Model Based Continuous Integration of Automotive Embedded Systems

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Volvo Group

We are one of the world’s leading manufacturers of trucks, buses, construction equipment and marine and industrial engines.

We also provide complete solutions for financing and service.
Our organization

Volvo Group CEO
& Group Executive Board

Deputy CEO

Group Human Resources

Group Communication

Group Finance

Group Legal & Compliance

BUSINESS AREAS

Renault Trucks
Mack Trucks
UD Trucks
Volvo Trucks
Group Trucks Asia & JVs
Volvo CE
Volvo Buses
Volvo Penta
Volvo Financial Services
Arquus

TRUCK DIVISIONS

Group Trucks Technology
Group Trucks Operations
Group Trucks Purchasing

Volvo Group Trucks Technology
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Background and Needs

Needs → Modelling & Simulation → Workflow → Tooling → Projects → Summary
- Reduced Lead Times
- Continuous Deployment
- Continuous Integration
- Quality
- Reuse
- Multiple cycle times
- Multiple Aspects
- Multiple Domains
- Multiple Teams

- Automation
- Connectivity
- Electrification
- Control Strategies
- Architecture (re)volution
Go Virtual

...to allow

- Daily Deliveries
- Maximize Verification Confidence
- Exercise Dangerous and Rare Events
Go Rigorous

Use Models and Data to
- provides Means to Secure Product vs. Needs and Requirements
- allow engineering rigor and automation
Go Multi-Method
Go Consistent

Models & Code

Binaries & Components
Go Continuous

"Weekly"  "Daily"  "Monthly"
Engineering Workflow

- **Represent**
  - AUTOSAR/EAST-ADL/FMI/UppAAL/Modelica/...
- **Resolve**
  - Configure and Resolve variability
- **Generate**
  - Automatic preparation for each tool
- **Simulate/Analyze/Verify**
  - Software centric simulations
  - Physics centric simulations
  - Arithmetic analysis
  - Formal verification
  - ...
Modelling & Simulation Technology

Models - MIL

Software - SIL

Hardware - HIL

Prototyping - RCP
Modelling Pattern to Support Integration

Model-in-the-loop: **Controller model** interfaces to models of sensors and actuators
Software-in-the-loop: **Software** interfaces to models of electronics
Hardware-in-the-loop: **ECU** interfaces to models of sensors and actuators
Hardware*-in-the-loop: Sensors and actuators interfaces to models of plant
Model Structure
Overall Workflow

Needs → Modelling & Simulation → Workflow → Tooling → Projects → Summary
Configuration

Application SW Integration
Platform SW Integration
ECU, I/O, Sensors & Actuators
Plant Integration
Environment Integration
Configuration

Software:
- AUTOSAR SWC Selection
- AUTOSAR SWC Parameterization
- Configuration ports
- Initialization values

Non-Software
- Logical Component Selection
- Function Mockup Unit Parameterization
- Configuration Ports
- Initialization values

Environment:
- Traffic Scenario:
  - OpenScenario Selection & Parameterization
- Roads:
  - OpenRoad Selection and Parameterization
Generation

Application SW Integration

Platform SW Integration

ECU, I/O, Sensors & Actuators

Plant Integration

Environment Integration

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Simulation

Adapt Simulation Platform
Engineering Automation

Make Changes

Automatic Resolution and Build

Automatic Invocation

Automatic Test

Local PC or Cloud
Tooling for Simulation, Modelling and Integration
An information model that captures engineering information in a standardized way
Functional & Software Architecture

Structure
Function Components
SW Components
HW Topology
Simulation

Behavior/Timing
Function Mockup Units + Execution Definition
Source Code + Execution Definition
Variability
ADAPT Integration Environment

- Framework for Continuous Integration and Delivery
- Simulation Environment for Code and Models
- Used for GTT Integration and Verification
Adding EnvironmentSimulator to ADAPT

- Roads and Scenarios defined in
  - OpenDrive
  - OpenScenario
Example

- Autogenerated Experiment from Model

- Configuration of
  - Software
  - Electronics
  - Plant
  - Environment
FFI Open Innovation Lab & FFI Simulation Scenarios

Government Funded Projects

- Open Innovation Lab
  - Third-Party Development of
    - Internal vehicle functions
    - External vehicle functions
    - Simulation Models

- Simulation Scenarios
  - Use of scripted roads and environment
    - OpenScenario
    - OpenDrive
EMISYS Technology:
Execution of Functional Mock-up Units in Simulator/PC

FMI Technologies:
- Code Generation technologies
- Solver Technologies - Efficient Simulation of multiple FMUs
- Simulator integration – Volvo Adapt Simulator, OMSimulator

EMISYS Technology:
Execution of Functional Mock-up Units in vehicle

eFMI Technologies
- Compiler technologies
- System Integration aspects
- AUTOSAR Compliance

EMISYS Technology:
Execution of Embedded Functional Mock-up Units in vehicle
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Summary

New Vehicle Functionality

Development Efficiency

Short Lead Time

Iterative & Incremental Development

Engineering Automation

Automatic Configurability

Automatic Evaluation

Variability Modelling

System & Plant Modelling

Configure

Simulate