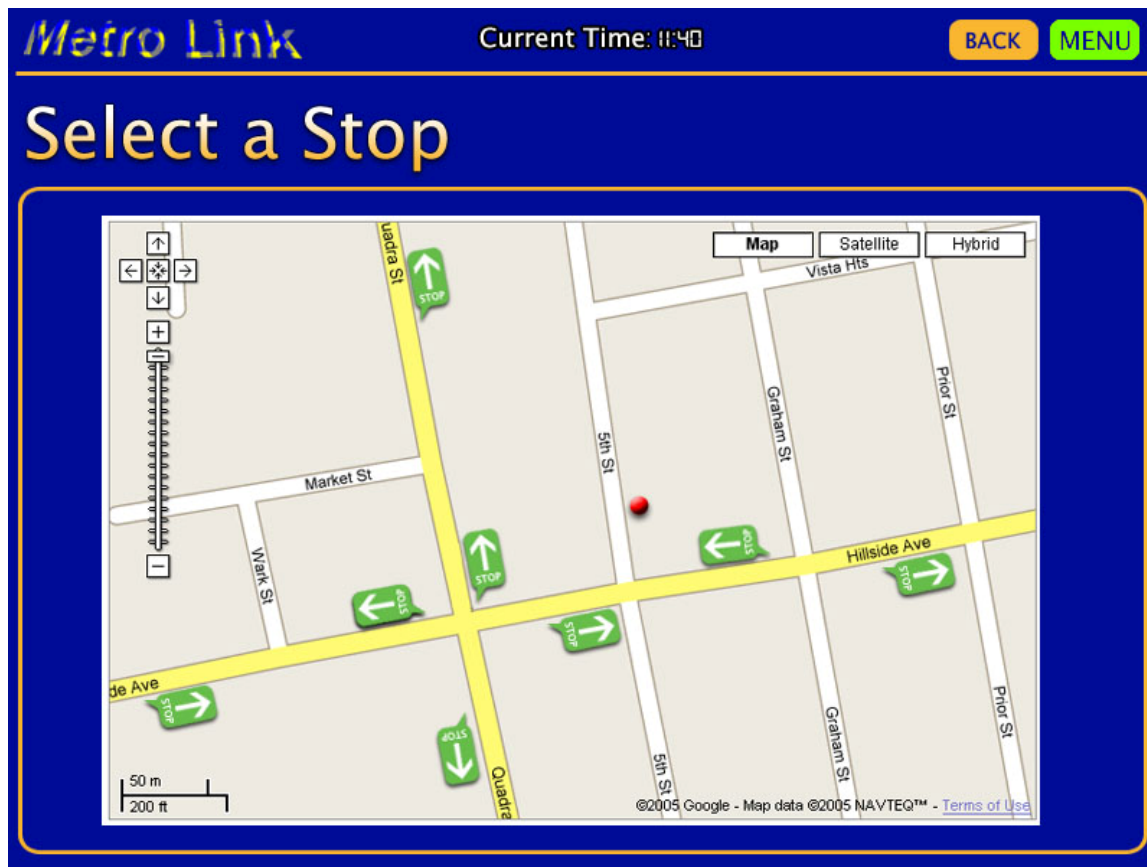


Figure 5 – Selecting a Stop

5.3.1 Selecting a different stop

By selecting the “Different Stop” option from the bus schedule screen, the user can enter an address and locate a bus stop where they would like to view route schedules (see Figure 5).

5.3.2 Viewing a Complete Route Schedule

If the user selects the “All Routes” option, they can view a sortable list and select a specific bus route from it. Once a route is selected they are presented with a schedule for that bus route which displays the times at major bus stops on the route throughout the day.

5.3.3 Viewing The Schedule

If the user selects a route for a specific stop, they are presented with a screen which displays a mini map of the bus stop and the selected route passing by it, and a list of all the times throughout the day that buses on that route stop at the selected stop.

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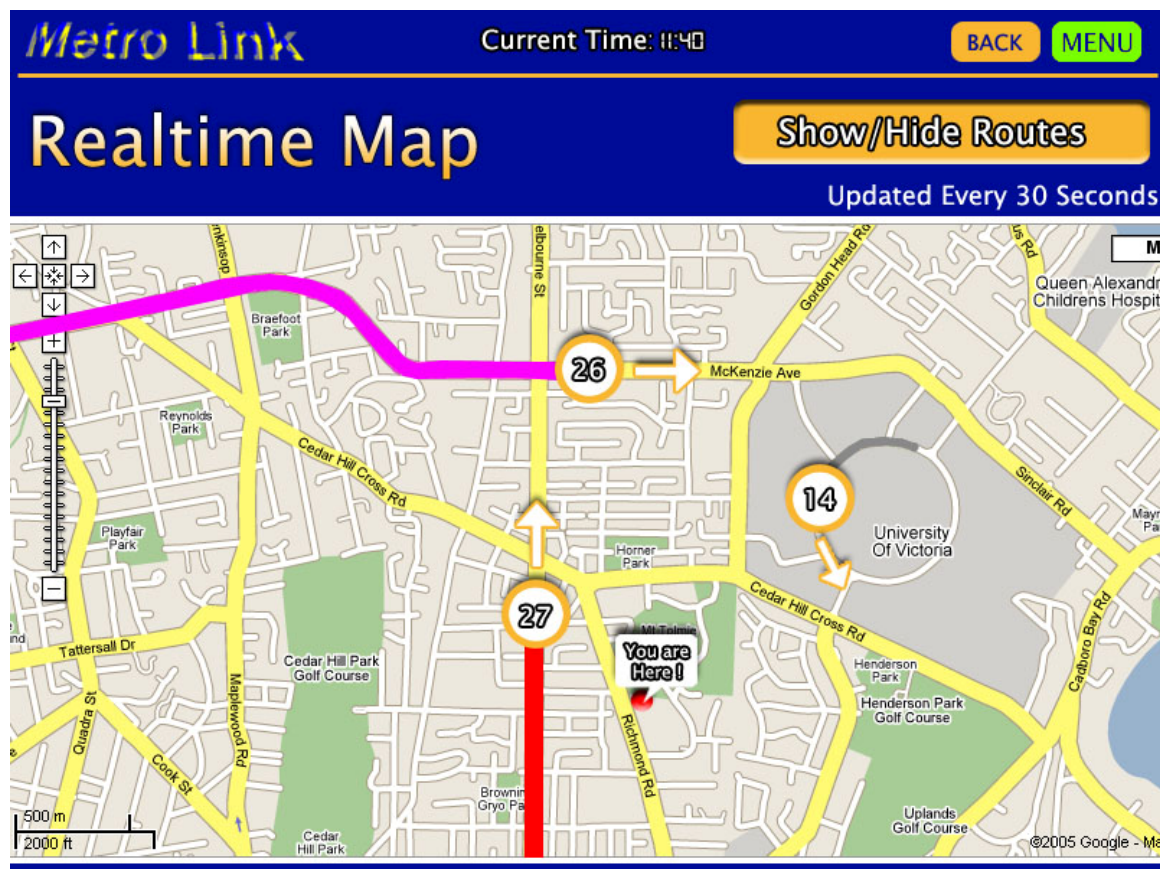


Figure 6 - Realtime Map

5.4 Realtime Map

The realtime map is a map that displays a 2km radius of the kiosk's current location. On this map, a color-coded overlay of all routes that intersect with the current bus stop will be displayed by default. The current location of the busses, subject to a thirty second delay will also be displayed graphically.

5.4.1 Bus Filtering

The user can choose to add or remove bus routes from the map by pressing toggle buttons on the side of the screen. These bus routes will then be toggled on or off being shown on the display.

6. Appendix 3: Change Log

6.1 Changes From RS 1.0 → RS 2.0

Section	Change	Rationale
2.1.1	Added "for statistical analysis"	Clarification
2.1.1	Changed "A reporting system" to "A collection of statistics"	Clarification
2.1.3.1	Added "PDA's and other web-enabled devices" to methods of route planning.	Issue List in RS1.1
2.1.3.2	Added "Bus drivers also require the system display current time"	Issue List in RS1.1
2.1.3.2	Added "as well as a notification of any route changes"	Additional detail

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2.1.3.3	Clarified route update frequency	Issue List in RS1.1
2.1.3.3	Added “Personnel at head office need to be able to see the locations of all busses in real-time”	Additional detail
3.1.1	Added requirement for graphical and minimal English interface.	Issue List in RS1.1
3.1.1.1	Added warning message that screen will reset	Issue List in RS1.1
3.1.1.1	Added option for manual reset	Issue List in RS1.1
3.1.1.2	Added options for additional features to main screen	Prototype feedback
3.1.1.2	Replaced “quickly” with “within 10 seconds”. Clarified behaviour when too many busses to fit on one screen.	Issue List in RS1.1
3.1.1.2	Added current time	Issue List in RS1.1
3.1.1.3	Added bus stop as input	Issue List in RS1.1
3.1.1.3	Changed input to “Return to default screen (if necessary)”	Prototype feedback
3.1.1.3	Added “for each route of the stop” to processing.	Prototype feedback
3.1.1.3	Changed output to “The arrival times for the next bus on each route serving the stop will be displayed”	Prototype feedback
3.1.1.5	Moved to section 3.1.1.4	Section numbering issue
3.1.1.6	Added requirement for realtime map display	Prototype feedback
3.1.1.6	Added detail about route filtering and default display	Issue List in RS2.1
3.1.1.6	Moved to section 3.1.1.5	Section numbering issue
3.1.2	Mentioned PDA and cellphone access	Additional detail
3.1.1.5	Value defaults to current day	Issue List in RS1.1
3.1.1.5	User can select other bus stops	Issue List in RS1.1
3.1.2.2	Added requirement describing schedule access	Additional detail, issues discussed in elicitation session
3.1.3	Added more specific details about the bus display screen and what functionality it will have	Elicitation session
3.1.3.2	Output will be a csv file.	Issue List in RS1.1
3.1.3.2	Stated that passenger exit data is calculated using the amount of time the door is open for.	Agreed during negotiation
3.1.3.2	Fields will include date, bus route, bus stop, and boarding passengers.	Issue List in RS1.1
3.1.3.2	Fields “exiting passengers” and “total passengers” will not be included	Requested in Issue List in RS1.1, however, there is no mechanism for counting exiting passengers
3.1.3.2	Added clarification that passenger data would be sent along with positional data every 30 seconds	Clarification
3.1.3.3	Removed “in 14 point font.”	Deemed unnecessary
3.1.6	Added section for trip planning	Issue List in RS1.1 required that trip planning be consistent for web site and kiosk
3.1.6.7	Expanded to 3.1.1.7 to 3.1.1.7 – 3.	Issue List in RS1.1
3.1.6.1	Deleted section	Deemed unnecessary
3.1.6.5	Replaced two with two or more	Issue List in RS1.1
3.1.6.5	Combined section 3.1.2.5 and 3.1.2.6	Prototype suggested it would be better to

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		combine these features
3.1.6.6	Removed “readable”	Issue List in RS1.1
3.1.6	No change. We will use TCP, and assume it will ensure signals will never be invalid, corrupted, or lost.	Issue List in RS1.1
3.1.3.3	Clarified route schedule is for current route	Issue List in RS1.1
3.1.4.1	Added audio alert	Issue List in RS1.1
3.1.4.2	Clarified what data is sent and how it is stored	Issue List in RS1.1
3.1.5	Touch tone phone needed.	Issue List in RS1.1
3.1.5	User can speak with live operator if user does not have touch tone phone, or requires additional assistance	Issue List in RS1.1
3.1.5.1	User can select route name	Issue List in RS1.1
3.4.2	Changed non-positional to passenger	Issue List in RS1.1
3.4.5	Added section for database size	Issue List in RS1.1

6.2 Changes From RS 2.0 → RS 3.0

2.1.3.3	Changed the phrase “real-time” to “last reported position”	Issue List in RS2.1
3.1.1	Clarified that realtime map shows the last reported position of each bus	Issue List in RS2.1
3.1.1	Added detail about setting a default location on a kiosk during installation	Issue List in RS2.1
3.1.1.1	Changed title from “Inactivity” to “Returning to Main Screen” and added additional detail	Issue List in RS2.1
3.1.1.3	Changed output from “The arrival time for the next bus...” to “The estimated time until arrival for the next bus...”	Issue List in RS2.1
3.1.1.4	Added as input that user must select the Bus Schedule option from the main screen	Issue List in RS2.1
3.1.1.4	Section removed because of redundancy	Issue List in RS2.1
3.1.1.5	Added as input that user must select the Bus Schedule option from the main screen	Issue List in RS2.1
3.1.2	Added detail about lightweight version of site	Issue List in RS2.1
3.1.3	Added that current time should be displayed on driver screen	Issue List in RS2.1
3.1.3.3	Driver display will show next 3 stops instead of next 5, as agreed upon in elicitation	Issue List in RS2.1
3.1.3.4	Added requirement describing connecting bus information feature	Feature discussed but previously undocumented
3.1.3.4	Stop at which connection will take place will be displayed as output	Issue List in RS2.1
3.1.4.2	Removed processing section	Deemed unnecessary
3.1.4.7	Changed the phrase “live bus locations” to “the last reported position of each bus”	Issue List in RS2.1
3.1.4	Added error conditions for user input	Issue List in RS2.1
3.1.4	Added confirmation that user action has taken place successfully	Issue List in RS2.1
3.1.4	Added that system will display a list of all categories and landmarks within these categories while in change mode	Issue List in RS2.1
3.1.4.1	Changed input to “Head office will send information about a disruption over the network, along with an alternate route for the driver to take” and removed processing section	Processing section deemed unnecessary
3.1.4.2	Deleted	Redundant section, as

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		this information was already covered in 3.1.3.2
3.1.4.2	Changed the term “live” to “last reported position”	Issue List in RS2.1
3.1.4.3	Added the requirement that administrators be able to create and modify landmarks	Agreed during negotiation
3.1.4.3	Added the requirement that administrators be able to create landmark categories	Agreed during negotiation
3.1.4.4	Added the requirement that administrators be able to rename landmark categories	Agreed during negotiation
3.1.4.5	Added the requirement that administrators be able to add landmarks to landmark categories	Agreed during negotiation
3.1.4.6	Added the requirement that administrators be able to remove landmarks from categories	Agreed during negotiation
3.1.4.7	Added requirement that administrators can access live bus location from head office	Feature previously discussed but never documented
3.1.4.8	Added requirement that an administrator should be able to add a route to the system	Use case for this situation previously existed, but a requirement was never documented
3.1.6.1	Added more detail about user input and defaults, and made some fields optional	Issue List in RS2.1
3.1.6.3	Removed unnecessary information regarding storage	Issue List in RS2.1
3.1.6.3	Noted that a single trip could satisfy one, two, or even all three of the cases	Issue List in RS2.1
3.1.6.4	Added that the list of trips will be sorted in chronological order	Issue List in RS2.1
3.1.6.4	Added the direction of travel to walking instructions	Issue List in RS2.1
3.1.6.4	Added Start Position and Destination to bus trip instructions	Issue List in RS2.1
3.1.6.4	Added kiosk display to output	Issue List in RS2.1
3.2.3	It should take a new user 3 minutes to get required information	Issue List in RS1.1
3.3	Added warning notice to head office	Issue List in RS1.1
3.3	Allow user to retry requests that take longer than 3 seconds	Issue List in RS1.1
3.3	Revised limitations on system downtime	
3.4.3	Changed notice of a connecting bus from 30 seconds to 5 minutes	Issue List in RS2.1
3.4.3	Changed interval with which a bus will receive information about a connecting bus from every 15 seconds to every 30 seconds	Issue List in RS2.1
3.9.1.1	Retained design of kiosk	Design is important
Appendix 1	Complete appendix added to describe typical use cases	Added to help facilitate understanding of system
Appendix 2	Complete appendix added to describe prototype kiosk (this is the kiosk prototype shown in a previous presentation to MetroLink with some additions and modifications)	Added to help facilitate understanding of system
3.1.6.4	Added map diagram to trip planner output.	Issue list in RS2.1
3.6.1	Added support for MacOS 9.2.* - Mac OSX	Issue list in RS2.1
3.9.2	Editing hardware device list and added descriptions	Issue list in RS2.1
Appendix 2	Renumbered items to make them consistent with numbering scheme in rest of document	Issue list in RS2.1

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Appendix 2	Updated with new kiosk screens, added schedule mode description	Update to make consistent with prototype
3.1.1	Removed reference to post installation setup because our design no longer requires kiosks to have their location set.	Results of RS 2.0 inspection
3.1.1.1	References to handling of inactivity has been moved to its own requirement	Results of RS 2.0 inspection
3.1.1.1	Added rationale for return to main screen button	Results of RS 2.0 inspection
3.1.1.2	New requirement Handling inactivity seperated from 3.1.1.1	Results of RS 2.0 inspection
3.1.1.2	Added rationale for automatic to return to main screen	Results of RS 2.0 inspection
3.1.1.2	Added rationale for prompting before returning to main screen	Results of RS 2.0 inspection
3.1.1.3	Clarified to state that the main screen should	Results of RS 2.0 inspection
3.1.1.4	New requirement: The main kiosk screen will display options for route planning, route schedules, and the real time map.	Results of RS 2.0 inspection
3.1.1.5	New requirement: Display current day and time on all screens	Results of RS 2.0 inspection
3.1.1.6	Removed - all content of 3.1.1.6 is now covered in 3.1.1.3	Make document more readable
3.1.1.6	New requirement: Each kiosk has a unique kiosk Identification code	Results of RS 2.0 inspection
3.1.1.7	Schedule Information is now a requirement separate from the Kiosk	Results of RS 2.0 inspection
3.1.1.8	Map Display is now a requirement separate from the Kiosk	Results of RS 2.0 inspection
3.1.7.1	New requirement: Schedule Information - Main screen	Results of RS 2.0 inspection
3.1.7.2	New requirement: Schedule Information - Default Bus Schedule Listing	Results of RS 2.0 inspection
3.1.7.3	New requirement: Schedule Information - Generalized Bus Schedule Listing	Results of RS 2.0 inspection
3.1.6.1	Added a rationale for the requirement	Results of RS 2.0 inspection
3.1.6.2	Focused on handling missing data	Results of RS 2.0 inspection
3.1.6.3	New requirement for handling invalid data	Results of RS 2.0 inspection
3.1.6.4	Reworded the requirement to make it more readable.	Results of RS 2.0 inspection
3.1.6.5	Trip Planning Route Summary - Explained handling of trips where there is only one possible route	Results of RS 2.0 inspection
3.1.1.1 - 3.1.1.6	Test Scenario added to requirement	Requirement of RS 3.0
3.1.6.1 – 3.1.6.4	Test Scenario added to requirement	Requirement of RS 3.0
3.1.7.1- 3.1.7.9	Test Scenario added to requirement	Requirement of RS 3.0

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7. Appendix 4: Requirements Inspection (by Metro Link)

A4.1 Summary Report

Overall, the RS incorporates the most recent version of most of the requirements. In most cases clear distinction has been made between functions and data by listing product features in section 3 and by separating the functional requirements into description, input, process, and output. Furthermore the requirements have been stated in a way that shows how they can be tested – most of the features can be tested through a user interface.

We did find there to be some areas where requirements for requested features had been omitted or incomplete. A few requirements that arose from the negotiations failed to appear in the document, and have been commented on below, but overall the requirements are shaping nicely.

We found that some items say to be determined (such as the components requiring purchase), these are not clear and should be further developed.

Some of the use cases were not very clear as to what the purpose was, and many were missing alternative scenarios.

In addition to the above issues, the following section details the particular sections of the RS that we found issues with and provides further information on the features we require for the system.

Thank you!

A4.2 Issue List

Priority Scale:

- 1 – low priority
- 3 – high priority

Section in Document	Description	Priority
General	Your use of the word real-time is ambiguous. How is this different from sampling every 30 seconds.	2
2.1.1.1	Which parts of the UI are available on the kiosk, and which are not? How are the parts not accessible through the kiosk used.	2
2.1.1.2	i* diagram is confusing.	1
3.1.1	There is no mention in this section of how the default location for each kiosk will be set during time of installation.	3
3.1.1	Requirements do not all start from the same location for user input. Some describe input starting at main menu (ie. 3.1.1.6), some start with user inputting route (ie. 3.1.1.5).	3
3.1.1.1	Is the option displayed allowing users to return to the main menu only after a period of inactivity or perhaps is this statement in the wrong section? Ideally, the start over button would appear on every screen.	2
3.1.1.3	Under output, is the arrival time the time until arrival or ETA (4 minutes) or time of arrival (3:22 pm). We would prefer the former to be consistent with requirement 3.1.1.2.	3
3.1.1.4	Redundant (covered in 3.1.1.5)	1
3.1.1.5	Not very concise about different options available to user (lists two options in first sentence, then two more in the second sentence.)	1

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3.1.1.6	Default map should have kiosk location in center, and default filters should include routes passing by kiosk.	3
3.1.1.6	Incomplete requirements for map display. No mention of route filtering or default display.	3
3.1.2	Light weight version of site should not remove any features, but be optimized for wireless transfer (less data transfer by smaller file sizes and fewer images). To allow for testability, the average page should less than 5 KB.	3
3.1.3	Conflicting information: Overall description says display shows next three stops, 3.1.3.3 says next five stops. We agreed on next three stops during negotiations.	3
3.1.3	Require current time output on the display for bus drivers to keep pace with the schedule and to know how much time they have to wait for connecting buses.	3
3.1.3.4	Require display of connecting stop so that drivers new to the route know where the connection takes place.	3
3.1.4	None of the requirements in this section address error conditions with user input (ie. duplicate landmarks).	1
3.1.4	We require the system to display a list of all landmarks and categories when in change mode so they can see what is there and delete existing landmarks.	2
3.1.4.2	The GPS data is updated every 30 seconds (not live).	2
3.1.4.3	Missing information: System should confirm that the landmark has been added (output).	1
3.1.4.4	Missing information: System should confirm that a new landmark category has been added.	1
3.1.4.5	Missing information: System should confirm the addition of a landmark to a category.	1
3.1.6	Descriptions are not requirement descriptions. These are preconditions.	1
3.1.6.1	Input should be optional on trip planning screen (except for destination, and start location if not accessing from a kiosk). By default the departure time will be the current time, and the start position will be the location of the kiosk (if accessing from kiosk).	3
3.1.6.1	Should be departure and/or arrival time. Some people may only care about when they leave, some only when they arrive.	2
3.1.6.2	Blank fields should also be treated as error conditions.	2
3.1.6.3	The manner of storage of the multitude of possible routes (in a list) is extraneous information. It only needs to be stated that it computes and selects the optimum routes based on walking distance, total trip time and fewest number of transfers.	1
3.1.6.3	It should be noted that these trips don't have to be unique (one trip could fit in one, two or all three of these categories).	3
3.1.6.4	Sorted by departure time: it should be clarified that this will be in chronological order, as opposed to, say, descending order (backwards).	3
3.1.6.4	Walking instructions are not clear enough. Start and destination is not sufficient, direction of travel is needed (ie, north on Douglas two blocks, turn west on Yates, etc.). Start and destination may be sufficient for someone who knows a lot about the city, but visitors will be lost.	3
3.1.6.4	Bus directions missing endpoint. There is no indication of what stop to get off the bus.	3
3.1.6.4	"Trip" is a vague term used ambiguously to describe both the whole route as well as one of the many sections of the route.	2
3.1.6.4	Output is not just web browser, but kiosk as well.	2
3.1.6.4	It may help to include an example of the output in this section for clarity's sake.	1
3.1.6.4	It would be beneficial to display the route graphically on a map as well (as in the prototype).	2
3.3	The kiosks need to be operational 5am-3am with an active network connection during that time. Any more than 15 minutes of downtime in one day is unacceptable (excluding the normal offline time from 3am to 5am).	2
3.4.3	If bus positions are sent every 30 seconds, receiving ETA every 15 seconds is	3

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	unnecessary. In addition, we require more than 30 seconds notice for connecting buses, 5 minutes is reasonable.	
3.4.4	Although it is not likely we will have more than 1000 buses running it could eventually happen in the future. Please provide information for what would need to be done to support more buses.	1
3.6.1	We require that both Mac OS 9.2.* and Mac OS X machine are supported.	2
3.9.2	List formatted poorly, initially thought touch screen was listed twice. Description of explicitly what each hardware device does may be helpful.	3
3.9.3	What software will be providing csv formatted data? Do most data management systems support exporting data in this format?	2
5	Please inform users that the times displayed are estimates.	2
5	Numbering is inconsistent with the rest of the document (you should use A2.1.0 or 5.1.0, not simply 1.0).	2
5 – 3.0	If the map is zoomed out and many busses are viewable to be filtered, the list of busses on the right side of the screen may become unmanageable. Perhaps a hide-able popup window would be a solution?	2
5	We have requested that a clock with the current time be displayed on all screens.	3

A4.3 Use Case Analysis

4.1 User Accesses Trip Planning Feature:

1. Main scenario:
 - Step 1: How is the case where user use website to make trip plan handled?
 - Step 3: Same as what 2.a is talking about.
 - Step 6: How are errors in input handled, for example, no destination entered? How does the system respond if user wants to make trip plan?
2. Alternate scenario:
 - Step 2.a.2: How to return to the main scenario? Does the system return to main screen automatically? How to deal with the case if user typed wrong location, would system allow user to edit?

4.2 User Accesses Full Schedule

1. Main scenario:
 - Step 1: This should be accessible both on the kiosk and website.
 - Step 1: What happens after user accesses this step? How do the two option come out?
 - Step 2: This step is not a response for the 1.b. How does the system respond to 1.b?
 - Step 6: How can user change to search another bus route?
2. Alternate scenario:
 - 2.a: Where does 2.a reference?
3. We want to make sure a user can check the bus schedule similar to what is presently done, and also allow user to check the schedule on kiosk, website and even some wireless. How to deal with this case?

4.4 On-Board Bus Display (Schedule information and Connecting Bus Information)

1. Main scenario:
 - Step 4: Explain how the display know if it passed the connection point?

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8. Appendix 5: Traceability Matrices

	RA1: Return To Main Screen	RA2: Display Warning	RA3: Reset Screen	RA4: View Approaching Busses	RA5: Functionality Accessible	RA7: Schedule Information	RA8: Map Display	RA9: Trip Planning	RA13: Kiosk Should Be...	RA14: User Can Use Kiosk	RA16: Date And Time	RA17: Kiosk Identification	RA18: Default Time	RA19: Kiosk Default Location	RA20: Default routes shown	RA21: Route Labeling	RA22: Display of bus location	RA23: Updates frequency	RA24: Show/Hide routes	RA25: Response Time	RA26: Maximum data age	RA27: System Warnings
RQ1: Return To Main Screen	↗																					
RQ2: Display Warning		↗																				
RQ3: Reset Screen			↗																			
RQ4: View Approaching Busses				↗																		
RQ5: Functionality Accessible Main...					↗																	
RQ7: Schedule Information						↗																
RQ8: Map Display							↗															
RQ9: Trip Planning								↗														
RQ10: Information Prompts								↗														
RQ11: Handling Invalid Data								↗														
RQ12: Processing Trip Planning Data								↗														
RQ13: Three Minutes To Learn Kiosk									↗													
RQ14: Find Next Arriving Bus Within 15..									↗													
RQ15: Using Any Feature Should Take...									↗													
RQ16: Kiosk Operational Between...										↗												
RQ17: No More Than 15 Minutes...										↗												
RQ20: Route Summary								↗														
RQ26: 10 seconds to view any bus				↗																		
RQ27: Date And Time											↗											
RQ28: Kiosk Identification												↗										
RQ29: Default Time													↗									
RQ31: Kiosk Default Location														↗								
RQ32: Missing Data								↗														
RQ33: Schedule Main Screen						↗																
RQ34: Default Bus Schedule Listing						↗																
RQ35: Generalized Bus Schedule Listing						↗																
RQ36: Default routes shown															↗							
RQ37: Route Labeling																↗						
RQ38: Display of bus locations																	↗					
RQ39: Updates frequency																		↗				
RQ41: Show/Hide routes																			↗			
RQ42: Response Time																				↗		
RQ43: Maximum data age																					↗	
RQ45: System Warnings																						↗

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	RQ1: Return To Main Screen	RQ2: Display Warning	RQ3: Reset Screen	RQ4: View Approaching Busses	RQ5: Functionality Accessible Main...	RQ7: Schedule Information	RQ8: Map Display	RQ9: Trip Planning	RQ10: Information Prompts	RQ11: Handling Invalid Data	RQ12: Processing Trip Planning Data	RQ13: Three Minutes To Learn Kiosk	RQ14: Find Next Arriving Bus Within	RQ15: Using Any Feature Should Take	RQ16: Kiosk Operational Between...	RQ17: No More Than 15 Minutes...	RQ20: Route Summary	RQ26: 10 seconds to view any bus	RQ27: Date And Time	RQ28: Kiosk Identification	RQ29: Default Time	RQ31: Kiosk Default Location	RQ32: Missing Data	RQ33: Schedule Main Screen	RQ34: Default Bus Schedule Listing	RQ35: Generalized Bus Schedule Listing	RQ36: Default routes shown	RQ37: Route Labeling	RQ38: Display of bus locations	RQ39: Updates frequency	RQ41: Show/Hide routes	RQ42: Response Time	RQ43: Maximum data age	RQ45: System Warnings
RQ1: Return To Main Screen																																		
RQ2: Display Warning																																		
RQ3: Reset Screen																																		
RQ4: View Approaching Busses																																		
RQ5: Functionality Accessible Main...																																		
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	T1: Return To Main Screen	T2: Display Warning	T3: Reset Screen	T4: View Approaching Busses	T5: Functionality Accessible Main Screen	T8: Map Display	T10: Information Prompts	T11: Handling Invalid Data	T13: Three Minutes To Learn Kiosk	T14: Find Next Arriving Bus Within 1	T15: Using Any Feature Should Take	T16: Reliability	T20: Route Summary	T26: Max Scrolling Time 10 Seconds	T27: Current Time Displayed	T29: Kiosk Identification	T30: Default Time	T31: Kiosk Default Location	T32: Missing Data	T33: Schedule Main Screen	T34: Default Bus Schedule Listing	T35: Generalized Bus Schedule Listing	T36: Default routes shown	T37: Route Labeling	T38: Display of bus locations	T39: Updates frequency	T40: Show/Hide routes	T41: No More Than 15 Minutes Down	T42: Response Time	T43: Maximum data age	T44: System Warnings
RQ1: Return To Main Screen	✓																														
RQ2: Display Warning		✓																													
RQ3: Reset Screen			✓																												
RQ4: View Approaching Busses				✓										✓																	
RQ5: Functionality Accessible Main...					✓																										
RQ7: Schedule Information																				✓	✓	✓			✓						
RQ8: Map Display						✓															✓	✓	✓	✓	✓	✓					
RQ9: Trip Planning								✓	✓																						
RQ10: Information Prompts								✓																							
RQ11: Handling Invalid Data								✓																							
RQ12: Processing Trip Planning Data													✓																		
RQ13: Three Minutes To Learn Kiosk									✓																						
RQ14: Find Next Arriving Bus Within 1										✓																					
RQ15: Using Any Feature Should Take											✓																				
RQ16: Kiosk Operational Between...												✓																			
RQ17: No More Than 15 Minutes...																											✓				
RQ20: Route Summary													✓																		
RQ26: 10 seconds to view any bus														✓																	
RQ27: Date And Time															✓																
RQ28: Kiosk Identification																✓															
RQ29: Default Time																	✓														
RQ31: Kiosk Default Location																		✓													
RQ32: Missing Data																			✓												
RQ33: Schedule Main Screen																				✓											
RQ34: Default Bus Schedule Listing																					✓										
RQ35: Generalized Bus Schedule Listi																						✓									
RQ36: Default routes shown																							✓								
RQ37: Route Labeling																								✓							
RQ38: Display of bus locations																									✓						
RQ39: Updates frequency																										✓					
RQ41: Show/Hide routes																											✓				
RQ42: Response Time																													✓		
RQ43: Maximum data age																														✓	
RQ45: System Warnings																															✓