

## **CHAPTER 7 TESTING AND EVALUATION**

### **7.1 INTRODUCTION**

The testing and evaluation of the system consist of at a high-level test intends to prove that the functionality of the system delivered with its final outcome; have met principal objectives of the project. In this particular chapter we will discuss about test environments, strategies and procedures were applied for testing and evaluation of this vehicle tracking software; during the course of system development, implementation and post implementation phases.

### **7.2 OUTLINE OF TEST PLAN**

The entire test plan is decomposed into series of different test cases which covers unit test, integration test, pre-implementation and post-implementation tests of the system. A test area was defined to test the functionality of each individual component of the vehicle tracking system during the developmental stage, and to demonstrate and verify the performance of the completed vehicle tracking system.

#### **7.2.1 OUTLINE OF TEST INCLUSIONS**

The test covers for all aspects of system functions which were already defined at the analysis and design stage. GUI testing of vehicle tracking software and unit testing were also included. The selected geographical map is restricted only to Colombo region map which was scaled down to 1:50,000. A portion of Colombo city limits was selected as a test area. The chosen test area runs from Union place, Slave Island, Colombo Fort, Borella, Kolpitiya, Bambalapitiya, Kohuwala, Kalubowla to Rathmalana boundary. The system was tested with two tracking vehicles simultaneously to convince the multiple vehicle tracking.

#### **7.2.2 CANDIDATES FOR POTENTIAL INCLUSIONS**

Two motor cars were operated as tracking vehicles when it was simulating the test environment. One tracking vehicle was equipped with *Wavecom<sup>S</sup> FASTRACK* GSM/GPRS modem as the car unit, while the other one was operated with basic mobile phone which was properly mounted on it. Tracking enable SIMs were inserted into both car units. It was also verified with the network operator regarding enough credit is available in their particular accounts to send SMSs.

### **7.2.3 OUTLINE OF TEST EXCLUSIONS**

Conditions that were explicitly excluded from the test plan are elaborated here.

The testing area is only restricted to Colombo region. It is not tested for other areas of the country. Maximum number of simultaneous tracking is limited to only two tracking vehicles. The error that could arrive from the LBS and the GSM network communication is disregarded. The system is not tested under extreme conditions such as high voltage and high noise areas which may have potential to damage the strength of the microwave signals. It is not tested in subways or tunnels.

### **7.3 TEST APPROACH**

The test approach consists of different type of appraisal tests which fully exercise the vehicle tracking system in order to discover its limitations and measure up vehicle tracking system's entire capabilities. The test approach has various types of testing techniques and types to satisfy the complete system testing aspects.

Outdoor testing was performed by two of colleagues and used their own automobiles for tracking purpose when they needed. Each test case has an outline scenario that represents a possible real world event. Each test case scenario was designed to test the over all application and specific functions. The individual tester has to fill out an evaluation form for each test case for which they participated. Testing categories on the evaluation form is rated by pass-fail (0 or 5) or ranking (1-5) as a quantitative measure and comments added. Evaluation forms is consolidated and an over-all rating given to the application. Following fields of testing aspects were considered when carry out the testing. Field evaluation form is attached in the *Appendix – E*.

#### **7.3.1 INTEGRATION TESTING**

This integration test validates the vehicle tracking software working together with other modules such as the LBS. The main objective of integration testing is to identify errors resulting from the integration phase of the vehicle tracking program, extensions, and its data. A test case was designed to carry out this integration test. *TestCase #1* and *TestCase #2* cover the integration testing which was performed with this vehicle tracking software and it is attached in the *Appendix-F*.

### **7.3.2 USER INTERFACE TESTING (GUI)**

In order to perform usability testing with the vehicle tracking system, a group of people was selected who fall into different profiles. For an example the usability test was carried out with some domain experts as well as kind of novice users who have no much prior knowledge in this particular domain area. Some principles of *Human Computer Interaction* (HCI) were practiced during the course of usability testing. It was observed that, the action of the users under controlled conditions while they were interacting with the system. This usability testing was typically more focused on the presentation and user interaction of vehicle tracking application, such as graphical user interface (GUI) including window designs, icon designs, fonts size and color, message window and some mouse click events, rather than on functionality of the vehicle tracking application.

### **7.3.3 SYSTEM TESTING**

A full system testing was done with the vehicle tracking system to check whether the system meets stated requirements and objectives by validating the entire system in real environment scenarios. In this system testing it was performed an end-to-end full system checkup with all available features. Two automobiles were set up while simulating the actual scenarios. According to the test cases, two cars were sent across the areas which have been mentioned in the above 7.2.1 section. Meanwhile the test cases were filled by the above nominated user group. All features were separately examined and tested in order to make sure seamless operation right through the entire system.

### **7.3.4 PERFORMANCE TESTING**

Performance testing was also carried out with the vehicle tracking system to verify the sustainability of the system. This performance test was kind of a black box testing which has an input, expected output and observed output result. Test case was prepared to cover this performance test in which response time, operational speed, searching speed and other time sensitive requirements are measured and evaluated. The performance profiling was implemented and executed to profile and fine-tune the performance of targeted test behaviors such as operational performance and hardware capability.

### **7.3.5 INTEGRITY TESTING**

The integrity testing was mainly focused on data and the database integrity. Positioning data which is stored in the database and retrieval of the same must be consistent and reliable when it is used to plot the location on the base map. This integrity testing involved in validation of quality and accessibility of vehicle tracking application and the database.

### **7.3.6 RELIABILITY TESTING**

The reliability and the availability testing were performed with the vehicle tracking system in order to determine the system conforms to required level of reliability and availability requirements. The vehicle tracking system relies on the location based service (LBS) and the GSM digital cellular network infrastructure. Therefore, those constraints were taken in to consideration when it was measuring up reliability and availability of the vehicle tracking system.

## **7.4 TEST CASES AND RESULTS**

The test must be as realistic as possible. So the tester must try to run these tests in the same way as an end-user operates the system. Thus it was found valid values to use in this test protocol. The following table (*Table 1: Table of Testing*) includes hopefully all possible events that can have to test to be sure that the vehicle tracking system works as expected. Following prerequisite are required for proper testing;

- The testing machine should install JAVA, Java2 platform standard edition 5.0 Development Kit (JDK 5.0) or higher, MySQL server version: 5.0.15-nt required Java libraries and Vehicle Tracking System should be installed and configured.
- The Internet connectivity must be arranged to the machine that runs the vehicle tracking system. This machine must be able to access the LBS via the Internet and that must be verified before starting the test.
- The car unit must be mounted on the tracking vehicle and tracking SIM should be inserted into that. The car unit must be powered and tested before starting the test.
- The tracking SIMs must have enough credit with their accounts to send SMSs.

### Test Cases and Results of Testing

<i>Test #</i>	<i>Test Case Description</i>	<i>Expected Result</i>	<i>Actual Result</i>	<i>Severity (H/M/L)</i>	<i>Comnt.</i>
	<b>Login Module</b>				
1	Login using exist user	Direct to tracking module	Correct	H	
2	Login with user id which is not in the system	Reject	Reject	H	
3	Login with incorrect password	Reject	Reject	H	
4	Login with new user	Direct to tracking module	Correct	H	
	<b>Common</b>				
5	Verify all buttons are work properly	buttons direct to correct operation	Correct	H	
6	Verify buttons and icons work with proper privilege	direct to correct operation	Correct	H	
7	Delete operation properly work in all screen	Check delete an item	Correct	H	
8	Add properly work in all screen	Check add an item	Correct	H	
9	Mandatory field check for the all UI items.	Cannot submit or update without this Mandatory field	Correct	H	
10	Log out	Mandatory field	Correct	H	
11	Error and notification	Receive an appropriate error or notification	Accept	M	
	<b>User Profile</b>				
12	Create User	Create user properly	Correct	H	
13	Delete User	Delete user properly	Correct	H	
	<b>Map Layers</b>				
14	Checked map layer	Map layer add properly	Correct	H	
15	Unchecked map layer	Map layer remove properly	Correct	H	
16	Add sequence of map layers	Add map layers in correct sequence	Correct	H	

<i>Test #</i>	<i>Test Case Description</i>	<i>Expected Result</i>	<i>Actual Result</i>	<i>Severity (H/M/L)</i>	<i>Comnt.</i>
17	Remove sequence of map layers	Remove map layers in correct sequence	Correct		
	<b>Tracking Vehicles</b>				
18	Add new tracking vehicle	Add new vehicle properly	Correct	H	
19	Add color code to a tracking vehicle	Add color code properly	Correct	H	
20	Remove a vehicle from the list	Remove properly	Correct	H	
21	Add multiple vehicle to the list	Allow multiple addings	Correct	H	
	<b>Restricted Areas</b>				
22	Add new restricted area	Add new restricted area properly	Correct	H	
23	Recording a polygon on the map correctly	Recording points properly	Correct	H	
24	Assigning a customized color code	Color code assign properly	Correct	H	
25	Adding a label on to the restricted area	Add label properly	Correct	H	
26	Add restricted area on to the map layer	Add on to map layer properly	Correct	H	
27	Add multiple restricted areas into the list	Add multiple restricted areas properly			
28	Remove a selected restricted area from the list	Remove it properly	In-correct	L	
	<b>Key Operations</b>				
29	Search for vehicle	Search works properly	Correct	H	
30	Search for multiple vehicles	Search works properly	Correct	H	
31	Search criteria work properly	Search criteria of vehicles	Correct	H	
32	Plot location on the map correctly	Correct plotting	Correct	H	
33	Plot multiple locations for multiple vehicles on the map correctly	Correct plotting and differentiate.	Correct	H	

<i>Test #</i>	<i>Test Case Description</i>	<i>Expected Result</i>	<i>Actual Result</i>	<i>Severity (H/M/L)</i>	<i>Comnt.</i>
34	Search in regular intervals	Work properly	Correct	H	
35	Plot previously tracked locations	Plot them properly	Correct	H	
	<b>Key Features</b>				
36	Check Zoom in / Zoom out buttons	Working zoom in / zoom out properly	Correct	H	
37	Check reset button	Working reset properly	Correct	H	
38	Check magnifying glass	Working magnifying glass properly	Correct	H	
39	Check Zoom in/Zoom out in right mouse click menu	Work properly zoom in /zoom out in right mouse click menu	Correct	H	
40	Check Left, Right, Up and Down in right mouse click menu	Work properly Left, Right, Up and Down in right mouse click menu	Correct	H	
41	Check close zoom in right mouse click menu	Work properly close zoom in right mouse click menu	Correct	H	
42	Check Reset in right mouse click menu	Work properly Reset in right mouse click menu	Correct	H	
43	Check Rotate map onto right hand side in right mouse click menu	Map properly turned to right hand side	Correct	H	
44	Check Rotate map onto left hand side in right mouse click menu	Map properly turned to left hand side	Correct	H	

**Table 1: Table of Testing**

## **7.5 VEHICLE TRACKING SOFTWARE VERIFICATION**

The LBS communication, Internet connection and car unit (car unit) were tested. The vehicle tracking software was tested with two tracking vehicles stationed outside in the test area. The car units (car unit), were successfully powered up by the power supply that comes from the vehicle battery. The tracking SIM's were then inserted into car units properly and tested.

Then the tracking application was tested. The monitoring station console was properly received an XML document along with available positioning information of tracking vehicles via the LBS. This was tested several times with approximately 1½ second intervals. The vehicle tracking software was able to properly distinguish and classify data streams which were coming from the two tracking vehicles. The vehicle tracking software was also able to successfully determine the sender. Then, received data were properly plotted on the base map. These results convinced that the LBS system, GSM digital cellular network, Internet link, car unit and the vehicle tracking software are properly functioning.

## **7.6 SUMMARY**

In this chapter, we discussed about the testing and evaluation of the vehicle tracking system. At the initial stage of creating a test plan it was clearly identified, inclusions and exclusions to the test plan. Then the test approach was defined that, how to execute the test plan through out the testing and evaluation phase. High-level test scenarios were also carried out to prove that, the system has achieved an intended outcome with regard to its functionality, accuracy, features and the performance. Appropriate test cases used for this testing and evaluation phase were attached in the appendices.

In next part of this document it will attempt to identify possible further development which can be carried out as future works with the vehicle tracking system and conclude this thesis.