MATLAB EXPO 2018

Model-Based Design per sistemi powertrain
From concept to production

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Agenda

• Introduction
• Motivation & Challenges
• Model-Based Design: why is a necessity
• Product Innovation
• PWT Model-Based Design toolchain
• Future developments
INTRODUCTION

NÜRBURGRING LAP RECORD

05th OCTOBER 2016 NÜRBURGRING - NORDSCHLEIFE
INTRODUCTION

- OEM achievements: Business demand, System Development and Quality
- Know-how preserve
- Product distinctive
- Time2Market (reduction)

Operations

- A process is a series of steps and decisions involved in the way work is completed
- System Development Life Cycle represents a process for designing, testing and implementation of software application

Business Demand (BD)
- Advanced functionality
- Minimize cost
- Ensure time2market

System Development (SD)
- Complex systems
- Unique Requirements
- E/E SW development

SDLifeCycle (SDLC)
- Communication
- Visibility
- Quality
MOTIVATIONS & CHALLENGES

- Speed up development of new concept
- Methodologies and unified toolchain for code production
MODEL-BASED DESIGN: WHY IS A NECESSITY

Model-Based Systems Engineering is the formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases.  

INCOSE SE Vision 2020 (INCOSE-TP-2004-004-02, Sep 2007)

MBSE allows productive cooperation with stakeholders, improving quality, increasing productivity and reducing risk.

Model-Based development for complex system, Berlin, 2017 September 21th
PRODUCT INNOVATIONS (1/2)

**Kers**

Kinematic Energy Recovery System is able to store and release energy to the vehicle for improving performances.

**VVT**

Vane cam phasers are used in ICE for changing the valve timing lifting up and down the intake and exhaust valves for improving vehicle performances.

**Pullaway**

The functionalities allow to the driver to start the vehicle based on the acceleration requested.

«**Model-Based Design** has allowed evident benefits in function development producing a new mentality to the software design»

Powertrain tells...

In 2010 a first tentative towards MbD approach was achieved integrating the KERS torque management entirely designed in Matlab along with Gallardo engine torque control. The experiment was successful and carried to prototype the vehicle in order to evaluate the benefits in performances (emission and driveability).

In 2012 the goal to make on production series some functionalities on Aventador project was achieved. Starting from the Kers experiences done in function development, new challenges was faced in term of code integration and fixed point design to be accomplished with the embedded project. A crucial role was the supplier collaboration.

In 2013 the the approach on Aventador production series carry on including a torque control functionality which allowed to manage internally the software development. In particular, pull-aways are performed by releasing the clutch pedal, while the engine control (usually the idle speed control) compensates for the additional load by increasing the engine torque.

Rapid Control Prototyping

When the vehicle is available the new functionalities development can be tested simply and fastly by running it on RT target. The Simulink model, designed on the PC, can be targeted by using InteCRI0 tools. ETAS910 (RT target) allows the RT communication among the host and the vehicle.

**Model-Based development for complex system, Berlin, 2017 September 21th**
EXTERNAL BYPASS IS A COMMON METHOD TO PROTOTYPE OR ENHANCE ECU ALGORITHMS RAPIDLY. DATA READ FROM ECU IS USED AS INPUTS TO THE BYPASS ALGORITHM CREATED IN SIMULINK AND EXECUTED EXTERNALLY.

THE OUTPUT OF THE BYPASS IS FED BACK INTO THE ECU AND USED INSTEAD OF THE OUTPUT OF THE ALGORITHM CALCULATED ON THE ECU.

PRODUCT INNOVATIONS (2/2)

RAPID CONTROL PROTOTYPING

SERVICE BASED BYPASS (SBB)

1. Individual bypass input variables of the bypass are copied at each service point
2. Bypass always gets always the last ECU values and executes exactly the same inputs and time function (replace o improving)
3. Bypass output data is written into the ETK and into the ECU at the end of the service point after synchronization

PROS
- Fully synchronized bypass execution with no raster delay
- ECU scheduling idea

CONS
- ECU scheduling idea

HOOK BASED BYPASS (HBB)

1. All bypass variables are copied at once from ECU, typically at the end
2. After bypass the outputs are written in the ETK buffer
3. Each vars are read back at the corresponding ECU software

PROS
- Low impact on ECU load and timing behaviour
- No information on ECU scheduling needed
- Minimal interrupt load
- One or more vars can be bypassed

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PWT MODEL-BASED DESIGN TOOLCHAIN

How tool works

• Linking requirement to documentation (V&V)
• Model (SLK, ML, SF)
• Implementation
  • MAAB rules guideline check
• Sync model version to GitHub
• Analysis (V&V)
  • MIL vs. SIL
  • Test coverage
• SW Specification (SL ReportGenerator)
• Code Generation (Embedded Coder)
  • Target customization
  • Library implementation

Is it possible integrate data for function development?

«By using MathWorks products the function development process automation it was possible raising in effectiveness and efficiency in the early stage of development»

Features

• Distributed app

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PWT MODEL-BASED DESIGN TOOLCHAIN
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Future developments

Toolchain enhancements:

• System Architecture (database)
• Model Requirements
• Consistency checks of custom MAAB rules
• PolySpace checks
Thanks for your patience