Hitachi Co-Simulation Cloud
A Brief Technical Overview

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1. Automotive System Development Challenges

**Trends in Automotive Control Systems**

**Past**
- Mechanical
- Hydraulic

**Present**
- ADAS
- Comfort
- Convenience

**FUTURE**
- Autonomous, Connected

- Exponential software increase
- > 300M lines of s/w by 2020

**Need for robust, systematic, comprehensive, design platform**

**Automotive Functional Safety Compliance**

- Software verification test cases increase almost 100-fold
- Tests under normal as well as abnormal / faulty conditions

**Trends in Simulation Technology**

**Trend 1 - Fidelity**
- Low

**Trend 2 – Coverage**
- ECU, Sub-system level (multi-domain)

**High Co-simulation**
- System, vehicle level
2.1 Hitachi Co-Simulation Cloud Solution

Breaking the walls – Multi-Domain Co-simulation

Example 1: Thermal-electrical system co-simulation

Electrical Power Analysis

Thermal Analysis

Saber

Chipset Temperature

Power

Ansys

Co-simulation Bus [CosiMate]
Example 2: Mass Air Flow Sensor (MAFS) flow behavior co-simulation

Electrical Analysis

Mass Air Flow Sensor

Mechanical Analysis

Saber

STAR-CCM++

Velocity

Simulink S-function

Co-simulation Bus [CosiMate]
2.2 Challenges: Component Level to System Level Co-Simulation

Use Case Study: High-fidelity Multi-ECU Motor Control System*

New Issues

Tedious Manual Configuration
- 5 Models
- 4 Simulators / 7 Instances
- 3 Binary Codes in 3 ECUs
- 3 Virtual CAN Buses
- 10 Ports / Each ECU-Plant
- 10+ Launch Scripts
- …
- 40+ clicks to launch on PC

50+ ECU -> Clicks?

Automation!

Huge Computing Demand
- 4 Simulators / PC → 4-Core CPU
- 3 High-Fidelity ECU → 2 PC

50+ ECU → ? PC

Scalable Infrastructure!

* To appear in 2016 SAE paper #2016-01-0013
2.2 Hitachi’s Solution: Moving into the Cloud

**Features**
- Multi-domain high-fidelity co-simulation
- Cloud
- Automation
- Model Database
- Highly customizable, scalable
- Vehicle-level co-simulation → possible

**Benefits**
- Faster development cycle
- Lower cost
- Earlier product delivery

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**Target Customers**
- Automotive
- Construction Machinery

**Prototype Running**

**Co-Simulation Environment**
- Virtualizer
- Saber
- Simulink
- Manager
- Database Manager
- VM Resource Manager

**Gateway**

**Cloud Manager**

**Test Scenarios**
- Web Browser
- Simulation Software

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Model

Prototype

Running

Test

Scenarios

HITACHI

Generic

VM

VM

VM

VM

VM

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3. Hitachi Co-Simulation Cloud Demo

* Virtualizer and Saber licenses were provided by Synopsys during large-scale trial tests on HDS Cloud Multi-ECU Co-Simulation on Hitachi Co-Simulation Cloud
4. Hitachi Co-Simulation Cloud Use Cases

**Engine ECU Co-Simulation (vHILS*)**
- Customer
- Hitachi
- Active Safety Framework
- Hitachi Simulation Cloud

**MAFS Flow Behavior Co-Simulation**
- Data
- Simulation
- Fatigue Life

**Mechanical Component Failure Prediction Co-Simulation**
- Fatigue Life

**Multi-ECU Co-Simulation**

**Thermo-Electrical Co-Simulation**
- Network Topology
- Data Transmission
- Radio Channel
- Network Simulation in MATLAB

**Full Vehicle Level EMC Co-Simulation**

**Suspension Co-Simulation**
- In-cylinder Spray Simulation
- Spray Design

**Spray and Engine CFD Co-Simulation**
- Sprays

* vHILS: Virtual Hardware-in-the-Loop Simulation

APL Automotive Product Research Laboratory

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5. Next Step

**Target Customers**

- Internet of Things, Social Innovation

**Test Scenarios**

- Automotive
- Aerospace
- Construction Machinery
- Appliances

**Ultimate Goal**

- Hitachi software
- Hitachi hardware
- Hitachi analytics

→ One-Stop Hitachi Solution

**Co-Simulation Environment**

- Virtualizer
- Saber
- Simulink
- Manager

**Gateway**

- Web Browser
- Simulation Software

**Test Results**

**Scalability**

**Data Analytics**
- Pilot Project on-going

**Cloud Infrastructure**
- Large-scale pilot test completed

**HITACHI Big Data Lab**

**HITACHI Data Systems**

**APL Automotive Product Research Laboratory**

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Questions/Discussion
Thank you
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