Saxton Transportation Operations Laboratory
Task 3.5 – STOL Operating Manual

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Contents

1 INTRODUCTION

The following document is a component of the vehicle build documentation (Subtask 3.5) of the Saxton Traffic Operations Lab (STOL) project. This Operating Manual provides a quick reference for using the Laptop interface provided with the STOL vehicles to: 1) control data recording on the VTTI NextGen DAS via a graphical user interface; 2) locally control ACC behavior via a graphical user interface; and 3), interact with the STOL Center Processing Stack (CPS) Linux Machine via terminal connection. As a companion to this document, a separate STOL Vehicle Build Document has also been produced. For most users, the STOL Operating Manual should be the primary reference. The STOL Vehicle Build document is intended for system developers who require additional, more detailed, information on the installed systems. In many cases, both documents should be used in combination.

Rather than develop new Cooperative Adaptive Cruise Control (CACC) system from scratch, the vehicles leverage the existing factory Adaptive Cruise Control (ACC) system. The equipment developed during Task 3 permits the SRX vehicles to receive instructions via cellular communication (server ACC), Dedicated Short Range Communications (DSRC), or from the experimenter laptop (emulating a roadside server) to automatically alter the vehicles' pre-existing ACC system (desired speed and headway). The factory ACC algorithms and safety systems are the last link and ultimately control the vehicles. Software modifications to the CACC system are readily enabled through configuration files and an onboard C++ development environment that allows experimenters to make changes in the field.

Operationally, the vehicles' CACC system may be used either independently or within a platoon of vehicles traveling together. When acting independently, the CACC accepts information sent by the infrastructure (or locally if the laptop is emulating a server) to affect the ACC operation. When following a vehicle, the CACC system continues to accept information from the infrastructure; however, behavior may be partially guided by the factory ACC, which manages the safe gap to the lead vehicle using a ranging sensor. The factory ACC also imposes limitations on the acceleration and braking levels that can be achieved. The relative contribution of the factory ACC algorithms depends on the logic inserted by the researchers.

When a message is received from the infrastructure (or experimenter laptop, if message emulation is being used) it is processed and turned into commands that are relayed to the vehicle's ACC system. The factory ACC system is always the last component in the vehicle control chain. As such, if the capabilities of the factory system are exceeded, vehicle control will be transferred back to the driver. **Any driver of this vehicle should be aware that control may be transferred back at any time. As such, drivers should always be alert to changing conditions and completely prepared to resume full vehicle control.**

The vehicles are configured with an open architecture to allow researchers to develop custom algorithms for controlling the CACC. The control software is configured to provide experimenters with the ability to make changes in the field by employing a set of configuration files, a development environment, and access to data elements collected from the vehicle sensors. Because of this open architecture, **software developers must be cognizant of potential unintended consequences and ensure safe operation will be retained. The vehicles should only be driven by trained engineers and are not for use with naïve participants.**

2 Laptop Operating Manual

The STOL Laptop is a Dell Latitude Model E6420, with a Windows 7 32-bit operating system.

2.1 Login Information

The STOL Laptop comes with TrueCrypt software to protect the hard drive data. Every time the laptop boots up, a password will be required. The following is the current password information for the TrueCrypt boot process:

TrueCrypt Password
STOL_V2I

Once booted, the Laptop will await windows login. Users should login as the

Windows User	Widows Password
STOL	**STOL_V2I**

The STOL Laptop requires an Ethernet or WiFi connection to the vehicles in order to run the VTTI Applications. The STOL Laptop should have an Assigned IP in the range of 10.10.50.xx to ensure connection is successfully established.

2.2 STOL NextGEN DAS GUI

The VTTI NextGen Control Application is located at the following path: **C:\Demo\stol_gui**. A shortcut should be on the Desktop to quickly launch this application. This application will attempt to communicate to the VTTI NextGen DAS via Ethernet; so a working Ethernet connection between the STOL Laptop and the VTTI NextGen DAS is essential.

In order to collect trip data, the specific trip details must be manually entered into the VTTI NextGen SOL Control Application via the user interface (shown in Figure 1). In order to start recording a new trip file, the user should assign the desired values to each of the parameters described below.

Parameter	Description
Trip_Number	Number for the trip which will be assigned on the trip filename
Scenario	Scenario ID for the current trip collection
Data_Run_Number	Data Run Number for the current trip collection
Task_Code	Task Code for the current trip collection

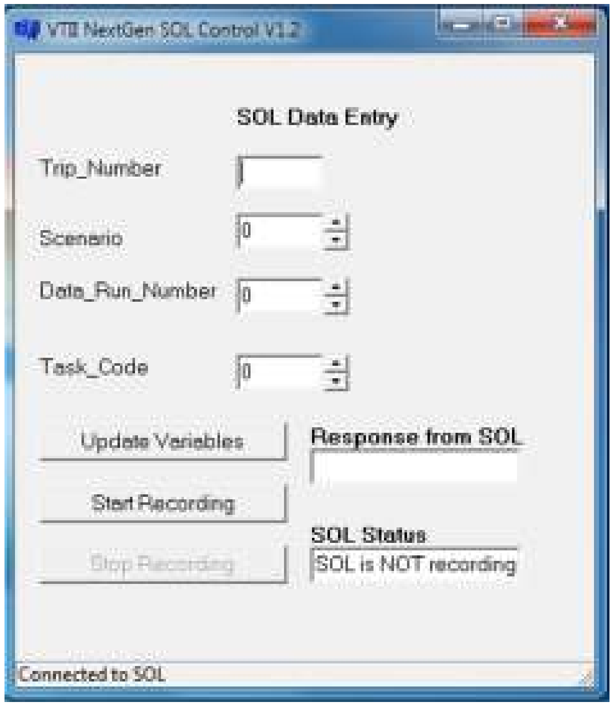

FIGURE 1: VTTI NEXTGEN SOL USER INTERFACE

The trip number will be located in the file name and can only be changed when data is not being recorded. The scenario, data_Run_Number and Task_Code will be contained within the collected data file and can be altered while collecting data.

2.2.1 START RECORDING A FILE

After the parameters are entered, the user should click on the "Update Variables" button which will enable the "Start Recording" button.

When the user is ready to collect data, the "Start Recording" button should be pressed and a "Success" response should appear in the "Response from SOL" text box and "SOL is recording" message should appear in the SOL Status text box. The "Stop Recording" button will then be enabled as shown in Figure 2.

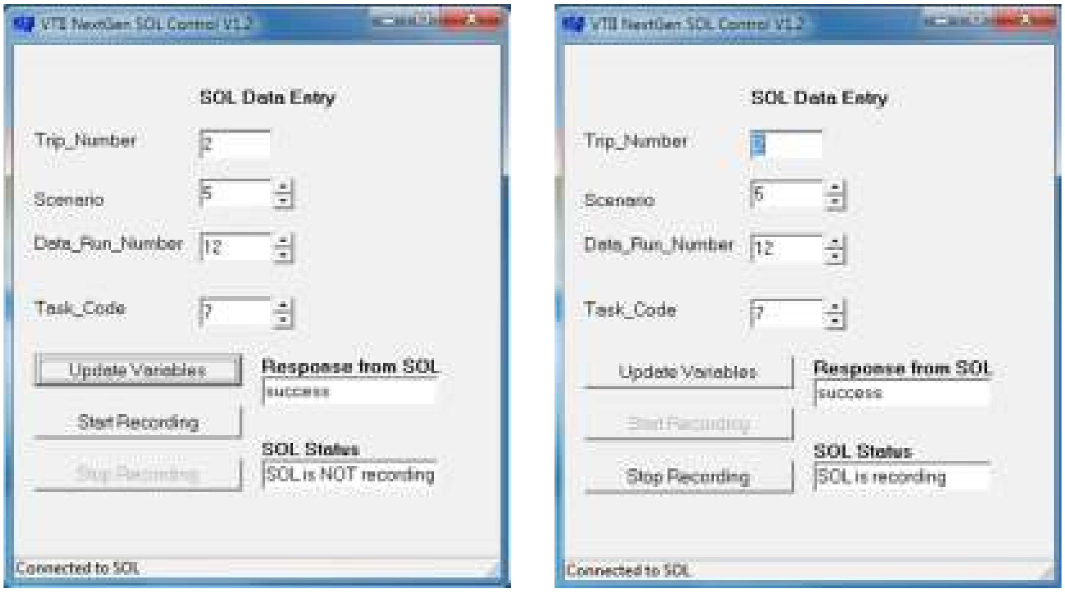

FIGURE 2: RECORDING A FILE USING SOL UI

2.2.2 Stop Recording a File

When the user is ready to pause or stop collecting data in the current trip file, press the "Stop Recording" button. When the VTTI NextGen DAS has successfully stopped the current trip data collection, the "SOL Status" text box will show the "SOL is NOT recording" message. The "Stop Recording" button will then be disabled and the "Start Recording" button enabled as shown in Figure 3.

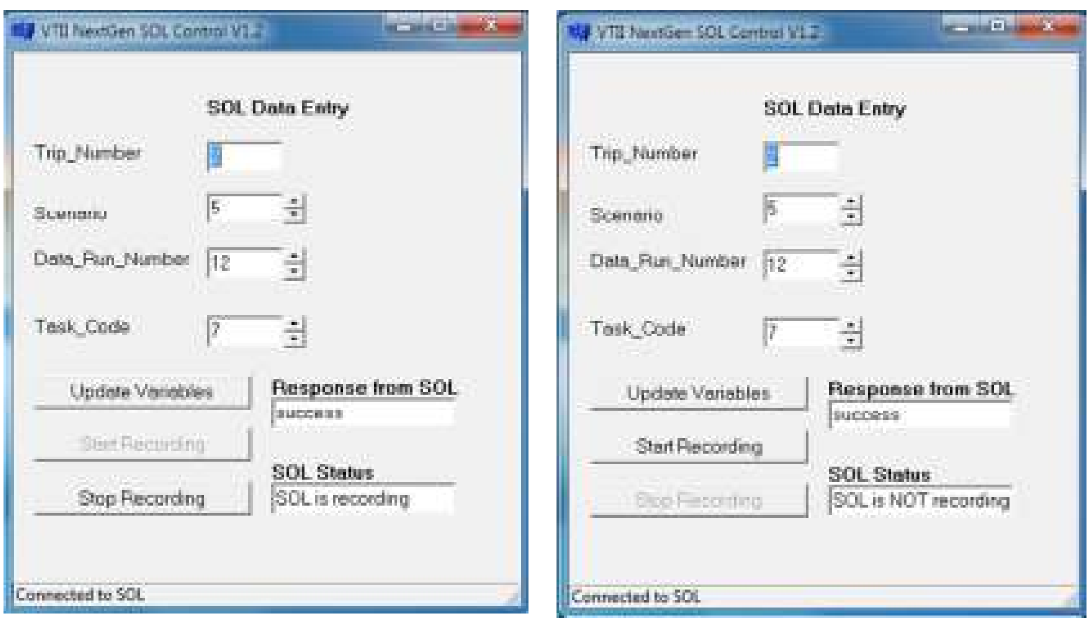

FIGURE 3: STOP RECORDING A FILE USING SOL UI

2.3 STOL ACC GUI

The VTTI STOL ACC Control Application is located at the following path: **C:\Demo\acc_gui.** The application allows the user to control the vehicle's ACC System by simulating a driver's manual button presses. The application supports two control methods, the Button Press method (as shown on the right-hand side of Figure 4) and the Picture-based method (as shown on the left-hand side of Figure 4).

FIGURE 4: ACC CONTROL APPLICATION

For both methods, the user needs to click on the button or the associated area of the picture to obtain the desired cruise control behavior. The application supports all the ACC controls and also includes the following functions:

Function	Description
Set Speed (MPH)	Send a UDP message to set the speed to the user defined input
GAP Far	Sets the GAP to Far setting
GAP Medium	Sets the GAP to Medium setting
GAP Near	Sets the GAP to Near setting

Note: The user should ensure the STOL CPS Linux Machine is running in the correct configuration ("User Mode") to allow the STOL Application to receive the proper UDP packets and execute the proper commands. Setting up this configuration is discussed in the next section.

3 Central Processing System Operating Manual

This section describes how to operate the STOL CPS Linux Machine over the laptop interface. It contains the procedures to control the STOL Application and how to modify the settings for the different configurations. This document is intended as a quick reference for future developers who will need access to the STOL CPS Linux Machine to develop applications necessary to enable various experiments. It is complimented by the more detailed STOL Vehicle Build documentation which provides additional information about the software and hardware stacks.

3.1 Basic System Operations

The CPS machine starts up on the vehicle's ignition on signal, and shuts down on ignition off. The user does not need to control the powering on/off events for this machine.

3.2 Using the STOL Application

The following section describes how to install the STOL Application package on to the CPS and provides the commands needed to execute and stop the application. The STOL application requires root elevation to run with the credentials provided below. The STOL application uses a configuration file which can be modified to change different features on the application during runtime. Please refer to the STOL Vehicle Build document to learn how to adjust the different settings on this file. Along with the STOL Application, the software package includes a real time User Interface (STOL_UI) to debug the entire software module's data. This section will describe how to execute this application.

The STOL CPS Linux machine can be directly controlled using a keyboard and mouse or it can be controlled remotely using a secure shell (SSH) connection. It is recommended to use the remote control (SSH) method from the laptop. If using Windows, an SSH Terminal Program, such as PuTTY, is required (and is installed on the laptops by default). For Linux users, the SSH client can be run from a terminal session.

3.2.1 Remote Access

In order to connect remotely to the STOL CPS Linux Machine, it is recommended to use PuTTY (found in the Windows Programs list) to establish the required SSH connection (shown in Figure 5). It is important to enable the X11 forwarding feature (shown in Figure 6) so the application can run on the remote terminal and use the main display interface.

To connect to the STOL CPS Linux Machine, use the following settings:

Setting	Value
IP	10.10.50.211
User	stol
Password	das
Port	22

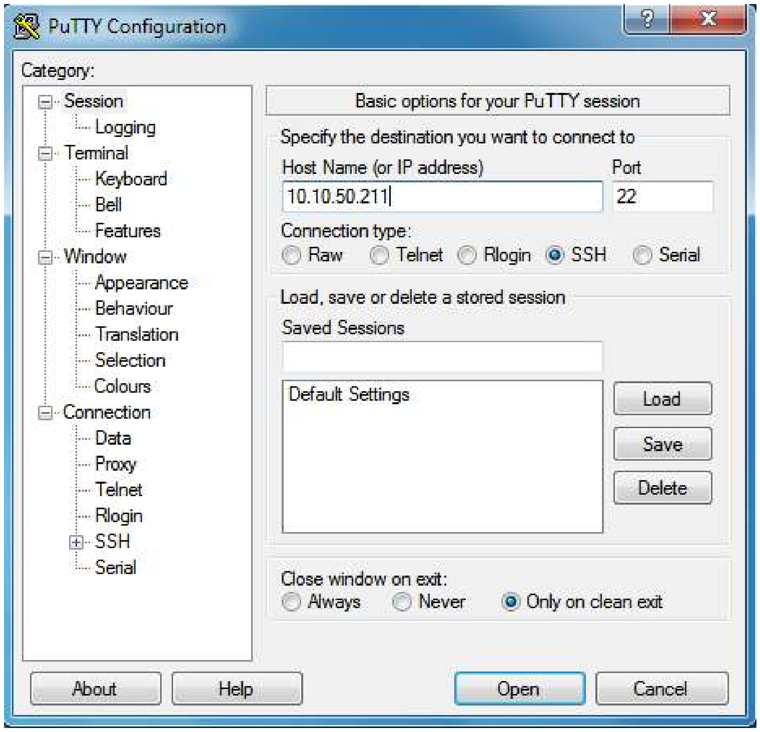

FIGURE 5: PUTTY SSH CONNECTION SCREEN

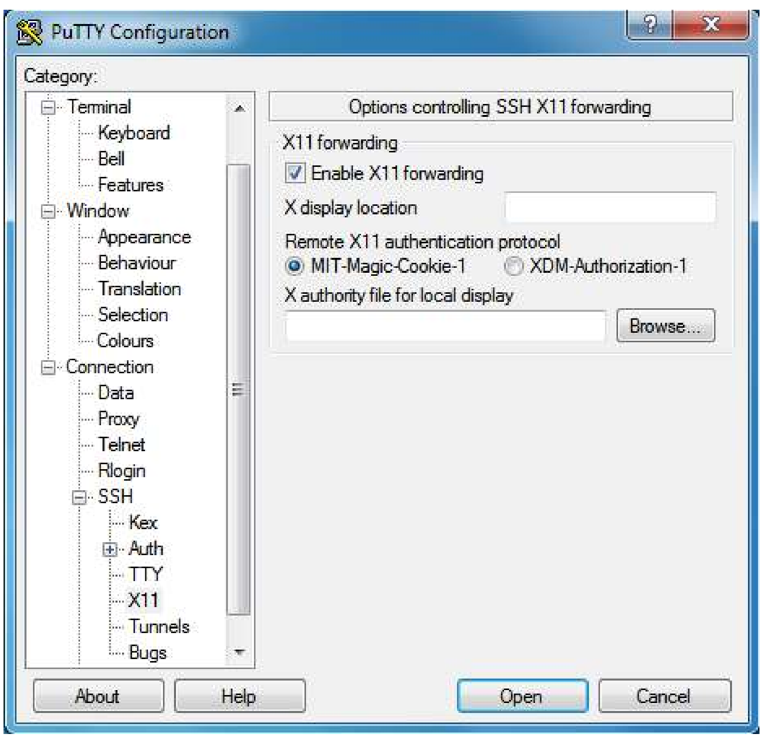

FIGURE 6: PUTTY X11 FORWARDING SCREEN

3.2.2 Start Application

The STOL Application will start automatically after the Linux machine boots up. If running the application manually, open an SSH connection to the STOL CPS Linux Machine and run the commands shown below. Before executing these commands, verify that the STOL application is not running.

Commands
cd /home/stol/stol
sudo ./runStol

Note: Proper login information is required to install the application packages. Refer to section 3.2.13.2.1 for the user/password information.

3.2.3 Stop Application

The STOL Application can be stopped at any time after execution. If stopping the application manually, open an SSH connection to the STOL CPS Linux Machine and run the following commands.

Commands
cd /home/stol/stol
sudo ./killstol

Note: Proper login information is required to install the application packages. Refer to section 3.2.13.2.1 for the user/password information.

3.2.4 STOL Application Configuration File

The STOL Application uses an XML configuration file to load the proper settings and run in different modes. The modes are described in detail in the STOL Vehicle Build document. There are two main parameters that can be changed to modify the general STOL application behavior as shown below.

Parameter	Module	Description
Mode	Main	0 = ACC OFF, 1 = User Mode, 2 = Server Mode
ACC_Type	CellPhone	1 = Speed Based, 2 = GPS Based

The **"Mode"** parameter defines how the main STOL application will run. There are three available options:

1. ACC Off (Mode = 0). The STOL application will not control the ACC system.
2. User Mode (Mode = 1). The STOL application will listen for UDP ACC packets and execute them.
3. Server Mode (Mode = 2). The STOL application will control the ACC based on Server requests.

The **"ACC_Type"** parameter defines how the STOL application will run when using Server Mode (Mode = 2). There are two options:

1. Speed Based (ACC_Type = 1). The STOL application will request speed values from the server.

2. GPS Based (ACC_Type = 2). The STOL application will send a GPS position and receive a speed/headway value set.

To modify the STOL application XML file, run the following commands.

Commands
cd /home/stol/stol
vim stol_config.xml

3.2.5 Start STOL User Interface

The STOL User Interface (STOL_UI) is a powerful tool for debugging and reviewing real-time data from the entire software module. These applications access the shared memory from each module and print real-time data on the STOL UI. To execute this application, run the following commands.

Commands
cd /home/stol/stol/stol_ui
sudo ./stol_ui

To quit the application, Press "q" or Escape key.

FIGURE 7: STOL USER INTERFACE

4 STOL Server and Data Harvesting Operating Manual

This section describes how to operate the STOL data harvesting terminal and server in order to collect and receive data. The server is a Dell R240 Intel Xeon processor (2.2 Ghz E5-2430) with 16GB of memory and 4 1TB hard drives in a RAID 5 configuration. In general, this server should be viewed as an appliance and will not require the user to login to the system for any typical operations.

4.1 Basic Operation

In order to harvest collected data, turn the vehicle off, wait for the DAS to shut down, and then remove the hard drive using the physical key provided. When the hard drive is inserted into the drive reader (aka: toaster), the server will automatically download the data, execute post-processing, and make the data available on a network share for users to access.

4.2 Data Harvesting

Remove the desired hard drive(s) from the DAS(s) and place each hard drive into the toaster. The notch on each hard drive slot ensures that the hard drives will be inserted into the toaster correctly.

To verify data is copying, open a web browser to http://ip_address_of_server, inserting the actual ip address of the server. If no entries show up on that webpage, the drive does not contain any data or there is an issue with the drive. If that happens, contact VTTI for further investigation.

Once the drive is done copying data, a "Remove drive" link will appear on the webpage. At that point, it is safe to click the remove drive link on the webpage and remove the drive from the toaster. The drive can now be reinstalled in the vehicle to collect more data.

Note: It is important that the user maintains allocation of the appropriate drive to its assigned vehicle. There are unique configurations on each hard drive associated with the system in each vehicle.

4.3 Data Processing and Access

Data processing will immediately begin on the server once the drives are done copying data. Once data processing is complete the data and video can be accessed via CIFS (server is running Samba), presumably from a Windows client.

To access the data, the web address will be formatted like the example below:

\\ip_address_of_server\matlab_analysis\50026B722700D267\2013_09_06_10_03_24_882048681

Hard Drive Serial Number

Date and time the drive was inserted into toaster (YYYY_MM_DD_HH_MM_SS_NNNNN)

For each trip it will generated two files:

- MP4 Video file

- CSV data file

The name convention for both files is the following:

CSTO_0096_0001_BB_130906_0907_00062.csv

STOL Project Name | Vehicle ID | Trip ID | Location | Date YY/MM/DD | Time | VTTI Trip number