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To cite this version:

Laurent Santandrea, Karim Azoum, Adel Razek, Gilles G. Grasseau, Denis Girou. Applying Corba technology to solve a magnetostriction problem. Sixth International Conference on Computation in Electromagnetics (CEM 2006), Apr 2006, Aachen, Germany. Proceedings - Sixth International Conference on Computational Electromagnetics, CEM 2006 : 4 - 6 April 2006, Aachen, Germany, 2006. hal-01547513

HAL Id: hal-01547513

https://hal.science/hal-01547513v1

Submitted on 26 Jun 2017

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Applying Corba technology to solve a magnetostriction problem

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Introduction

Modelling and simulation of systems involving multi-physical phenomena are complex, and cannot be obtained by only one computation software or only one class of physical or mathematical models. When the coupling is weak, one can then think of associating several dedicated codes. These codes will be encapsulated and regarded each one as independent object. They will exchange data and shared methods via a software bus (the ORB of CORBA) in the form of client/server applications. The example is a case of a multi-physical phenomenon which can be found in some electric power devices and some Micro-Electro-Mechanical Systems (MEMS): the magnetostriction effect. This work was carried out within a framework of collaboration between LGEP and IDRIS. To illustrate this concept, a Fortran 2D finite element mechanical code and a C++ 2D finite element magnetic code are associated using this computational approach.

Physical description of the problem

Mathematical consideration

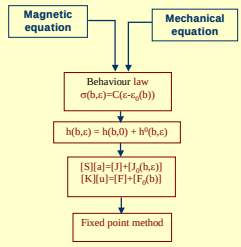
Maxwell equations

$$\int_{\Omega} \nabla a[\nu(\mathbf{b})]\nabla a\, d\Omega = \int_{\Omega} J a\, d\Omega$$

Fundamental principel of mechanics

$$\int_{\Omega} \varepsilon_{ij}(u')[C_{ijkl}]\varepsilon_{kl}(u)\, d\Omega - \int_{\Omega} \varepsilon_{ij}(u')[C_{ijkl}]\varepsilon^{0}_{kl}\, d\Omega = \int_{S} u'\sigma_{ij}.n\, dS$$

Ref : K. Azoum, M. Besbes, F. Bouillault, T. Ueno, 3D F.E. modelling of magnetic force control based on magnetostrictive phenomena, CEFC 2004



Scheme of the magnetostriction problem resolution

CORBA

CORBA (Common Object Request Broker Architecture) is middleware standard define by an international consortium the Object Management Group (OMG).

Objective :

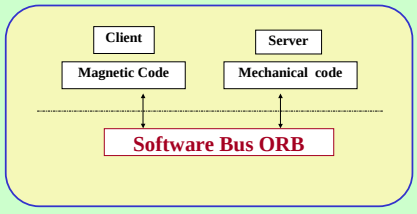
- **Creating distributed object based application**
- **Interoperability**
- **Client/server approach**

Object Request Broker (ORB) : ORB is the software bus which provides communication between clients and severs applications. It hides system dependence and assure interoperability.

Interface Definition Langage (IDL) : IDL is not a programming language but rather a specification language used to define the interfaces between the different objects used in the development of applications. IDL can be mapped to any programming language such as C++, JAVA, Smalltalk…

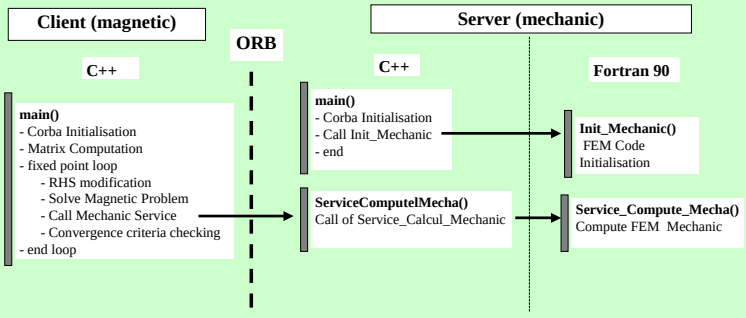
Object approach allows :

- **Modularity** : a object is composed of attributes (data, variables) and methods (treatments, procedures)
- **Encapsulation** : allows the use of an object without knowledge of its internal structure. Data can be access only between a public method of the object.
- **Reusability** : modularity and encapsulation allow the object reusability.



Computational

It exists no interface langage between CORBA and Fortran 90. One of the solution is to encapsulated Fortran 90 code in a C++ code which one has an IDL description.



Computational aspects

Operating Ssytem :Linux environment (Mandrake 10.0)

Free Corba distribution Omniorb

Intel Fortran and Intel C++ compiler

Conclusion

Within this study, CORBA seems to be well adapted to apply object oriented concepts to existing codes in a multi-physics context. In particular, it allows the data and programs encapsulation. Then, it can be very useful in multi-physics simulation to organize and to structure existing dedicated programs to build a extensible architecture and then to carry out a software workshop in a research context. Accessible and visible methods of an object (dedicated program) are then specified within an interface using IDL language. Of course, this encapsulation can be made only if we have got the source codes because some modifications in the program are necessary. This concept is also applied in the Salome platform [5]. In our case, the coupling is rather obvious because we solve the non linear system with an iterative method which allows the decoupling of the system equations. When the coupling concerns directly the finite elements matrix, the CORBA technology can be envisaged but major code modifications have to be considered which can make this concept less interesting.