AMESim and the Network Level

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- AMESim: What, Where, How...
- Interface with SIMPACK: Why, How, Examples...
- Future possibilities for this interface
Where is AMESim coming from?

- IMAGINE S.A. / 50 people
- engineering society based in France, U.S., Germany, Japan
- AMESim is a 6 years old program - a „young“ software
- AMESim is coming from the university. More than 50 Universities are using AMESim around the world

What is AMESim?

- 1D Simulation, technological libraries of 1D Models
- solver: automatic selection of adapted calculation methods
- generic models, bond graph, multiports
- an open architecture: interfaces, open code source

Hydraulic - Pneumatic - Mechanic - Control - Thermal - Electromagnetic - Systems
What is AMESim?

A typical case study: valve design

- 4 domains:
  - Power electronics
  - Magnetic
  - Mechanical
  - Hydraulic
What is AMESim?

Multi-domain model

- Mechanical
- Magnetic
- Hydraulic
- Power electronics control unit

Modeling Levels

- Functional level
- System level
- Network level
- Geometry level

Design Process

- Function
- System
- Component

Design & development

Validation & test

ASCET

AMESim

IMAGINE
AMESim in the industry

- automotive
- aerospace
- robotics
- railway
- industrial
- hydraulic
- pneumatic

Interface SIMPACK / AMESim

Why an interface?

- for AMESim, it's an access to the 3D World for mechanical systems (elastics bodies, complex non-linear 3D kinematics)
- for SIMPACK, it's an access to detailed and technological actuation systems
- studying of 1D/3D Coupling for system analysis

Interface: Co-Simulation

Co-Simulation via IPC-Link with SIMPACK as Master
Development: DLR - INTEC
Easy to build & 2 powerful solvers
What is Co-Simulation?

\[ \dot{x}_{SIMPACK} = f(x_{SIMPACK}, u) \]
Equations are solved by SIMPACK

\[ \dot{x}_{AMESim} = f(x_{AMESim}, y) \]
Equations are solved by AMESim

Data of the interconnection vectors are exchanged at a variable sample rate (variation of the sample rate defined at the beginning of the co-simulation)

Scenario: Power steering system
Why such a coupling in power steering is interesting?

- several vibration phenomena in the hydraulic part
- major contribution of car suspension in vibration filtering
- possible interaction? Which parts involved? Influence of tyres?

FIRST OBJECTIVE: to demonstrate that a theoretical case study works

Definition of Interconnection Vectors

\[
\begin{align*}
U_1 &= F_{\text{servo}} \\
Y_1 &= X \\
Y_2 &= \dot{X} \\
Y_3 &= \alpha
\end{align*}
\]
Front car suspension

Co-Simulation SIMPACK / AMESim

Hydraulic Power Steering System

Co-Simulation SIMPACK / AMESim

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Co-Simulation SIMPACK / AMESim

First Results

Torque Tyre (Nm)  Torsion Steer (Nm)

Force Rod (N)  Angle (rad)
Future Development for this case study

To have the possibility to analyse vibration phenomena on an industrial case study. (experimental results)

Possibility to model the hydraulic part of a braking system and a suspension

Future Development

a „Hydraulic Component Design“ case study: H.L.A.
Other applications for the Co-Simulation

POWERTRAIN

Other applications for the Co-Simulation

BRAKING SYSTEMS
- pneumatic
- hydraulic
- by wire
BRAKING SYSTEMS
- ABS
- ESP
- Brake judder
- ...

SUSPENSION
One way valve for semi active damper
Other applications for the Co-Simulation

INJECTION

VALVE ACTUATION
The “Co-Future” is in your hands.

SIMPACK & AMESim coupled together allow a lot of new perspectives in the analysis of complex systems.

Beta- Version now exists,
works and is available.

Before any industrialisation of this Co-Simulation, we need industrial projects in order to improve the way in which future users will be supported.