Holistic Virtual Testing and Analysis of a Concept Hybrid Electric Vehicle Model

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The electrification of automotive powertrains is one of the key factors in meeting the development targets for fuel consumption and emissions. Both with and without the use of plug-in technology, powertrain hybridization assists the internal combustion engine in operating in optimal conditions and enables the recuperation of kinetic energy during braking. It also helps to increase fuel efficiency and reduce exhaust gas emissions.

Given the wide range of hybrid electric vehicle variants, finding optimized setups often poses a challenge due to the varying boundary conditions, different cases of application, as well as interdependent vehicle subsystems. In this case, optimization processes and tools assist in finding the best compromise, taking into account all the various constraints.

In this paper; the development, integration, and analysis of a hybrid electric vehicle (HEV) using system-level virtual testing will be presented.
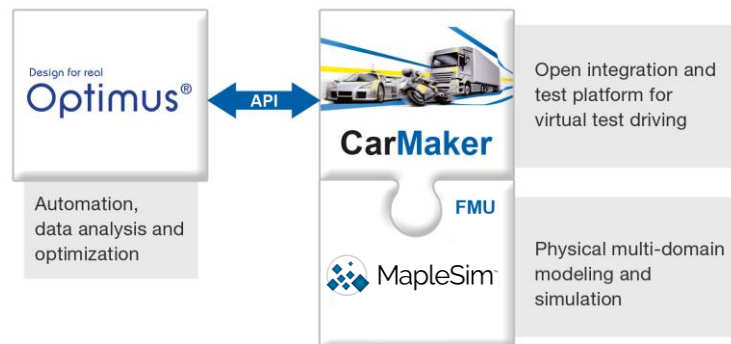

Figure 1. Modeling, Simulation and Optimization Environment

The work will discuss how a Modelica-based Parallel HEV powertrain model developed using MapleSim™ is integrated into an industrial vehicle modeling software tool (IPG CarMaker®) using the Functional Mockup Interface (FMI) standard; and how virtual testing and analysis was performed with an optimization tool (Noesis Optimus®).

The acausal modeling of the HEV powertrain was done using Modelica 3.2.1, allowing the flow of energy to be inferred from the operating characteristics and controller design. The multidomain model uses components from the electrical and mechanical libraries, and commercialized library components from MapleSim's Driveline Component Library and Battery Component Library.