

Centralized Traffic Control Graphical User Interface Software Requirements Specification

Version 1.0

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PAAC Demonstration System

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# Introduction

## Product Overview

The final system will be a software prototype of a Centralized Traffic Control (CTC) Center and Signaling System for a light-rail passenger transit system. It is intended for use by the North Shore Extension of the Port Authority of Allegheny County (PAAC).

## Purpose

The purpose of this document is to define a set of requirements that will dictate all of the functions and features for the CTC Graphical User Interface (GUI)

## Scope

The scope of this document includes and the requirements applicable to the CTC GUI and its interfaces with other components of the train control system.

## Reference

1. IEEE-830 Software Requirements Specification
2. NSC-009 PAAC Bid Package

## Definitions and Abbreviations

**Authority** – How far in distance the train is permitted to travel.

**Block** – A section of a railway line

**CTC** – Centralized Traffic Control

**GUI** – Graphical User Interface

**Setpoint** – The speed suggested to a train by a CTC operator

# Overall Description

## Product Perspective

The Train Control System for Port Authority Allegheny County (PAAC) North Shore Connector enables the CTC Office to view the data and status of trains and tracks graphically and send control commands to trains and tracks. The context diagram below illustrates the external entities and relationships.

Figure 1: Context Diagram

## 

## User Characteristics

### Transit System Controller

This user’s role is to suggest speed, authority, and routes to trains, and to control various track components in the transit control system.

### Train Scheduler

This user’s role is to schedule trains, including their departure station, departure time, and destination.

### Track Maintainer

This user’s role is to add or remove track, or close track for maintenance.

### Observer

This user’s role is to view the transit control system in a read-only mode.

## Assumptions and Dependencies

### The CTC office GUI is dependent on track component and train information provided by the track controller interfaces

### The CTC office GUI is dependent on the communication interfaces provided by the track controllers to forward suggestions to track components and trains

### The CTC office GUI track editor is dependent on the track library to implement algorithms on the designed track to ensure coherency of the designed track layout

# Specific Requirements

## External Interface Requirements

### Software Interfaces

#### The CTC shall directly interface with track controllers as a means of indirect communication to track components and trains

#### Track components shall include, but are not limited to, track blocks, track switches, train stations, tunnels, and railroad crossings

#### Track Controllers shall provide an interface to the ctc for the following operations:

#### Retrieving the physical location of the track controller in (x,y) coordinates

#### Retrieving a list of all track blocks and components managed by the track controller

#### Retrieving the length of specific given track block managed by the track controller

#### Retrieving the physical location of a specific track component managed by the track controller in (x,y) coordinates

#### Retrieving and suggesting the current signal status of all track blocks managed by the track controller (Red, Yellow, Green, Super Green)

#### Retrieving and suggesting the current switch direction of track switches managed by the track controller

#### Retrieving and suggesting the open or closed state of railroad crossings managed by the track controller

#### Retrieving the position of a specified train in (X,Y) coordinates

#### Retrieving the number of train cars composing a specified train

#### Retrieving the number of passengers on a specified train

#### Retrieving the estimated mass of a specified train

#### Retrieving and suggesting the speed of a specified train

#### Retrieving and suggesting the authority of a specified train

#### Retrieving and suggesting the planned destination of a specified train

#### Retrieving and suggesting the planned route of a specified train

#### Retrieving and suggesting the status of a specified train’s passenger doors (open/closed)

#### Retrieving and suggesting the external lights status of a specified train (i.e. headlight for tunnels and dark areas)

### Communications Protocols

#### Communication shall be passed from module to module as follows:

##### CTC office to track controller

##### Track controller to Track block

##### Track controller to Train controller

##### Train controller to train

### Memory Constraints

#### The running process of the CTC GUI shall not consume more than 2 GB of memory on the host machine at any time

### Product function

The CTC GUI software will function as the top-level interface to the prototype PAAC North Shore Extension transit system simulation. The CTC office is responsible for monitoring the transit system and providing an interface between human operators and the transit system.

## Software System Attributes

### Reliability

#### The CTC office GUI shall reliably be capable of performing its designed functions at all times while the program is running

#### The CTC office GUI shall handle all software exceptions in a contained manner, taking a safe action and attempting to recover when possible

#### The CTC office GUI shall not “crash” due to an unhandled exception at any time

### Security

#### The CTC office GUI shall prompt for user authentication consisting of a username and password when the program starts

#### The user shall not be able to view transit system information or send commands to track controllers until the user has been successfully authenticated

#### Failed user authentication shall result in denial of access, and a re-prompt for user authentication

### Portability

#### The CTC office GUI shall be capable of running on a machine with Microsoft Windows XP or later with the Microsoft .Net Framework 4.0 or later installed, at least 2 GB of RAM, a monitor, mouse, and keyboard

### Performance

#### The GUI display shall refresh the screen at least twice per second to ensure the displayed information is accurate

#### Any user interactions with the GUI (e.g. button presses) shall cause the system to respond within one second of the user action

## Database Requirements

### Configurable information

#### The CTC office GUI shall maintain configuration settings on disk that are retained through closure and re-opening of the GUI and system power cycles

#### Configuration settings shall include, but are not limited to:

#### Measurement standard on the GUI (Metric or Imperial)

#### Simulation speed

#### Scheduling mode (automatic, user confirmation, or manual)

### User authentication information

#### The CTC office GUI shall maintain a database of Usernames and passwords for user authentication

#### Usernames and passwords stored on disk shall be encrypted such that they are not human-readable without the appropriate decryption algorithm

## GUI Requirements

### Layout

#### The CTC office GUI main screen (henceforth “main screen”) shall display the track, track components, and trains in a panel occupying the majority of the screen, reffered to as the track display

#### The main screen shall display information related to the currently selected track component or train (henceforth “component”) in a panel occupying the lower portion of the screen, referred to as the information display

#### The main screen shall display possible actions related to the selected component in a panel occupying the right portion of the screen, referred to as the action display

#### The main screen shall display checkboxes for toggling the display of the track, track components, and trains in a panel occupying the lower right corner of the screen, referred to as the view control display

### Track display

#### The track display shall display the transit system track layout in a semi-geographical fashion

#### Track blocks shall be displayed as a thick line proportional to the length of the block

#### Track blocks shall be colored according to the current signal state of the block (red, yellow, green, super green)

#### Track blocks shall be separated by visible empty space to indicate the end of a block and the beginning of a new block

#### Track switches shall be displayed as the intersection of exactly three track blocks with a thin circle around it

#### Railroad crossings shall be displayed as an X with R’s on opposite sides horizontally and a circle surrounding it, similar to the image below:

#### 

Figure 2: Railroad Crossing icon

#### Train stations shall be displayed as a black rectangle proportional to the size of the station

#### Trains shall be displayed as an icon resembling a transit train with a circle around it, similar to the image below:



Figure 3: Train Icon

#### Tunnels shall be displayed as icons on each end of the tunnel resembling a tunnel entrance connected by a dotted line, similar to the image below:



Figure 4: Tunnel Icon

#### Track controllers shall be displayed as a square icon with the first letter of the controller name in the middle, similar to the image below:



Figure 5: Track controller icon

#### When a train is selected, the track blocks associated with the planned route of the train shall display a small colored dot to indicate the planned route

#### When a track controller is selected, each track block managed by the selected controller shall display a small colored dot to display the range of the track controller

#### The track display shall allow the user to select track components or trains by single-clicking on them

#### The selected component shall toggle between its normal color and white, changing colors every 500 ms

### Information Display

#### The information display shall be statically sized and large enough to display all the information regarding the selected component using a consistent font size

#### If no component is selected, the information display shall be blank, with the exception of a label denoting the information display

#### The information display panel shall display the name of the selected component centered horizontally at the top of the panel

#### The information display panel shall display all information regarding the selected component in a bulleted format in no more than three columns, depending on the amount of information to be displayed

#### The information display panel shall display all information regarding the selected component in the format “Label: Value”

#### If a piece of information received by the CTC GUI regarding the selected component is unknown or otherwise invalid, the value shall display “UNKNOWN”

#### Distances, speeds, and any other data requiring a unit of measurement shall be in the measurement standard specified in the system configuration (Metric or Imperial)

### Action Display

#### The action display shall be statically sized and large enough to display all the possible actions regarding the selected component using a consistent button size

#### If no component is selected, the action display shall be blank, with the exception of a label denoting the action display

#### The action display shall display all the possible actions regarding the selected component, and no other actions regarding any other component

#### When a train is selected, the action display shall provide an option to show or hide the planned train route on the track display

#### When a track controller is selected, the action display shall provide an option to show or hide the range of the track controller on the track display

#### If necessary, pressing an action button shall display a popup window to request additional information from the user. Additional information may include a text box for entering an alphanumeric value, or radio buttons for selecting from a fixed set of options.

#### Popup windows for additional information shall have an OK and a Cancel button.

##### Pressing the OK button will attempt to take the requested action.

##### If the value entered is invalid, the popup shall display text indicating to the user that the value is invalid and the popup shall remain open

##### If the value entered is valid, the popup will be dismissed and the action request will be sent to the appropriate destination (e.g. the track controller)

##### Pressing the cancel button will dismiss the popup without taking any action

### View Control Display

#### The view control display shall display checkboxes for track, railroad crossings, trains, tunnels, and train stations

#### Checking or unchecking a checkbox shall update the track display immediately with the appropriate components. A checked box indicates the corresponding components should be displayed, and an unchecked box means to hide the corresponding components

#### When a component is selected, the view control display shall display a button to unselect all elements. Pressing the unselect button will unselect all elements.

### Routing Trains

#### The CTC GUI shall provide the ability to suggest routes to trains via an action button in the action display

#### While in the train routing mode, track blocks on the track display shall display a colored circle if part of the planned route, or an empty circle if not part of the planned train route

#### While in the train routing mode, clicking components in the train display shall not select the component

#### While in the train routing mode, the action display shall provide options to suggest the displayed route, or to cancel route editting

##### If the displayed route is contiguous and valid, clicking the suggest button shall immediately suggest the displayed route to the selected train and exit train routing mode

##### If the displaye route is not contiguous or is otherwise invalid, a popup shall be displayed to the user indicating the route is invalid, and the train routing mode shall remain open

#### While in train editing mode, clicking track blocks shall toggle the inclusion of that track block on the displayed train route

### Scheduling Trains

#### The CTC GUI shall provide access to the train scheduler via a drop-down menu at the top of the screen

#### Opening the train scheduler shall open a new window containing a table of the scheduling information

#### If the scheduling information does not fit in the window, a verticle scrollbar shall be provided on the window to scroll through the entires

#### The scheduling table shall display columns for the train name, departure station, departing time, destination, and recurrence

#### Each schedule entry shall contain information in every cell of the row, with the exception of recurrence which may be “NONE”

#### Each schedule entry shall provide options to edit or delete the entry on the right side of the entry row

#### When the edit button is clicked, the schedule entry shall be highlighted and allow editing of the entry information

##### When editting a schedule entry, the edit button shall be replaced with an OK button, and the delete button shall be replaced with a Cancel button

##### The OK button shall check the schedule entry for validity, save the changes if valid, and exit editting mode

##### If the entry data is valid, a popup shall be displayed indicating to the user that the entered data is invalid, and editting mode shall remain open

##### The cancle button shall revert any changes to the schedule entry and exit editting mode

##### The train, departure, and destination fields shall allow selection from a drop-down menu of valid trains and stations

##### The departure time shall be entered via keyboard and must be entered in hh:mm am/pm format

#### Pressing the delete button shall display a popup with an OK and Cancel button to confirm deletion of the schedule entry

##### Pressing the OK Button will remove the entry from the table and close the popup

##### Pressing the Cancel button will close the popup without deleting the schedule entry

#### The scheduler window shall provide a button to add new schedule entries

#### Pressing the add button shall create a new entry in the table which is highlighted and editable

#### The behavior of adding a new entry shall be identical to editting an existing entry, except that the fields are initially blank

#### Editing or adding a schedule entry shall immediately calculate and send a suggested route to the affected train

### Simulation

#### The transit control simulation shall run at the speed specified in the system configuration

#### When the scheduling mode is set to automatic in the system configuration, the CTC shall automatically send a suggestion to trains to depart from their scheduled stations at the scheduled simulation departure time when possible

#### When the scheduling mode is set to user confirmation in the system configuration, the CTC shall display a popup to the user at the scheduled simulation departure time

#### The popup shall display the train name, departing station, and departure time, and a prompt to dispatch the train or cancel the dispatch

##### Confirmation of the dispatch shall dismiss the popup and send a suggestion to the train to depart from the station

##### Cancellation of the dispatch will dismiss the popup and will not send a suggestion to the train

### Track Editing

#### The CTC GUI shall provide access from a drop down menu to load stored track and simulation configurations from disk

#### Loading a track configuration shall immediately update the track display with the track layout and initial train states

#### Track configurations shall be editable in human-readable text files created outside of the GUI (e.g. in Notepad)