MIL In Test-driven Development
For Achieving Agile ECU Development

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Automotive Industry/OEMs

To Launch New Vehicle Models
OR
Upgrade Existing Designs

Requires almost Twice a Year

Develop Models, Software and test Cases Together

Test Driven Development Approach

Agile Methods

This leads to

Time Feature Set

Solution
Problem Statement

Increased ECU feature sets

Feature Set

Feature Requirements

Years

Feature Requirements

Problem Statement... continued

Reduced Time to Market

Graph:
- X-axis: Year (2008 to 2020)
- Y-axis: Development time in months (0 to 30)
- Trend line showing decreasing development time over years.
Development Strategy to solve the problem

Approaches discovered for different scenarios of ECU development requirements.

1. Requirement of software development on an existing ECU hardware.

2. Requirement of a whole new ECU software and hardware.
Development Strategy to solve the problem

- Model based Development
- AutoSAR Platform Approach
- Test Driven Development
Development Strategy to solve the problem... continued

Changes with every Variant (Update in Feature Set)

Remains fixed most of the times

Application

Base Software
Development Strategy to solve the problem... continued

Application Model

MIL with ECU Hardware

MIL with HIL System
MIL with ECU Hardware

Pre-Requisites

- ECU H/W
- COMM Layer
- Established BSW
- Test Setup MIL Capabilities

Benefits

- Actual H/W in-loop to drive the loads.
- Closed loop testing with actual sensor and load feedback.
- Model Developer does not need to wait for Software Integrator.
- Model and Signals can be traced/logged.
- Minimal change in HIL Setup and test cases when testing production ready part with Integrated H/W and S/W.
Requirements Coming as Changes
OR
New Requirements

Validation Of Requirements before Code Generation

Model Simulation is also done for the Validation.

Reduction in Time getting wasted in re-iterations and Code Generation
MIL with HIL System

**Pre-Requisites**

- COMM Layer
- Test Setup with MIL Real Time

**Benefits**

- No actual H/W required to drive the loads.
- Closed loop testing with actual sensor and load feedback.
- Model Developer need not to wait for Software Integrator.
- Co-development of Model and Test cases.
- Model and Signals can be traced/logged.
- Minimal change in HIL Setup and test cases with each iteration.
**MIL with HIL System**

- **Model Development & Testing in Real Time Over HIL**
  - MATLAB model as Requirement for better understanding and better test results

  - Benefit is same test cases (MIL, HIL) can be used to test Actual Hardware

  - By Simple mapping available in HIL, tester can switch between Model under test setup and ECU under test setup

  - Requirements, Model, Software and test cases become matured together with the right agile approach.

  - Reduces Time
Work Flow for MIL in Test-Driven Development

1. Create model & map to signals/system variables
2. Create Configuration in test environment
3. Build model for Test Environment & Load
4. Map System Variables with model & H/W IOs
5. Load CAN database in Test Environment
6. Run model & test Cases in the test env
MIL with ECU Hardware System - Testing Flow Diagram

- Test Cases
- CANoe
- Model
- ECU
- Actual Loads
MIL with HIL System - Testing Flow Diagram

Test Cases → CANoe → Vector VT System → Actual Loads
Production Ready HIL Setup - Testing Flow Diagram

Test Cases → CANoe → VT System → ECU → Actual Loads
Tools Required

Application Design Through Model Based Approach

**Design - Simulink/State-Flow**

**Simulation & Test - Design Verifier/Simulink test**
Tools Required

Application Design Through Model Based Approach

Code Generation – Embedded Coder/AutoSAR Tool Box

Change Management - Integrated Version Control-Git
Summary

Requirement of less time to deliver and huge feature set for ECU are challenging in traditional ECU development approach.

$$\text{MIL} = \text{Saves time} + \text{Maturing requirements through validation}$$

Re-using test cases used in MIL testing with actual ECU with less or no efforts in test case change further saves time to deliver and reduces number of iterations.
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