ARCHITECTURING MULTIPHYSICS FEA/BEA SIMULATION SOFTWARE:
A CASE OF MICRO DEVICES SIMULATIONS

S. K. Kassegne and S. A. Quarshie

(1) – Finite Element App. Department, RAM International. E-mail: samk@ramint.com
(2) – Research and Development, Peregrine Systems. E-mail: seth.quarshie@peregrine.com

The simulation of micro devices such as MEMS (Microelectro-mechanical systems) under a multitude of physical effects such as electrostatic loads, mechanical loads, thermal loads, electromagnetism, acoustics, fluidics and so on is an important part of the life-cycle design and prototyping of these devices.

The life-cycle design process consists of not only computational simulation, but also CAD/CAM and EDA (Electronic Design Automation) modeling. Efficiency in product development in MEMS can be achieved if seamless integration of these processes is present in software/computer modeling environment. However, the lack of integration between EDA, CAD/CAM and FEA/BEA still accounts for a significant inefficiency in the industry. Commonly used FEA and BEA software for micro devices simulations are based on legacy technology and code that do not lend themselves well to seamless integration between these components. Furthermore, because of the ever expanding precision requirement for engineering analysis and the need to tackle problems at the micro and nano levels across a wide-spectrum of spatial and length scales, existing legacy code are in need for a new adaptive software architecture capable of evolving. While some vendors have achieved some degree of integration, CAD itself hasn’t been successfully implemented in the MEMS industry. We propose that what is required is a process or system based objects approach where the device-level engineer is able to design his modules, simulate them and store or transfer information as state objects capable of having their own state, attributes and behavior. The system-level engineer can then retrieve information such as layout, behavioral models, and FEM models and through assembly, the designer can create and simulate a system-level design. Chip-level design work for micro devices is then done by the back-end team that has access to all these information.

This work further proposes a modular object-oriented design and architecture for FEA, BEA and molecular dynamics simulation software. This consists of an abstraction that encapsulates a null self-describing element, solvers, and process flow. The physical domain to be simulated is fed as a seed at the top of the hierarchy. At the highest level of abstraction, we propose base objects for Finite Elements, Boundary Elements and Molecular Dynamics Elements. The FEA base object will then have multi-field FE and single-field FE as derived objects. Examples of multi-field objects are mechanical-electrical (also known as Electromechanical transducer element, it helps model coupling between mechanical and circuit elements), thermal-electrical, acoustics-structure element and so on. A structural shell element is an example of a single field element.

Through an example of simulation of a micro device under multiple energy domains, we propose to demonstrate software architecture capable of evolving and open to tackle advances in field-equation solution and computer architecture in distributed and collaborative computing.