A COMPREHENSIVE INTEGRATION METHODOLOGY BASED ON MULTI-PHYSICS COSIMULATION. CASE STUDY: ELECTRO-THERMAL SIMULATION OF A DRILLING SYSTEM IN A HARSH ENVIRONMENT

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ABSTRACT

System integration in a realistic harsh environment is a difficult issue in particular due to the numerous physical constraints faced by the different elements.

Multi-physics simulation is an efficient way to solve some of the raised problems at various development steps. It helps designers in their choices by giving them more realistic predictions of their modules behavior from the earliest stage of their development process.

The objective of this presentation is to demonstrate the benefits of a genuine multi-physics approach based on “bus” cosimulation at the predesign stage of a drilling system for space exploration.

The simulation tools used are:

- SABER (SYNOPSYS®) for electro-mechanics and control laws,
- IDEAS NX (SIEMENS®) for 3D thermal aircraft studies.

Coupled together by a dedicated communication bus (COSIMATE, CHIASTEK®), they improve significantly the understanding of the system functioning in its final environment and increase greatly the engineer confidence in his design.

The advantage of the proposed methodology is that the tools used are specialized in their respective domain and are well known in the industry so that no training is requested to operate them.
From a development point of view, the use of such a “bus” cosimulation technique does not change the way teams work and enhances the exchanges between them. More than a representativeness advantage, it improves greatly the co-engineering between designers or between supplier and customer at the integration phase.

The “bus” cosimulation permits eventually to simulate models coming from different companies or departments without sharing any confidential

information. This point shall be highlighted because it permits to protect the intellectual property of each partner.

Cosimulation becomes then a differentiating practice during the development phase.

This approach will be applied here to the predesign of an autonomous water search drilling system embarked on a spatial probe for MARS exploration. The objective is to develop a multi-physic Virtual Test Rig in order to validate technological choices and anticipate integration issues in the probe working environment (MARS atmosphere).

First a state of the art of the current pre-design practices will be presented showing the improvements brought by the proposed methodology.
Then the various developed models will be detailed with their associated design assumptions:

- Environmental working conditions linked to MARS,
- Electrical motor design to actuate the driller,
- 3D view of the piece of equipment,
- Thermal modelling,
- Electrical architecture modelling,
- Network monitoring and control laws.

Afterwards the integration process will be performed and some drilling cases will be run. The results obtained will be compared to the standard nodal methods in use today so that the benefits of the approach will be demonstrated in particular in terms of representativeness of the results obtained.

The conclusion of this presentation is that, if it is generalized at various stages of the system development V-cycle, the “bus” cosimulation technique represents an efficient way to increase the designer confidence in his architecture. It provides a realistic virtual test rig gathering all the most important phenomena influencing its piece of equipment functioning so that an early design error or integration issue can be anticipated in a cost effective way.