

Streamlining FMU-Based Calibration in Vehicle Co-Simulations at GM

Hunter Poole **General Motors**

- Vehicle Dynamics simulation integration engineer
- Wide range experience with active chassis controls system, steering development, vehicle integration and manufacturing
- BS and MS in Mechanical Engineering from Texas A&M and MS from the University of Michigan





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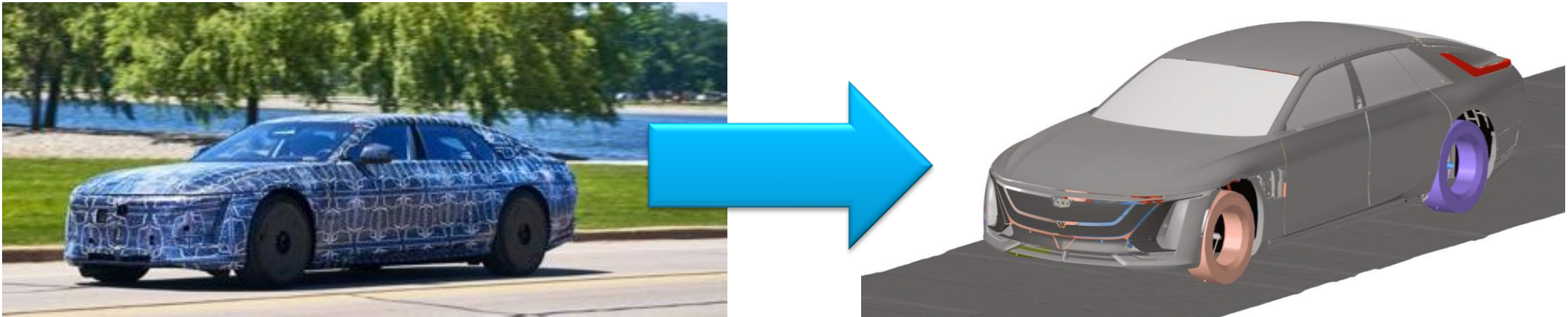


MathWorks
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Introduction

What is Driving the Industry Towards Virtual Engineering?

- Speed – Get to market faster
- Quality – Better engineering
- Throughput – engineer more products for the same money



Problems with hardware testing

What's wrong with testing everything with hardware?

A few examples...



Mules

Developing calibrations for an unrepresentative prototype vehicle



Breaking Hardware

Too late or very expensive to fix!



Scalability

Expensive to scale vehicles/dynos/benches

What is Virtual Engineering?

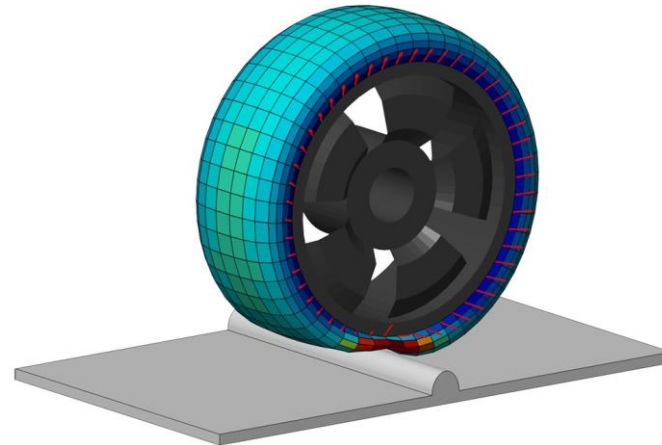
Examples of the virtual world

Some components required for full vehicle simulations



Vehicle Dynamics Model

Ride, Loads, Handling, NVH, etc.
evaluations



Tire Models

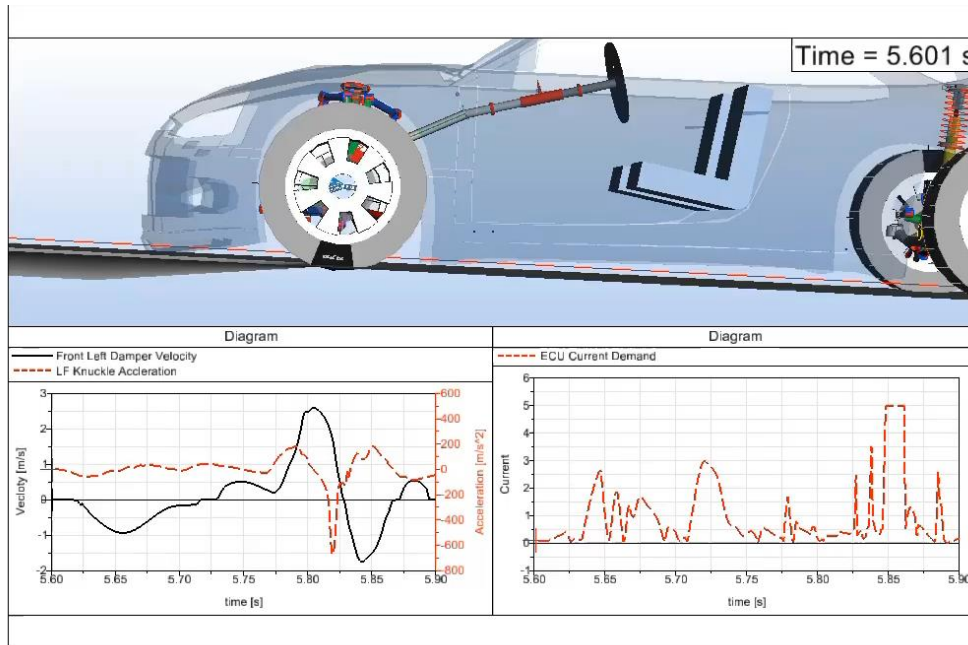
Enables the vehicle model



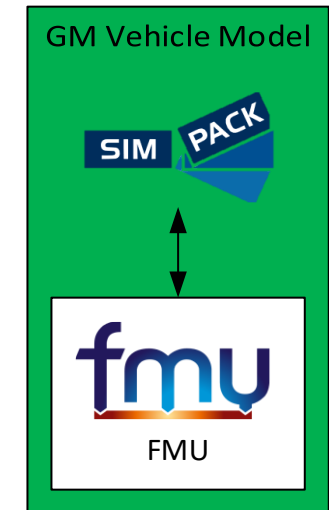
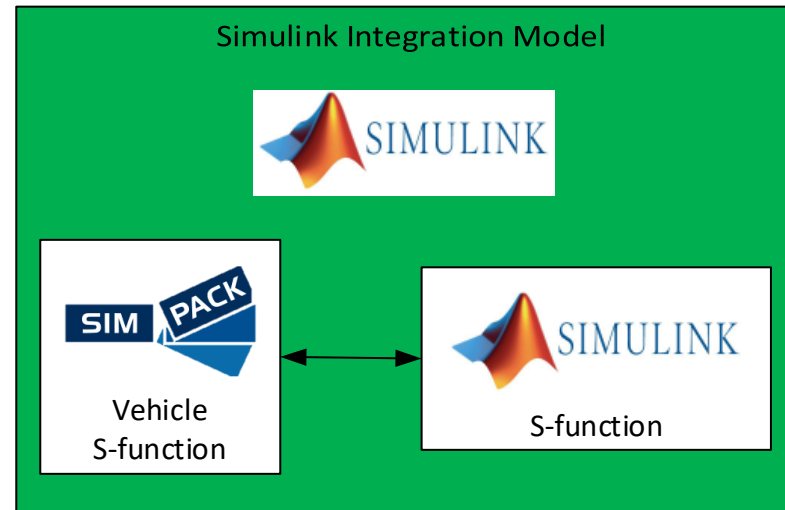
Powertrain Models

Drive quality, performance analysis,
calibration, etc.

Cosimulation – Bringing multiple models together



Simple Examples



What is an FMU?

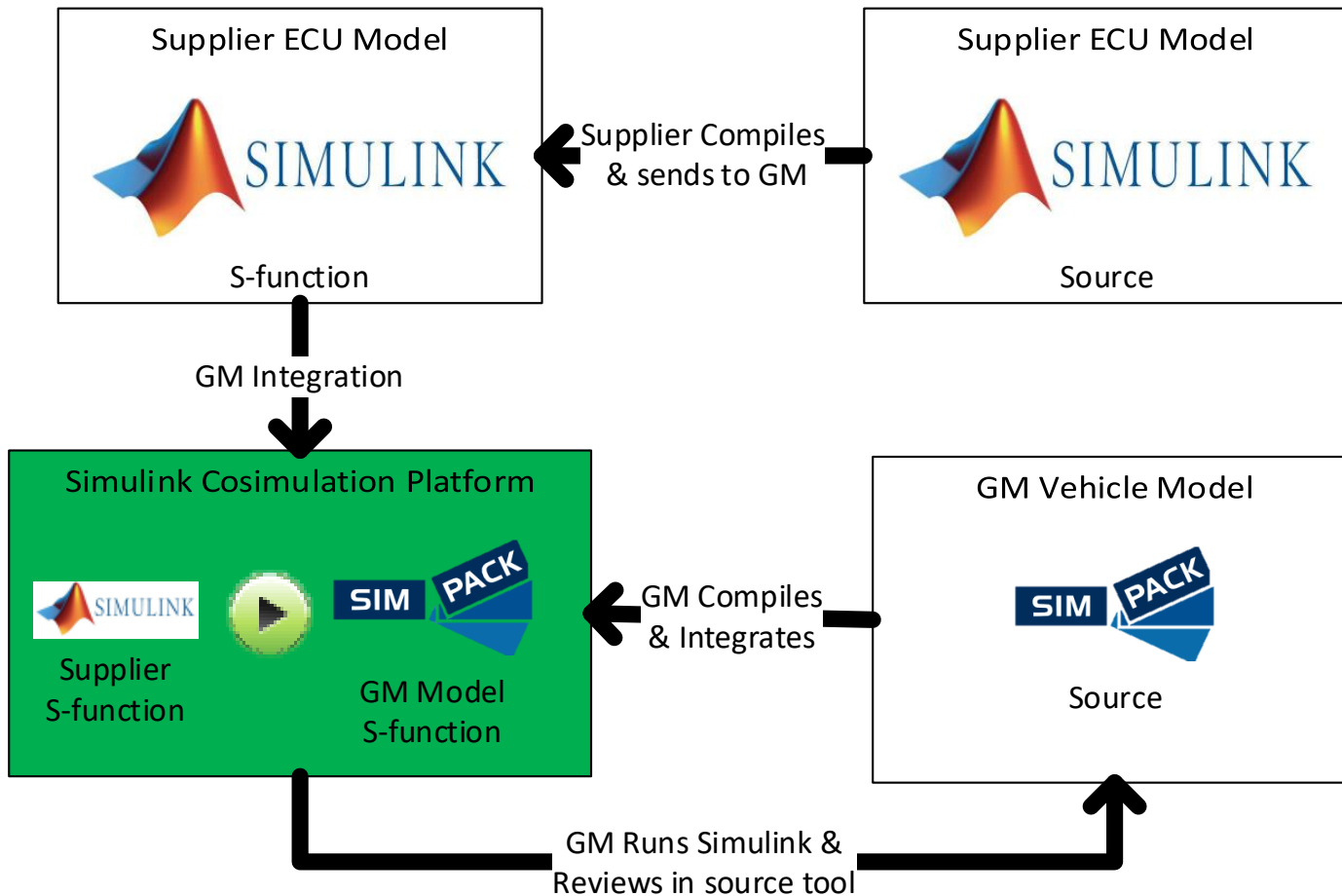
- Self-contained model format that can be executed by most off-the-shelf tools. Ex:
 - MathWorks - Simulink
 - dSPACE - VEOS
 - Dassault Systemes - Simpack
- Similar to a Simulink S-function, but it is not proprietary
- Protected source code
- We use FMUs for all kinds of models
 - physics “plant” models
 - virtual Electronic Control Units (vECUs)



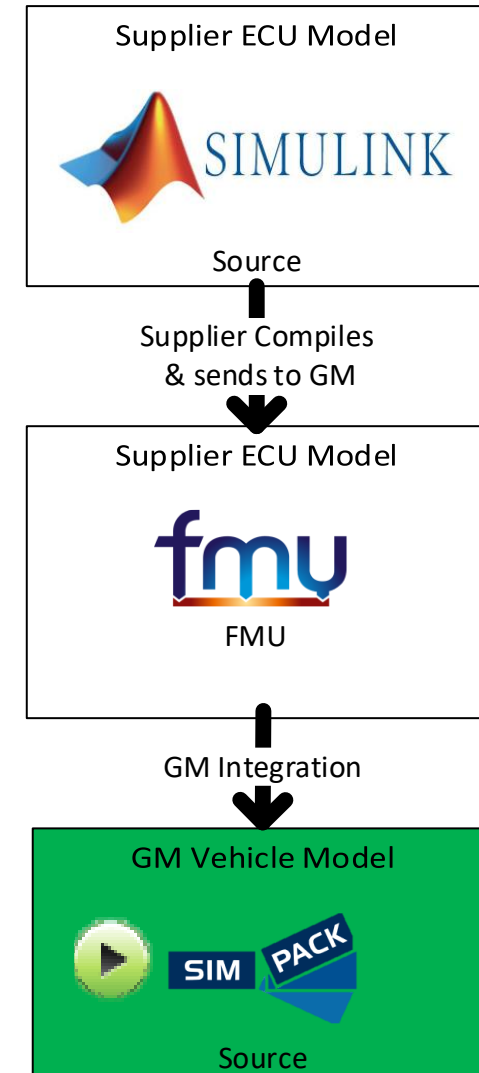
<https://fmi-standard.org/>

Example Integration Process

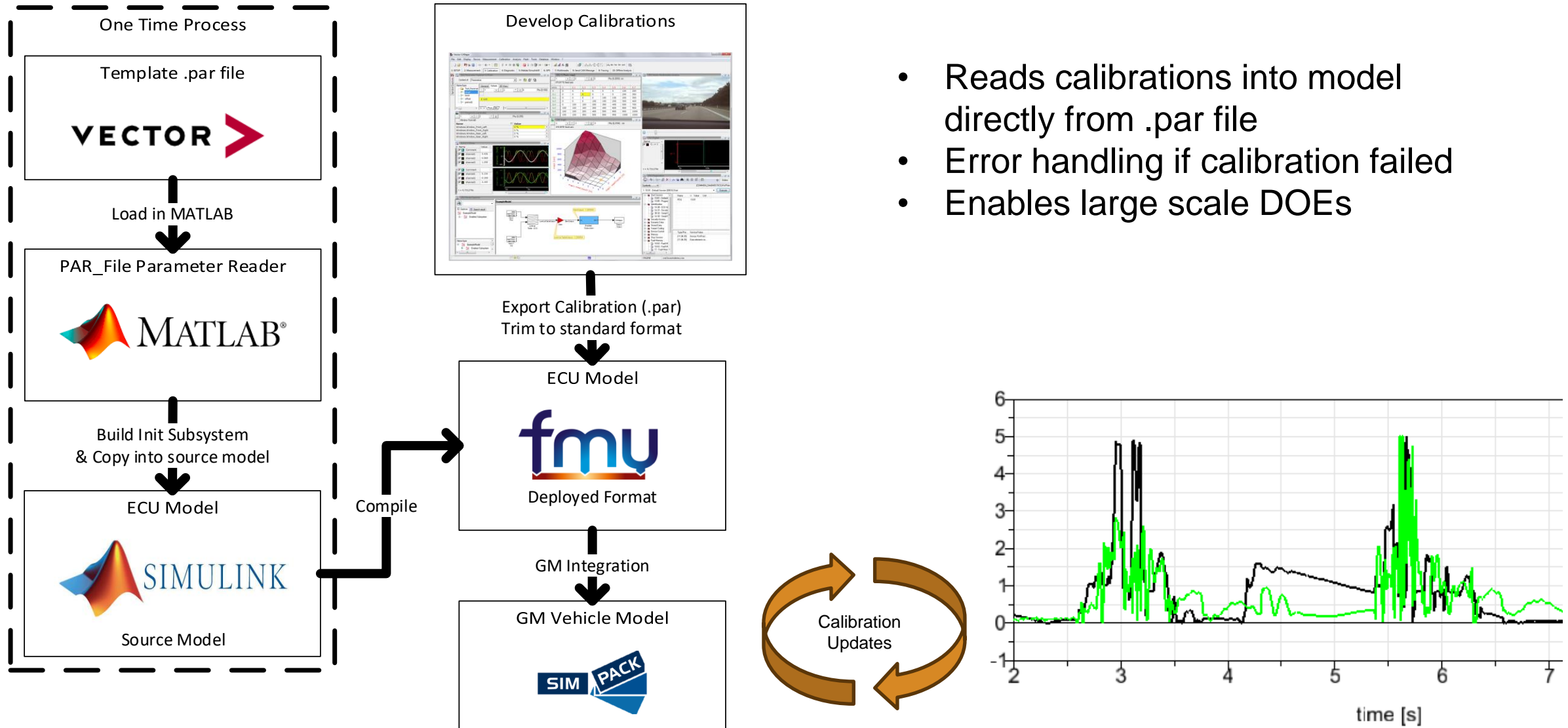
S-Function Based



FMU Based

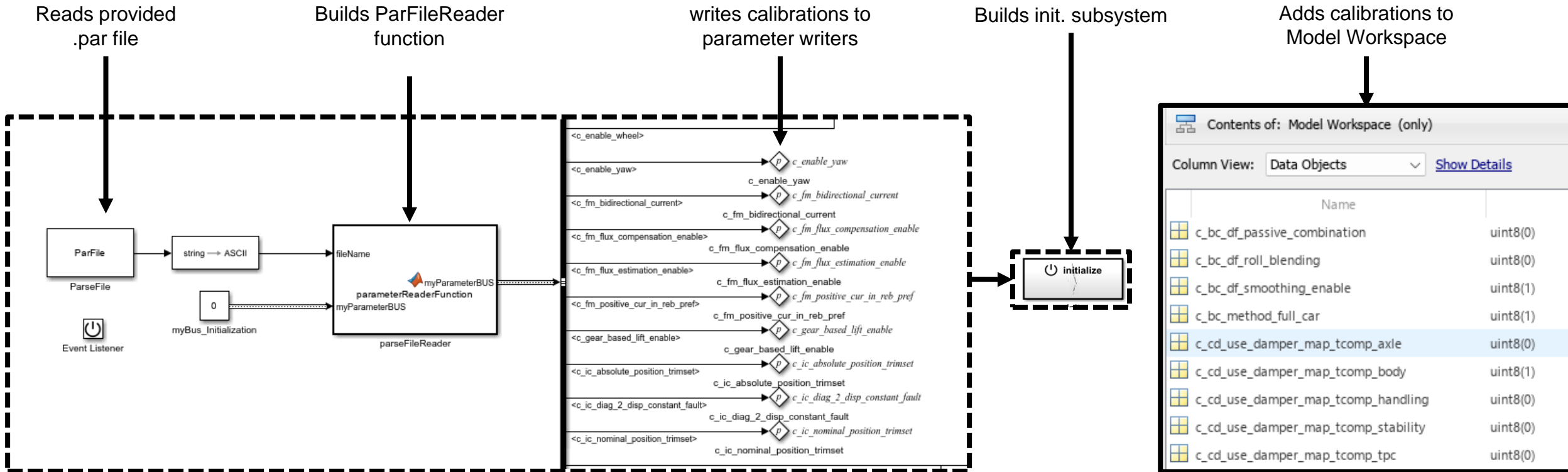


Par_File Parameter Reader Product Support Package

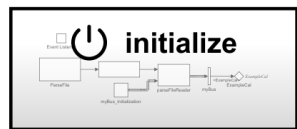


- Reads calibrations into model directly from .par file
- Error handling if calibration failed
- Enables large scale DOEs

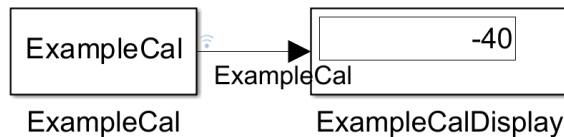
What the toolbox builds



ExampleCal [FLOAT] -40 ; -40

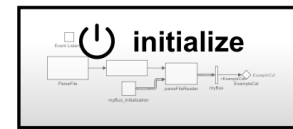


Init



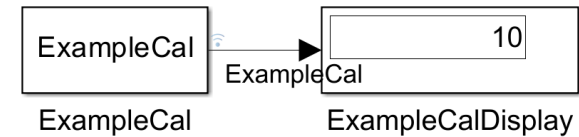
ExampleCal

ExampleCalDisplay



Init

ExampleCal [FLOAT] 10 ; -40



ExampleCal

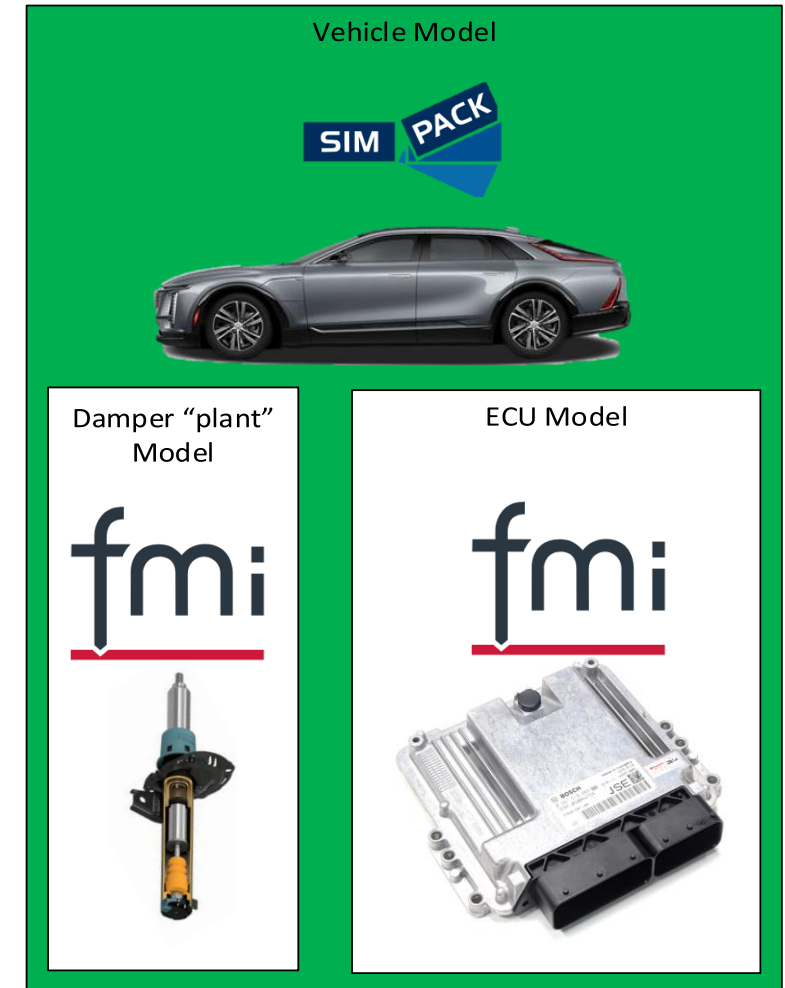
ExampleCalDisplay

How have we used it?

- Deployed supplier damper ECU inside our vehicle model
- Run cosimulation from native tool, no learning curve
- Enables DOE of damper calibrations early in design process

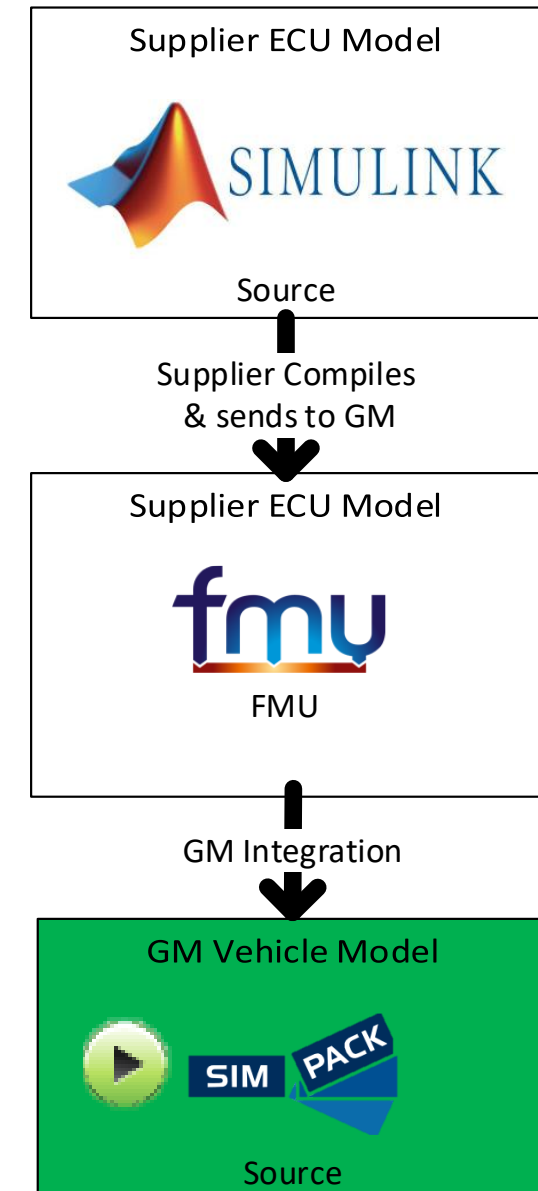
Other Applications/Future Work

- Other vECU models that use CANape .par format
- Parsing other calibration formats like standard CDFX

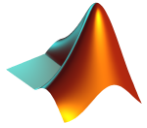


Summary

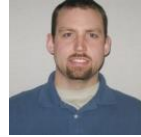
- Running a complex full vehicle co-simulation often requires utilizing virtual Electronic Control Units (vECUs) from various sources
- Compiling these vECUs as Functional Mock-up Units (FMUs) provides the flexibility to run in different environments
- The toolbox MathWorks developed enables FMUs to be calibrated via their native calibration file



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North America

Thank you



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