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**USER’S**

**MANUAL**

***Train Trax Navigation System***

**CPE 658: Software Studio II**

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**USER'S MANUAL**

**TABLE OF CONTENTS**

1.0 Purpose 5

2.0 General Information 5

2.1 System Overview 5

3.0 System Summary 5

3.1 System Configuration 5

4.0 GETTING STARTED 5

4.1 Motion Detection Unit (MDU) 5

3.2 Train Navigation Database 6

3.3 Train Navigation Service 6

3.4 Installation 6

Installing Motion Detection Unit (MDU) hardware 6

Install Dependencies 6

Procedure 6

Installing TrainTrax Android App 8

Install Dependencies 9

Default Settings 9

Train Navigation Service / Train Navigation Database Setup 9

Train Trax App Setup 10

Database Data Uninstall 11

5.0 USING the APPLICATION 12

4.1 Settings 12

4.1.1 Edit Database Port Number 12

4.1.1 Edit Service Port Number 12

4.1.2 Edit IP Address 12

4.1.3 Save Settings 13

4.2 Main Menu View 13

4.3 Train Monitor View 13

4.3.1 Track Diagram 14

4.3.2 Track Switches 14

4.3.3 Train Position 15

[Figure 1. Settings Menu 7](#_Toc449450974)

[Figure 2. Main Menu View 8](#_Toc449450975)

[Figure 3. Train Monitor View 9](#_Toc449450976)

[Figure 4. Track Switch icons 9](#_Toc449450977)

[Figure 5. Switch State change from Pass to Bypass mode 10](#_Toc449450978)

[Figure 6. Train Position Icon 10](#_Toc449450979)

# Purpose

The purpose of this document is to provide the user information about how to operate each of the components of the Train Trax project. It is intended to describe the procedure of how to set up the system to operate properly as well as give a description of the implemented functionality. The step-by-step instructions will allow a user unfamiliar with the software to follow the manual and be able to build, install and start operating the software.

# General Information

## System Overview

The Train Trax App is an Android application that displays a diagram of a train track system including all associated track segments and switches from a pre-load loaded database train coordinate system. The Train Trax application monitors and displays position of trains that are moving on the loaded track diagram. The Train Trax App receives coordinate information about the points located on the track diagram from the Train Navigation Database and then takes that information to build a display of the track diagram. Position updates are received from the Train Navigation Service which are used to display the actual position of the train for a display the track and associated switches. The Train Trax Android App can also control switches on the track when the user selects a switch on the display.

# System Summary

## System Configuration

The Train Trax App operates on mobile devices with Android operating system. It is compatible with Android 4.0 API level 15 and higher versions but may also run on versions below that. The App has been optimized specifically to run on the HP Slate mobile device for the displaying of Train Track information in UAH’s Train Lab, which runs on Android 4.0 Jelly Bean (API 15). The application requires a connection to Internet in order to connect to the Train Navigation Service and Train Navigation Database, to receive and send data. After installation on an Android device, additional port number and IP configuration is required to ensure that Train Trax App can connect to the Train Navigation Service and Train Navigation Database.

# GETTING STARTED

## Motion Detection Unit (MDU)

The Motion Detection Unit is the hardware module that is actually mounted in the car of a train whose position you want to monitor. The Motion Detection Unit consists of hardware and software that runs on each train to sense and report train motion and RFID tag detection to the Train Navigation Database for use by other Train Trax subsystems.

## Train Navigation Database

The Train Navigation Database is used by the Train Trax App to provide it with a layout of the track. The Train Trax App takes a list of Adjacent Point, Track Block, Track Switch, and Track point coordinates to compute and display the overall track layout. The specific format required for Train Trax App to accept this data is described in the Train Navigation Database ICD. An internet connection is required in order to connect to the Train Navigation Database. Setup of the Train Navigation database is required prior to running the app which includes setting the appropriate port and IP address under the Main Settings window in the Train Trax App.

## Train Navigation Service

The Train Navigation Service is used by the Train Trax App to receive position updates and control and update the state of the track switches. Once the application is up and running, the initial state of the track switches will be received from the train navigation service. Any time the user clicks a switch, a state change occurs and that state change is sent to the Train Navigation Service. The Train Navigation service also sends position updates for each train position in the track every second. Setup of the Train Navigation service is required prior to running the app which includes setting the appropriate port and IP address under the Main Settings window in the Train Trax App.

## Installation

The Train Trax App can be installed on your Android device by downloading the .apk file onto the device and selecting it to begin the installation process. The .apk file while be included as part of the release but can also be generated when the Train Trax app is compiled, and is stored in the /app/build/outputs folder. Optionally the app will also install if executing the Train Trax Project in Android Studio with the mobile device connected to the computer.

To setup up the Train Navigation and Train Navigation Database to run with Train Trax follow the steps below:

### Installing Motion Detection Unit (MDU) hardware

Below describes what is necessary to open, configure, and program the source code for the MDU.

#### Install Dependencies

* Install Arduino IDE software 1.6.7
* A message will pop up twice asking you to install the Arduino USB Driver. Select yes when this message appears.
* A message will pop up twice asking you to install the libusb Driver. Select yes when this message appears.

#### Procedure

|  |  |
| --- | --- |
| Description | Expected Result |
| 1. Open Arduino 1.6.7 | The Arduino application should start and appear on screen. |
| 1. Open MDU Source Code | Select the File menu and select open. Navigate to the C:/TrainTrax/CPE656TL-master/source/MDUsource/MDU\_2.0 directory. Select and open MDU\_2.0.ino. |
| 1. Configure MDU Source | At the top of the Arduino application, select the config.h tab. Modify the TRAIN\_ID value to the hex value of the MDU hardware’s ID. (e.g. Train 26 should have TRAIN\_ID = 0x1a) |
| 1. Connect the MDU hardware to programming computer | Disconnect the XBee from the horizontal side pins on the Arduino. Connect that FIDI Basic such that the RXI pin connects to the TXO pin on the Arduino. Attach the USB cable to the FIDI Basic and to a USB port on the programming computer. |
| 1. Configure Project for programming | Select the Tools Tab and verify that the Board field lists: “Arduino Pro or Pro Mini” if not select that option under the expansion window. Under the same tab, verify that the Processor field lists: “Atmega328 (3.3V, 8MHz)” if not select it under the expansion window. Record the value of the Port Field as it will be necessary to configure the MDU utility test driver. |
| 1. Prepare the MDU Hardware for programming | Locate the RXI pin on the vertical headers. This pin connects the RFID tag reader to the Arduino, and must be removed to program the MDU. Disconnect this wire. |
| 1. Program the MDU | Select the arrow icon in the top left of the Arduino to begin compiling and programming. |
| 1. Prepare the MDU for use. | When the Arduino application completes programming, as indicated on the status bar in the lower left of the program, reconnect the RFID tag reader pin to the vertical RXI pin of the Arduino. Disconnect the FTDI basic and connect the XBee cable to the horizontal RXI and TXO pins as indicated on the connector. |
| 1. Connecting the battery | Connect the 9v battery to the battery connector. |
| 1. PC Hookup | Connect the computer side XBee to the USB port the FTDI basic was connected to. |

### Installing the Train Navigation Database and Train Navigation Service

#### Install Dependencies

* Run mysql-installer-community-5.7.11.0.msi to install MySQL Server.
* Select the default developer setup configuration.
* Ignore the message about installing Python, just click next to skip that part.
* Use root/root for the defaults when prompted to create an administrator account and password.
* Leave the default DB port to 3306.
* Leave the default host name to localhost.
* When prompted to install drivers, select yes.
* Select MySQL to run as a Windows service (will be the default value).
* Follow the rests of the steps of the installation wizard until you click Finish to complete the installation.
* Run JMRI.4.2.1-R6b48b4.exe to install JMRI.
* Select 'Install for anyone using this computer'.
* Click Next and continue to follow the instructions on the install wizard until you click Finish to complete the installation.
* Unzip CPE656TL-master.zip and move the extracted folder into C:/TrainTrax.

#### Clearing Train Data From the Database

Perform this step only if you need to import a new track geometry data into the database.

Perform the step below then

* root/root are the default credential used for the MySQL Database
* 3306 is the default DB port
* localhost is the default DB host name
* Call clear\_train\_data.bat to remove all of the data in the database
* Windows Firewall may prompt you to allow network traffic for the program, you should allow this so that TrainTrax can communicate.

#### Importing Train Data To the Database

Be sure to perform instructions in section ‘4.4.2.2 Clearing Train Data From the Database’ first

Perform the step below then

* root/root are the default credential used for the MySQL Database
* 3306 is the default DB port
* localhost is the default DB host name
* Call install\_train\_data.bat to add all of the data in the database
* Windows Firewall may prompt you to allow network traffic for the program, you should allow this so that TrainTrax can communicate.

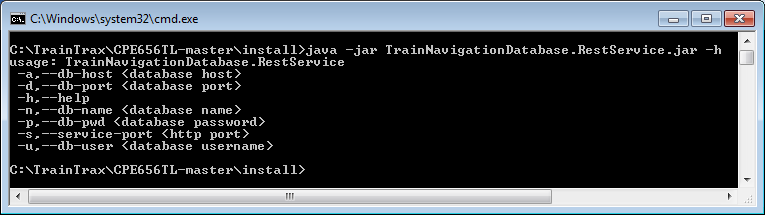


Figure 2 Train Navigation Database Rest Service Commandline Arguments

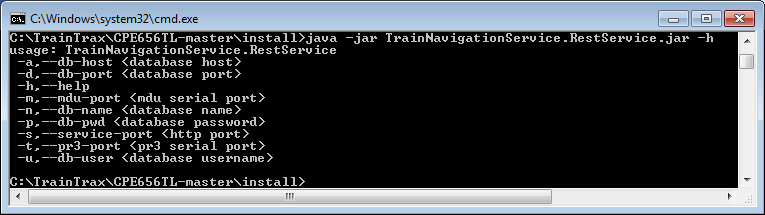


Figure 2 Train Navigation Service Rest Service Commandline Arguments

#### Digitrax PR3 Programming Interface Setup

* Unzip PR3 WindowsXP Vista32\_64.zip to C:\TrainTrax\dependencies\PR3  
  WindowsXP Vista32\_64
* Insert the USB cable attached to the PR3 Programming Interface into the PC.  
  When Windows prompts for a driver,
* Browse to C:\TrainTrax\dependencies\PR3 WindowsXP Vista32\_64\win\_xp\_vista32\_64
* Select mchpcdc.inf as the driver install file.

#### Default Settings

* root/root are the default credential used for the MySQL Database
* 3306 is the default DB port.
* localhost is the default DB host name
* 8182 is the default Navigation Database Rest Service port.
* 8183 is the default Navigation Service Rest Service port
* COM4 is the default COM Port for the PR3
* COM5 is the default COM Port for communication with the MDU

#### Train Navigation Service / Train Navigation Database Setup

* Verify that all of the default Settings are correct.
* The Train Navigation Service run script is setup by default to connect to two serial ports for the Motion Detection Unit (MDU) and Loconet Switch on the track. If running without these COM port values, then the run script must be changed to instead point to two COM ports on your PC. See next step for details.
* To modify the run script, Right-click on the train navigation database run script: “ C:\TrainTrax\CPE656TL-master\install \run\_nav\_service.bat” and click on “Edit” to bring up an editor to change the script. Add arguments at the end of the command line statement that tell Java to run the database service. Use the ‘—set-mdu-port’ option to change the COM port used to contact the MDU. Use the ‘—set-pr3-port’ option to change the COM port used to contact the track with the DigiTrax PR3 Programming Interface. See Figure 2 for a listing of all of the arguments that the JAR used to run the Train Navigation Database Rest Service uses. Any of those are valid to add to the end of the command line. Below is an example for changing the MDU port to COM1 and the PR3 port to COM2:
  + java "-Djava.library.path=C:\Program Files (x86)\JMRI\lib\x64" -Dfile.encoding=Cp1252 -jar "C:\TrainTrax\CPE656TL-master\install\TrainNavigationService.RestService.jar" --pr3-port=COM2 --mdu-port=COM1
* To determine which COM ports are mapped to which hardware press the CTRL+SHIFT+ESC keys to launch the DeviceManager.
* Expand the COM PORTS Tab, then Right Click on each comm port and chose 'Properties'.
* Look at the Manufacturer of the device in the General tab. It should say 'DigiTrax' for the PR3s and 'Digi' for the XBee module)
* A similar process must be done in both the Train Navigation Database Rest Service and the Train Navigation Service Rest Service (i.e. editing the run scripts and adding or changing arguments at the end of the Java statement used to launch the jar) to change the credentials and/or port settings used by the MySQL database. See Figure 1 and Figure 2 for full commandline options. Below is an example for changing the Train Navigation Database Reset Service (from “ C:\TrainTrax\CPE656TL-master\install \run\_db\_service.bat” ) to access a database at “1.2.3.4” on port 5678 with a user name of “bob” and a password of “password”:
  + java -jar "C:\TrainTrax\CPE656TL-master\install\TrainNavigationDatabase.RestService.jar" –db-host=”1.2.3.4” –db-port=5678 –db-user=”bob” –db-pwd=”password”
* Run the install\_train\_data.bat script to install the Train Navigation Data from scratch and initialize tables.
* Windows Firewall may prompt you to allow network traffic for the program, you should allow this so that TrainTrax can communicate.
* Run CPE656TL-master/install/run\_nav\_service.bat to run the Train Navigation Service Rest Service.
* Windows Firewall may prompt you to allow network traffic for the program, you should allow this so that TrainTrax can communicate.
* Run CPE656TL-master/install/run\_db\_service.bat to run the Train Navigation Database Rest Service.
* Windows Firewall may prompt you to allow network traffic for the program, you should allow this so that TrainTrax can communicate.

### Running and building with Eclipse

* Run the Eclipse.exe executable located in the Install directory of C:\CPE656TL\Install to open Eclipse.
* When prompted for a workspace folder to load projects, browse to C:\TrainTrax\CPE656-master\workspace.
* The eclipse application should appear upon the screen.
* The default configuration is setup to automatically build once the IDE is loaded.

#### Generating Train Navigation Service JAR File

If code changes have been made that require a new JAR file to be generated for the Train Navigation Service continue to follow these steps:

* To generate a JAR file of the Train Navigation Service, right click on the TrainNavigationService.RestService project and select export.
* Next select runnable JAR file.
* Select the Launch configuration for the TrainNavigationService
* Select an export destination, the name of the file should be TrainNavigationService.RestService
* Select Finish
* Make sure to copy the JAR file into the C:\CPE656TL\Install folder and replace the old JAR file

#### Generating Train Navigation Database JAR File

If code changes have been made that require a new JAR file to be generated for the Train Navigation Database continue to follow these steps:

* To generate a JAR file of the Train Navigation Database, right click on the TrainNavigationDatabase.RestService project and select export.
* Next select runnable JAR file.
* Select the Launch configuration for the TrainNavigationDatabase
* Select an export destination, the name of the file should be TrainNavigationDatabase.RestService
* Select Finish
* Make sure to copy the JAR file into the C:\CPE656TL\Install folder and replace the old JAR file

Generating Train Navigation Database JAR File (only required if code changes are made to database)

### Installing TrainTrax Android App

* Unzip CPE656TL-master.zip and move the extracted folder into C:/TrainTrax.
* Make sure that the Java run time development (JDK) is installed for example if installed it may show up in: C:\Program Files\Java\jdk1.8.0\_77
* If JDK is not already installed, run jdk-8u92-windows-x64 from the dependency folder to install Java 8
* Follow the prompts and proceed by clicking 'Next' until the 'Close' button is available for you to complete the installation
* Select the android-studio.exe file from the installation directory to start the android studio installation
* Select the default options and follow the setup wizard to install Android Studio and any necessary SDK tools until installation is complete.
* When launching Android Studio for the first time, be sure to choose 'I do not have a previous version of Studio or I do not want to import my settings'.
* Next, the Android Setup Wizard will appear. Select the 'Standard' Android setup type and click Next.
* Click 'Finish' on the Verify Settings Screen.
* A screen may now popup where additional components are downloaded, click 'Finish' when done.
* The 'Welcome to Android Studio' window should appear.
* Click 'Open an existing Android Studio project'.
* Browse to C:\TrainTrax\CPE656TL-master\UI\_Code\TrainTrax and Click OK.
* A message 'Sync Android SDKs' error may appear. Click OK.
* Click 'Install Build Tools 23.0.1' from the link in the messages window.
* Click Next to continue the download in the window that appears.
* Click Finish to complete the install.
* Go to the build menu at the top.
* Select Build APK
* Select Show in explorer to show the location where the .apk is stored, it will be called app-debug.apk.
* Logon to your google drive account
* Create or browse to an existing folder used for storage
* Right click and select ‘Upload Files’
* Browse to the folder where the .apk file is stored
* Select the .apk file and select open
* File will upload to folder
* Log onto mobile device
* Go to google drive account from here and browse to the folder where you stored the .apk file
* Download the .apk file onto device to install it, the .apk file should be stored in the Downloads folder.
* Select the .apk file from the Downloads folder, an option to open with Package Installer will be presented.
* Select Open with Package Installer, a window with an option to install Train Trax will be presented.
* Select Install to initiate the install process.
* Once completed, you can open app from the Apps Menu to run it.

#### Train Trax App Setup

* Click on the settings menu Tab on the top right of the main menu (shown in Figure 1), should be three vertical white dots
* Select Edit Database Port Number
* Set Database Service Port number to 8182
* Select Edit Navigation Service Port Number
* Set Navigation Service Port number to 8183
* Select Edit IP Address
* Set IP address to the IP address of the machine hosting both the Train Navigation Service and the Train Navigation Database.
* Select Save Preferences
* Using the new settings to connect to the Train Navigation Service and Train Navigation Database requires a restart of the Train Trax App
* To close the app and remove it from the app queue, swipe up or down from the blank areas above and below the app
* Go back to the Apps menu to restart the app.



Figure 1 Settings

# USING the APPLICATION

## Settings

The settings menu shown below in Figure 3, is accessed by clicking on the upper right portion of the ActionBar in the main menu view window. There are three settings that can be controlled for the application which are the Edit Database Port Number, Edit Service Port Number and Edit IP address options. These are required to connect to the Train Navigation Database and Train Navigation Service. There’s also an option to save the settings which if selected will save the settings to a preference file that will be loaded the next time the app is started.



Figure 3. Settings Menu

### Edit Database Port Number

The Port Number is used by the application to set up a client/server connection to the Train Navigation Database.

### Edit Service Port Number

The Port Number is used by the application to set up a client/server connection to the Train Navigation Service.

### Edit IP Address

The IP Address is used by the application to set up a client/server connection to the Train Navigation Service and Train Navigation Database.

### Save Settings

The port and IP settings can be saved for future use at any time by the user by selecting Save Preferences in the settings menu.

## Main Menu View

The Main Menu View of the Train Trax App is displayed once the application is started. In this view a diagram of the track is displayed without any switch or train positon information. The settings menu where you can set the Port and IP address for connecting to the Train Navigation Service and Train Navigation Database is accessed from this view. From the Main Menu view selecting the Train Monitor button will enter the application into the Train Monitor mode state. In the event of an error occurs trying to connect to the Train Navigation Database, an error message will be displayed and the option to enter the Train Monitor mode will be inaccessible.

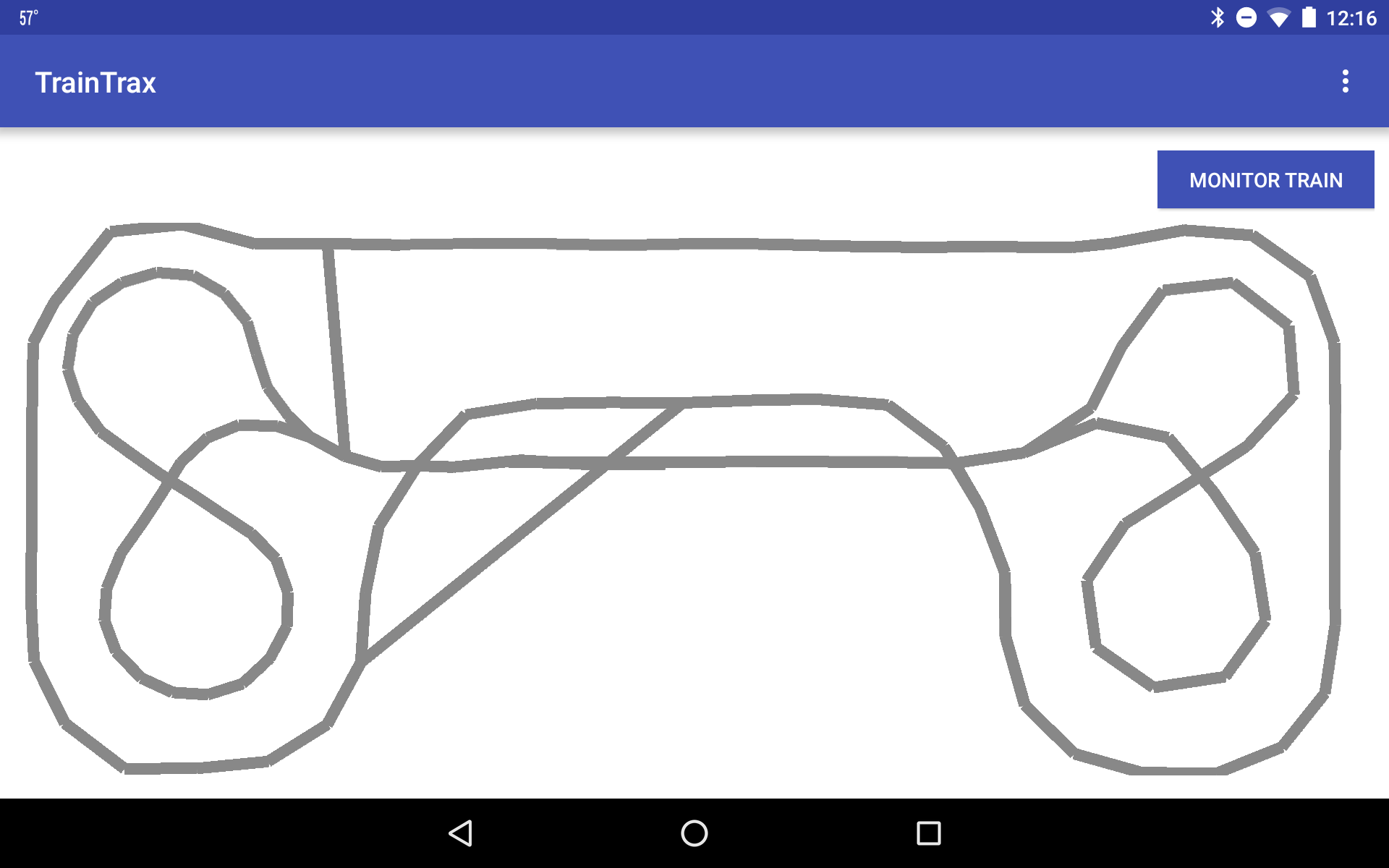


Figure 4. Main Menu View

## Train Monitor View

The Train Monitor View of the Train Trax App is displayed once the Train Monitor button is selected from the Main Menu View. In this view, a diagram of all track coordinates are displayed, switch position and state information is displayed, and the position of each train on the track at the current time is displayed. The Train Monitor View is updated every second as position updates are received from the Train Navigation service. The Monitor View will receive the initial state of the track switches from the Train Navigation Service upon startup. From there on, anytime the user selects a switch, the state will be changed and the view is updated and Train Trax sends the updated state change back to the Train Navigation Service. The Train Monitor View includes a legend at the bottom of the screen describing what the colors and symbols mean in the view.



Figure 5. Train Monitor View

### Track Diagram

The track diagram displayed on the Monitor Train view includes all components of the track including, switches, trains, and points. The points are received from the navigation database upon startup and used to draw a diagram of the track. The track layout is drawn in green and red, the green symbolizing the path of the track that is allowable by a switch, and red indicating an incorrect path controlled by the track switch.

### Track Switches

The track switches icons will be a square box that says Switch. The boxes will be colored black when in pass mode and red when in bypass mode.

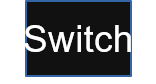


Figure 6. Track Switch icons

Each switch should initially be in pass (closed) and will toggle to bypass (open) when selected. When the switch is selected the active path of the track diagram will change to reflect the new path controlled by the switch

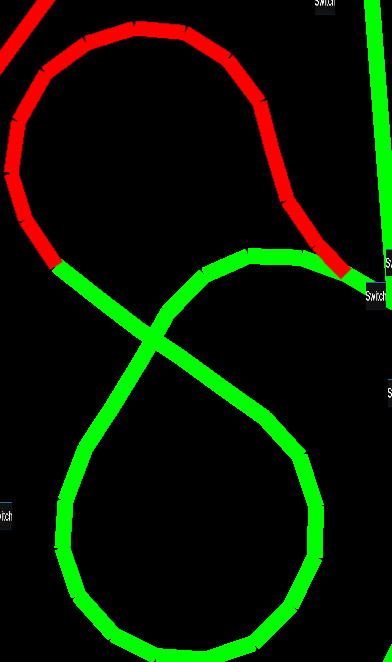
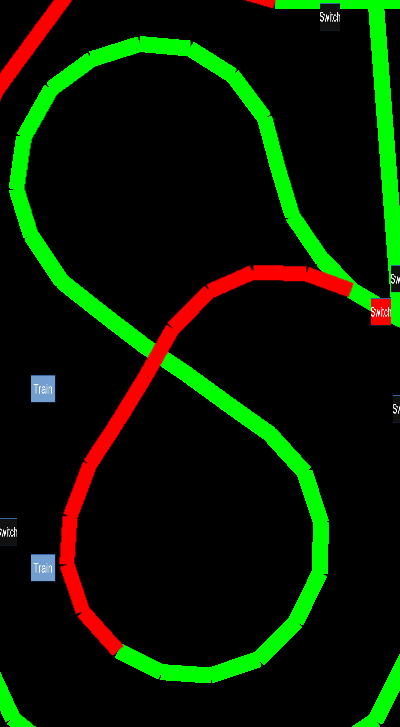


Figure 7. Switch State change from Pass to Bypass mode

### Train Position

The train position icons displayed in the Monitor View will be a square box that says Switch. The boxes will be colored blue with white text. An example of the icon is shown in Figure 6. The speed of the train will at that position will also be displayed in a text box right below the train icon. If a train that was moving comes to a stop, an alert will pop up letting the monitor know that the train has stopped.



Figure 8. Train Position Icon