TUTORIAL
"HARDWARE-IN-THE-LOOP (HIL) SIMULATION"

*in the framework of **MEGEVH**, French network on HEVs*

EVS-24, 13 MAY 2009, 13:30-17:30

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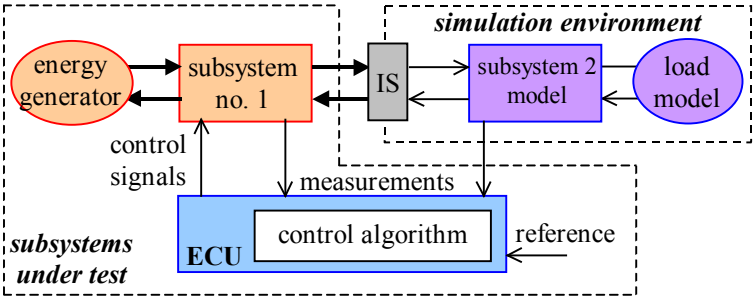
HIL SIMULATION

Electrical drives are increasingly used in automotive industry. Rigorous performance evaluation has to be made during equipment development and before implementation on actual systems. In particular, interactions of the drive with the motion part have to be studied thoroughly. Computer simulation of the entire system is an established means to investigate interactions between subsystems to set the technical requirements. Within the past decade, Hardware-In-the-Loop (HIL) simulations became an advanced means for investigative experimentation, model validation and testing before implementation of drives in actual processes. In addition to pure computer simulation, HIL simulation replaces some simulation models of a system by one or several actual components. The rest of the system and processes are simulated in real-time, which typically requires a parallel computing environment with adequate input-output capability for signals of adequate bandwidth. Most recently, incorporating power hardware (i.e. the drive) into an HIL simulation has been introduced by means of high power and high bandwidth power electronic amplification equipment. Due to the flexibility of HIL simulations to test a wide range of operating conditions and scenarios this method will contribute to improving the availability and reliability of drives (machines, power electronics, and/or control) and a better understanding of system interactions before their insertion on the system.

HIL simulation has been intensively used for controller assessment for a long time. The aerospace industry has used this technique since flight control systems is a safety-critical aspect. This methodology yields exhaustive testing of a control system to prevent costly and damageable failures. Moreover, HIL simulations reduce development time and can enable more tests than on the actual system. From 90's, many groups in automotive industry have employed HIL simulation for testing embedded Electronic Control Units (ECU). Indeed, this methodology avoids intense and complex integration tests on the actual vehicle. Thus, the time development can be reduced and a high quality assurance can be obtained. HIL simulation is becoming a standard for ECU development in the automotive industry. HIL simulation is nowadays more and more used to develop new components and actuators in many fields. Vehicle component evaluation, assessment of drive controls, railway traction systems for trains and subways, power propulsion systems for electric vehicles (EVs) and hybrid electric vehicle (HEVs).



HIL simulation of an energy conversion system

CONTENTS OF THE TUTORIAL

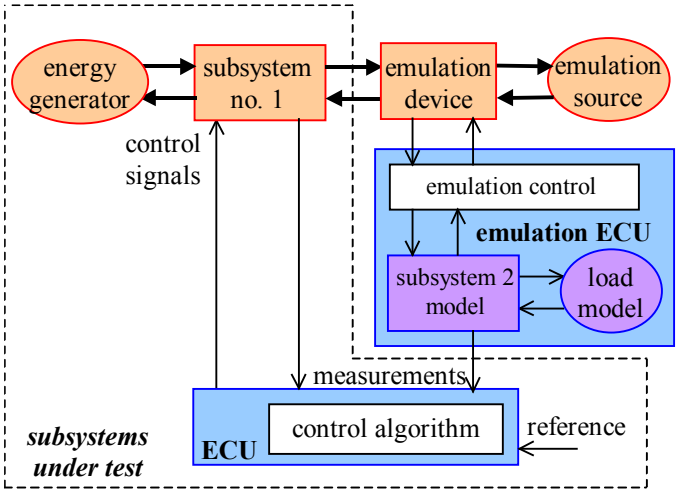
The tutorial is composed of two parts.

The first part will be dedicated to the HIL simulation concepts and the different kinds of HIL simulation:

- Software simulation and Hardware-In-the-Loop (HIL) simulation
- Interest of HIL simulation for vehicle applications
- Signal and power HIL simulation
- Full scale and reduced scale HIL simulation
- Technical requirements for HIL simulation developments
- Organisation of a HIL simulation

The second part will be focused on of HIL simulation and automotive applications. The example of HIL simulation of an Electric Vehicle will be discussed :

- signal HIL simulation for testing ECU
- power HIL simulation for testing power electronics
- power HIL simulation for testing electric drives



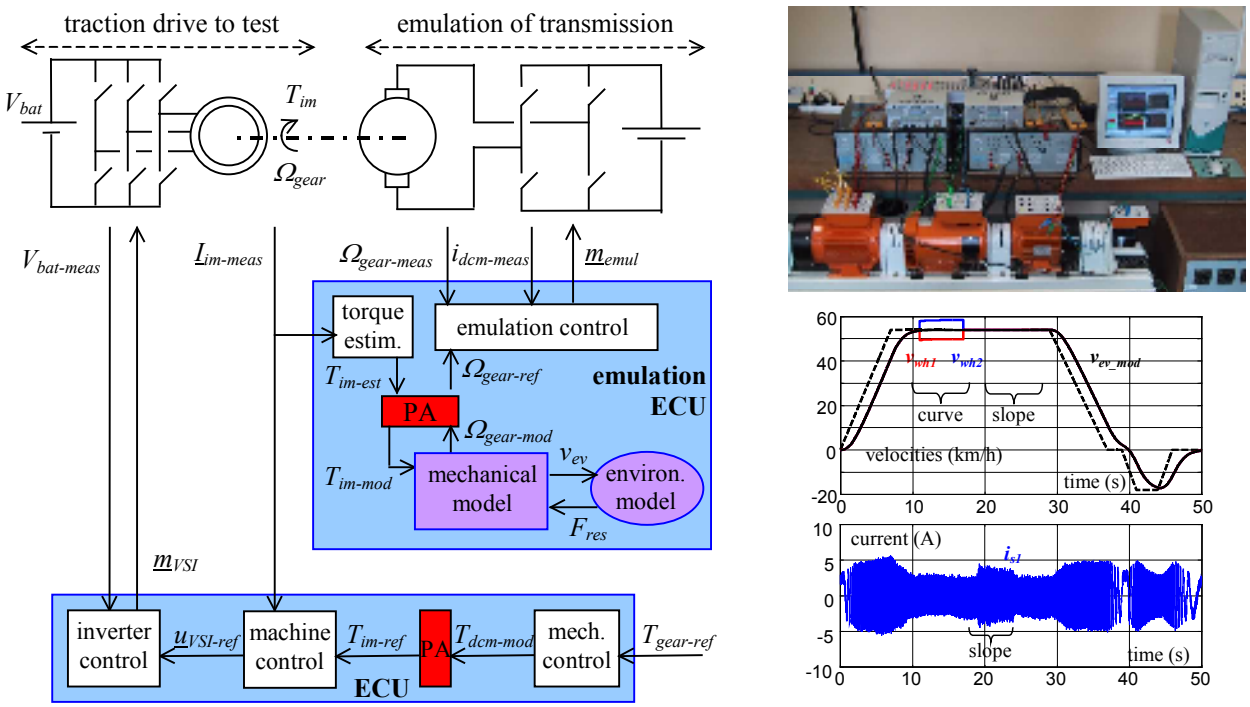
Practical implementation of power HIL simulation of an electric drive

BIOGRAPHY

Alain BOUSCAYROL received Ph.D. degree in Electrical Engineering from INP Toulouse, France, in 1995. Since 1996, he was engaged as assistant Professor at University of Lille 1, Sciences and Technologies, France. He received the "Habilitation à Diriger des Recherches" degree from the University of Lille 1 in 2003. He has been engaged as Professor at University of Lille 1 since 2005.

In the L2EP (Laboratory of Electrical Engineering of Lille), his research interests include electrical machine controls and multi-machine systems. From 1998 to 2004, he managed the Multi-machine Multi-converter Systems project of GdR-ME2MS, a national research program of CNRS (Centre National de Recherche Scientifique). Since 2004, he has managed the national network on Hybrid Electric Vehicles (MEGEVH). He is on of the Guest Editor of the special section “Hardware-in-the-loop simulation “ of IEEE transaction on Industrial Electronics (http://l2ep.univ-lille1.fr/ss-tie-hils.htm).

His research interests include graphical descriptions (Energetic Macroscopic Representation...) for control of electric drives, wind energy conversion systems, railway traction systems, electric and hybrid vehicles. Most of the control proposed on these topic have been validated using Hardware-in-the-loop simulation.



Practical implementation of power HIL simulation of an Electric Vehicle traction using Matlab-Simulink™ and dSPACE™

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