JAMBE
Japan Automotive Model-Based Engineering center

OEM/Supplier Model Exchange Case Studies at JAMBE

Yoshihiko Nishi (AISIN CORPORATION)
Tatsuya Masuhisa (AISIN CORPORATION)
Dai Araki (Toshiba Corporation)
Yoshito Morii (Toyota Motor Corporation)
Yasushi Noguchi (Toyota Motor Corporation)

Agenda

1. About JAMBE
2. About Aisin Corporation
3. Model Exchange use case of MIL, SIL
4. Model Exchange use case of HIL
5. Summary

JAMBE (Japan Automotive Model-Based Engineering Center)



https://www.jambe.jp/

Date of Establishment	March 8, 2023
Vision and Goals	• Contribute to the SDGs through vehicle innovation such as carbon neutrality and CASE by applying MBD. • Promote efficient R&D with MBD, regardless of company size.

JAMBE Organization Overview



Committees

4

Working Groups
Work Packages
Task Forces

15

Companies

212

Members

720

- **15** Automobile OEMs
- **64** Parts suppliers
- **35** Tool vendors
- **63** Engineering service providers
- **3** Engineering associations
- **4** Trading companies and staffing agencies
- **9** Universities / research institutes
- **9** Regional promotion organizations

JAMBE Vision

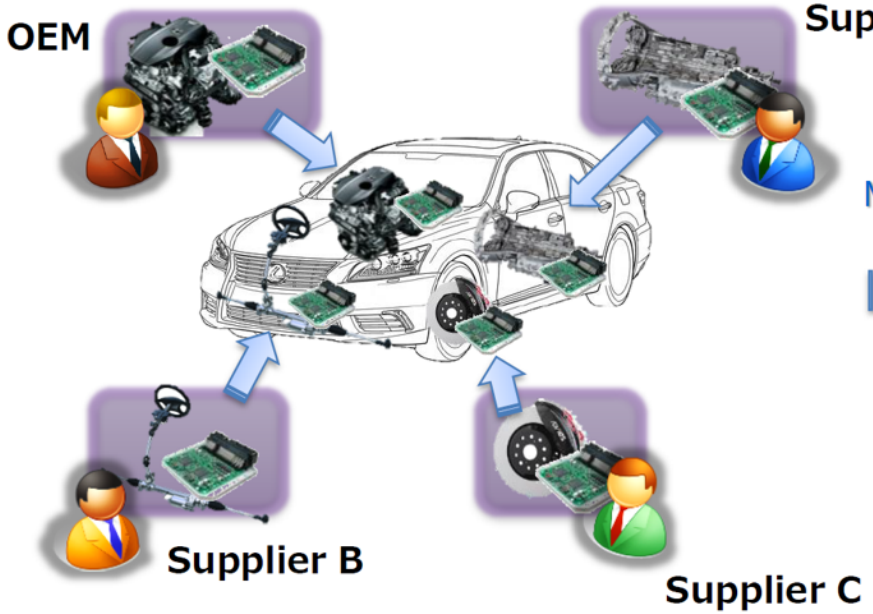
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Collaborative MBD between OEMs and suppliers should resolve these issues

Current

Individual development with MBD

- OEM : Large reworks due to mainly relies on individual optimization with many individual simulations
- Suppliers : Verifying requirement fulfillment with only a limited set of evaluation conditions

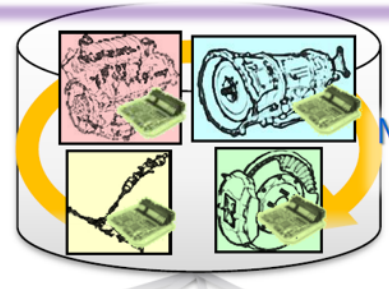


Model exchange and sharing of vehicle and components

What we aim for

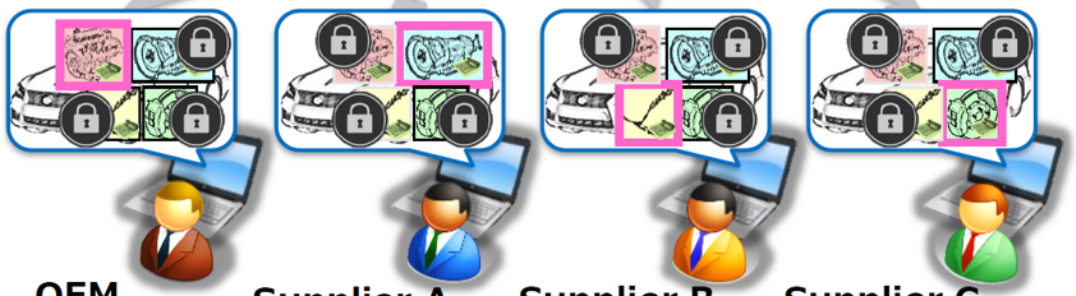
Collaborative MBD using common vehicle model

- OEM : Global optimization using integrated vehicle-level co-simulation using OEM and supplier's model
- Supplies : Participate in co-simulation with other parties to validate own part under various driving conditions



Model Management and Co-simulation

Vehicle simulation model integration by combining (confidential) component models



FMI and SSP activities in JAMBE

JAMBE Japan Automotive Model-Based Engineering center

General Assembly

Steering Committee

Auditor

Secretariat Office

Strategic Planning Committee

Intellectual Property Committee

MBD Promotion Committee

Model Exchange Promotion Committee

International Collaboration WG

Domestic Collaboration WG

Plant Model IF Guideline WP

Model Exchange Guideline WP

Control Guideline WP

Autonomous Driving WP

Trial Analysis WP

Measurement Model WG

Leaders Meeting

Vehicle Dynamics WG

BEV WG

AD/ADAS WG

prostep ivip

SystemX INSTITUTE OF RESEARCH AND TECHNOLOGY

Plant Model IF Guideline

Guideline-Compliant Model

fmi Functional Mock-up Interface

ssp System Structure & Parameterization

Model Exchange Process Guideline

Use Case Examples

vvv smart Systems Engineering

Model Integration Guideline for AD Models

Guideline-Compliant Model

Model Usage / Exchange Trial Cases

Collaboration Environment

Requirements / Manual Format

Model Metadata

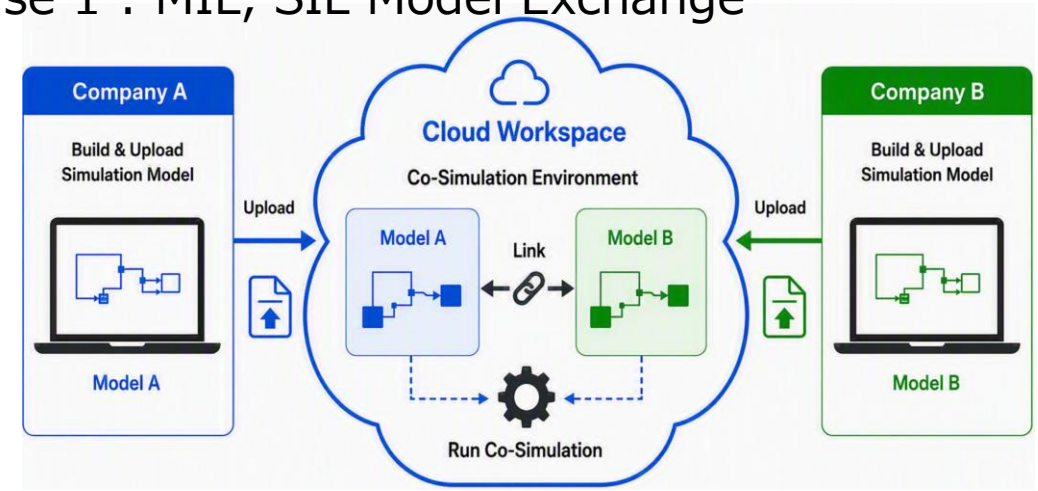
fmi Functional Mock-up Interface

ssp System Structure & Parameterization

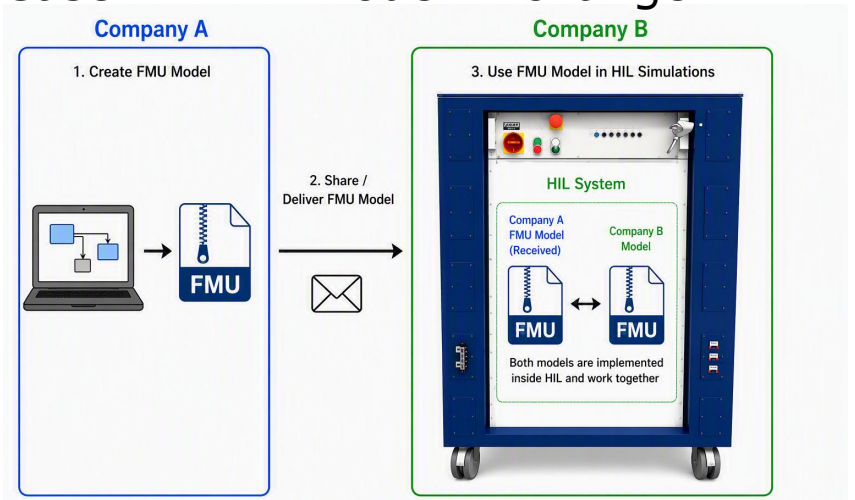
Model Exchange use cases of MIL,SIL and HIL

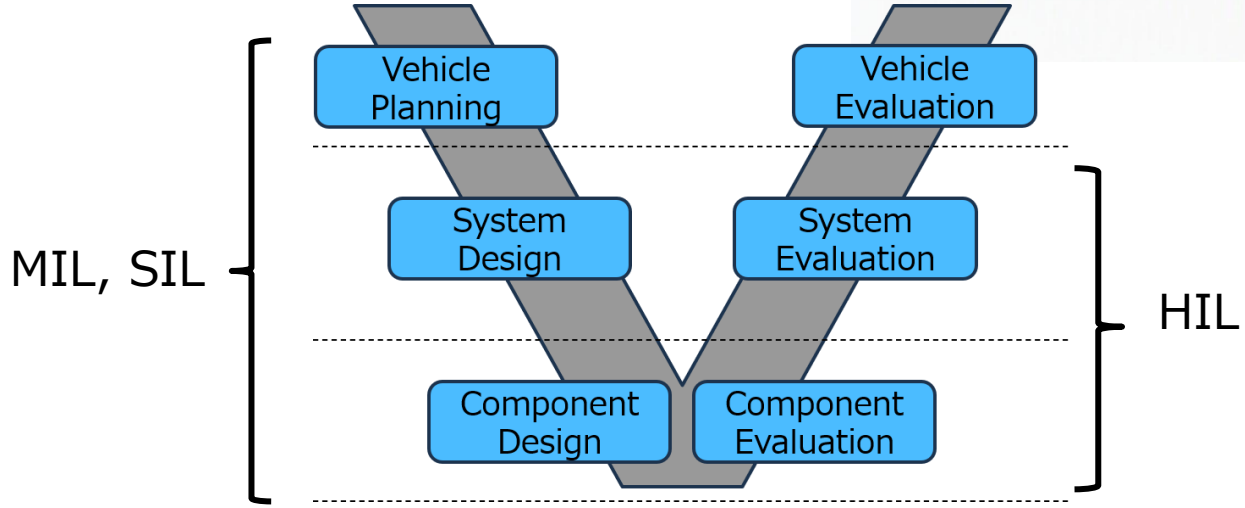
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Case 1 : MIL, SIL Model Exchange



Case 2 : HIL Model Exchange





AISIN would like to introduce two model exchange use cases.

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Company Profile

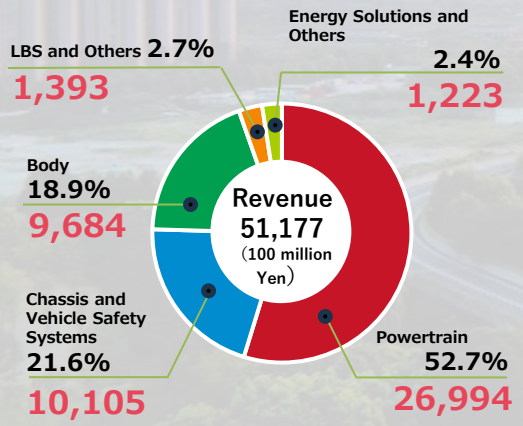
JAMBE
Japan Automotive Model-Based Engineering center

Annual revenue: Approx. 5 trillion yen * FY2025

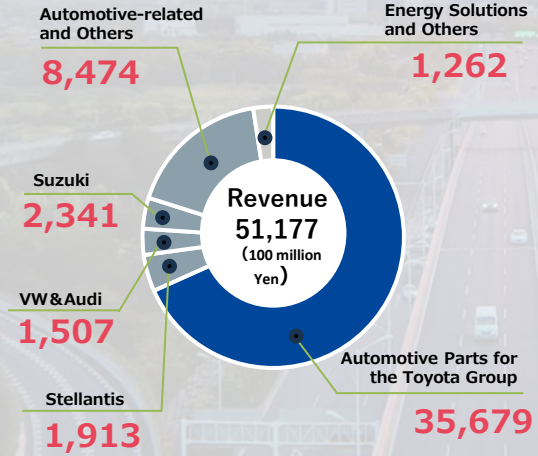
Approx. 190 group companies in Japan and overseas

Approx. 110,000 consolidated employees

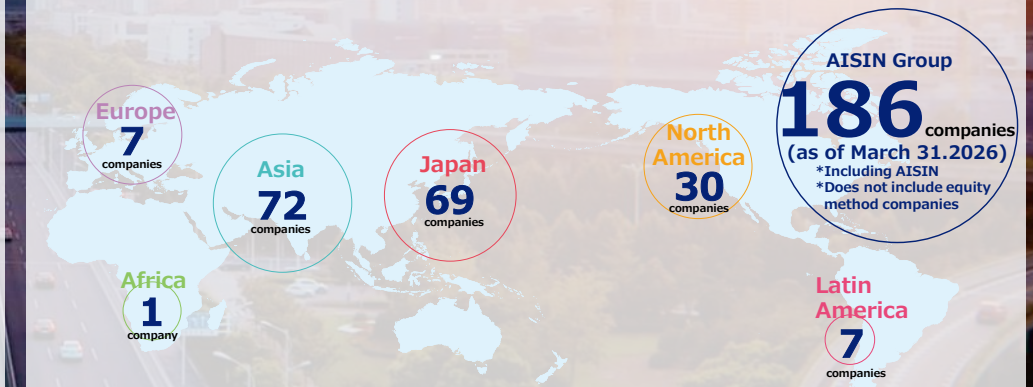
Revenue by Product



Revenue by Customer



Global Network



Products and Businesses

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Mobility Domain

Powertrain



eAxle



Hybrid transmission



Automatic transmission

Body



Power sliding door system



Heat Sink

Chassis and Vehicle Safety Systems



Automated parking system



Cooperative regenerative brake system

LBS (Location Based Solutions)



“Choisoko” rideshare service



Car navigation system

Aftermarket



Repair and maintenance products

Beyond Mobility

E-VC (Energy-Value Chain)



Cogeneration system for residential use

New businesses and others



Hydraid
Ultra-Fine Water Penetration Technology



YYProbe
real-time voice recognition app

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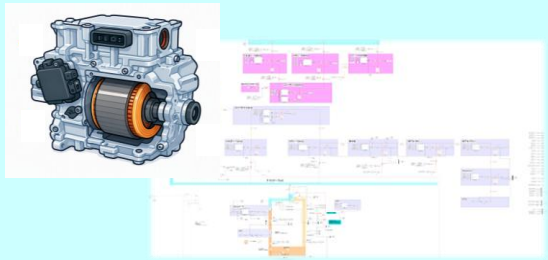
OEM/Supplier Exchange Case

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SUPPLIER
Component model

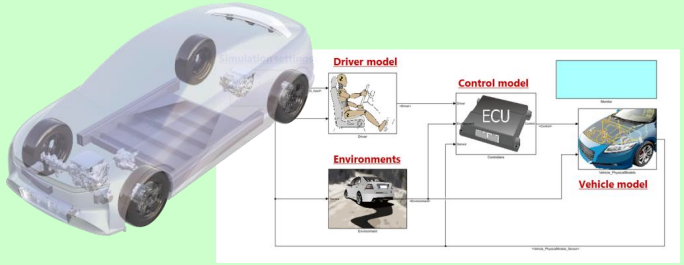


Supplier



Exchange

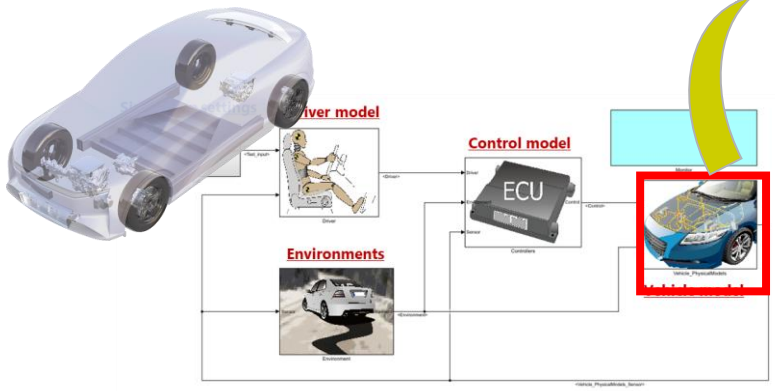
OEM
Vehicle model





OEM

OEM-Supplier Coupled Model (e.g., thermal model)



Supplier Model



E-Axle

Heat Exchanger

Battery

Radiator

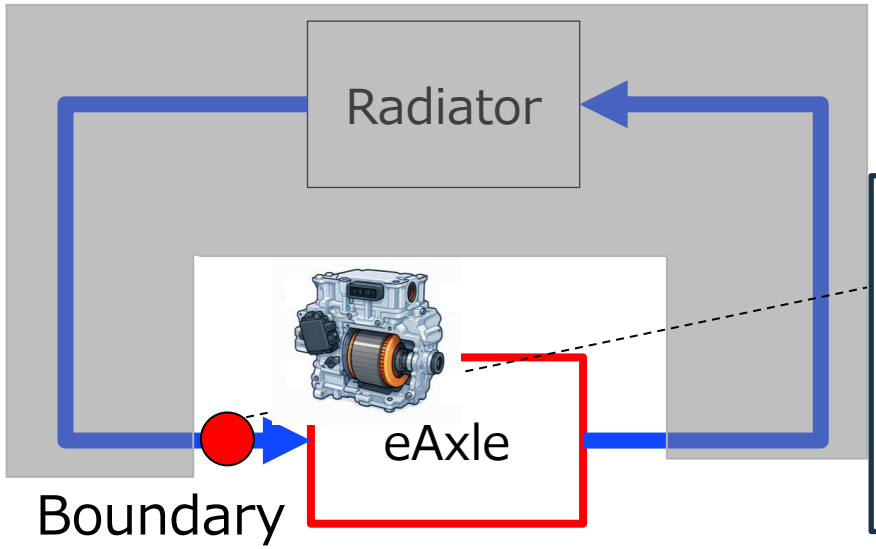
Thermal model

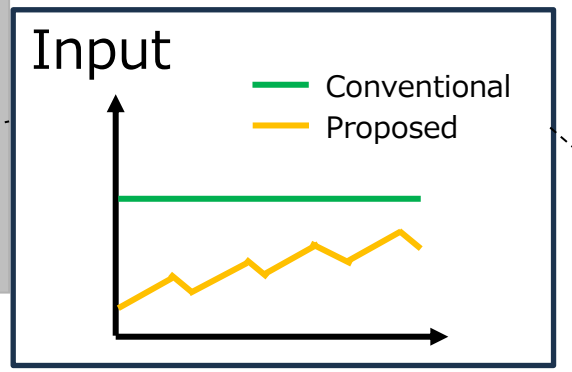
OEM and supplier collaborate using a shared model for performance simulation.

Use Case (Thermal Reliability)

Verification of thermal feasibility of motor

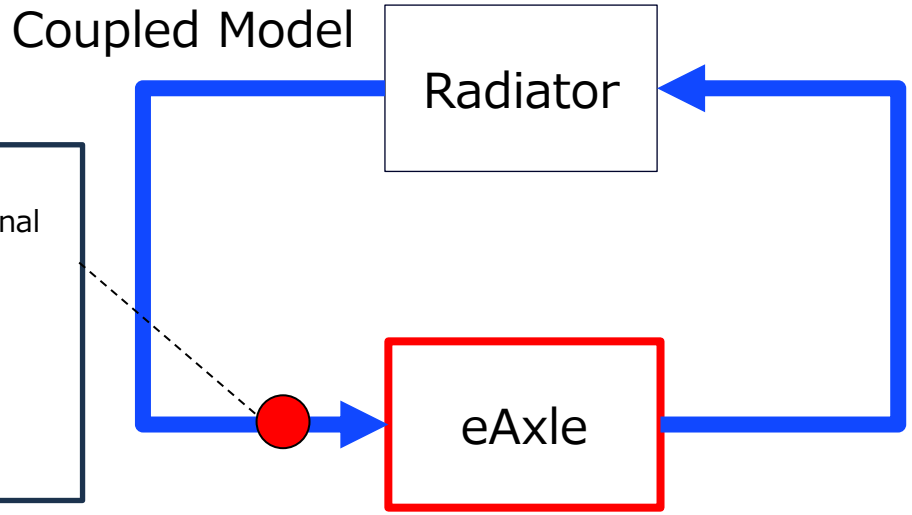
Conventional Approach



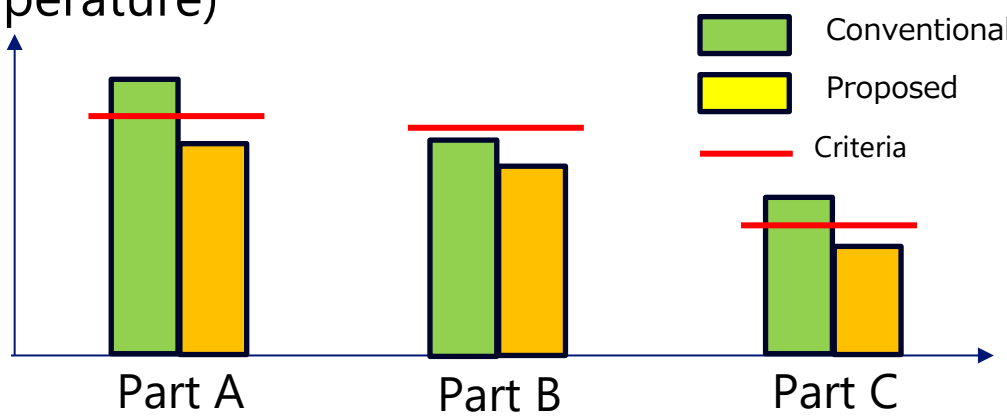


【Problems】
- Margin-based specifications setting
- Worst-case-based specifications

Proposed Approach



Output (Temperature)



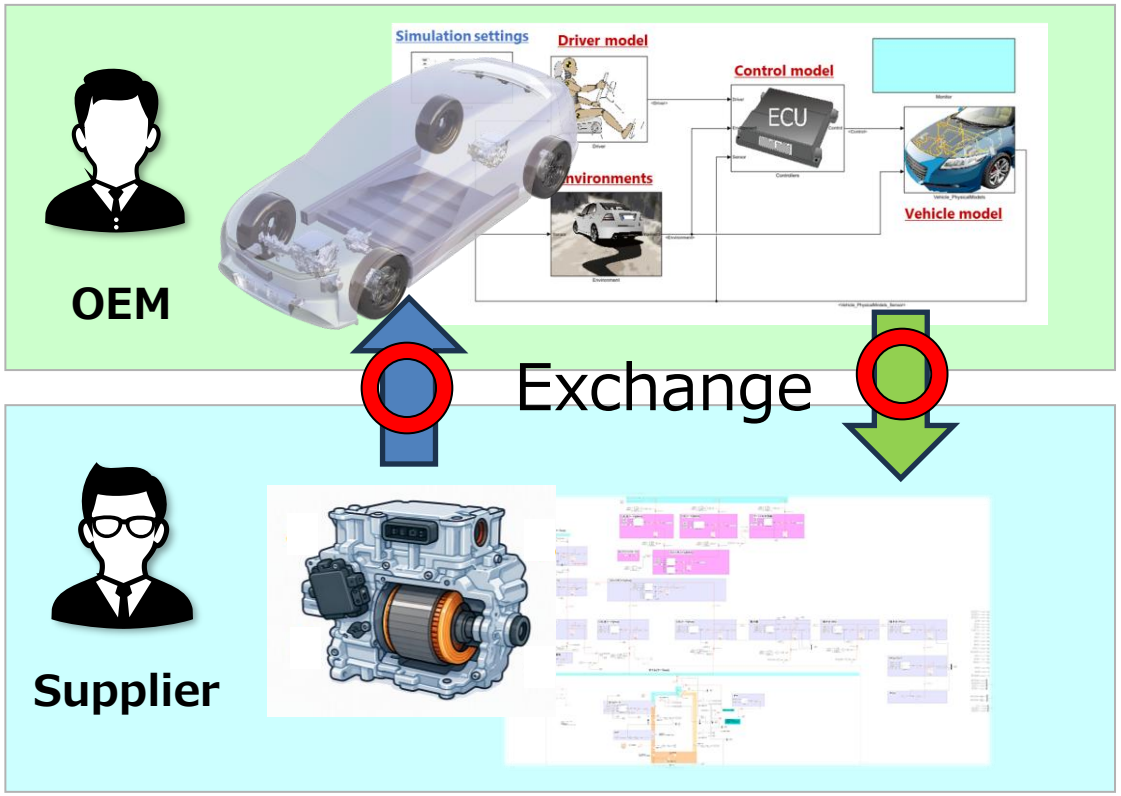


Supplier

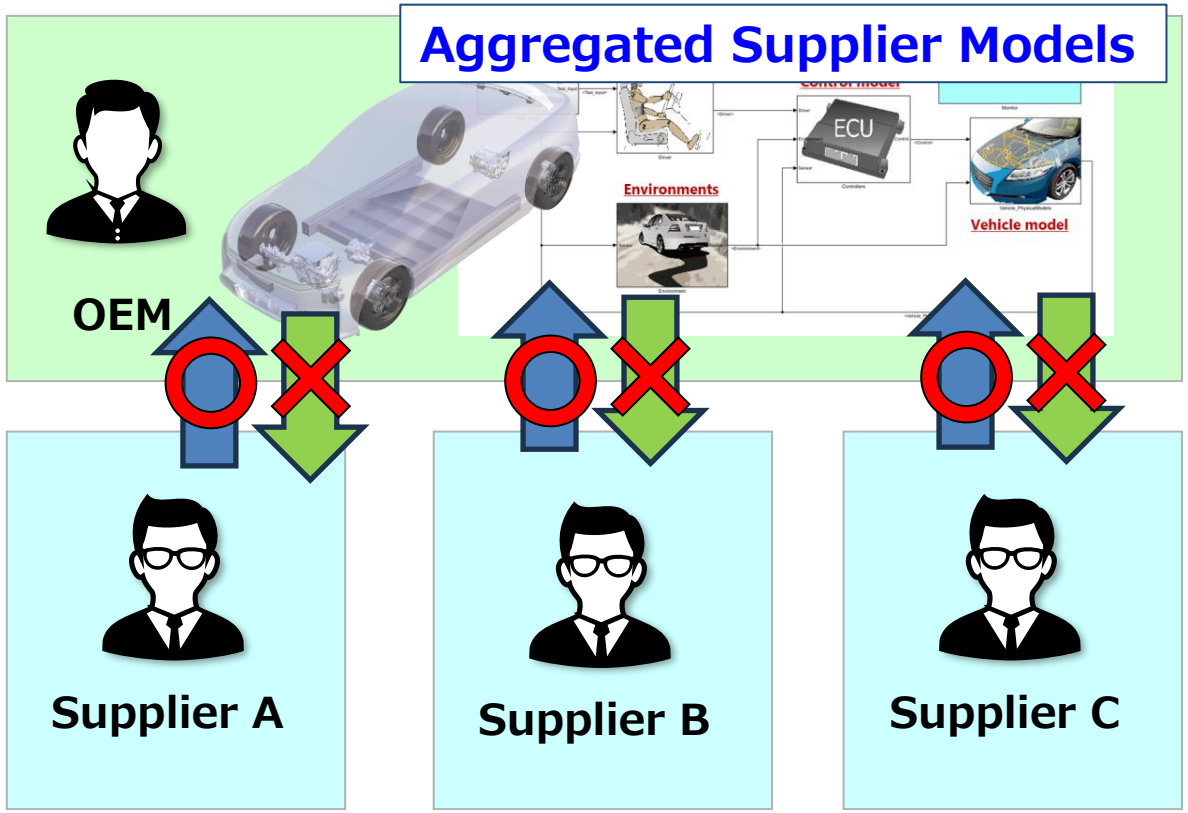
- **Immediate impact assessment of specification changes.**
- **Better specifications selection.**

Challenges in OEM/Supplier Model Exchange

①OEM vehicle model created independently



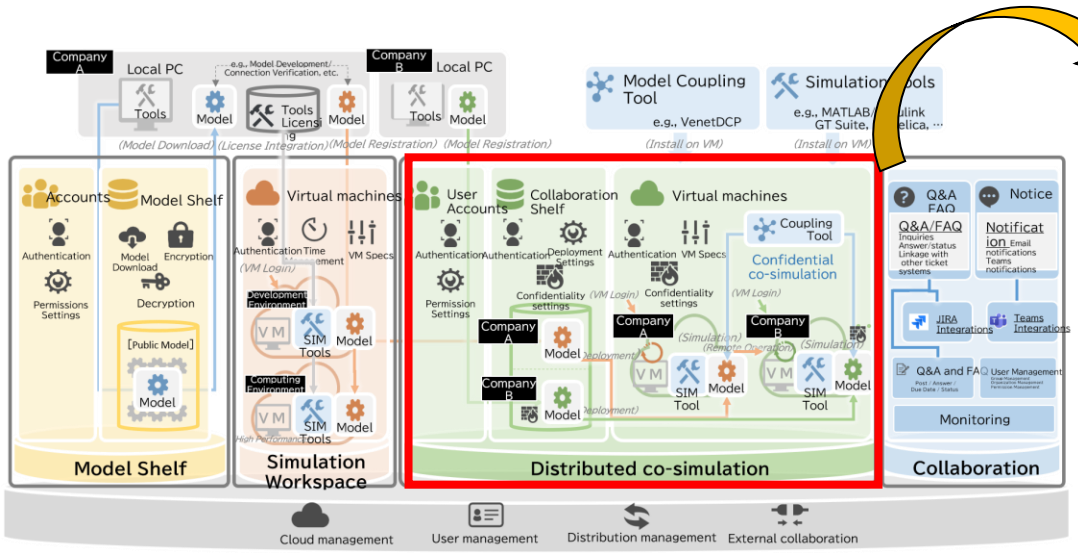
② Vehicle model including models from other suppliers



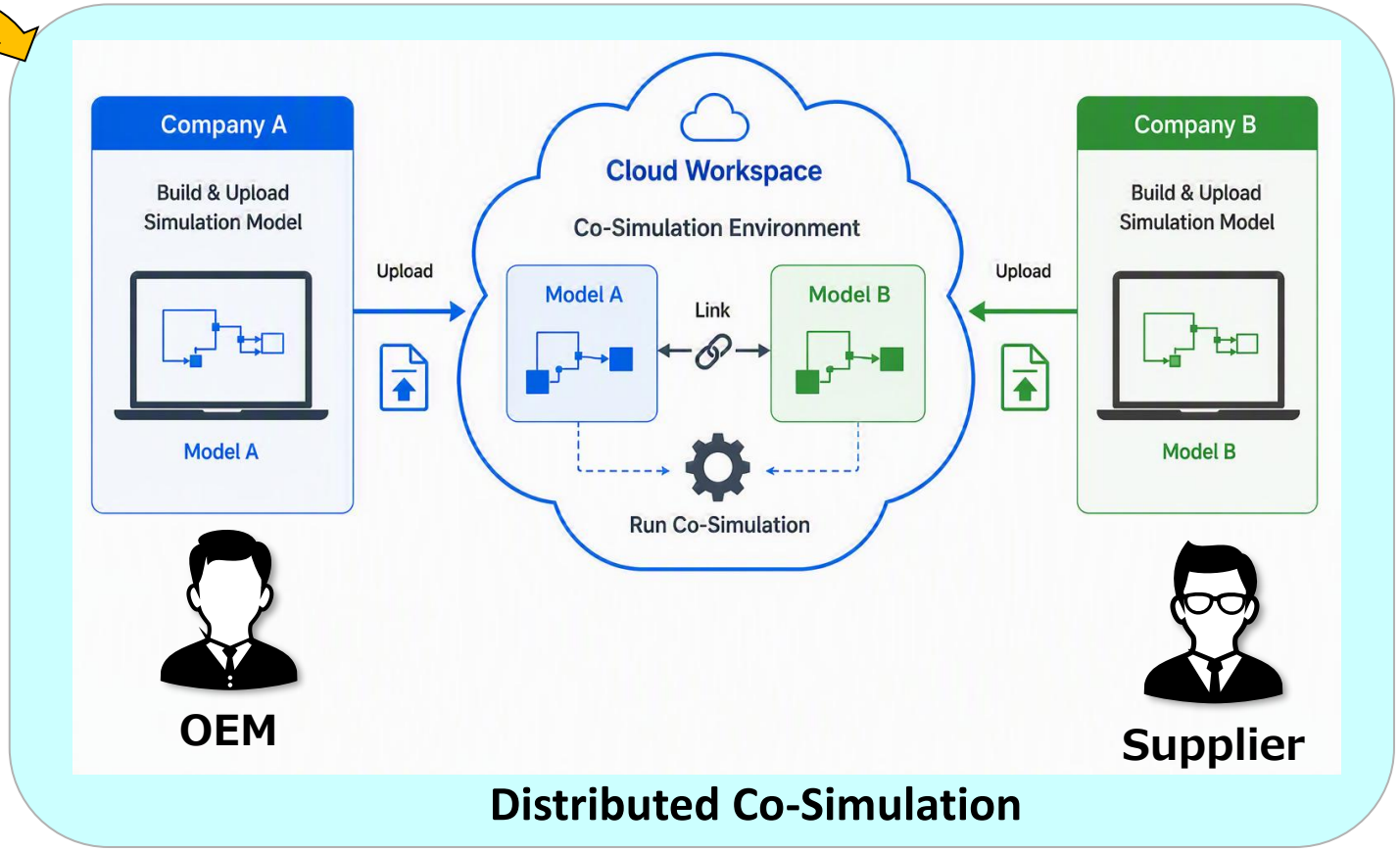
【Problems】
・Cannot share the models with other suppliers

Model exchange is hindered when the OEM vehicle model contains models from other suppliers.

Benefits of Distributed Co-Simulation



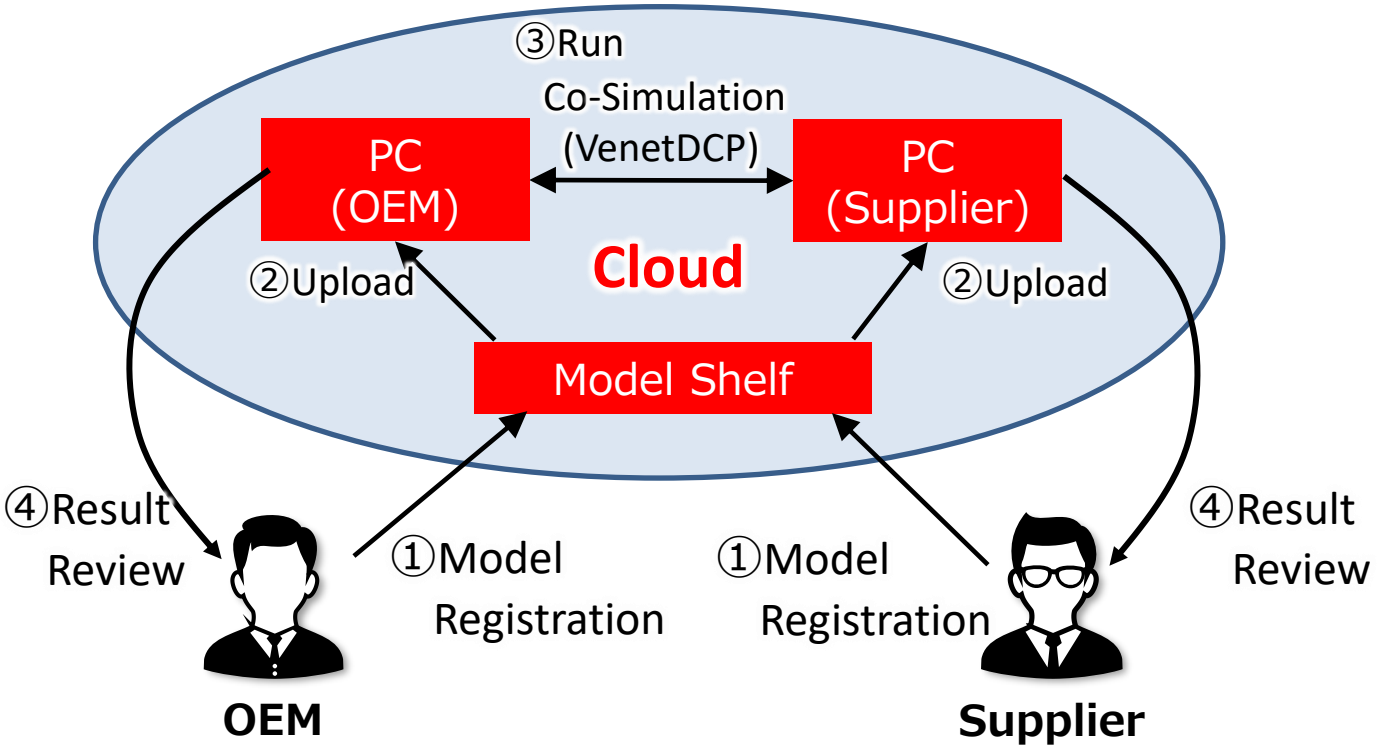
Model Exchange Platform Service



Distributed Co-Simulation

- ✅ **No Model Sharing Required**
- ✅ **IP & Know-How Protection**
- ✅ **Real-Time Collaborative Simulation**

Distributed Co-Simulation Pilot Trial



Workflow

Activities

- ✅ **Distribute Co-Simulation User Guide**
- ✅ **Define the Operational Framework**
- ✅ **Collaborate with Tool Vendors**
- ✅ **Conduct Project Trials**

Pilot trials are underway for broader adoption across JAMBE member companies.

Pilot Trial Conclusions Overview

Category	Conclusions
Benefits	・Same Analysis Results Produced
	・Traceability Ensured
	・Reduced Engineering Effort
Challenge	・Difficulty Learning the Tool

Promoting wider adoption of distributed co-simulation across industry.

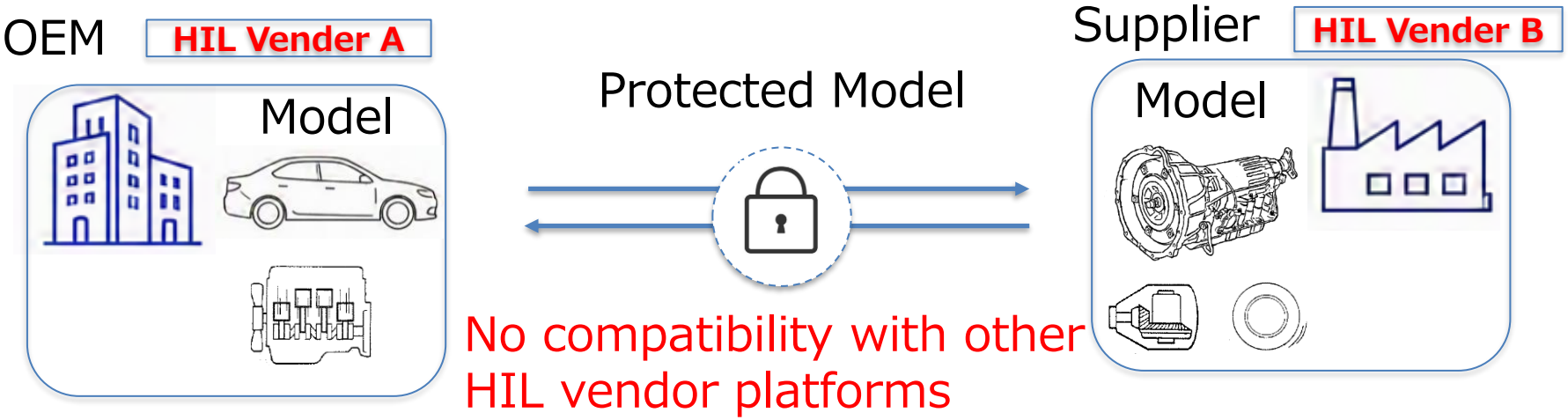
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HIL-Based Model Exchange

Key Challenges

A standard method of model exchange is needed across different HIL vendors and environments between OEM and supplier.



Key Issues

IP Protection

Exchanged models must protect proprietary algorithms and know-how.

HIL Compatible

Protected models are not directly executable on different HIL platforms.

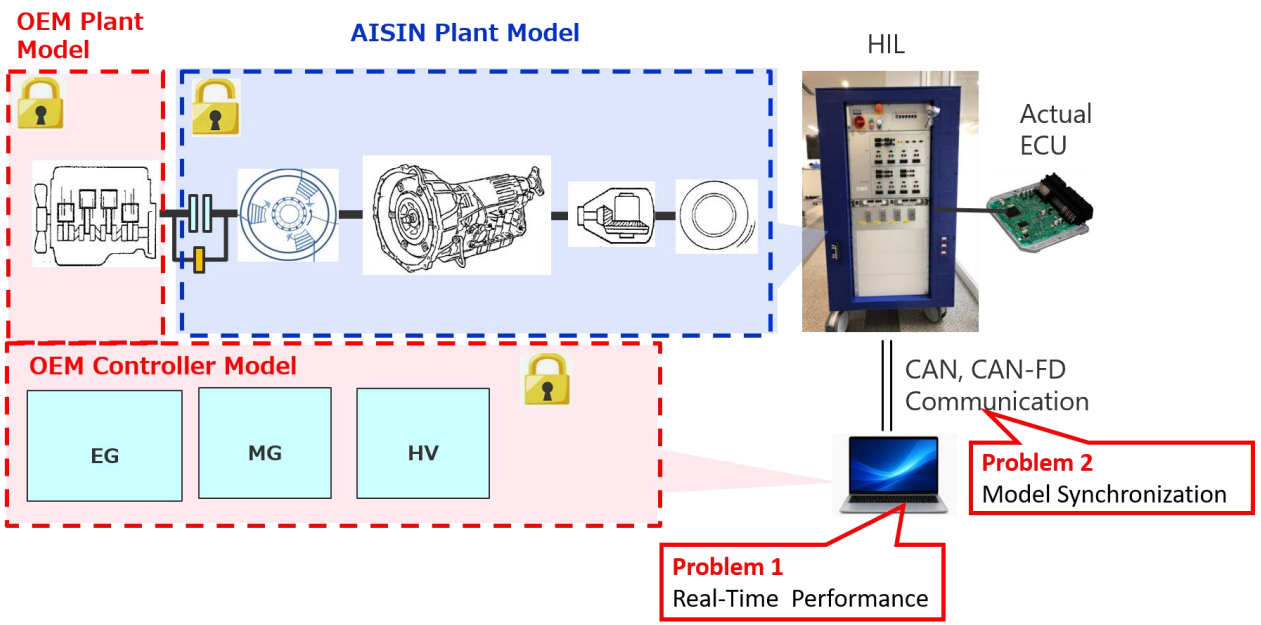
Additional Integration Effort

Co-simulation environment and custom interfaces must be developed.

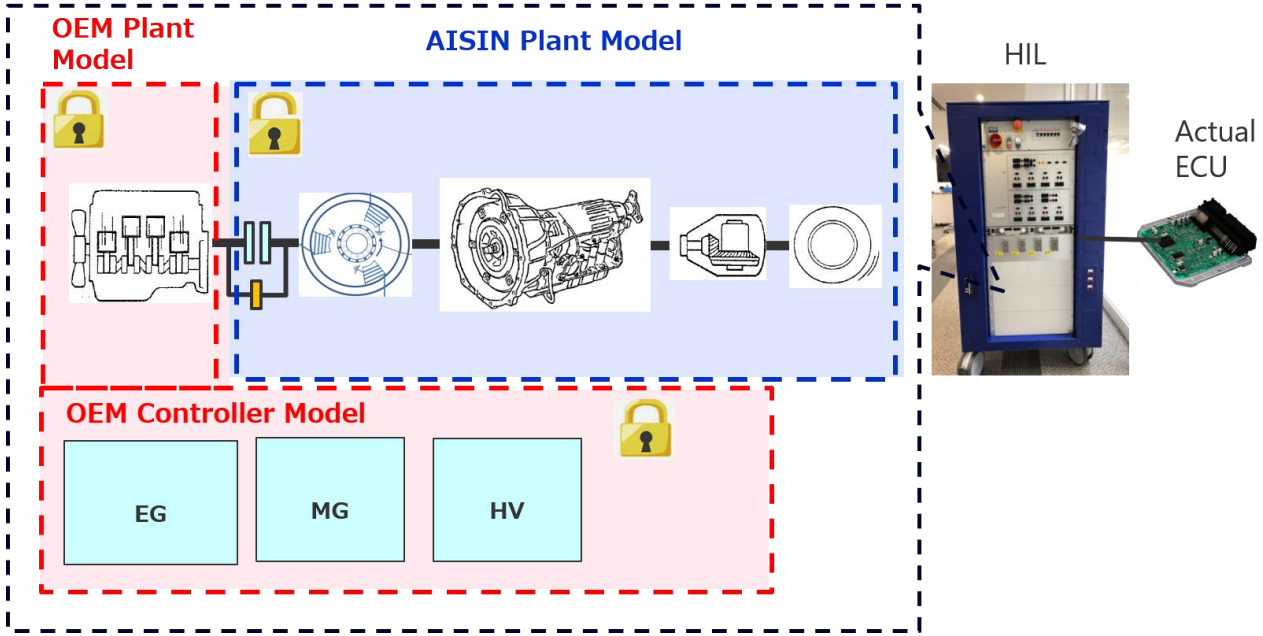
JAMBE Trial Analysis WP studied to solve these issues with major HIL Vendors.

Target Vison for HIL-Based Model Exchange

Before



After



OEM model is located outside of the HIL, and Co-Simulation is necessary.

Whole model is located inside the HIL.

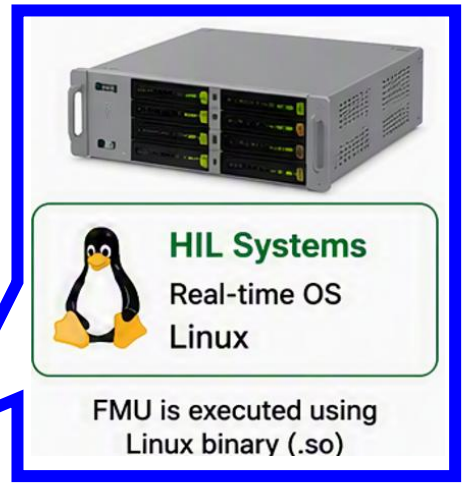
Achieving Real-time Performance, Model Synchronization and Cross-HIL compatibility.

Countermeasure for HIL-Based Model Exchange

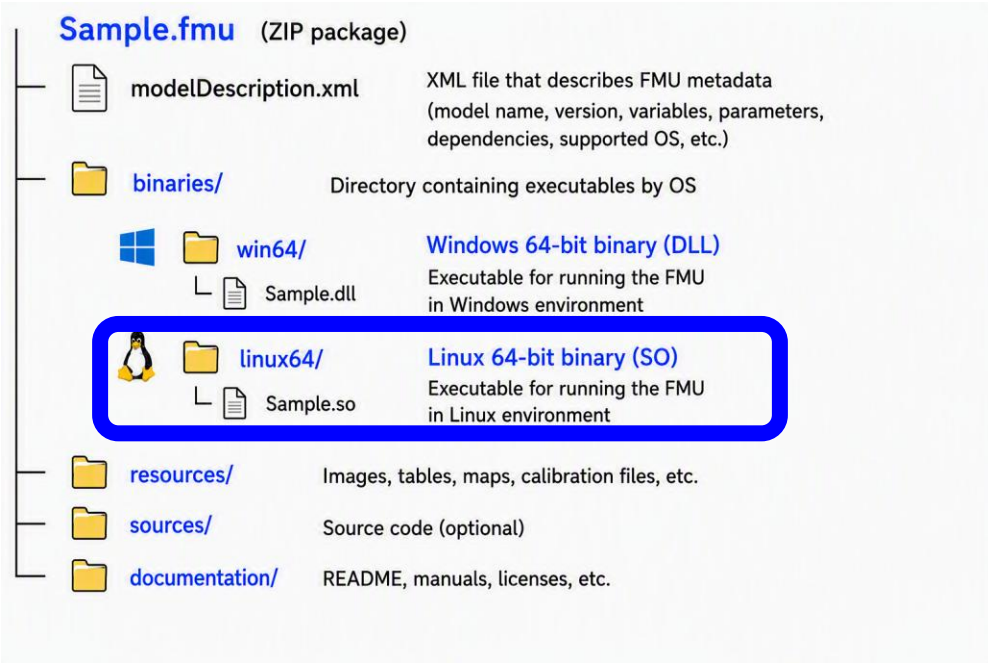
RT-Linux could be the key enabler across HIL vendors.

HIL Element	Example
GUI	Vendor custom (I-Test, ControlDesk LABCAR-OPERATOR Veristand)
MATLAB Ver	R2024a, R2025a etc.
HIL Compiler	Vendor custom
CPU Architecture	x86/Arm
OS	RT-Linux
I/O Hardware	AD/DA/DIO/PWM etc.

Common part across HIL Venders

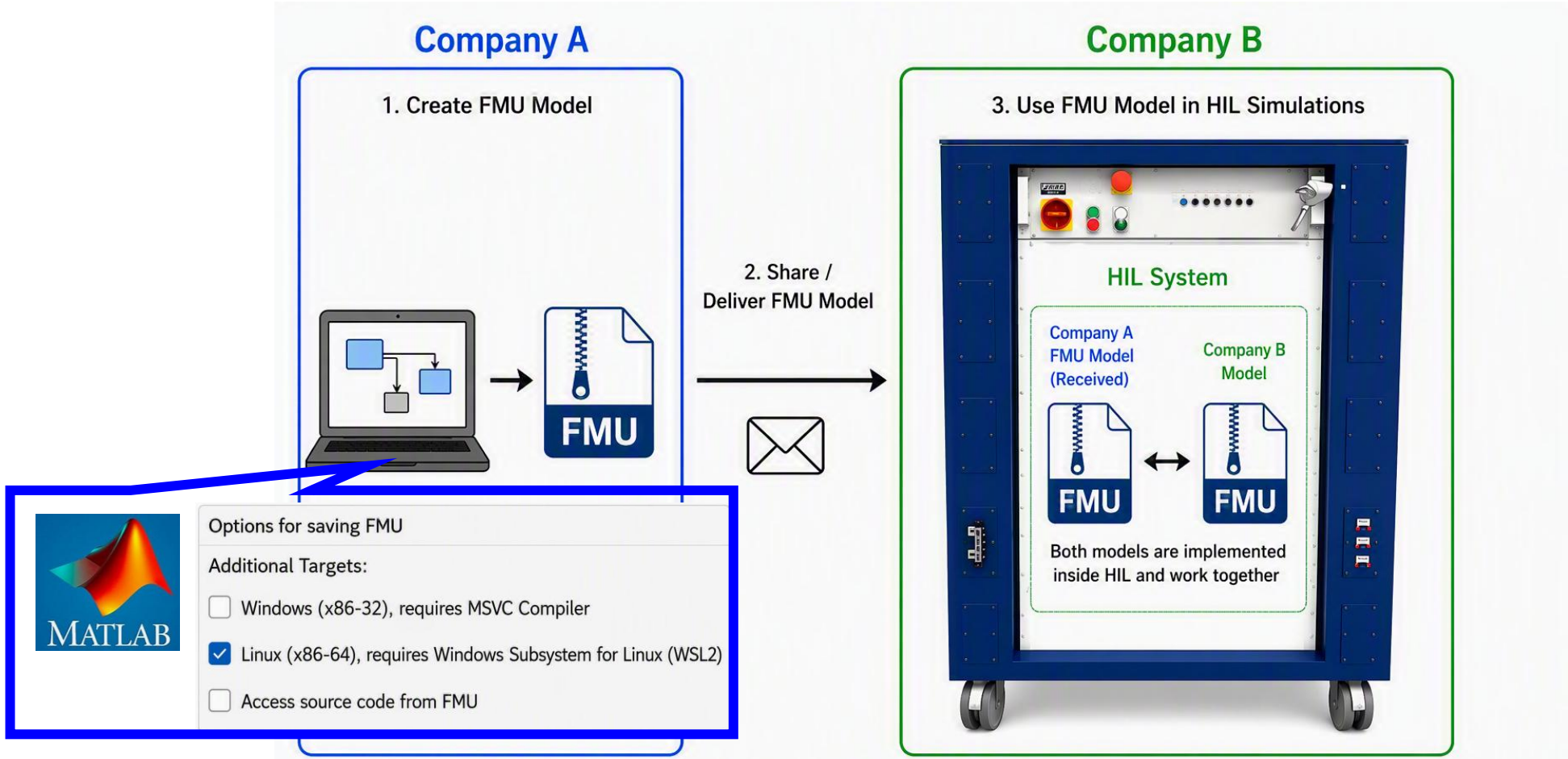


FMU file structure



Adopted FMUs with Linux binaries as the solution.

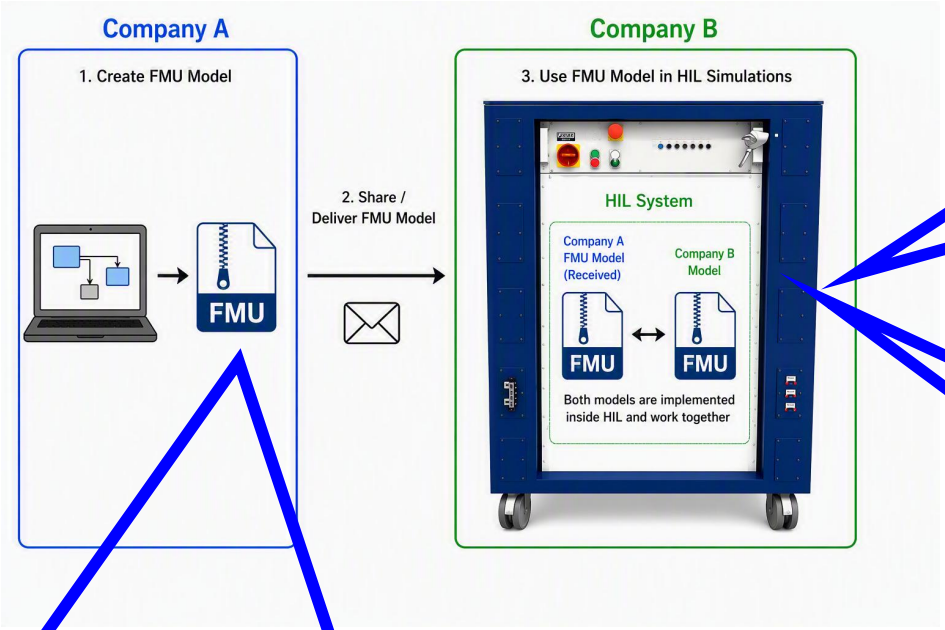
Solution Approach for Secure Model Exchange



From MATLAB 2024A update 1(From April 2024),
Simulate FMU with Linux Binary on Windows is available.

MATLAB feature makes it easy to build FMU Linux Binaries on Windows OS.

Validation Activities



HIL Environment

- ✅ FMI Support Investigation
- ✅ Linux Binary FMU Deployment

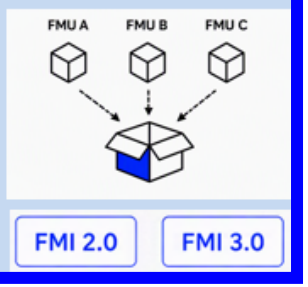
HIL Vendors and platforms

- ✅ Across Multiple HIL Vendors

A&D dSPACE ETAS NI

MATLAB/Simulink Environment

- ✅ Linux Binary Generation
- ✅ Multiple FMU Integration
- ✅ Behavior Across FMI Versions



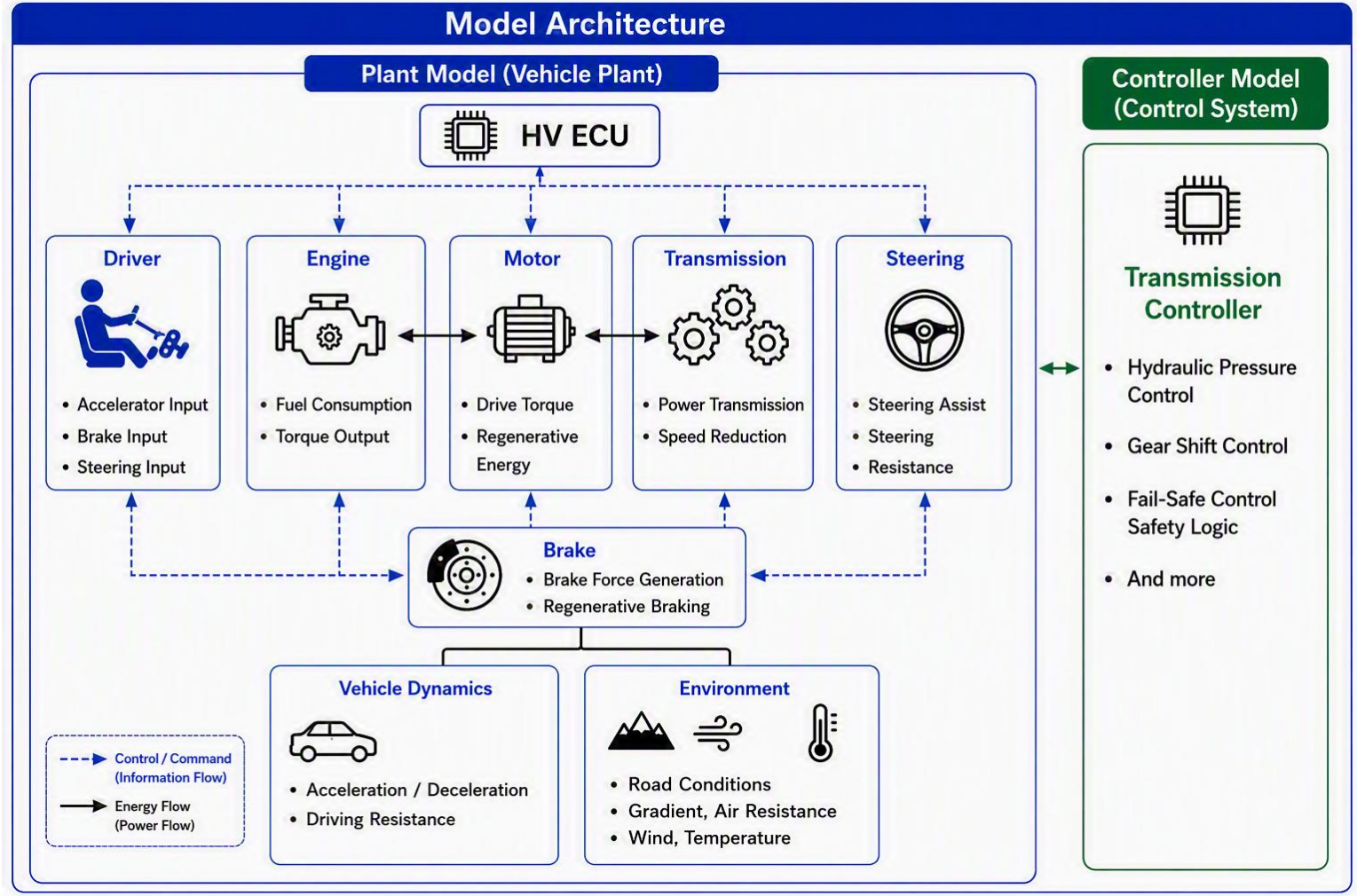
Validation completed for FMU generation, HIL deployment, and multi-vendor HIL operation.

Model Verification for FMU-Based Model Exchange

JAMBE Japan Automotive Model-Based Engineering center

FMU Generation Information

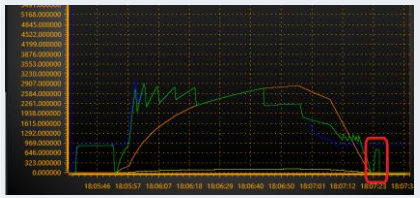
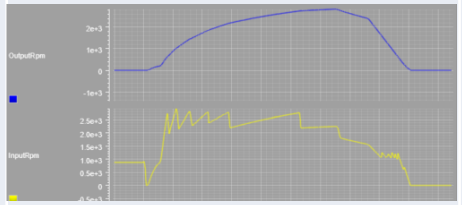
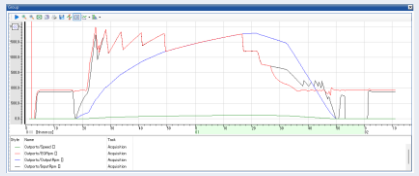
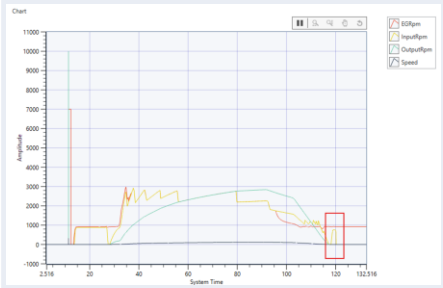
Tool	MATLAB R2025a
FMI Version	FMI 2.0 / FMI 3.0 Co-Simulation
Solver	ode1 (Euler)
Binary Type	Linux 64-bit Binary
Sampling Time	0.001 s
Monitored Signals	InRpm, OutRpm, EGRpm, Vehicle Speed
Validation Criteria	FMU results match native Simulink simulation results



Aisin's actual large scale plant and controller model were used instead of generic model.

Verification Results

HIL Vendor (Alphabetic order)

	A&D HELIOS	dSPACE SCALEXIO	ETAS LABCAR	NI VeriStand
Linux OS Version	Linux 6.1.11	Linux 4.14	Linux 6.7.1	Linux 6.1.108
FMI Ver. 2.0	✅	✅	✅	✅
FMI Ver. 3.0	🕐 Planned	✅	❌ Not Supported	✅
Wave form				
Remarks	Planned support for FMI 3.0	—	Minor configuration adjustment required	—

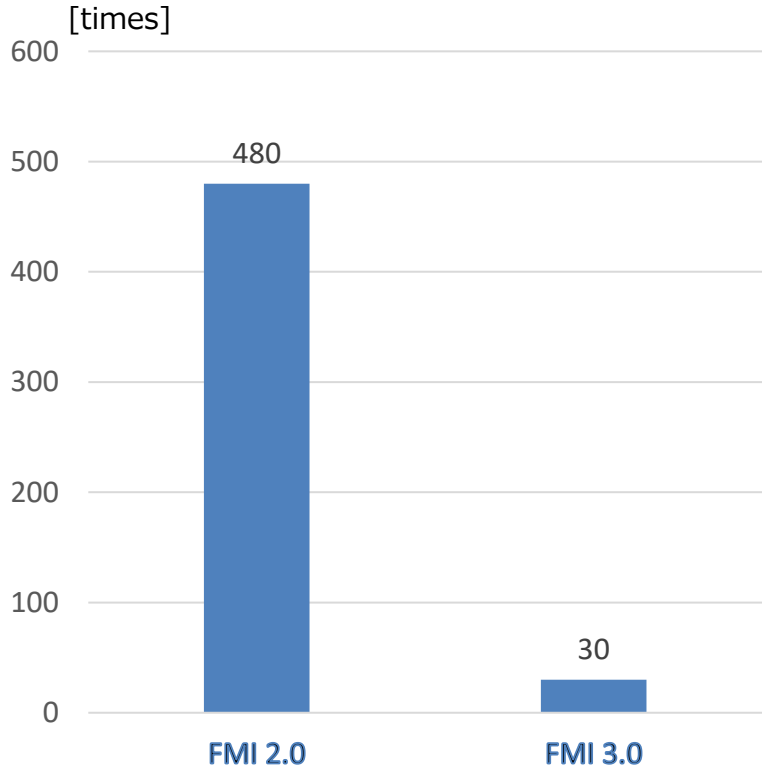
FMU Linux Binary was executed across major HIL platforms.

Result Analysis

HIL Simulation Result



Number of task overrun count



FMI 3.0 tool support is recommended for HIL controller model exchange.

Conclusion of HIL Model Exchange

- ✅ IP-Protection
- ✅ Real-time Performance
- ✅ Model Synchronization
- ✅ Cross-HIL compatible
  (FMI 3.0 support is recommended)

FMU with Linux binary provide a practical solution for cross-HIL model exchange.

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Summary

These two projects demonstrated practical and secure model exchange methods, which are now being adopted in actual development.

What we aim for:



Protect Intellectual Property.



Enable Seamless Model Exchange.



Improve Development Efficiency.



Promote Automotive Industry-wide Standardization and Collaboration.

Driving Automotive Industry-Wide Value via Model Exchange!