# Design and Development of Automated Test Environment for Electronic Control Unit

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***Abstract:*** **Engine control Unit (ECU) is an important part of modern engine. Telematics is one of the latest enhancements to the sophisticated electronic control mechanisms which aid us in extracting the greatest possible efficiency, utility and safety information from our vehicles. In a vehicles the size of the number of microcontrollers increases day by day. For example, luxury vehicles may have up to 100 on-board microprocessors in the near future. Automotive electronics has become a technology driven by competitive decisions. Overall complexity and dependency on software have increased over the period. So it is highly important to test and validate the performance and features of the ECU before deploying it in actual working environment. To generate the automated test environment for ECU. Before this manually testing was done which is time consuming and many of drawbacks in that testing. To Reduce the Testing efforts in Actual test environment, NI Test Stand and LabVIEW is used for the test automation that provide many of benefits. Well documented test results, Comprehensive execution of specified test. Compared with manual testing the verification of several variants in the same amount of time. Shorter testing intervals[1].**

***Keywords:*** **ECU, Telematics, NI Test Stand, LabVIEW.**

## I. INTRODUCTION

To provide safety and comfort, engine manufacturer gives various facilities which are called as ‘Engine Features’. Initially, to control various properties of engine like Fuel economy, Speed of vehicle, emission of gases, etc. mechanical operations and settings were used. Though mechanical settings are used but optimal results are not obtained. As man has discovered various sensors and as he got idea of electronic signals and its processing, Electronic Control Unit (ECU) for engines were developed. Processing on electronic signals and controlling operations of mechanical engines using electronic controller is easier and gives better results. Today, design of engine feature is combination of both hardware and software. Engine feature as a part of ECU software plays very important role in operation of vehicle[8].

With advancements in fields of embedded system, telecommunication and vehicular technologies, sending and retrieving the on-board information of a vehicle has become quite possible Automatic Vehicle Location is now being used for gaining access to the location of the vehicle through devices and modules vehicle tracking. The location of vehicle can be observed by the owner of vehicle or someone else in charge, using vehicle tracking system, which is an electronic device or module placed in vehicle. With the technology scaling down, reduced device sizes have enabled us to deploy a wide range of electronic devices in a small area. The Electronic Control Unit (ECU) along with various sensors is an integral part of today’s vehicles. To satisfy various needs like safety, comfort, environment protection, etc., the control algorithm or engine software must be highly responsive and accurate. Manual testing of these algorithms requires longer testing time and may also include manual errors. Therefore, there is a need to develop test automation tool for testing engine software in order to verify all possible positive and negative effects before testing on actual vehicle. Proposed test automation tool uses NI TestStand as a software platform for test sequence development [2].

## II. TELIMATICS

### *A. Telematics in Vehicle:*

Telematics is transferring the electronic messages and information at remote locations. It is integrated use of telecommunications with information and communications technology. It is the technology of sending, receiving and storing information relating to remote objects like vehicles – via telecommunication devices. Telematics is a method of monitoring a vehicle. It can be feasible by merging a GPS system with on-board diagnostics to record – and map – exactly where a car is and how fast it's traveling, and cross reference that with how a car is behaving internally. The basic architecture of the system involves a TCU connected to the ECU via a CAN bus. It is shown in fig.1.The telematics unit(TCU) is communicate with a web server via the cellular data network, which collect data from the telematics unit and push updates for the unit and ECU[5].

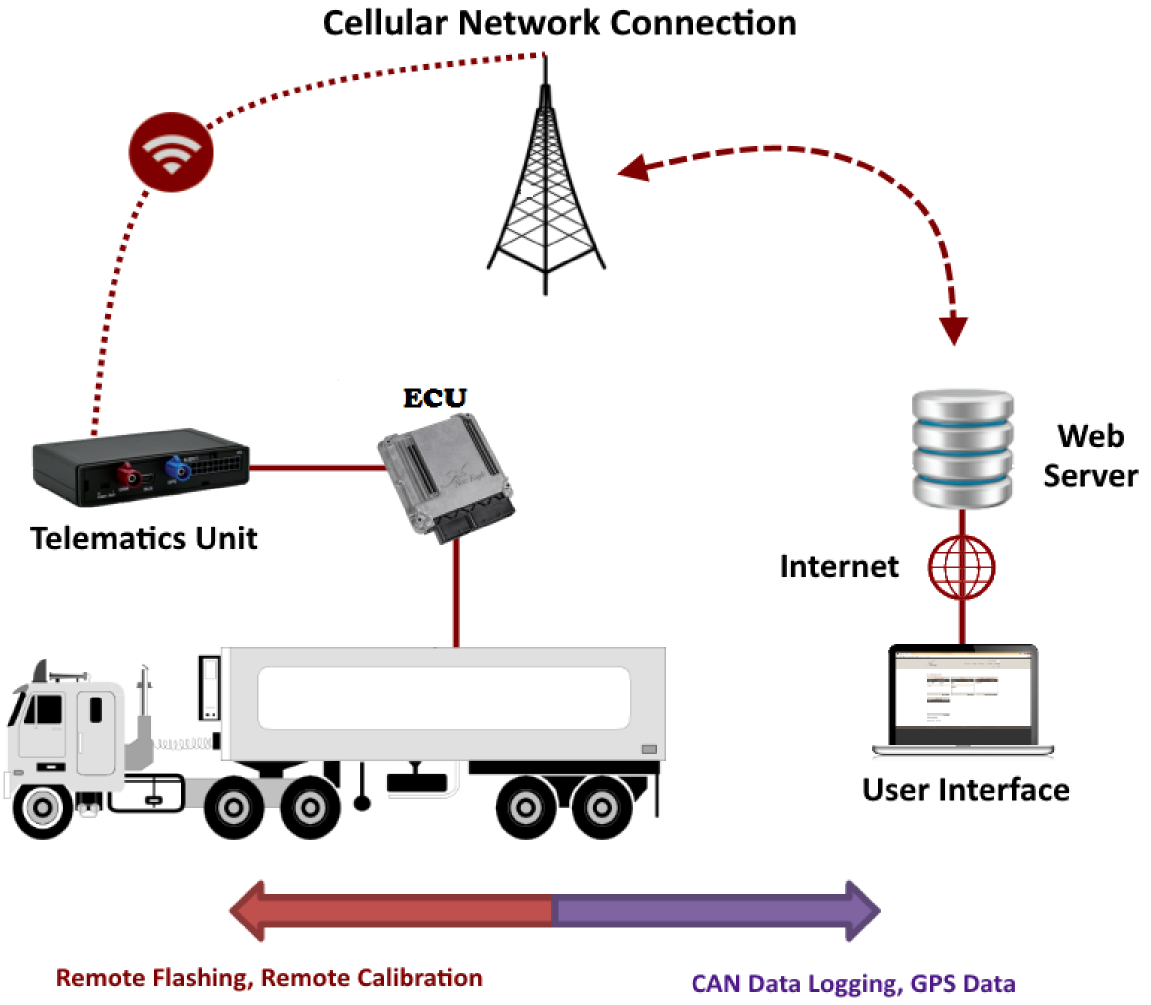


**Fig 1: Telematics [7]**

### *B. Telematics Services:*

At its core, automotive telematics deals with services provided to vehicles over a telecom device. The safety and security services include the automatic crash notification, emergency and medical assistance. These were the first set of services to be provided as part of the telematics and also the primary motivation for the conceptualization of automotive telematics. Diagnostics is another upcoming area of telematics services. Telematics services include remote diagnostics, performance data collection The TCU in the vehicle is made capable of performing detailed diagnostic scans when triggered remotely or when certain key thresholds are crossed. Some of the key services presently available in the domain of automotive telematics include [7]:

• Automatic Crash Notification

• Roadside Assistance Services

• Vehicle Tracking

• Remote Door Services

• Navigation Assistance

• Traffic Assistance

• Infotainment Services

• Diagnostics

***C. Flow chart for Telematics Functionality:***

Telematics is a method of monitoring the vehicle parameters. It is the technology of sending, receiving and storing information to vehicles those are remotely located.(Refer fig. 2).

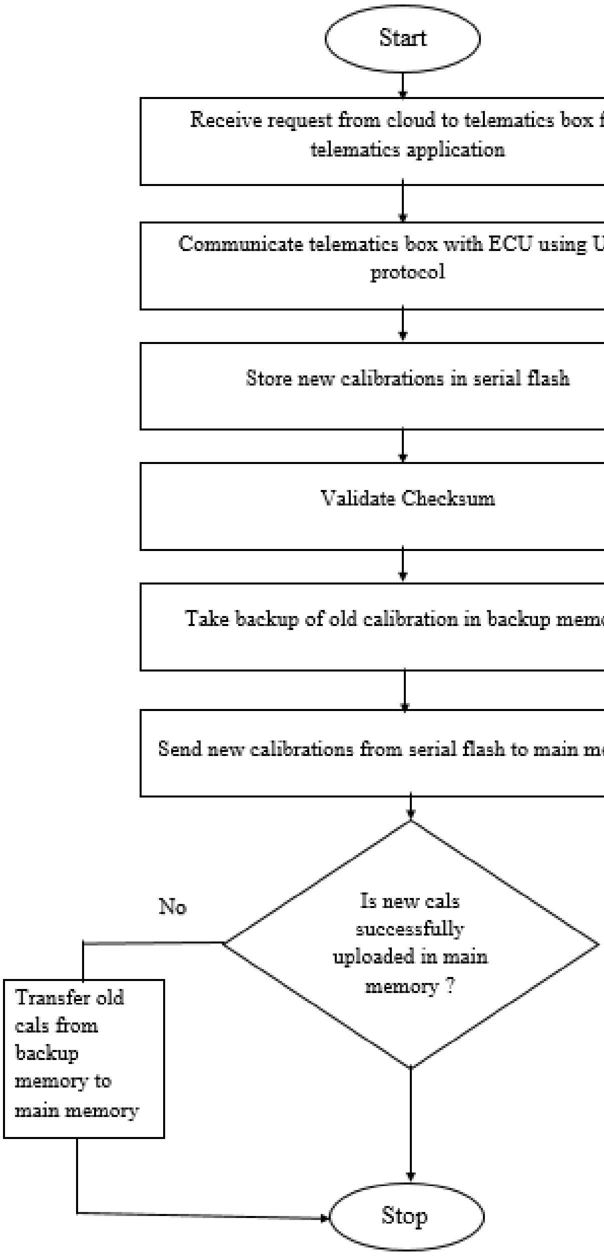


**Fig 2: Flow chart for telematics**

## III. SYSTEM ARCHITECTURE

ECU has microcontroller, which is programmed using software it is necessary to be tested before deploying it into the actual environment. ECU is connected to test bench using wiring harness. Test Bench and system (Test PC) is connected through PCAN that is CAN Bus. Fig 3 describes the block diagram of the system. Hardware used are testing module/ ECU, Harness for connection, PCAN adapter for communication and test bench is LUIS bench is used[3].

### *A. Test PC:*

All the required software tools are controlled through the test PC. The Cummins proprietary software is used to continuously monitor the system while doing the manual testing. The Peak explorer software tool is used to monitor all CAN related activities. The NI Teststand software is used for the automation purpose. The NI test stand software tool directly monitors the parameters from the ECU.

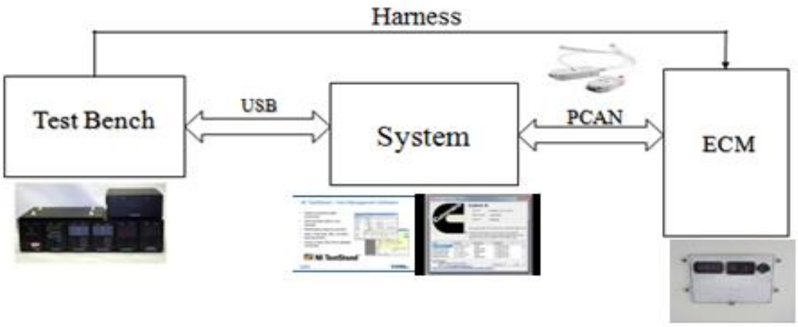


**Fig 3: Block Diagram**

### *B. CAN Hardware:*

It is used to make the communication of the ECU, controlling software. It works over CAN protocol i.e. J1939 SAE standard for automotive applications. It is a two wire twisted pair protocol having characteristic impedance of 120Ω.

### *C. Wiring Harness:*

The wiring harness is a bunch of all the wiring set up used for developing the complete test bench setup. Set of wiring harness is for the LUIS bench and ECU. If the type of the ECU for the complete test bench set up changes then the wiring harness also changes.

### *D. LUIS Bench:*

LUIS Stands for Load Box User Interface System, it is an engine simulator used to facilitate bench top engine control system hardware and software testing. The pictorial view is shown in fig 4. The LUIS Gen2 has a main module that is connected to the PC via USB. Additional modules can be added including Wave maker, Switch, Analog and Resistive Loads to customize the system to fit the user's specific needs[6].

**Fig 4: LUIS Bench**

## IV. IMPLEMENTATION AND RESULTS

This section describes the complete implementation flow, implementation and results for telematics testing and testing time comparison report between manual testing and automated testing. Fig 5 shows the complete implementation flow of the system right from writing the telematics sequence to the performing automated testing on the LUIS test bench

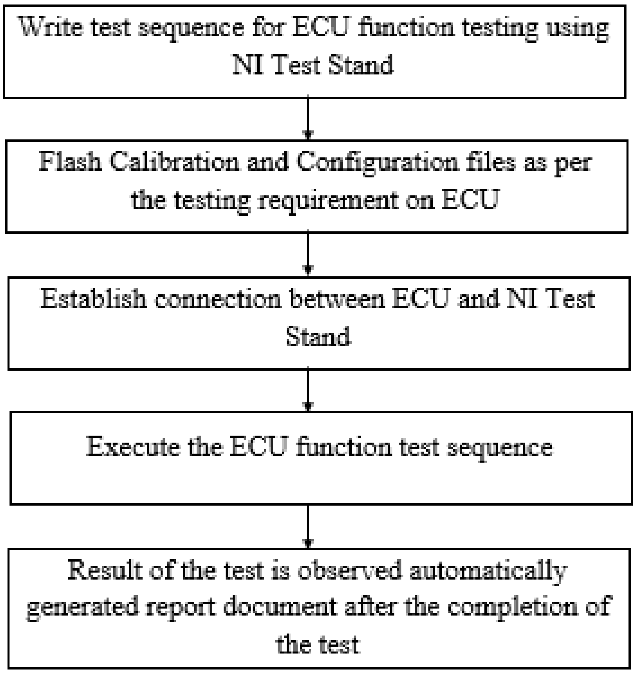


**Fig 5: Generalized work flow of test automation tool**

### *A. Pass/Fail Criteria:*

NI TestStand is used to write automated test sequence. NI TestStand reads the response parameter value from ECU as 'Actual Parameter Value' and compares with the 'Expected Parameter Value' comparison result either 'Pass' or 'Fail' will be reported in 'Report sheet' through test sequence only.(Refer Fig.6).

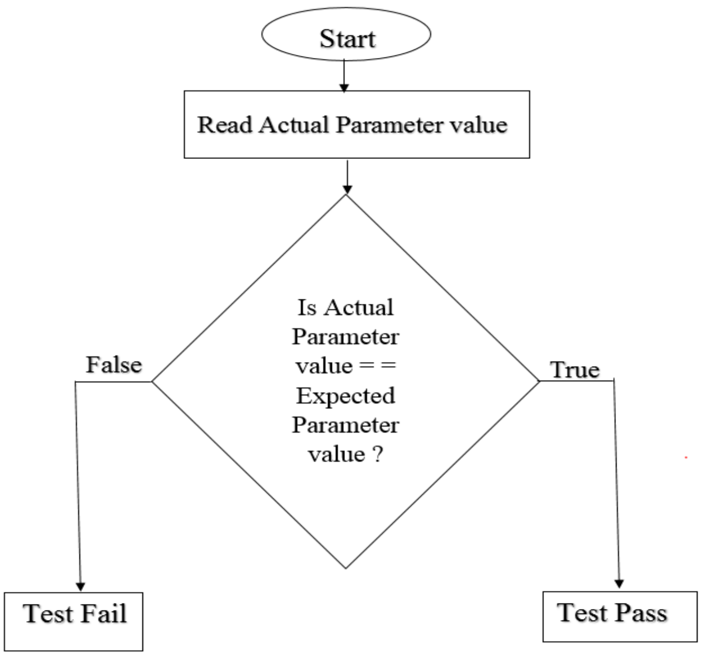


**Fig 6: Flow chart of Pass/fail Criteria**

### *B. Report Generation and validation:*

TestStand is capable of reporting results in ASCII text, HTML, XML and even in the new ATML standard reporting. This reporting is completely customizable and uses a plan to create a report using the test results obtained in TestStand. This particular report is in HTML. We can see report format selection and other settings in TestStand report option window. Our report contains Station ID, Date, Time, Overall test Result at the heading of report file. If there is failure in any sub sequence, it is reported in header. For individual test, we can add/change content to be displayed in report[4].

5.2.3.4. Validate DM Address Translation — Test Start Time 5:23:26 PM Test End Time 5:25:14 PM

5.2.3.4-1: DM Address Translation For Telematics Events on Current Region

| DM_Region | DM_Event_Type | DM_Source_Addr | DM_Length | Dest_Addr_Exp | )est_Addr_Actua | evice_mngr_Status_E | e_mngr_Status_A | Pass/Fail |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 10485760 | 16 | 4063232 | 4063232 | 0 | 0 | |
| 0 | 0 | 0x00A00000 | 0x00000010 | 0x003E0000 | 0x003E0000 | 0x00000000 | 0x00000000 | PASS |
| 0 | 0 | 4224 | 12152 | 0 | 0 | 0 | 0 | |
| 0 | 0 | 0x00001080 | 0x00002F78 | 0x00000000 | 0x00000000 | 0x00000000 | 0x00000000 | PASS |
| 0 | 0 | 16640 | 32520 | 65536 | 65536 | 0 | 0 | |
| 0 | 0 | 0x00004100 | 0x00007F08 | 0x00010000 | 0x00010000 | 0x00000000 | 0x00000000 | PASS |
| 0 | 0 | 262144 | 444688 | 131072 | 131072 | 0 | 0 | |
| 0 | 0 | 0x00040000 | 0x0006C910 | 0x00020000 | 0x00020000 | 0x00000000 | 0x00000000 | PASS |
| 0 | 0 | 1610701832 | 196 | 4128768 | 4128768 | 0 | 0 | |
| 0 | 0 | 0x60015C08 | 0x000000C4 | 0x003F0000 | 0x003F0000 | 0x00000000 | 0x00000000 | PASS |

**Fig 7: Automated Report generated**

### C. Testing time Comparison between conventional and automated testing:

The bar graph for the comparison of time required performing telematics testing manually and the automated is given in Fig. 8.

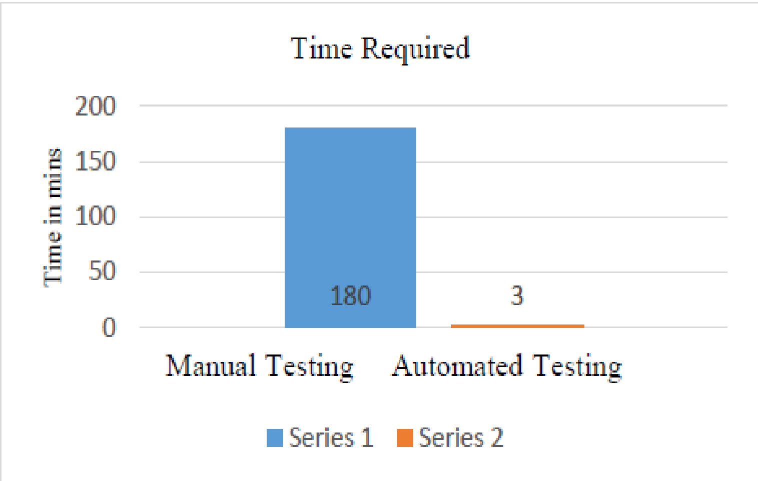


**Fig 8: Time Required Graph**

## V. CONCLUSION

Automated testing is more reliable, accurate, less time consuming, reusable and having large test coverage. For this project we have designed a test suite which is combination of different software's like LabVIEW, CSH and NI TestStand. We can test our specific ECU and verify the correctness or soundness of Telematics functionality.

## ACKNOWLEDGEMENT

I express my gratitude to my guide Prof. S.B. Dhaygude and Mr. Harish P. Tilak (Test Team Lead Embedded software, Cummins Electronics) for their valuable guidance throughout my Dissertation work. I feel proud to present my dissertation under their guidance I express my sincere thanks to all our staff members and colleagues who have helped me directly or indirectly in completing this project.

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