

Association for standardisation of automation and measuring systems



Collaborating in California – Dynamic Skip Fire Development Using HIL API

7th ASAM US-Workshop, Oct. 29, 2014, Novi, MI, USA

Hartmut Jürgens, dSPACE GmbH Paul Liu, Tula Technology, Inc.





Preface

The ASAM HIL API addresses standardized interfaces of HIL test systems. Mr. Liu will give a report from Silicon Valley, California and show how HIL API is at work at Tula Technology, Inc. Tula has created the digital engine, thereby providing a cost-effective and easily integrated fuel-reduction technology. Tula's dynamic skip-fire technology makes dynamic firing decisions on an individual combustion engine cylinder basis. Thus the engine functions at its most fuel efficient operating point. Mr. Jürgens will present tools supporting HIL API, that also have been proved during cross tests performed in 2012 and 2013 by major vendors. To sum it up: HIL API is the right choice for engineers who like to reuse their existing tests and rely on a state-of-the-art standard that enables a better know-how transfer from one test bench to the other, resulting in reduced training costs for employees as well.

Contribution to the 7th ASAM US-Workshop, Oct. 29, 2014, Novi, MI, USA

Speakers: Paul Liu, Tula Technology, Inc., Hartmut Jürgens, dSPACE GmbH





1 HIL API and XIL API in dSPACE Products

2 Tula Dynamic Skip Fire Validation





Association for standardisation of automation and measuring systems

HIL Test Bench Architecture





Association for standardisation of automation and measuring systems

dSPACE Support of HIL API Ports Today

MAPort (Implementations available in the Market) Model Access port provides access to the simulation model read and write parameters, capture and generate signals.

DiagPort

Diagnostic port communicates with a diagnostic system, reads data via diagnostic services from an ECU.

ECUPort (ECUMPort, ECUCPort)

The ECUM port allows capturing and reading of measurement variables. The ECUC port is used for calibration.

EESPort (currently available for dSPACE SCALEXIO)

Electrical Error Simulation port controls electrical error simulation hardware. It allows the setup of different types of errors (e. g. short cuts).





dSPACE Clients

- AutomationDesk
 - HIL API Built In Library
 - HIL API Convenience Custom Library
- HILAPI.NET
- HIL API Python

dSPACE Server

- ✓ HIL (PHS based, SCALEXIO),
- ✓ RCP Platforms*
- ✓ VEOS











HIL API in AutomationDesk







Association for standardisation of automation and measuring systems

Platform Independent Tests in AutomationDesk





ASAM

dSPACE HIL

3rd party HIL

VEOS Offline Simulation

HIL API

Compliant HIL

- Use the HIL API to access the simulation model
- Switch comfortable between vendor specific HIL API implementations with HIL API Vendor Switch¹)

InitMAPort	
ConfigurationDict:{u'Application	
S Vendor:dSPACE	
MAPort:Extended Value is hidde	
	InitMAPort

Members of successful ASAM AE HIL Cross Tests

- dSPACE GmbH
- ETAS GmbH
- National Instruments Corporation
- Vector Informatik GmbH.



- Cross-Test Participants: dSPACE, ETAS, NI, TraceTronic, Vector
- Cross-Tests Goal: Check interoperability between client and server combinations of all vendors
- Cross-Test Results:
 - Test systems and test automation software using ASAM HIL API are able to communicate immediately.
 - Few minor functional deficits coming up due to a standard misinterpretation were identified.





Test Platforms



Roadmaps for Products

Platform API Package + Failure Simulation API Package + AutomationDesk







- dSPACE supports the ASAM HIL API standard from 2009 as main stream for HIL access in test automation tools
- XIL API compliant interfaces for MA Port and EES Port will be offered in dSPACE products as successor of the HIL API based functions
 - Platform API Package & Failure Simulation API Package
 - AutomationDesk
 - ControlDesk Next Generation
- XIL API 2.0 contributes features that facilitates platform independent tests:
 - ✓ Test reuse and know-how transfer between development stages (MIL, SIL, HIL)
 - ✓ Test reuse on simulation platforms of different vendors
 - ✓ Reduced training costs for employees





1 HIL API and XIL API in dSPACE Products

2 Tula Dynamic Skip Fire Validation





Introduction to Tula Dynamic Skip Fire

Traditional Variable Displacement Engines

GM Small Block V8 CHRYSLER HEMI V8 AFM MDS **Active Fuel Management** Multi-Displacement System V8 1-8-7-2-6-5-4-3 V4 8-2-5-3 V8 1-8-4-3-6-5-7-2 V4 8-3-5-2 VW 1.4L TDI HONDA V6 VCM ACT Variable Cylinder Management Active Cylinder Technology V6 1-4-2-5-3-6 V4 1-2-5-6 L3 4-5-6 L4 1-3-4-2 L2 1-4





Figure 1. Cylinder deactivation systems as deployed by GM, Chrysler, Honda and VW

dSPACE



The Tula Variable Displacement Engine



For a short video about Tula's Solution www.youtube.com/watch?v=YXkq6Fzuuas



Test Hardware

- Tula test hardware consists mainly of the dSPACE MABX with dSPACE RapidPro
- The MABX talks to the third party hardware that simulates an Engine
- The MABX also use dSPACE PGI-SPI to talk to Tula Co-Processor





Automated Test Architecture

- Having an effective and efficient testing architecture is very important. A typical testing environment ٠ looks as shown in the figure.
- As evident from before Tula employs hardware from different vendors in their current setup. Both the ٠ vendors have their own proprietary platform access
- Thus there was a need of a platform access API that meets the following demands:
 - Synchronization between the different hardware from different vendors.
 - Standardized functions for platform access. .
 - Fast execution of commands.
 - Stimulus testing
 - Triggered data capturing to synchronize and efficient recording. •





Automated Test Architecture (Contd.)

- After careful research and investigation Tula narrowed down to ASAM HIL API for platform access for platform access. HIL – API is an ASAM standard. Thus to write automated tests Tula uses HIL API, it helps in protecting investments and incorporates the testing of the 3rd party hardware in one tests.
- HIL API met Tula's high expectations:
 - \cdot The average response time for read and write was < 1ms .
 - · Stimulus testing was reliable, accurate and completely scriptable.
 - Capture was accurate with no missing data points even at rates higher than 2 samples per milli second.
 - With the use of hardware trigger, data capturing was synchronized to within 1 sample point.
- With the use of HIL API, Tula can now integrate with ease its test hardware/software with other OEM as long as they use the standard too.





dSPA

Tula System Test Setup

- Tula Technologies relies on the dSPACE AutomationDesk for the system testing. AutomationDesk is a test creation and test execution software. The advantages of using AutomationDesk are:
 - Support for HIL API, thus supporting integration of hardware from different vendors.
 - Supports creation of custom libraries or blocks, helps with the DRY principle.
 - · Easy and effective test creations
 - · It supports a combination of script and graphic based test creation.
 - · Control over the report generation

ГША

- API access to the software to enable integration with Tula WebCarLab.
- Stable and Reliable testing.



DSF Application Benefits

The Tula DSF Application

SAM

- Computes the optimal variable displacement configuration for the demanded torque and provides air, fuel, and spark compensation parameters
- Integrates with existing ECU and powertrain components and offloads additional computation burden on a hardware co-processor
- Incorporates Tula specific checks that enhances existing engine diagnostics
- Provides extensive calibration support to achieve fuel and drivability targets

