Model-Based Integration Platform for FMI Co-Simulation and Heterogeneous Simulations of Cyber-Physical Systems

Himanshu Neema[1]   Jesse Gohl[2]   Zsolt Lattmann[1]   Janos Sztipanovits[1]
Gabor Karsai[1]   Sandeep Neema[1]   Ted Bapty[1]   John Batteh[2]
Hubertus Tummescheit[2]   Chandrasekar Sureshkumar[2]
[1]Institute for Software Integrated Systems, Vanderbilt University
1025 16th Avenue South, Suite 102, Nashville, TN 37212, USA
[2]Modelon, Inc.
2389 Main Street, Glastonbury, CT 06033, USA
himanshu@isis.vanderbilt.edu jesse.gohl@modelon.com
lattmann@isis.vanderbilt.edu sztipaj@isis.vanderbilt.edu ga-
bor@isis.vanderbilt.edu sandeep@isis.vanderbilt.edu bap-
ty@isis.vanderbilt.edu john.batteh@modelon.com huber-
tus.tummescheit@modelon.com chandrasekar.sureshkumar@modelon.com

Virtual evaluation of complex Cyber-Physical Systems (CPS) [1] with a number of tightly integrated domains such as physical, mechanical, electrical, thermal, cyber, etc. demand the use of heterogeneous simulation environments. Our previous effort with C2 Wind Tunnel (C2WT) [2] [3] attempted to solve the challenges of evaluating these complex systems as-a-whole, by integrating multiple simulation platforms with varying semantics and integrating and managing different simulation models and their interactions. Recently, a great interest has developed to use Functional Mockup Interface (FMI) [4] for a variety of dynamics simulation packages, particularly in the automotive industry. Leveraging the C2WT effort on effective integration of different simulation engines with different Models of Computation (MoCs), we propose, in this paper, to use the proven methods of High-Level Architecture (HLA)-based model and system integration. We identify the challenges of integrating Functional Mockup Unit for Co-Simulation (FMU-CS) in general and via HLA [5] and present a novel model-based approach to rapidly synthesize an effective integration. The approach presented provides a unique opportunity to integrate readily available FMU-CS components with various specialized simulation packages to rapidly synthesize HLA-based integrated simulations for the overall composed Cyber-Physical Systems.

References

[1]   J. Sztipanovits: Composition of cyber-physical systems, 14th Annual IEEE Int'l. Conference and Workshops on the Engineering of Computer-Based Systems (ECBS '07), Washington, DC, USA, IEEE Computer Society, 2007, pp. 3–6.

[2]   Graham Hemingway, Himanshu Neema, Harmon Nine, Janos Sztipanovits, Gabor Karsai: Rapid Synthesis of High-Level Architecture-Based Heterogeneous Simulation: A Model-Based Integration Approach", Simulation 88(2), 217-232 (2012).

[3]   C2WT community wiki: wiki.isis.vanderbilt.edu/OpenC2WT.

[4]   Functional Mock-up Interface: www.fmi-standard.org.

[5]   HLA standard – IEEE standard for modeling and simulation (M&S) high-level architecture (HLA) – framework and rules: ieeexplore.ieee.org/servlet/opac?punumber=7179.